Norwegian Safety Investigation Authority

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REPORT AVIATION 2024/01

Serious incident at Bryne in Rogaland county, Norway, 25 October 2022 with Airbus Helicopters AS 350B3, LN-OGN operated by Helitrans AS

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

The purpose 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 make possible safety recommendations. It is not NSIA's task to apportion blame or liability.

Use of this report for any other purpose than for flight safety should be avoided.

Photo: Helitrans 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 of reference.

Factual information

This investigation has had limited scope. For this reason, the Norwegian Safety Investigation Authority (NSIA) has chosen to use a simplified reporting format. The reporting format in accordance with the guidelines given in ICAO Annex 13 is used only when the scope of the investigation makes it necessary.

Data

Aircraft:	
Type and registration:	Airbus Helicopters AS 350B3, LN-OGN
Year of manufacture:	2020
Engine:	Safran Arriel 2D
Operator:	Helitrans AS, Norway
Date and time:	Tuesday 25 October 2022 at 1400 hrs
Incident site:	App. 5 km South of Bryne in Rogaland, Norway (N58.6892 E005.6844)
ATS airspace:	Non-controlled airspace class G
Type of incident:	Serious aviation incident, loss of control during stringing a power line mast.
Type flying:	Commercial, Specialised Operations (SPO)
Weather conditions (1350 local time)	METAR ENZV 251150Z 23007KT 8000 OVC004 12/12 Q1004=
Light conditions:	Daylight
Flight conditions:	VMC
Flight plan:	None
Persons on board:	1
Injuries persons:	None
Damage to aircraft:	Right skid bent
Other damage:	Minor damage on top of power line mast
Commander:	
Gender and age:	Male, 55 years old
Licence:	CPL(H)
Flight experience:	In total app. 5 800 hours of which app. 4 800 hours on type.
Sources of information:	«NF-2007 Rapportering av ulykker og hendelser i sivil luftfart» from the Commander, interviews with the Commander and witnesses, as well as the Norwegian Safety Investigation Authorities' own investigations.

All times given in this report are local time (UTC + 2 hours), if not otherwise stated.

Sequence of Events

Helitrans AS had a contract with the energy company Eviny in connection with the construction of a 9 km long 132 kV power line from Opstad in Ålgård to Håland at Bryne. The masts were already erected, and on the day in question, work was scheduled to begin installing the power lines. Each mast consisted of two approximately 22 meter high poles with a crossbeam between them. The mast was to have five lines, one of which was to hang under the crossbeam between the poles, and one line under each end of the crossbeam (see figure 1). The remaining two lines were to be suspended at the top of the poles.

The helicopter was in a hangar at Stavanger Airport Sola, and the aircraft Commander flew it to Bryne where the stringing work was to commence. On the ground, there was an experienced task specialist and a task specialist who was being trained, both from the helicopter operator. The Commander could communicate with the personnel on the ground via an aircraft radio. During the work, a tool weighing approximately 600 kg was to be used. The purpose of the tool was to ensure that a pilot line (steel cable) could pass under the crossbeam between the poles without assistance from personnel in the mast. The tool hung from the helicopter's cargo hook via an 11 meter long line and a 3 meter long, 12 mm thick steel cable. At the end of the steel cable, there was attached a 10–15 kg heavy steel ball. The steel ball was used to connect or disconnect the steel cable from the tool using a wedge-shaped groove in the tool.

The pilot line, which was to be pulled through pulleys on the crossbeams, was 10 mm thick and coiled on a drum. The pilot line was later to be used to pull out the permanent and significantly thicker high voltage power lines. When the pilot line is pulled out, it is attached to the tool. Using the steel ball, the tool is then attached to the steel cable under the helicopter. This allows the helicopter to pull out the pilot line using the tool hanging under the helicopter. When the pilot line is to be inserted into the pulleys under a crossbeam, the tool must first be hung on the crossbeam and disconnected from the steel cable. Then the helicopter must move the steel cable, including the steel ball, to the opposite side of the crossbeam and reconnect it to the tool using the steel ball. The helicopter can then lift the tool off the crossbeam, insert the pilot line into the pulley, and continue to the next mast.

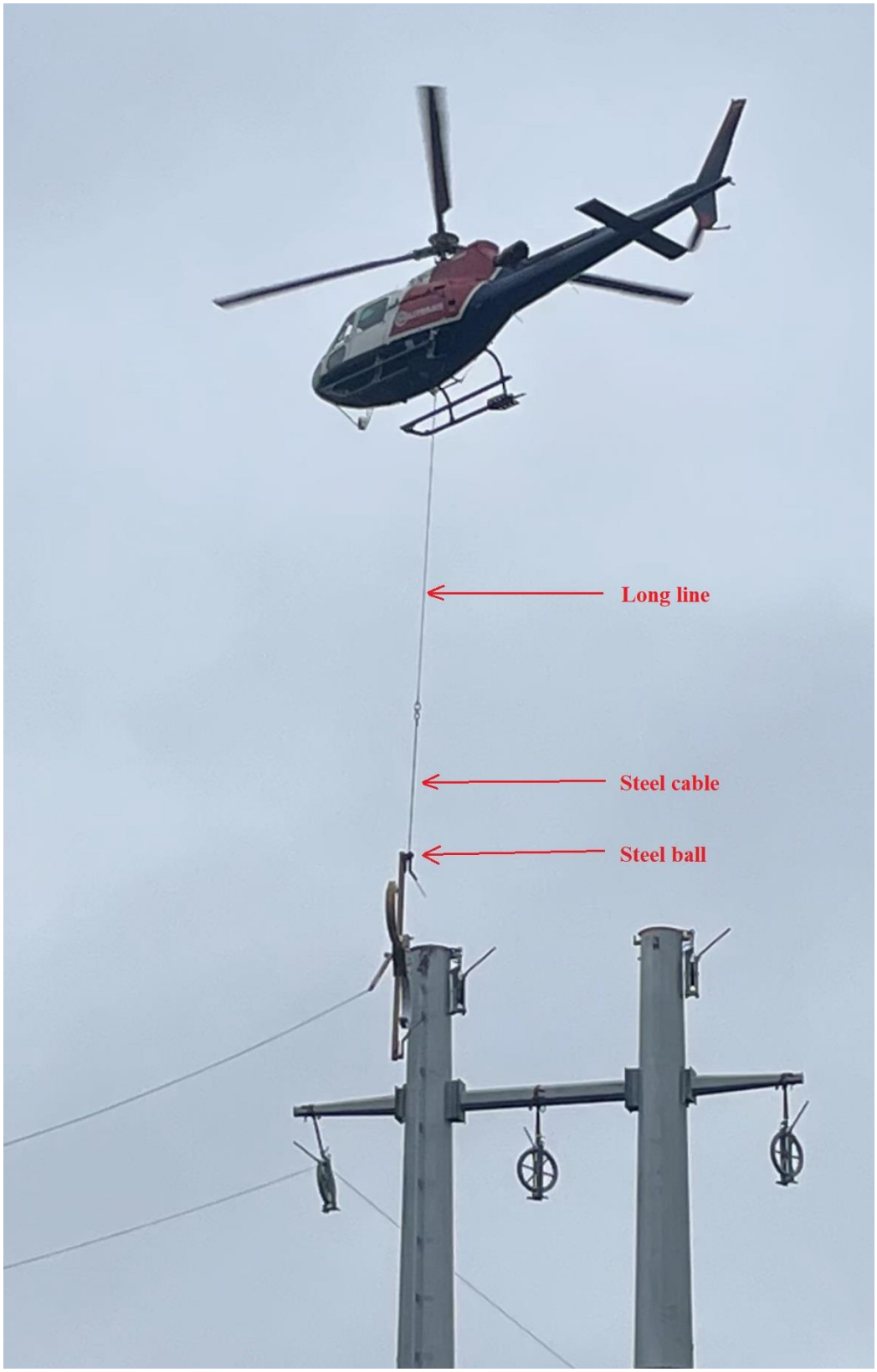

Figure 1: An illustration of the tool with the connected pilot line hanging under the helicopter. A pilot line is already installed on the left end of the crossbeam. At the photo the helicopter is approaching the crossbeam where the tool is to be hung. The photo was not taken in connection with the incident and shows a somewhat different connection between the tool and the helicopter. Photo: Helitrans/SHK

The work began in the middle of the power line, at mast number 20, and progressed towards one end of the power line. The Commander first pulled the pilot line that ran on the outside of the crossbeams. Then he began to pull the pilot line that was to hang between the poles.

At the first mast the pilot line jammed in the pulley, and work had to be paused until the line was freed. Stringing then proceeded normally until the third mast. The Commander was in the process of hanging the tool on the crossbeam when the helicopter suddenly started to move uncontrollably. He dropped the line including the tool a second before the helicopter struck the top of a pole with the right skid (see figure 2). However, the Commander regained control and landed.

The helicopter was equipped with a recorder of the Appareo Vision 1000 type mounted on the ceiling above the rear seats. The Norwegian Safety Investigation Authority has got access to the video and data from the device. The video provides somewhat limited information about the incident because it records only 4 frames per second.

The following relevant information was retrieved from the recorder:

- The helicopter was in a hover with a power output (First Limit Indicator – FLI) ranging between 7.8 and 8.0. and heading southwest. The helicopter was maneuvered with relatively large cyclic movements. FLI suddenly dropped to 6.0, then up to 8.0, and then decreased to 4.0.
- 1.5 seconds after FLI began to vary, a hydraulic pressure low warning light came on and stayed on for 4 seconds.
- 3 seconds after FLI began to vary, the Commander released the cargo by pressing the release button on the cyclic.
- 4 seconds after FLI began to vary, the right skid struck the top of one of the poles. Due to the vibrations, the images from Appareo Vision 1000 became blurred for one second. At the same time, a red cross appeared on the upper right half of the helicopter's Multi-Function Display (MFD) in the cockpit, and the image of the artificial horizon disappeared. The display of the artificial horizon was absent until after the helicopter had landed. The vibrations also affected the registration of the helicopter's attitude in Appareo Vision 1000, so recorded data during certain periods did not correspond to the helicopter's attitude as shown in the video.
- After the helicopter's landing gear struck the top of the pole, it banked approximately 30° to the left and moved sideways to the left. Just over a second later, it banked over 45° to the right, while the nose pointed steeply downward for a period. At the same time, the helicopter lost altitude and turned to the right. After the Commander regained control of the helicopter, it had turned so that the helicopter headed north.
- The Commander landed the helicopter in a controlled manner next to the mast 62 seconds after FLI began to vary.

After landing, it was found that the right skid had been bent outward between the landing gear x-tubes (see Figure 3). Helitrans AS found no other damage or faults with the helicopter before it was put into operation again.

A cover on top of one of the poles was damaged during the incident. The tool, along with the line and steel cable, fell into soft marshy soil next to the mast and was not damaged.

Additional information

The Commander explained to the Norwegian Safety Investigation Authority that he thought he experienced the phenomenon Pilot-induced-oscillations (PIO). This can be described as unintended oscillations due to inadvertent interaction between the pilot and the aircraft. The Commander further explained that during the incident, he was tossed around in the seat even though he was securely fastened with seat belts. He believed for a while that the helicopter was going to crash.

The Commander carried out the mission during his off-duty time. However, he was well-rested, alert, and motivated for the task. The friction on the collective was set low, which he believed could have been a factor in the incident. He also said that the friction on the pilot line drum was set quite high so that the pilot line was somewhat hard to pull out. The friction was set high to prevent the pilot line from sagging when crossing roads. The Commander believed that weather conditions was not a factor.

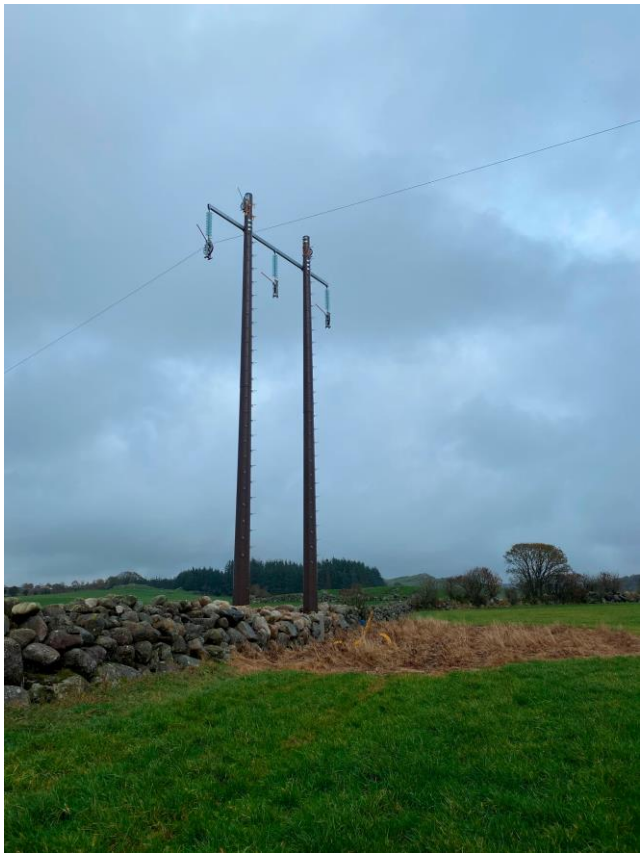

Figure 2: The actual mast where the incident happened. Photo: Helitrans/NSIA

Figure 3: The right skid. The red arrow is pointing towards the bend: Photo: Helitrans/NSIA

Helitrans has described the stringing procedure in its Operations Manual Part E, Chapter 7. The procedure includes the following:

> *This SOP is considered High Risk due to the combination of low speed and altitude placing the helicopter almost continuously inside the H/V diagram.*
>
> *Seeing as the needle flying may be considered the most demanding and stringing the second most demanding a highly experienced pilot is required.*
>
> – – –
>
> *(G) Crossing roads will be closed or secured with superstructures.*

Helitrans' procedure describes in detail how needle flying (stringing) should be carried out. The tool used in the incident is different from the "needle," and there is no procedure for the use of this tool.

In the helicopter's Flight Manual, the following is stated regarding the adjustment of friction on the collective:

> *2. Cyclic and collective friction……..AS REQUIRED.*
>
> – – –

NOTE

Adjust collective and cyclic frictions so that friction loads are felt by the pilot when moving the flight controls.

When the phenomenon of PIO is mentioned in connection with helicopters, the term Rotorcraft Pilot Coupling (RPC[1]) is often used. RPC can be divided into two subgroups. PIO where the pilot contributes with active steering commands and PAO (Pilot-assisted oscillations) where the pilot gives unintended steering commands because he is influenced by the helicopter's movements. The Norwegian Safety Investigation Authority has discussed the topic of RPC with the helicopter manufacturer Airbus Helicopters. They have started work to better understand this phenomenon in connection with operations with underslung loads. The topic is complex, and several factors affect the risk of RPC occurring. Key factors include:

- The natural frequency of the helicopter and rotor system.
- The natural frequency in the underslung load.
- The natural frequencies and damping in the connection between the helicopter and any load. Airbus believed that the difference in using a fiber or steel cargo line was marginal.
- The characteristics/sensitivity of the flight controls.
- The pilot's influence through the collective.

For oscillations (RPC) to occur, there must be a triggering factor. Such triggering factors can include:

- Changes/shocks in the underslung load, such as contact with the ground or a mast.
- Turbulence.
- The pilot's maneuvering.

With direct pilot-induced influence through the collective (PIO), the frequency will be in the region of 0–2 Hz. The pilot can unintendedly contribute to amplifying vertical movements in the frequency range of 2–8 Hz if the arm is shaken by the helicopter's movements (PAO). Significant friction on the collective reduces the likelihood of RPC occurring.

Several documents and articles discuss RPC. One method mentioned to stop the phenomenon is to release the collective. This breaks the connection between the pilot's hand and the helicopter's flight controls. This method is perceived by pilots as contradicting instincts and common sense when the helicopter is at low altitude. Reference is also made to the NSIA's investigation report no. 2011/04 issued on 25 May 2011, which dealt with a PIO incident with LN-OWB. The pilot during this incident described that the bouncing movements ceased immediately when he pulled the collective decisively.

In addition to this incident involving LN-OGN, the Norwegian Safety Investigation Authority is currently investigating an accident involving RPC. The accident occurred on 16 November 2020, during transport of concrete with LN-OAX in Songesand. The investigation has not yet been completed with a report.

[1] Can be described as inadvertent, sustained aircraft oscillations which are a consequence of an abnormal joint enterprise between the aircraft and the pilot.

The Norwegian Safety Investigation Authority's assessments

The Norwegian Safety Investigation Authority has assessed this incident as being serious. The helicopter was completely out of control for a short period while losing altitude directly above a mast. It is likely that the Commander experienced RPC during this approximately 3-second period, until the cargo line was released. The helicopter's skid struck one of the masts shortly after. This further exacerbated the helicopter's loss of control. The Norwegian Safety Investigation Authority believes it was purely coincidental that the helicopter did not become entangled with the mast, come into contact with the lines, or the mast with one of the rotors. However, the Commander managed to regain control of the helicopter and landed safely.

PIO and RPC are very complex dynamic situations that can be difficult to understand. Literature on the phenomenon often focuses on it in connection with fixed-wing aircraft.

Relatively high friction on the collective reduces the likelihood of RPC occurring in a helicopter. Low friction on the collective most likely played a role in this case. It cannot be definitively determined whether abrupt maneuvering by the Commander and/or contact between the tool and the mast triggered the RPC.

If RPC occurs with an underslung load, the phenomenon can be stopped by releasing the load. It is not inconceivable that RPC also can be stopped by pulling the collective decisively, although this is not documented. In the 2011 incident with LN-OWB, it appears that RPC was stopped by a decisive pull on the collective.

The Norwegian Safety Investigation Authority is aware that the adjustment of friction on collectives is a well-known topic and believes that this must be given further attention. The Norwegian flight safety forums for onshore helicopter operations should be suitable to address the topic.

Helitrans AS considers that stringing pilot lines is a high-risk operation. The NSIA therefore urges the company to put in place a procedure that describes the current method of stringing and not just needle flying.

The Norwegian Safety Investigation Authority believes that the warning light for low hydraulic pressure came on as a result of the rapid and large movements in the flight controls when the RPC occurred. Hence, the warning light was a consequence of the incident.

Norwegian Safety Investigation Authority
Lillestrøm, 18 January 2024