Norwegian Safety Investigation Authority

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REPORT AVIATION 2024/09

Serious aviation incident near the Gullesfjord in Kvæfjord municipality, Troms county, on 6 September 2021 involving Airbus Helicopters AS 350 B1, LN-ORJ, operated by Heli-Team AS

This report has been translated into English and published by the NSIA to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report for reference.

The Norwegian Safety Investigation Authority (NSIA) has compiled this report for the sole purpose of improving aviation safety.

The object of the NSIA's investigations is to clarify the sequence of events and causal factors, elucidate matters deemed to be important to the prevention of accidents and serious incidents, and to issue safety recommendations if relevant. It is not the NSIA's task to apportion blame or liability under criminal or civil law.

This report should not be used for purposes other than preventive aviation safety work.

Photo: Vesterålskraft Nett AS/NSIA

Legal authority for the Norwegian Safety Investigation Authority's activities is enshrined in Section 12-1 of Act No 101 of 11 June 1993 relating to aviation (Aviation Act); cf. Section 3 of Regulations No 906 of 7 July 2016 on public investigations of accidents and incidents in civil aviation.

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Report on aviation incident

Table 1: Data

Type of aircraft:	Airbus Helicopters, AS 350 B1
Nationality and registration:	Norwegian, LN-ORJ
Owner and user	Heli-Team AS, Harstad
Crew/aircraft commander:	1
Passengers:	3
Location:	Tverrbakkhella in Kvæfjord municipality, Troms and Finnmark county.[1]
Time of incident:	6 September 2021 at 14:15

All times given in this report are local times (UTC + 2 hours) unless otherwise stated.

Notification

At 15:16 on 6 September 2021, the Norwegian Safety Investigation Authority (NSIA) was notified by Troms police district's operations centre that a helicopter had performed an emergency landing near the Gullesfjord in Kvæfjord municipality in Troms og Finnmark county. There were no personal injuries, and the extent of the damage to the helicopter was unknown. Shortly afterwards, the helicopter company also notified the NSIA about the same incident.

It took the NSIA some time to clarify the scope of the incident. The NSIA travelled to the helicopter operator in Harstad the following week and started an investigation.

[1] At the time of the incident, the county where it occurred was called Troms og Finnmark county. On 1 January 2024, the county was divided in two and the incident occurred in what is now Troms county.

Summary

The helicopter, an Airbus Helicopters AS 350 B1 operated by Heli-Team AS, became caught in and cut an overhead power line spanning the Gullesfjord in Troms on 6 September 2021. The incident occurred in connection with a line inspection of a power line. There were four people on board, and there were no personal injuries or damage to the environment.

The NSIA is of the view that only coincidence prevented this incident from becoming a fatal accident. The way the helicopter caught the power cable and the commander's manoeuvring after he became aware of it reduced the scope and consequences of the incident. After the helicopter's rotor blade cut the power cable, the commander demonstrated good airmanship and performed a successful emergency landing.

The NSIA is of the opinion that inadequate preparation by the helicopter operator, planning and performance, the poor visibility of the line and the pilot's limited experience of line inspections and high mental workload in the situation in question explain why the pilot did not become aware of the overhead power line spanning the fjord until a collision was inevitable.

Vesterålskraft Nett AS[2] had commissioned Heli-Team AS to perform a pole top and power line inspection in the Sortland area. The commander was assigned the assignment on the Friday of the preceding week, with performance tentatively planned for the Monday of the following week. Final confirmation that the assignment was to be performed came the day before the flight was to take place. This was the first assignment in which the commander was to inspect a 22-kV power line. The safe job analysis had identified crossing power lines as the main risk. The power line that was cut had already been inspected by the commander that day as part of the same assignment.

After crossing the Gullesfjord, north of the power line spanning the fjord, the helicopter flew to Gullesholm and then followed the power line south towards Tverrbakkhella. At Tverrbakktinden where the eastern power line masts were mounted, the mountain rises in a south-eastern direction. At the same time, the power supply fitters had identified a fault in the crossarm of an electricity pole. The power supply fitters wanted to return to the electricity pole in question to document the fault. The commander received the information and planned a right-hand turn to go back. Without realising, he flew the helicopter under the overhead power line crossing the fjord. The commander started an ascending right-hand turn, and after approximately 180 degrees of the turn had been completed, the helicopter started to descend towards the location of the fault. At that moment, the commander became aware of the power line crossing the fjord and pulled the collective pitch control up hard, but a collision with the line was inevitable. The helicopter became caught in the middle of the three cables in the power line, which was then lifted over the northernmost cable.The helicopter was briefly stuck in the power line before the rotor blade cut the cable it was caught in. The helicopter was damaged in the impact, but the rotor blade was not critically damaged and the flight controls were intact, enabling the commander to perform a controlled emergency landing.

[2] Vesterålskraft Nett AS has changed its name to Vestall AS.

About the investigation

Purpose and method

The NSIA has classified the incident as a serious aviation incident. The purpose of the investigation has been to identify the factors that resulted in LN-ORJ catching one of its skids on the middle cable in Vesterålskraft Nett AS's overhead power line spanning the Gullesfjord.

The serious aviation incident and the circumstances surrounding it have been investigated and analysed in line with the NSIA's framework and analysis process for systematic safety investigations (the NSIA method[3]).

Sources of information

- Form NF-2007, Report from the helicopter operator
- The NSIA's own investigations including
    - Interview with the commander
    - Interview with the power company personnel on board during the flight
- Information, report and photos from the power company Vesterålskraft Nett AS
- Information, report and photos from the helicopter operator Heli-Team AS
- Information from the Civil Aviation Authority (CAA) Norway
- Report and drone footage from Vesterålskraft Nett AS

The investigation report

The first part of the report, 'Factual information', describes the sequence of events, related data and information gathered in connection with the accident, as well as the NSIA's investigation and findings.

The second part, 'Analysis', contains the NSIA's assessment of the sequence of events and contributory factors based on factual information and completed investigations/examinations. Circumstances and factors found to be of little relevance to explaining and understanding the accident will not be discussed in detail.

The final part of the report contains the NSIA's conclusions and safety recommendations.

[3] *NSIA – Norwegian Safety Investigation Authority. See https://www.nsia.no/About-us/Methodology*

1. Factual information

1. Factual information

1.1 Sequence of events

1.1.1 INTRODUCTION

The power company Vesterålskraft Nett AS, a subsidiary of Vesterålskraft AS, had commissioned and entered into a contract with the helicopter operator Heli-Team AS to carry out visual line[4] and pylon/pole top inspections[5] by helicopter on parts of its power grid in the area around Sortland. The power lines being inspected were live throughout the inspection. The incident occurred during a line inspection between Langvassbukta and Gullesfjordbotn in Kvæfjord municipality in Troms county.

1.1.2 COMMISSIONING AND PLANNING

The commission from the power company included two black and white maps on which the power lines to be inspected were marked, see figure 1. It was 188.16 km of line inspection and 38.97 km of pylon/pole top inspection. The maps only showed the power company's own power lines, and other power companies' lines running through the same area were not visible on the map. The commission also specified the desired date for the inspection, and that two power supply fitters from the power company were to take part in the inspection. The week before the flight, the power company asked Heli-Team AS whether it would be possible for a third person to take part in the assignment as a passenger to take photos for the power company's social media platforms.

[4] Line inspection is an operation whereby a visual inspection is carried out of a section of line or parts thereof.

[5] Pylon/pole top inspection/control is a type of inspection intended to document the state of the power line's attachment to the pylon/pole. This is done by inspecting the crossarms and insulators, often in combination with sensors/cameras mounted on the helicopter.

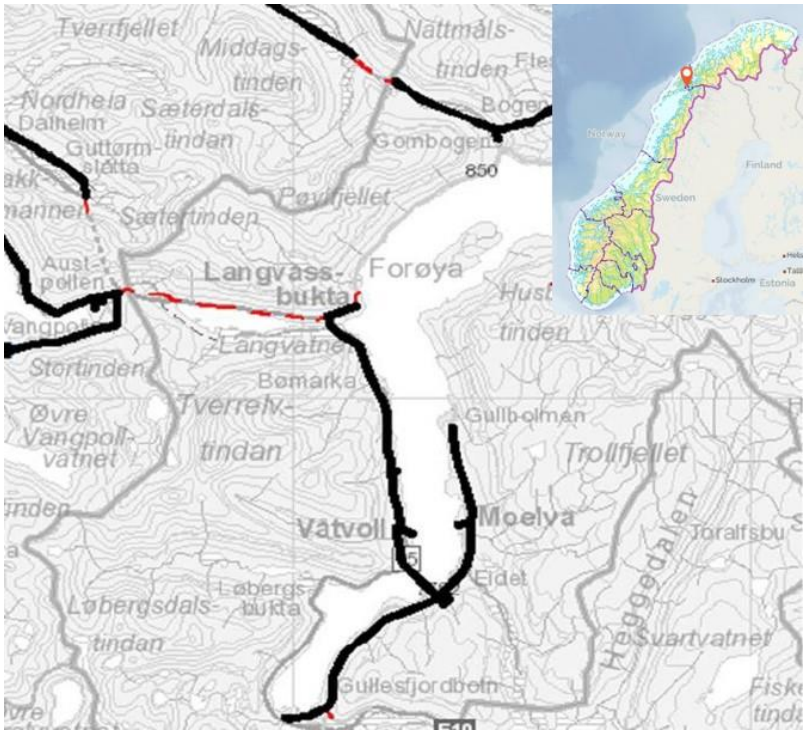

Figure 1: Map excerpt from the power company's commission. The map shows the section from Langvassbukta to Gullesfjordbotn marked in black in the map. Map: Vesterålskraft Nett AS/Heli-Team/NSIA

The commander received some information about the assignment on Friday, 3 September 2021, three days ahead of the assignment. The final order was made on Sunday, the day before the assignment. Heli-Team has stated that the background for the late award was Vesterålskraft Nett AS's wish to carry out the assignment continuously. The commander has explained that he spent about an hour planning the assignment. The Air Navigation Pro software and the Armed Forces' M517AIR map were used as maps in connection with planning. The commander's understanding based on the map information provided was that the overhead power line spanning the fjord and the specific power cable to be inspected were connected in a T-junction configuration. Both the overhead power line spanning the fjord and the cable to be inspected were 22-kV lines and part of the distribution network. After the planning was completed, the time and place were agreed with the power company. The power company's request for an extra passenger did not reach the commander. The commander also checked the weather forecast for the area where they would be flying the following day. The forecast of clouds on top of the mountains did not prevent the flight from being performed under visual flight rules (VFR).

The commander flew from Heli-Team's main base in Harstad to the agreed meeting point by Folkvang community hall 3.4 km south of Sortland. The commander was collected there and taken to Vesterålskraft AS's head office in Sortland, where a start-up meeting was held with the two power supply fitters from Vesterålskraft Nett AS. One of the fitters only attended part of the meeting due to other duties.

During the meeting, the commander was made aware that the inspection concerned the 22-kV distribution network power line. The distribution network's power lines have lower voltage and normally extend lower over the terrain than the power lines belonging to the transmission and regional network. At the same time, the commander was informed that a third person was to participate in the inspection as a passenger. The updated weather forecast indicated a southerly wind direction, and it was decided that the inspection would be flown from north to south.

The power supply fitter who was to sit in the left front seat had attended a safety course conducted by Heli-Team in January 2016. The assignment was his first power line inspection from a helicopter. The other power supply fitter was seated behind the commander. His role was to record

and document faults. He had taken part in a line inspection the year before, but lacked documented training. The passenger in the left rear seat had not undergone safety training for helicopter flights.

When the commander returned to the helicopter with the power company's personnel, he informed them about the emergency procedures for the helicopter, the use of seat belts, how to adjust the volume in the headsets, and how to enter and evacuate the helicopter.

The commander has stated that he carried out a safe job analysis (SJA) in accordance with Heli-Team's procedures and documented it on the company iPad. Crossing power cables and the two overhead lines spanning the Gullesfjord, were identified as the primary risks, and it was also confirmed that all operations were to take place at a distance of more than 30 metres from the nearest power line. In connection with the SJA, the commander also informed the power supply fitters and the passenger of the planned performance of the line inspection.

The SJA concerning the point where Vesterålkraft Nett AS's overhead power line spanning the fjord crossed the power cable to be inspected was based on the commander's planning. His understanding from reading the map was that both power lines were connected to each other at the same height, and did not pose any direct hazard or risk, as the inspection was to take place above the power line. The SJA did not establish any additional or other barriers in relation to crossing power lines. Electrical safety factors and the fact that the power lines were live were not included in the SJA.

The power company's operations centre had not been notified of the pylon/pole top and line inspection before the flight.

1.1.3 OVERHEAD POWER LINES AND CABLES AT THE SITE IN QUESTION.

Vestrålkraft's overhead power line crosses the Gullesfjord between Våtvoll and Tverrbakkhella. It consisted of three identical power cables with a steel core surrounded by aluminium wires. Each cable has a tensile strength of 19.6 tonnes. All three hang approximately parallel and at the same height.

A Statnett SF overhead power line also runs close to where the incident occurred. The distance between the overhead power lines decreases to the north. In addition to these lines spanning the fjord, the inspected line runs on the eastern side of the fjord, see Figure 2.

Both overhead power lines have been reported as obstacles to aviation, but only Statnett's line has been physically marked.

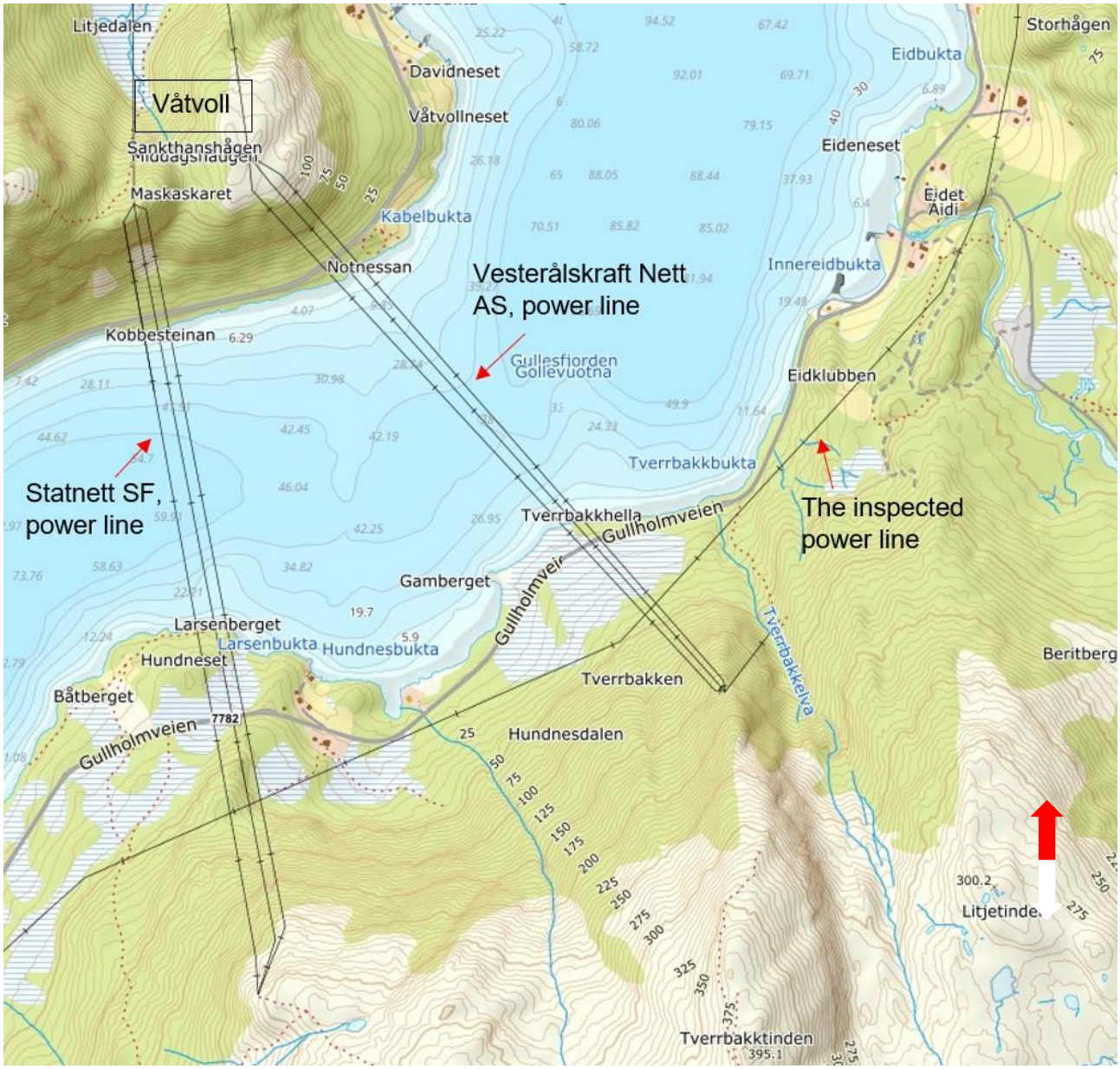

Figure 2: Map section showing the location of Vesterålskraft Nett AS's overhead power line in relation to Statnett's line over the Gullesfjord. Map: © Norwegian Mapping Authority / Heli-Team / NSIA

1.1.4 PERFORMANCE OF LINE AND POLE TOP INSPECTION OF POWER LINES

The inspection started with a pole top inspection in the morning, and the commander used an iPad attached to the helicopter's front window for navigation. The line inspection of the distribution network itself began after lunch. The inspection proceeded as normal until the section between Langvassbukta and Gullesfjordbotn; see Figure 1. During the course of the inspection, the helicopter crossed the Gullesfjord north of Vesterålskraft Nett AS's unmarked 22-kV overhead power line. The helicopter then flew straight north to Gullholmen to resume the inspection in a southerly direction towards Gullesfjordbotn; see Figure 3.

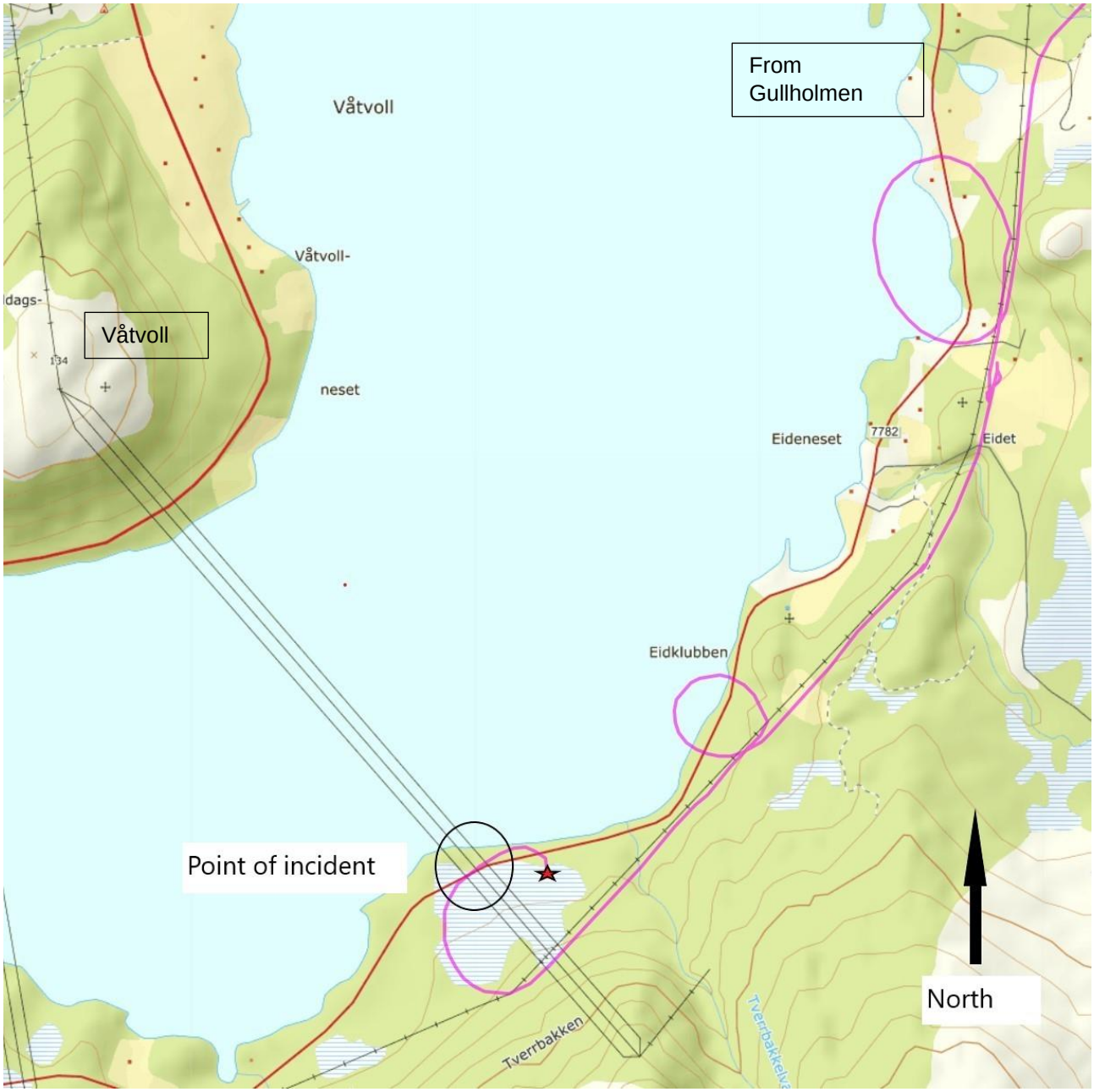

Figure 3: Map section of the incident showing the power company's overhead power line spanning the fjord and the power cable being inspected. The pink line shows the helicopter's flight path along the power line from Gullholmen, downloaded from the helicopter's iPad. The downloaded position data deviate from the explanation given by the commander and the power supply fitters. Map: © Norwegian Mapping Authority / Air Navigation Pro / NSIA

During the flight south along the Gullesfjord, the commander and the power supply fitters explained that the helicopter flew on the west side of the power line. However, information downloaded from the detachable iPad shows that the helicopter flew on the east side of the power line. The NSIA is aware that position data from a detachable piece of equipment at low altitude may be inaccurate, see Figure 3.

The commander's explanation and information stored on the iPad also show that, in some cases, the helicopter was closer to the power line than the minimum 30-metre requirement, a distance at which a safety manager (LFS) must be appointed.[6] The inspection identified several faults on the

[6] *The industry organisation Energi Norge's industry guide requires a safety manager to be appointed for inspections of power lines where the distance between the helicopter and the power line will be less than 30 metres.*

power line between Gullholmen and Tverrbakken. Each time a fault was identified, the commander did a 360-degree turn to allow the power supply fitters to document it more thoroughly.

At Tverrbakken, just before the crossing overhead power line spanning the Gullesfjord, the fitters observed another fault on the crossarm of an electricity pole, see figure 4. The flight also became more demanding at this point with light rain and rising terrain to the left of the helicopter. The fitters have stated that at this point in time, they were focused on inspecting the electricity pole, while the commander was planning another 360-degree right turn to go back to the crossarm where the possible fault had been identified.

Figure 4: An example of a crossarm with damage inspected the same day as a part of the power line inspection. Photo: Vesterålskraft Nett AS / NSIA

The commander has explained that he checked the helicopter's instruments while he may have looked down a few times at the fault on the power line.

The helicopter then started to turn right at a speed of between 40 and 60 kt and passed under the power line without the commander noticing. The helicopter then commenced a slight ascent before switching to a downward turn, after about 180 degrees, see Figure 5. While making the turn, the commander suddenly noticed the overhead power line spanning the fjord and instinctively pulled up the collective pitch control to avoid a collision. Shortly after, the helicopter’s right skid caught in the middle cable and lifted it over the northernmost cable. The commander and the power supply fitter sitting in the front seat heard a bang as the middle cable made contact with the northernmost one and short-circuited. The commander has stated that the helicopter was momentarily caught in the cable, causing the helicopter’s nose to point downwards at an angle of about 90 degrees.

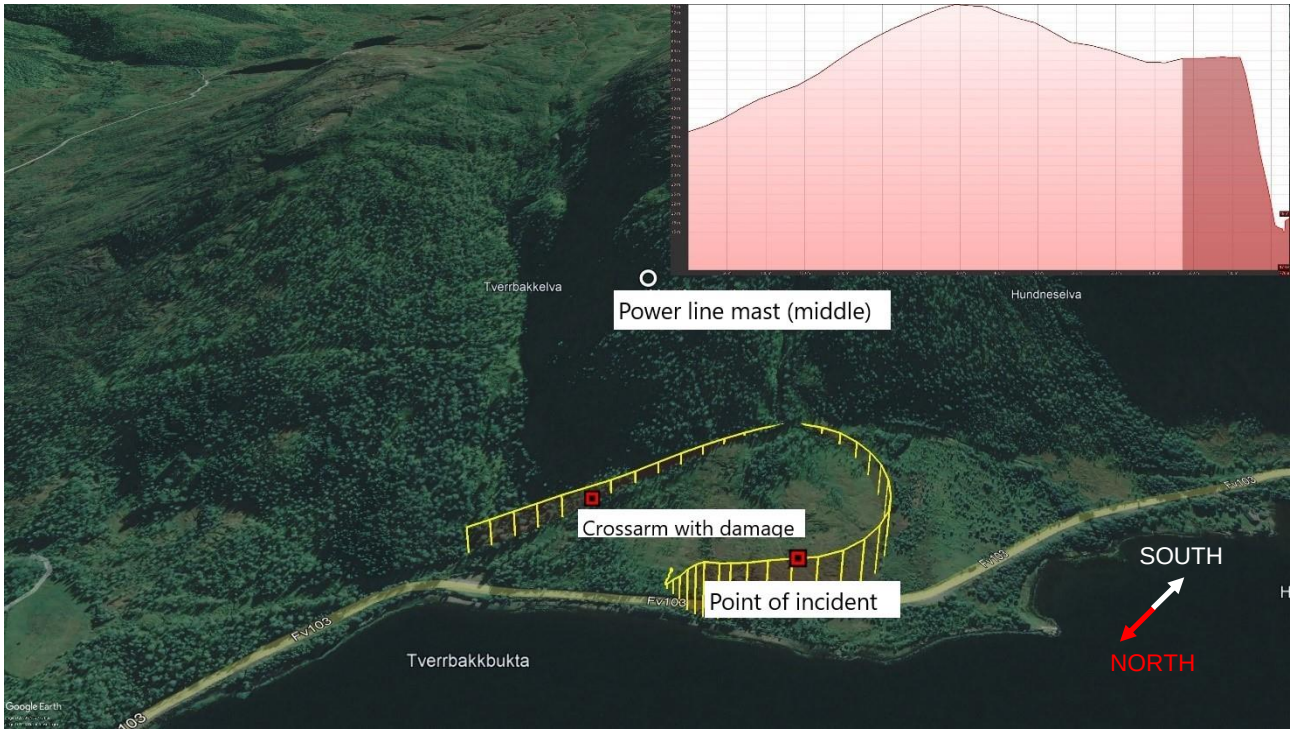

Figure 5: The last part of the helicopter's flight path (seen from the northwest). The graph shows the elevation profile of the flight path (highlighted in yellow) where the point of impact is at the start of the dark red area. Source: Air Navigation Pro. Map: Google Earth/NSIA

Since the helicopter was still in the process of making a right-hand turn when it caught the power cable, the rotor blades on the right side of the helicopter were its lowest point. The rotor blade struck the middle cable 27 centimetres from the tip of the rotor blade, see Figure 6. Simultaneously or shortly before, the aluminium wires surrounding the cable's steel core were torn off. The severed aluminium wires twisted wound around the helicopter's skids, see Figure 7.

Figure 6: The rotor blade that cut the power cable. Photo: Heli-Team/NSIA

The commander and the power supply fitter in the cockpit both heard an audio warning after the helicopter hit the power cable. This helicopter has only two possible audio warnings; for low rotational speed on the main rotor and for a drop in hydraulic pressure, respectively. The commander acted on low rotational speed. Both fitters also heard the rotational speed[7] dropping when the helicopter caught the high-voltage cable.

The commander has stated that he felt that he lost control when they hit the power line. He moved the cyclic control, but felt no or little response. He therefore feared that the rotor head (Starflex) had been damaged. As he got little response from the helicopter's flight controls, he planned to expend all energy from the main rotor just above the ground to soften the landing. Shortly thereafter, the helicopter's flight controls began to respond again, however, and the commander started to look for suitable places for an emergency landing. He deemed a marshy area due east of Gullholmveien (County Road no 7782) to be the best option, see Figure 2. Just before the helicopter made contact with the ground, he pulled the collective up hard, and the helicopter hovered in place 0.5–1 metre above the ground before landing. The commander perceived the main rotor to be functioning normally, but he saw that one of the rotor blades was moving in an abnormal manner.

The commander instructed the passengers not to leave the helicopter until the rotor blades had stopped. The power supply fitters simultaneously considered whether the power cable now lying on the ground could be live. Since the electricity in the power line crossing the Gullesfjord goes from Våtvoll to Tverrbakkhella, they concluded that the live part of the cable would be in the sea.

After everybody on board had evacuated the helicopter, the commander found that one of the rotor blades, the skids, floats and tail rotor cover had been damaged.

Figure 7: The aluminium wires wrapped around the helicopter's right skid with floats after the emergency landing on the marsh. Photo: Heli-Team/NSIA

[7] *It was probably the main rotor's rotational speed, but neither the commander nor the power supply fitter could determine at the time of the incident whether it was the engine or the main rotor's rotational speed they heard.*

The commander notified the helicopter company's operations unit to inform them about the incident. The power supply fitters notified the operations centre at the same time to disconnect power, before contacting the power company to report the incident.

The power company activated their emergency response procedures and held a debriefing with their personnel later that day. A few days after the incident, the helicopter was transported to Heli-Team's base at Stangnes.

A witness living north of the power line spanning the fjord heard a helicopter flying over his house, and went outside to watch it. A little later, he saw the helicopter approaching from a distance. Suddenly, he saw the nose of the helicopter pointing sharply downwards. Before he saw the helicopter regain control and disappear towards the ground, he saw a white stripe in the fjord.

1.2 Personal injuries

Table 2: Personal injuries

Injuries	Crew	Passengers	Other
Fatal			
Serious			
Minor/none	1	3	

1.3 Damage to aircraft

The helicopter sustained damage to the rotor blade, tailboom case and skids. See section 1.12 for further information.

1.4 Other damage

Vesterålskraft Nett AS's 22-kV power line spanning the Gullesfjord was cut.

1.5 Personnel information

The commander held an airline transport pilot licence (ATPL-(H)) with VFR restrictions, and had flown since 2018. His experience was mainly of flying the same type of helicopter as the one he flew during the incident; see Table 3. The commander had some experience of line and pylon/pole top inspections of the transmission network (420 kV) and the regional network (132 kV). This was the first assignment in which the commander was to inspect a 22-kV power line.

The commander started his helicopter pilot training in August 2016 at a flight school near Torp. He was employed by Heli-Team AS as a loadmaster in spring 2017. After the 2017 season, he continued his ATPL-(H) training at Torp, where he completed his pilot training. In 2018, after completing his training, the commander was employed as a trainee pilot with Heli-Team AS in Harstad.

Table 3: Flying experience, commander

Flying experience	All types	Airbus Helicopters AS 350
Last 24 hours	4:35	4:35
Last 3 days	12:35	12:35
Last 30 days	40:45	40:45
Last 90 days	143:40	143:40
Total	664:00	530:05

1.6 Aircraft information

1.6.1 GENERAL INFORMATION

Airbus AS 350 B1 is a light, single-turbine engine helicopter with three main rotor blades and a conventional tail rotor. There are several variants of this helicopter type, and they are used by several Norwegian helicopter companies in connection with different types of operations. The LN-ORJ is an older version of the helicopter type and thus lacks some of the safety improvements found on newer versions. This includes energy-absorbing seats and crash-resistant fuel systems that were an option on newer helicopters. Nor was it equipped with a simple data or film recorder that stores vital technical data besides images and sound. This is standard equipment for newer helicopters of the same type.

Manufacturer, aircraft type:	Airbus Helicopters AS 350 B1
Nationality and registration:	Norwegian, LN-ORJ
Manufactured:	1989
Serial number:	2212
Type certificate:	EASA.R.008
Accumulated total flight time:	14,258:24
Engine:	Safran Arriel 1D
Maximum permitted take-off mass:	2,200 kg
Fuel:	Jet A-1

1.6.2 TECHNICAL INFORMATION

LN-ORJ's most recent major service/inspection was a 600-hour inspection. It was carried out at Heli-Team's workshop on 17 June 2021 at a total flight time of 14,160 flying hours, just under 100 flying hours before the incident.

The helicopter's Airworthiness Review Certificate (ARC) was issued on 21 September 2019 and renewed on 19 September 2020 with validity until 15 October 2021.

The NSIA has only performed a limited review of the helicopter's airworthiness. The review has not revealed any irregularities in the maintenance of the aircraft or in the technical condition that may have had an impact on the sequence of events.

1.6.3 MAIN ROTOR SYSTEM

Airbus AS 350 B1 has a three-blade main rotor and a two-blade tail rotor that compensates for the torque produced by the main rotor and provides directional control.

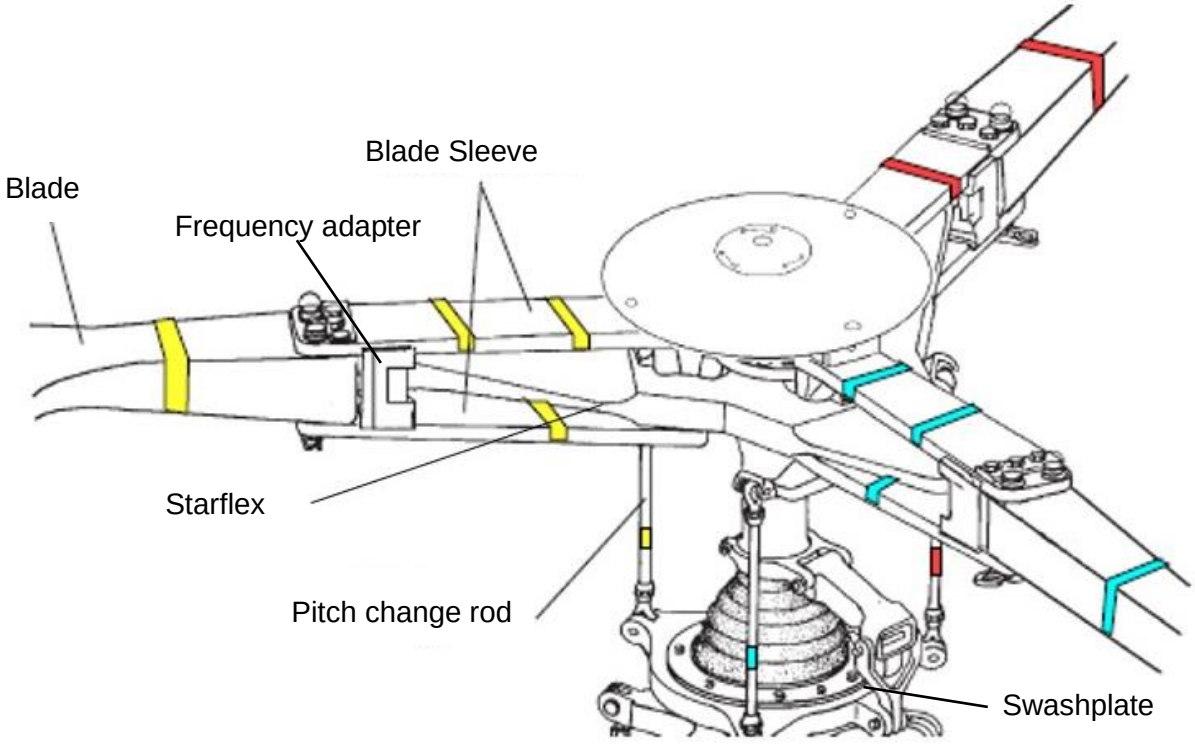

Figure 8: The Starflex Hub's position in the rotor head. Source: Airbus Helicopters / NSIA

Airbus Helicopters has named its main helicopter rotor head Starflex. The rotor head consists mainly of composite material. The rotor blades are made from laminated, flexible fibreglass, and each blade is mechanically attached to two sleeves. Starflex frequency adaptors are fitted between the sleeves. The rotor blades' angle of attack is adjusted by the rotating part of the swashplate and the pitch change rods, see figure 8.

1.6.4 THE AIRCRAFT'S MASS AND BALANCE

The commander adjusted the quantity of fuel the helicopter carried as part of the mass because there were three passengers instead of two as stated in the commission. He chose to take on 85–90% fuel to have a margin up to the maximum mass. The commander considered the helicopter's mass to be within the requirements for carrying four people. The NSIA has investigated the aircraft's configuration and calculated that the helicopter's mass and centre of gravity were within the limits.

1.7 Meteorological information

SHK received a photo taken immediately after the serious incident, see figure 9. Weather data and analysis were also obtained from the Norwegian Meteorological Institute at the actual time for the incident. The analysis from the Norwegian Meteorological Institute describes the following:

The NSIA obtained weather data and a weather analysis from the Norwegian Meteorological Institute for the time of the serious aviation incident. The Norwegian Meteorological Institute's analysis describes the situation as follows:

The weather situation in general

At 06 UTC, a low-pressure system of 995 hpa is in position N71 W015, directly north-east of Iceland. It changes little as the day wears on. It sets up a south-westerly wind field in over Northern Norway with a front system.

There is a warm front over Finnmark, and a cold front and an occlusion are moving north across Nordland county. Between 13 and 16 UTC, the occluded front passes Lofoten and Vesterålen, and precipitation intensifies during this period.

METAR from ENLK, ENSK, ENEV and ENSH shows that the cloud base was between 0800 FT and 3000 FT, and during periods of precipitation the cloud base was 0400–0800 FT.

Visibility varied from 4 km to +10 km (Good visibility, more than 10 km). Poor visibility in connection with precipitation. No signs of fog/mist.

Figure 9: The photo was taken immediately after landing and shows the weather at the time. The power cable that was cut can be seen in the background lying above the southbound telephone line. Photo: Heli-Team/NSIA

1.8 Aids to navigation

An iPad with Air Navigation Pro software was used as a navigation aid. The software shows the helicopter's position and speed in real time in addition to the obstacles to aviation registered in its map database. Air Navigation Pro has a recording function that stores the helicopter's position, speed and altitude every second. If the function is switched on, this information can be downloaded and transferred to maps. The position data from detachable equipment must be considered in relation to its uncertainty[8] as the margin of error may be significant.

The software showed both overhead power lines, while the inspected line running between Gullholmen and Gullfjordsbotn was not shown, see figure 10.

[8] *The accuracy of the GPS position of the equipment in question depends on the availability of GPS satellites.*

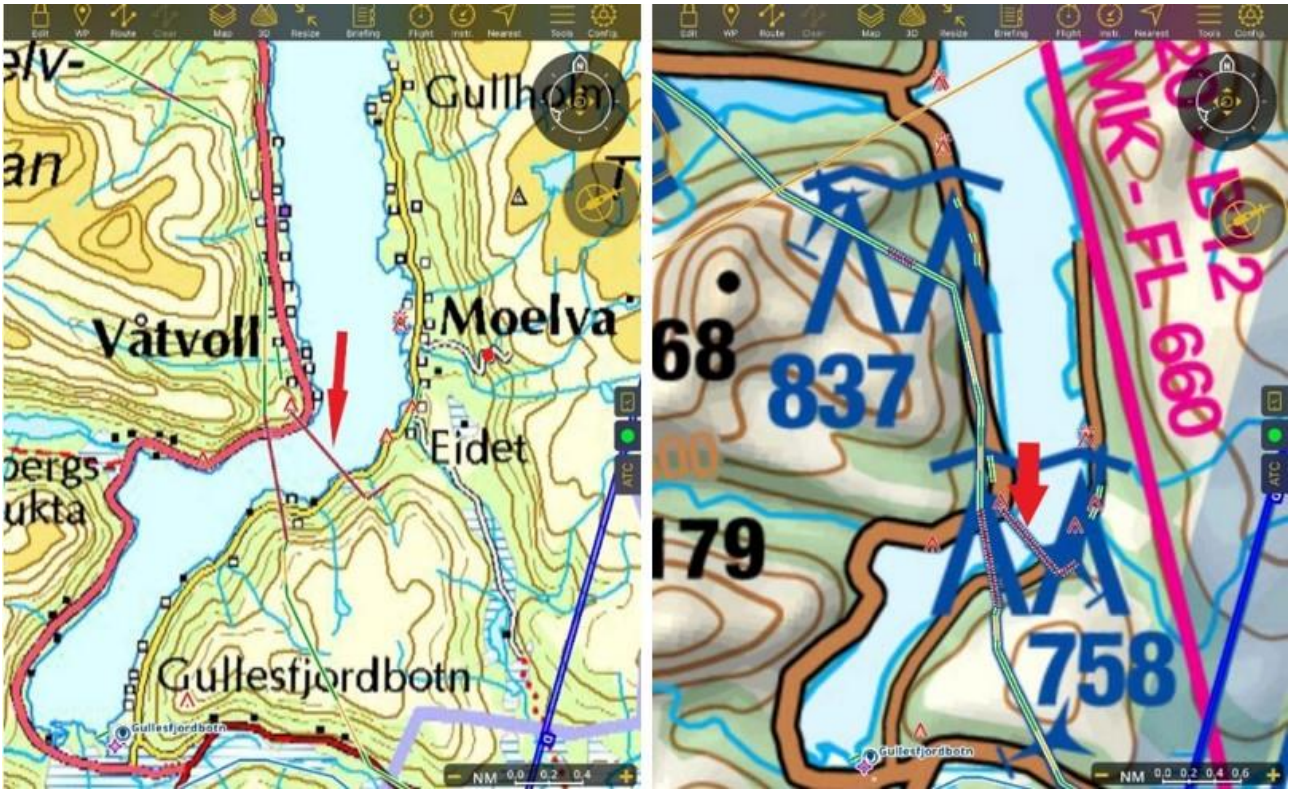

Figure 10: The position in question is displayed in the Air Navigation Pro software. Both overhead power lines are shown in both pictures. The one that was cut is indicated with a red arrow. Map: © Norwegian Mapping Authority / Heli-Team / Air Navigation Pro / NSIA

1.9 Communications

Not applicable.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

None installed, nor were they required for the aircraft type in question at the time of the incident.[9]

1.12 Wreckage and impact information

The helicopter landed in a marsh near Tverrbakkhella on Hinnøya island in Kvæfjord municipality in Troms County. The NSIA inspected the helicopter at Heli-Team's main base a few days after the incident and found damage to the helicopter's skids, rotor blade and tailboom. The inspection also confirmed that the rotor blades had made contact both with the power line and the cover of the tail rotor axle. The NSIA also visited the site after the incident to document this.

Vesterålskraft Nett AS's overhead power line supplied electricity to 76 customers, who had to be supplied from a mobile generator after the line was cut. The western part of the severed cable at Våtvoll was caught in trees and remained sufficiently high above the Rv no 85 road to allow

[9] *Newer helicopters in the AS 350 family are delivered with a simple flight data recorder of the type Appareo Vision 1000 as standard equipment.*

vehicles to continue to pass underneath it. The overhead power line was disconnected from the power source when the helicopter cut one of the cables.

The incident did not result in any fuel leakage or other significant environmental damage to the terrain.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

No fire occurred.

1.15 Survival aspects

The helicopter made a controlled emergency landing on land and the cabin remained intact after the collision with the power line. Only the commander was wearing a helmet. The LN-ORJ was not equipped with energy-absorbing front seats.

The landing did not trigger the installed ELT.

1.16 Tests and research

None.

1.17 Organisation and management

1.17.1 THE HELICOPTER OPERATOR

Heli-Team AS is based at Stangnesterminalen in Harstad. The company was formed in 1988 and is an established helicopter company in Norway’s inland market. The company carries out assignments for commercial and private clients and has considerable experience from work on line and power development. At the time of the incident, the company operated a total of eight helicopters, of which seven were of the type AS 350.

Heli-Team AS holds an Air Operator Certificate (AOC) for commercial helicopter activities issued by the Civil Aviation Authority (CAA) Norway. In addition, the company conducts several specialised operations (SPO) described in the company's OM-E.

1.17.2 THE HELICOPTER OPERATOR’S OPERATIONS MANUAL SYSTEM

The company's operations manual (OM) is divided into several parts and describes the company's routines and procedures.

OM-A describes the company’s administrative procedures, management system, the commander’s job description and procedures for allocating and authorising assignments, among other things.

OM-B describes type-specific information about aircraft of relevance to the company.

OM-C contains information about aids to navigation and communication, as well as information about routes and landing sites.

OM-D concerns the company's procedures for training their own personnel.

OM-E contains the operator's Standard Operating Procedures (SOP). SOP provides detailed descriptions of how a type of assignment is to be carried out and which other requirements apply to its performance. OM-E also describes the safe job analysis (SJA) and its use.

OM-E chapter 3.2 'Preflight Operational and Safety Meeting' (Job Briefing) section 3.2.1 makes requirements for training of personnel involved in the assignment:

> *Therefore, all personnel involved from the customer shall receive training in the use of helicopters and a training course (ex. Safety Course – Helicopter) should be held by Heli-Team AS before any customer personnel is allowed to be directly involved in the helicopter operations. In addition to the 'Safety Course – Helicopter' add-on courses regarding the different operations will be held as required.*

OM-E SOP 8, 'Power Line Inspection – Visual' is the operating procedure of relevance to this line inspection. The procedure describes where the power company's personnel should sit, specifically for two of the customer's personnel. The recommended seating arrangement is the right-hand side behind the commander and the left front seat. The procedure makes no mention of any additional duties as map reader. Section 8.1.4 of the procedure defines that only persons necessary to the assignment in question should be on board the helicopter.

The following is quoted from OM-E SOP 8.1.4:

> *Only passengers who are necessary to the execution of the assignment shall be on board the helicopter during power line inspections; however, personnel may be brought along for training purposes.*

SOP includes a description under 'Pre-flight preparations' (OM-A 8.1.5) This states that '*emphasis should be placed on the marking of crossing power lines*'. The procedure does not say how the operator envisages that this is to be done so as to be a practical aid to the pilot.

The following is quoted from OM-E SOP 8.1.5:

> *Pre-flight preparations*
> *Before the flight commences, the pilot shall review the assignment on a suitable map together with the power line inspector. In particular, emphasis shall be placed on marking crossing power lines, cable cars, radio masts, the possibility of zip lines in the area, as well as any particularly difficult topography, etc.*

1.18 Additional information

1.18.1 THE CIVIL AVIATION AUTHORITY NORWAY'S WORK

The Civil Aviation Authority (CAA) Norway conducts audits, evaluates the companies' risk assessments and issues approvals in accordance with the requirements stipulated in the Regulations of 7 August 2013 No 956 relating to air operations (the air operations regulations). The regulations implement EU Commission Implementing Regulation No 965/2012 of 5 October 2012.

Line inspection of power lines is defined by CAA Norway as a high-risk operation (cf. AIC-I 01/17).

When preparing procedures, the operator shall, in addition to ensuring that all the applicable requirements in the regulations are met, perform a risk assessment to identify and manage all hazards for the individual type of operation. The risk assessment and the company's procedures

must be attached to the application. CAA Norway shall subsequently review the submitted application with the attached procedure and risk assessment before issuing a new authorisation. This is normally done by the operator submitting applications for changes to its procedures specified in the company's operations manual system. Revisions of the operations manual must be authorised by CAA Norway before the operator can start operating according to new procedures. It is the operator's responsibility to ensure that the company revises its procedures in order to comply with all the rules in accordance with the applicable regulations. CAA Norway conducts audits of operators on a continuous basis by verifying that procedures comply with the applicable regulatory framework and are observed in practice.

1.18.2 INDUSTRY GUIDES FOR POWER COMPANIES

Several guides have been published for power companies concerning procurement, training and the performance of helicopter services. These have been implemented on the initiative of the aviation safety forum for onshore helicopters (Flysikkerhetsforum – FsF).

In 2016, the industry organisation Energi Norge[10] published a guide to procuring helicopter services entitled *Helikoptertransport i kraftnæringen* ('Helicopter transport in the power industry' – in Norwegian only). The guide discusses risk, categorisation, use of helicopters, a contract proposal, etc. It also contains recommendations and guidelines on how to commission helicopter services.

REN[11] is a limited liability company owned by several Norwegian network operators. The company was formed in 1998 to work on standardisation of equipment and work methods. REN has also published the guide *RENblad 8070*, which includes information about how a risk assessment must be carried out in cooperation with the helicopter operator and how pylon/pole top inspections should be documented, as well as information about maps and HSE in relation to helicopter operations.

1.18.3 THE 22-KV DISTRIBUTION NETWORK IN THE GULLESFJORD AREA

The Gullesfjord area contains a high-voltage 22-kV distribution network extending from Skaret in the north to Stranda in the south. The distribution network has lower voltage than the regional grid (which has a voltage of 66 kV or 132 kV). The normal voltage on the distribution network is 230 or 400 volts. The high-voltage distribution network has three phases with each phase in a cable suspended between pylons with crossarms.

1.18.4 OVERHEAD POWER LINE SPANNING THE GULLESFJORD, REQUIREMENTS FOR REPORTING AND MARKING OBSTACLES TO AVIATION

In 2010, at the request of CAA Norway, the power company contacted CAA Norway to request an exemption from marking of the overhead power line spanning the fjord. The communication contained information about the line profile and the fact that 90 metres of the line was more than 60 metres above sea level. It also stated that Statnett's overhead power line was marked and that this was located about 400 metres further up the fjord.

CAA Norway assessed the overhead power line in accordance with Regulations No 1384 of 13 December 2002 (BSL E 2-2) on the marking of aviation obstacles, which was in force at the time.

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[10] Energi Norge is a national interest and employers' organisation, representing the companies that produce, transport, supply and build renewable energy infrastructure in Norway.

[11] The company REN was formed in 1998 to start work on standardisation of Norwegian network operators' equipment and work methods. REN is now spreading knowledge and guidelines on design, installation, operation and maintenance through RENblad guides developed based on industry best practice.

CAA Norway concluded, without much justification, that the power line spanning the fjord did not constitute an obstacle to aviation. The regulations in question have since been replaced by Regulations No 980 of 15 July 2014 on reporting, registering and marking of obstacles to aviation.

Regulations No 1384 of 3 December 2002 on the marking of obstacles to aviation (BSL E 2-2) Section 3 (2) define requirements for the marking of obstacles to aviation and was consequently used when assessing exemptions in 2010.

> *Section 3. Definitions*
>
> *(1) Airport: A specific area of land or sea (including buildings, installations and equipment) wholly or partly used for aircraft take-off, landing and other manoeuvring on the ground.*
>
> *(2) Aviation obstacle: All structures or objects, whether temporary or permanent, as a rule of a height of 60 metres or more above the level of the ground or water. CAA Norway may, based on a specific assessment, decide that certain structures or objects are not to be considered obstacles to aviation even though their height is 60 metres or more. Correspondingly, CAA Norway may decide that certain structures or objects are considered to constitute obstacles to aviation even though their height is less than 60 metres. An obstacle could be a building, wind power plant, tower, chimney, overhead power line, pylon, antenna, bridge etc. with pertaining stay cables, stays and anchorage arrangements etc.*
>
> *Section 4. General information*
>
> *(1) The owner of an aviation obstacle must mark all such obstacles in accordance with these regulations.*
>
> *(2) Unless determined otherwise by CAA Norway, requirements for the marking of aviation obstacles do not apply in the following cases:*
>
> *a) Structures that are covered by or hidden behind other permanent structures or terrain.*
> *b) Structures in a town or built-up area where there can be no doubt that the structure does not pose a risk to aviation.*
> *c) Overhead lines where less than 100 metres of the line is of such a height that it should be regarded as an obstacle according to the definition of aviation obstacle in section 3.*

The regulations on reporting, registering and marking of aviation obstacles as amended by Regulations No 2158 of 19 December 2023 amending regulations on reporting, registering and marking of aviation obstacles (hereinafter the amendment regulations of 19 December 2023), adopted by CAA Norway on 19 December 2023.

Paragraph 2 of the regulations classifies aviation obstacles as follows:

> *Section 2 (1) Aviation obstacles cover all:*
>
> *a. man-made objects, temporary or permanent, of a height of 15 metres or more above ground or water. However, in areas designated for industrial and commercial activities, urban or built-up areas, objects are not considered aviation obstacles unless they have a height of 30 metres or more. If there is doubt about whether an object is located within an area designated for industrial and commercial activities or urban and built-up areas, reporting is required if the object is 15 metres or higher.*
>
> *b. signal-carrying and live overhead power lines, regardless of altitude.*
>
> *c. overhead power lines not covered by section 2 first letter (a) or (b), regardless of height, that cross or follow along public roads closer than 10 metres from the roadside.*

d. cable cars, including ski lifts, rope tows, chairlifts, aerial cableways, zip lines and gravity cables.

e. end pylons of overhead power lines as mentioned in letters (a) to (d), irrespective of height.

Marking requirements are specified in section 7.

Section 7

(1) Aviation obstacles must be visually marked in accordance with the provisions in this chapter.

(2) All aviation obstacles with a height of 60 metres or more must be marked. Temporary aviation obstacles of a height of 15 metres or more must be marked. However, marking is not necessary for

a. aviation obstacles that are covered by or hidden behind other permanent obstacles or terrain,

b. overhead power lines where less than a continuous section of 100 metres is above the height subject to the marking obligation.

(3) CAA Norway may, on the basis of a specific overall assessment, also establish marking obligations for aviation obstacles that are not covered by the general marking obligation, or that are specifically exempt from this obligation. The assessment must place particular emphasis on whether the aviation obstacle can pose a risk to aviation, the obstacle's proximity to the landing site or frequently used flight paths, as well as terrain conditions. In the same way, CAA Norway may stipulate that an aviation obstacle subject to a marking obligation must be marked beyond the minimum requirements otherwise stipulated in the regulations.

(4) CAA Norway may, following a specific overall assessment, approve other marking than that otherwise stated in the regulations for one or more specific aviation obstacles. Other marking must:

a. be based on the principle of visual marking set out in the regulations

b. in daylight, be visible at a distance of at least 1,500 metres from all relevant approach angles

c. when using lighting, use, at least, the same light intensity as set out in the regulations or described for the aviation obstacle in question

d. not reduce the minimum safety otherwise stipulated for any area of aviation in the regulations

e. not have a negative impact on aviation safety otherwise, including not interfering with communication, navigation or monitoring equipment in aviation

f. *for systems activated by aircraft, have an embedded system for continuous visual marking if the system stops working as intended.*

The amending regulations of 19 December 2023 include a new point in section 9 (7) that concerns the marking of crossing overhead power lines that are subject to line inspection requirements pursuant to Regulations No 1626 of 20 December 2005 relating to electrical power installations, Chapter 6.

The point in question reads:

> *Section 9 (7) Overhead power lines subject to line inspection requirements pursuant to Regulations No 1626 of 20 December 2005 relating to electrical power installations, Chapter 6. High-voltage overhead lines, to be inspected by manned or unmanned aircraft, crossing beneath overhead power lines must be marked. The three last poles, pylons or truss structures connecting the underlying power line before it crosses the overlying power line must be marked. The marking shall take the form of signs, paint or other materials with a reflective surface. The marking must be clearly visible to aircraft during line inspections to make them aware, when flying along power lines, that they are approaching crossing overhead lines. Each side of the crossing overhead power line must be marked, and in accordance with annex 3. The marking requirement also applies when the crossing under an overhead power line is an earth cable.*

1.18.5 OTHER AVIATION OBSTACLES WHERE CAA NORWAY HAS GRANTED AN EXEMPTION FROM MARKING

CAA Norway has informed the NSIA that it has reviewed decisions relating to overhead power lines with an exemption or partial exemption from the marking obligation from 2009 onwards. CAA Norway has stated that most of the relevant cases will come under the new requirements specified in the amendment regulations of 19 December 2023.

1.18.6 OTHER RELEVANT ACCIDENTS, OH-HNX REPORT 2019/08

In 2018, a helicopter hit a power line 10 km northwest of Grimstad. The accident was investigated by the NSIA, as described in report 2019/08. The following is quoted from the report;

> *The Finnish helicopter company Heliwest was contracted by Agder Energi Nett to map and document the condition of 22-kV power distribution lines and surrounding areas. During this work north-west of Grimstad, the helicopter collided with a 132-kV power line that crossed over the 22-kV line. The main rotor cut all three conductors in the 132-kV line, but the helicopter was controllable, and the commander flew back to the base at Arendal Airport Gullknapp. After landing, it was ascertained that three main rotor blades were damaged at the tips. The helicopter was flying 40–50 m above the line to be mapped at a speed of 80–100 km/h when the collision occurred.*

The investigation report made one recommendation 2019/01T on marking crossing cables and power lines

> *Safety recommendation SL 2019/01T*
>
> *On 21 June 2018 OH-HNX, a helicopter from Heliwest hit a crossing power line and cut all three conductors. The risk of collision with crossing lines is very real in connection with helicopter work at low altitude along power lines. This is e.g. illustrated by the fact that, over a six-month period, Agder Energi Nett had three incidents in connection with work along the company's power distribution network. Sweden and Finland have introduced requirements for physical marking of power lines before they are crossed by overhead cables. The Accident Investigation Board Norway (AIBN) believes such marking could, to a substantial degree, prevent the risk of collision.*
>
> *The Accident Investigation Board Norway recommends that CAA Norway introduce requirements for physical marking of crossing lines in Norway.*

The amendment defined in the amendment regulations of 19 December 2023 paragraph 9 (7) defines requirements for marking of crossing lines (see 1.18.4).

1.18.7 VISUAL PERCEPTION

Visual perception is about what we notice visually in our surroundings. Some objects attract attention in such a way that our eyes are more or less automatically drawn to them. Flashing lights, strong colour contrasts and movement attract attention.

Overhead power lines and cables have several characteristics that mean that they do not draw our attention. Firstly, there is little contrast against the background. Other characteristics that play a role in determining whether or not we notice an object is the object's size and relative movement. Larger objects are more readily noticed, and objects that move in relation to their background attract our attention. When seen from the helicopter, a power line is only a narrow strip, and even when close up, a power line will still occupy a relatively minor part of our field of vision. Objects moving directly towards you as opposed to from the side exhibit relatively little movement in relation to their background and therefore do not attract much attention. Precipitation on cockpit windows will reduce contrast and further decrease the likelihood of perceiving objects.

1.18.8 MENTAL CAPACITY AND CONCENTRATION

Human beings filter out unnecessary information when we concentrate on something that demands a great deal of attention. This ability enables us to focus our attention to what we are doing, which is deemed necessary in order to carry out complex tasks (Reisberg, 2013, pp. 118-159)[12].

1.19 Useful or effective investigation techniques

No methods warranting special mention have been used in this investigation.

[12] *Reisberg, D., 2013. Cognition exploring the science of the mind. 5th ed. New York W.W. Norton & Company*

2. Analysis

2. Analysis

2.1 Introduction

The assignment in question concerned a commission from Vesterålskraft Nett AS to Heli-Team AS for pylon/pole top and line inspection by helicopter. In the course of this investigation, the NSIA has analysed the division of responsibilities, planning, use of maps and marking of power lines.

The NSIA is of the view that only coincidence prevented this incident from becoming a serious accident. The way in which the helicopter caught the power cable and the commander's manoeuvring after he discovered it limited the scope and consequences of the incident. After the helicopter's rotor blade cut the power cable, the commander demonstrated good airmanship and performed a successful emergency landing.

The NSIA is of the opinion that if the intention of safety recommendation 2019/01T, which proposes marking of crossing power lines, had been met at the time of the incident, the commander would most likely have noticed and avoided Vesterålskraft's overhead power line.

The investigation did not reveal any technical factors relating to the helicopter that might explain the cause of the incident. The technical condition of the helicopter is therefore not described in further detail in the analysis.

In connection with the investigation, the NSIA has used electronic data retrieved from the iPad used during the flight. The downloaded position data differ somewhat from the information provided by the commander and the power company personnel. The NSIA has based its analysis of the incident on the commander's and passengers' explanations.

Despite the fact that material information has been available, we cannot rule out the possibility that a flight registrator, such as an Appareo Vision 1000, might have provided more detailed information from the time the helicopter caught the power cable. The NSIA has investigated several accidents involving AS 350 aircraft in which factory-fitted flight recorders have provided invaluable information. All newer versions of the helicopter type have a simple flight recorder as standard, fitted by the helicopter manufacturer. One of the recommendations following an accident involving an LN-OFU at Alta on 31 August 2019, Safety recommendation Aviation No 2022/12T states:

> *The Norwegian Safety Investigation Authority recommends that EASA revise Regulations EU 965/2012 for lightweight flight recorders, by extending the scope to all helicopters used for commercial air transport of persons, regardless of their certificate of airworthiness date.*

It may seem like EASA will not meet the intention of this safety recommendation by requiring the flight recorder retroactively. The NSIA recommends that those ordering helicopter services requires that helicopters are equipped with a flight registrator.

2.2 Sequence of events

The incident took place at Tverrbakkhella during an inspection of the power line between Langvassbukta and Gullesfjordbotn. The overhead power line spanning the fjord crosses the power line that was being inspected at the incident site.

The commander experienced a difficult situation at Tverrbakkhella. At the place in question, where a fault was discovered on the power line, the overhead power line crossed the Gullesfjord and the terrain became more demanding. Immediately afterwards, the helicopter passed under the unmarked overhead power line crossing the fjord without the commander noticing it. In interviews

with the NSIA, the commander has explained that it would have been advantageous for him to establish some checkpoints in the planning where extra attention was required. The NSIA shares this view.

The NSIA finds it probable that the pilot's workload at the time was so high that he neither saw nor remembered the overhead power line. This was despite the fact that earlier the same day, it had been identified as a risk during the SJA and that they had flown over it during the pylon/pole top inspection. At the time of the SJA, the pilot's understanding was that the two overhead power lines were at the same height above the ground.

The way in which the helicopter hit the power line had considerable bearing on the sequence of events that followed. The helicopter's vertical position resulted in the right-hand skid catching the power line. The point of impact with the skid meant that the helicopter heeled sharply to the right. The damage to the rotor blade is compatible with the steel core of the power cable being cut by the rotor blade. In the NSIA's opinion, small margins and coincidence are to thank for the cable first hitting the helicopter between the fuselage and the skids instead of hitting the rotor system. Had the cable hit the rotor system, the outcome would very likely have been catastrophic.

The commander has stated that he lost control of the helicopter after it was caught in the cable and that he heard an audio warning at the same time. The NSIA assumes that this audio warning was related to low rotor rpm. Despite a highly demanding situation, he remained calm, made the right decisions and kept flying.

The power short-circuited when the middle cable came into contact with the northernmost cable in the overhead power line spanning the fjord. The line was thus not live when the cable was cut by the helicopter's rotor blades shortly after.

2.3 Survival aspects

Had the helicopter hit the cable in a different way, the situation could have developed into an accident with a lower likelihood of survival.

The NSIA considers that safety will generally be improved by everyone on board wearing a helmet during operations with a higher risk profile. This has been touched upon in several of the NSIA's investigations following helicopter accidents. Only the commander was wearing a helmet during this assignment. All the other persons on board the helicopter represented the power company. Two of them had a defined role in the assignment. The NSIA recommends that the power company consider whether employees with a role in assignments with an elevated risk should be equipped with a suitable helmet in future.

A passenger had been accepted to join the flight. The flight by nature had an elevated risk and if this incident had developed into an accident, the consequences would have been greater than necessary. This is intended to be safeguarded by the operator through OM-E SOP 8.1.4:

> *Only passengers who are necessary to the execution of the assignment shall be on board the helicopter during power line inspections.*

In this case, the operator had accepted that the passenger was allowed to join. The fact that it was pre accepted made it difficult for the commander to change that decision. The fact that this became known to the commander only when the mission was about to begin did not make it any better. The NSIA believes that this was an incorrect decision by the operator and not in accordance with the procedure for the assignment in question.

The commander performed an emergency landing with a high degree of control and thus the helicopter was not significantly damaged. The helicopter was not equipped with a crash-resistant fuel system, which was also the case for all other AS 350 helicopters in Norway at the time of the incident. A crash-resistant fuel system reduces the risk of fuel igniting immediately in an accident. The NSIA made several recommendations to this effect in the investigation following an accident involving LN-OFU at Alta on 31 August 2019 (Aviation report 2022/02).

2.4 Planning before inspections

Line inspection is a type of operation that requires good planning and thorough risk assessment. The commander used the map provided by the power company and the Armed Forces' M517AIR map on scale 1:250 000 in addition to the Air Navigation Pro app when planning the assignment.

He assumed that both 22-kV lines, the overhead power line spanning the fjord and what they were going to inspect, would be the same height and that the flight would therefore be safe with regard to passing the overhead power line.

The power company's commission was accompanied by two black-and-white overview maps with the sections to be inspected drawn in by hand. The Air Navigation Pro app and the M517AIR map only show the two power lines spanning the fjord and pertaining pylons on the east side of the Gullesfjord.

The NSIA is aware that it may be challenging to plan a line inspection that is to take place over a long distance. It can be difficult to identify all the points that represent the highest risk and maintain an overview of risk points during the flight.

Both in connection with this incident and other incidents where helicopters have collided with power lines, the NSIA has seen that maps and map material are of great importance to conducting safe flying. Following the incident, the helicopter operator has updated the maps in the company's iPads that are used during flights. The company has also updated its procedures in the company's OM-E regarding the use of more detailed maps. The NSIA strongly encourages all operators to ensure that detailed maps are used when planning line inspections or other operations at low altitude.

It is the NSIA's assessment that the maps on the company's iPad and in the commander's 'memory' regarding places and locations were the final safety barriers meant to prevent conflict with the overhead power lines spanning the fjord. Human barriers are generally considered weak safety barriers, as this incident also confirms.

2.5 The overhead power line spanning the fjord, marking and exemption from marking

Vesterålskraft Nett AS's overhead power line spanning the Gullesfjord had not been marked, and the company had contacted CAA Norway in 2010 to request an exemption from marking. CAA Norway concluded, without much justification, that the power line spanning the fjord did not constitute an obstacle to aviation and referred, among other things, to the fact that Statnett's overhead power line spanning the fjord just south of it was marked. The NSIA believes that this may be a misjudgement. The fact that one of the two overhead power lines spanning the fjord was marked may further reduce the visibility of the unmarked line by drawing attention away from it. The result may thus be an increased risk of collision. The NSIA makes one safety recommendation to CAA Norway to reconsider its decision and assess whether the power line spanning the Gullesfjord should be physically marked.

Nor can the NSIA rule out that other aviation obstacles may have been exempted on the same grounds, and has asked CAA Norway whether such exemptions are in place for other power lines. CAA Norway has informed the NSIA that it has reviewed decisions relating to overhead power lines with an exemption or partial exemption from the marking obligation from 2009 onwards. The NSIA makes one safety recommendation to CAA Norway to follow up overhead power lines that are exempt or partially exempt from the marking obligation in order to verify that they are marked in accordance with the Regulations on reporting, registration and marking of aviation obstacles, FOR-2014-07-15-980.

2.6 The helicopter operator's role in the performance of the assignment

The final assignment was allocated to the commander late on his day off, the day before it was to take place. Also, information about the third passenger did not reach the commander. He had limited experience of power line inspection and had no experience of line inspection of the distribution network where the lines run low in the terrain, where the risk is greater. It is the NSIA's opinion that insufficient information about the assignment, in combination with the commander's limited experience of this type of operation, contributed to a heavy workload for the commander immediately before and during the assignment. Based on this, the NSIA is of the opinion that Heli-Team did not make provisions to enable the pilot to plan for, nor carry out, an optimally safe assignment.

The commander authorised, planned and conducted assignments largely in accordance with an interpretation of procedures described in the company's operations manual, sections OM-A and OM-E.

Heli-Team's Standard Procedures Manual OM-E contains the most important guidelines and standard procedures for operating personnel. Among other things, it stipulates requirements for personnel from the customer to have received a dedicated assignment and training from the helicopter operator before participating in helicopter operations. The company's OM-E has been updated with a revised procedure for line inspection. The new procedure has more focus on the use of maps, situational awareness and that a local expert or task specialist is used to help with navigation. The NSIA believes that the local expert must have operational training from the

helicopter operator. The operator's revised OM-E could have been even clearer related to the training of the local expert.

OM-E procedure 8 is the standard procedure in force for visual inspections. Section 8.1.6 sets requirements for a safety distance of 15 metres to power lines. For inspections of overhead power lines spanning fjords, the distance is 30 metres. It also requires the power company to have appointed a safety manager if the distance to a live cable is less than 30 metres. If Heli-Team's planning reveals a need to fly closer than the specified minimum distance from the overhead power line, it must be made known to the power company. This will enable necessary safety barriers and external functions such as LFS to be considered. The NSIA is of the opinion that the increased risk exposure was not taken into account by flying the helicopter closer than 30 meters towards the power line in addition to carrying an additional passenger.

The NSIA is of the opinion that the complexity of the operation and the risks involved appear to have been underestimated by the helicopter operator. The operator must ensure that risk assessments are carried out well in advance of assignments, taking into account the complexity of the assignment, the commander's experience and customer requirements. The risk assessment can also be carried out in cooperation with the power company as recommended in RENblad 8070. The NSIA considers that Heli-Team should have conducted a more thorough and better operational risk assessment for this assignment.

Heli-Team has implemented several measures following the incident, and updated manuals and procedures have been sent to the NSIA.

- The company's OM-E has been updated with a revised procedure for line inspection. The new procedure focuses more on the use of maps, situational awareness and the use of a local guide or Task Specialist to assist with navigation.
- A new management position with responsibility for Crew Training only has been established and introduced.
- The company's risk assessment for line inspection has been updated.

2.7 The power company's role as commissioner

Energi Norge and the organisation REN have prepared a guide (RENblad 8070) on how to commission helicopter services. The NSIA's view is that the guide provides good information, but that it was not fully utilised in connection with Vesterålskraft Nett AS's commission of assignments. RENblad 8070 contains a number of recommendations, including that notifying the network operator's operations centre should be included in the helicopter company's instructions, and that the network operator should, along with the helicopter company, ensure that a proper risk assessment has been carried out for the assignment. The risk assessment must also be documented. The NSIA has not been presented with documentation of the risk assessment.

Examples of the assignment not being adequately risk assessed are that the inspected power line was live during the inspection and the power company's operations centre was unaware of the ongoing inspection. Moreover, the power company had not appointed a person to be in charge of safety.

The NSIA is of the opinion that the power company could have better fulfilled its role as commissioner. The operations centre would then have been informed about the line inspection, and whether a person should have been designated to take on safety responsibility would have

been considered. A dedicated safety manager would have been important for alerting emergency services if the outcome of the incident had been different.

If the network operator had risk assessed the assignment in advance, together with the helicopter company, it is not unlikely that several areas of elevated risk would have been identified, such as taking an additional passenger without any duties for the actual flight that on a mission which by nature, had an elevated risk. The NSIA recommends the power company to check that its procedures ensure that a joint risk analysis is performed.

Following the incident, Vesterålskraft Nett AS has conducted its own investigation of the incident. The NSIA has been granted access to this investigation. The report sheds light on several circumstances and recommends a number of measures. Vesterålskraft Nett AS has established new procedures that can be applied throughout the group. New procedures have been drawn up for commissioning helicopter services, and documented training of personnel. The training must be completed and documented before employees take part in helicopter operations.

2.8 Division of responsibilities during the flight

The NSIA's impression is that the division of responsibilities during the assignment was unclear.

In connection with inspections of power lines, the power company depends on its own fitters continuously assessing faults found during the inspection. At the same time, line inspection is an advanced helicopter operation that requires a great deal of the pilot, in terms of safe manoeuvring of the helicopter, navigation and maintaining situational awareness.

The power company had selected two power supply fitters as active participants during the flight. At the start-up meeting, it was decided where the participants were to sit in the helicopter. The fitter sitting in the left front seat was assigned the task of map reader, a job he was not trained for.

Assisting the commander as map reader with a printed map or an iPad can, at times, be a highly demanding function. The task requires skill at keeping track of where the helicopter is on the map, which can be much more demanding in connection with a flight than, for example, driving a car. Good communication, training and experience are required. The helicopter company is responsible for the flight and performs it in accordance with its own procedures whereby personnel are taught and trained.

The NSIA believes that the power supply fitter was given a task he was not qualified to do. The NSIA therefore believes that only dedicated trained personnel affiliated to the helicopter operator should be given a defined role as map reader.

2.9 Why did the commander not see the power line they flew into?

Knowledge about visual perception, concentration and mental capacity is described in section 1.18.7.

The NSIA is of the opinion that it was difficult for the pilot to see the power line the helicopter collided with. It did not stand out in relation to the background, and a light drizzle meant that the commander had to use the windshield wiper. The line occupied a relatively small part of the field of vision, and, as it was not marked, it had no visual elements that attracted his attention. Since the helicopter flew towards the crossing line and thus had limited relative movement, there was little to attract the pilot's visual attention.

3. Conclusion

3. Conclusion

3.1 Main conclusion

Only coincidence prevented this incident from becoming a serious accident with a fatal outcome.

The NSIA is of the opinion that planning and performance of the assignment, the poor visibility of the line, the pilot's limited experience and high mental workload in the situation in question are the reasons why the pilot did not become aware of the overhead power line spanning the fjord until a collision was inevitable.

3.2 Investigation results

A. The NSIA is of the opinion that the incident came very close to a total loss of the aircraft when it collided with the overhead power line spanning the fjord.

B. The commander's manoeuvring after the helicopter caught the power line probably contributed to preventing the incident from becoming an accident with a potentially fatal outcome.

C. The company's procedures as described in OM-E were not complied with nor addressed in their entirety.

D. Inaccuracies in the mission's assignment from the helicopter operator led to poorer planning, which increased the commander's workload.

E. The commander used an iPad with Air Navigation Pro software for planning and general navigation purposes during the flight. It did not show the power line that was being inspected.

F. Following the serious incident, the operator has updated its procedures, risk assessments and maps.

G. The weather, with drizzle on the windshield of the helicopter, may have affected the commander's chances of identifying the overhead line that was cut.

H. The crossing power line was not marked, a decision the aviation authority had approved for the power company.

I. The aviation authority had concluded that the power line spanning the fjord did not constitute an obstacle to aviation.

J. Energi Norge and the organisation REN have prepared guides for training of own personnel and establishing safe procedures for commissioning helicopter operations. These guidelines were not used.

K. The commander held valid privileges to fly the helicopter.

L. The commander had valid check-out for the type of operation performed.

M. The helicopter's airworthiness and maintenance were not a factor in this incident.

4. Safety recommendations

4. Safety recommendations

Two safety recommendations are issued after the incident: [13]

Safety recommendation Aviation No 2024/10T

During an inspection of a power line on 6 September 2021, LN-ORJ, a helicopter from Heli-Team, cut an overhead power line cable spanning the Gullesfjord in Kvæfjord municipality. Vesterålskraft Nett AS's overhead power line spanning the Gullesfjord had not been marked, and the company had contacted CAA Norway in 2010 to request an exemption from marking. CAA Norway concluded, without much justification, that the line spanning the fjord did not constitute an obstacle to aviation and referred, among other things, to the fact that Statnett's line just south of it was marked. The NSIA believes that this may have been a misjudgement. The fact that only one of two lines was marked may further impair the visibility of the unmarked line by drawing attention away from it. The result may thus be an increased risk of collision.

The Norwegian Safety Investigation Authority recommends CAA Norway to reconsider its conclusion and consider whether the overhead power line spanning the Gullesfjord should be physically marked.

Safety recommendation Aviation No 2024/11T

During an inspection of a power line on 6 September 2021, LN-ORJ, a helicopter from Heli-Team, cut an overhead power line cable spanning the Gullesfjord in Kvæfjord municipality. The overhead power line over the Gullesfjord had been assessed by CAA Norway to determine whether it required physical marking. CAA Norway had concluded that it did not require marking and granted an exemption. The NSIA cannot rule out that other aviation obstacles may have been exempted on the same grounds, and has asked CAA Norway whether such exemptions are in place for other power lines. CAA Norway has informed the NSIA that it has reviewed decisions relating to overhead power lines with an exemption or partial exemption from the marking obligation from 2009 onwards.

The Norwegian Safety Investigation Authority recommends CAA Norway to follow up overhead power lines that are exempt or partially exempt from the marking obligation in order to verify that they are marked in accordance with the new Regulations on reporting, registration and marking of aviation obstacles, FOR-2014-07-15-980.

Norwegian Safety Investigation Authority
Lillestrøm, 23 October 2024

[13] The Ministry of Transport forwards safety recommendations to the Civil Aviation Authority and/or other involved ministries for evaluation and follow-up; see Section 8 of the Regulations on Public Investigations of Accidents and Incidents in Civil Aviation.

Abbreviations

Abbreviations

AOC	Air Operator Certificate
AIBN	Accident Investigation Board Norway (former name of the NSIA)
AIC	Aeronautical Information Circular
ARC	Airworthiness Review Certificate
CPL	Commercial Helicopter Licence
EASA	European Union Aviation Safety Agency
ELT	Emergency Locator Transmitter
MTOW	Maximum take-off weight
NSIA	Norwegian Safety Investigation Authority
OM	Operation Manual
SJA	Safe job analysis
SOP	Standard Operation Procedures
SPO	Specialised Operation
VEMD	Vehicle and Engine Monitoring Display
VFR	Visual Flight Rules