Statens haverikommission
Swedish Accident Investigation Authority





# *Final report RL 2014:08e*

**Accident 85 km north of Kiruna on September 26, 2013 involving the helicopter SE-JHH of the model EC 120 B, operated by Kallax Flyg AB.**

File number L-136/13

6/11/2014

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring again, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK´s web site: www.havkom.se

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This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.



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## Content

## General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring again, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or e.g. by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

Investigations of aviation incidents are governed mainly by Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and by the Accident Investigation Act (1990:712). The investigation is carried out in accordance with Annex 13 of the Chicago Convention.

## The investigation

SHK was informed on September 26, 2013 that an accident involving a helicopter with the registration SE-JHH of the model EC 120 B had occurred 85 km north of Kiruna, Norrbotten county, on the same day at 13.13 hrs.

The accident has been investigated by SHK represented by Mr Jonas Bäckstrand, Chairperson, Mr Nicolas Seger, Investigator in Charge, Mr Stefan Carneros, Operations Investigator, Mr Jens Olsson, Investigator behavioural science and Mr Urban Kjellberg, Investigator specialising in Fire and Rescue Services.

Accredited representative of France, State of Manufacture, has been Mr Arnaud Toupet from the BEA[1].

[1] The BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile) is the French authority responsible for carrying out safety investigations relating to accidents or serious incidents in civil aviation.

The investigation team of SHK was assisted by Mr Julien Ballester, BEA, and via the BEA, by Mr Vincent Lassus, Eurocopter (since January 2014 Airbus Helicopters) and by Mr Jean-Louis Lalaas, Safran/Turbomeca, as advisers assisting the Accredited Representative of France.

The investigation was advised by Mr Magnus Axelsson of the Swedish Transport Agency.

The following organisations have been notified: the International Civil Aviation Organisation (ICAO), the European Aviation Safety Agency (EASA), the European Commission, the BEA and the Swedish Transport Agency.

Investigation material

Interviews have been conducted with the pilot, the Flight Operations Manager and the passenger.

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## Final report RL 2014:08e

| | |
|---|---|
| Aircraft: | Helicopter |
| Registration, type | SE-JHH, EC 120 |
| Model | EC 120 B |
| Class, Airworthiness | Normal, Certificate of Airworthiness and Valid Airworthiness Review Certificate (ARC) |
| Owner/Holder and Operator | Stenvalls Trä/Kallax Flyg AB |
| Time of occurrence | September 26, 2013, 13.13 hrs in daylight Note: All times are given in Swedish daylight saving time (UTC + 2 hrs) |
| Place | Gaíku, 85 km north of Kiruna, Norrbotten county, (position 68 35,4N 020 34,0E, 720 metres above sea level) |
| Type of flight | Aerial work with sling load |
| Weather | According to SMHI[2]'s analysis: wind north to northeast 15-25 kts, visibility down to 2 000 metres in snow or sleet, probable cloud bases between 1 000 and 2 000 feet, temperature/dew point +1/0 °C, QNH[3] 1015 hPa |
| Persons on board: | 3 +1 canine |
| crew members including assistant | 2 |
| passengers | 1 |
| Injuries to persons | 1 minor |
| Damage to aircraft | Substantially damaged |
| Other damage | Load, one quad bike/ATV, damaged Limited oil spill |
| Commander: | |
| Age, licence | 32 years, CPL (H)[4] |
| Total flying hours | 2 678 hours, of which 657 hours on type |
| Flying hours last 90 days | 223 hours, of which 158 hours on type |
| Number of landings last 90 days | 550 |

[2] SMHI - Swedish Meteorological and Hydrological Institute.
[3] QNH - Atmospheric pressure at an airport or other defined area calculated at sea level in accordance with the International. Standard Atmosphere.
[4] CPL (Commercial Pilot Licence – Helicopter).

## SUMMARY

The accident occurred in low mountainous terrain during sling load operation with a helicopter of the model EC 120 B. Besides the pilot there were two persons and a canine on board.

The flight started in a northerly direction followed by a left turn into downwind. Despite the output of maximum power the helicopter lost height and the sling load started to drag in the ground. The helicopter struck the ground and went down on its side. The engine was shut down and all aboard evacuated the helicopter. One person sustained minor injuries. The helicopter was substantially damaged.

The examination of the helicopter has not shown that there were any malfunctions before the accident.

The tailwind component, and probably the effect of a downdraught, resulted in the translational lift ceasing and the helicopter beginning to descend.

The non-initiation of emergency release of the sling load was probably caused by the fact that the pilot had not previously executed the emergency release of a sling load in practice or in a live situation and because he was not mentally prepared for instinctively implementing such a measure.

The accident was caused by underestimation of the assignment's degree of difficulty.

Contributing factors were misjudgement of the wind direction and terrain inclination.


### Safety recommendations

The Swedish Transport Agency is recommended to ensure that:

- Operators engaging in flight with sling loads conduct practical exercises of simulated emergency release in their training. (*RL 2014:08 R1)*

# 1. FACTUAL INFORMATION

## 1.1 History of the flight

### *1.1.1 Circumstances*

The company engages in aerial work, and the flight in question took place within the scope of a reindeer herding operation.

The account below is based on information from interviews with the pilot, the passenger and with the company's Flight Operations Manager. The information presented constitutes only such information as has been provided by the interviewees and thus does not contain any assessments or conclusions by SHK.

In the morning, a technician got the helicopter ready in Abisko. The pilot performed a daily inspection and began at 08.30 hrs by carrying out a 15-minute sightseeing flight in the Abisko area with four customers. The helicopter was subsequently refuelled and loaded with extra fuel and equipment for sling load.

He then took off towards Pulsujärvi, where he landed after about 30 minutes, met the assistant and went through the operation and the area for reindeer herding. Refuelling was carried out. There were some snow showers on the way there, a northerly wind of about 10-15 knots and the temperature was 3 °C to 4 °C. However, the snow showers ceased, and visibility increased to >10 km with a high cloud base. Reindeer herding was subsequently carried out for two hours and fifty minutes.

In the course of reindeer herding, the pilot received a request to assist with the air transport of a damaged quad bike to Pulsujärvi for onward car transport to a repair shop. Since the weight of the load was estimated to be about 350 kg, it was planned that the transport be carried out during the last part of the sortie as the helicopter would be light enough to fly with a sling load.

The weather was windy, with gusty winds from north to northeast, and visibility was good. The terrain consisted of low mountainous terrain.

### *1.1.2 History of the flight*

The pilot landed next to the quad bike, coupled the load with a 12-metre cable and 4-metre straps. The functioning of the cargo hook was checked. The assistant, the quad bike driver and the driver's dog were taken on board. The flight time to Pulsujärvi was calculated to be approximately 10-13 minutes, which the pilot calculated was within the fuel planning minima.

The pilot made a calculation of weight and balance. These values were within permitted limits. The pilot declared that there was a small margin to the maximum gross mass.

In connection with lifting into the hover and the load lifting off, FLI[5] displayed the approximate value of 9, which meant a lower power output than expected. The pilot estimated the wind to be due north and initiated a northerly forward motion with the sling load at a height of about 5-10 metres above the ground.

The pilot has declared that the expected positive increase in speed was obtained initially. Thereafter, an unexpected height reduction was experienced, which was countered by maximum power output corresponding to the red radial mark on the FLI (see Figure 1). The reason why more power was not used was that the pilot considered the situation not to demand it.

The pilot has further stated that he assessed the terrain on the left side to be inclined and that he was turning to the left. The wind was now experienced as coming from the right. Despite the output of maximum power, no increase in height margin was obtained; instead the rate of descent increased.

Shortly thereafter, the sling load made ground contact and began to drag in the ground. The pilot has stated that he groped after the button with the intention of releasing the load with the ordinary release device on the cyclic stick, but that it is possible that the button was not depressed. The pilot has also declared that he did not have time to think about the cable (secondary release on the collective stick).

In connection with the load dragging in the ground, the pilot lowered the collective lever and brought the cyclic stick towards him in order to perform a flare[6] before he made ground contact.

Shortly thereafter, the helicopter struck the ground with a relatively steep nose-down attitude and with a light bank angle to the right. The helicopter overturned, went down on its right side and stopped opposite to the direction of travel.

The pilot shut down the engine by operating the emergency fuel shut-off handle and turned off the battery switch. The helicopter was subsequently evacuated.

None of those aboard sustained any serious injuries. The pilot himself called the aviation company in order to inform it of the event, turned off the Emergency Locator Transmitter and awaited support from the aviation company. The aviation company contacted SOS Alarm but a rescue operation was not assessed necessary.

[5] FLI (First Limitation Indicator) – Instrument for engine values and engine limitations.
[6] Flare – Manoeuvre which aims to reduce speed before landing.

The accident occurred in daylight at 13.13 hrs, about 85 km north of Kiruna, in position 68 35,4N 020 34,0E, 720 metres above sea level.

## 1.2 Injuries to persons

| | Crew | Passengers | Total in the aircraft | Others |
|---|---|---|---|---|
| Fatal | - | - | 0 | - |
| Serious | - | - | 0 | - |
| Minor | 1 | - | 1 | Not applicable |
| None | 1 | 1 | 2 | Not applicable |
| Total | 2 | 1 | 3 | - |

## 1.3 Damage to aircraft

The helicopter sustained substantial damage. The tail boom separated from the fuselage and all rotor blades were broken in several places. The front part of the fuselage was damaged.

## 1.4 Other damage

A quad bike/ATV, which constituted an external sling load, was damaged in connection with the accident.

### *1.4.1 Environmental impact*

It cannot be ruled out that the following maximum volumes of oil leaked out at the accident site:

- Hydraulic oil: Between 1 and 2 litres (Nycolube FH2)
- Mineral oil: 0.22 litres (Nycolube 3525)

## 1.5 Crew/Personnel information

### *1.5.1 Pilot*

The pilot was 32 years old and had a valid CPL (H) Licence with valid operational and medical eligibility.

| Flying hours | | | | |
|---|---|---|---|---|
| Latest | 24 hours | 7 days | 90 days | Total |
| All types | 8 | 14 | 223 | 2 678 |
| This type | 8 | 14 | 158 | 657 |

Number of landings this type previous 90 days: 550.
Type rating concluded on 22 April 2012.
Latest PC (proficiency check) carried out on 12 June 2013 on EC 120 B.
Line-check covering, inter alia, reindeer herding and flying with a sling load carried out two weeks prior to the event.

### *1.5.2 Other personnel*

An assistant and driver of the quad bike, who were required to complete the assignment.

### *1.5.3 The pilot's duty schedule*

The pilot was working the fourth day of the work cycle. The previous period of leave lasted for seven days.

The pilot retired to sleep at about 22.00 hrs the night before, got up at 07.00 hrs and considered himself well rested following a rest period of about nine hours.

## 1.6 Aircraft information

### *1.6.1 Helicopter data*

| | |
|---|---|
| ***Helicopter*** | |
| TC-holder | Eurocopter until January 6, 2014, thereafter Airbus Helicopters |
| Model | EC 120 B |
| Serial number | 1200 |
| Year of manufacture | 2001 |
| Gross mass, kg | Max authorised/actual 1 800/1 754 |
| Centre of gravity | 389.7 cm, within permitted limits (388.0 and 409,5 cm) |
| Total operating time, hrs | 6 447.8 |
| Operating time since overhaul, hrs | 63.8 |
| Number of cycles | 19 092 total, 265 since inspection |
| Type and quantity of fuel on board at time of event | Jet A1, remaining quantity measured to be about 95 litres corresponding to 76 kg |
| ***Engine*** | |
| TC-holder | Turbomeca |
| Engine type | Arrius 2F |
| Number of engines | 1 |
| Serial number | 34302 |
| Total operating time, hrs | 4 487.8 |
| Flying time since latest overhaul, hrs | 1 723.8 |
| Flying time since latest inspection, hrs | 63.8 |
| ***Main rotor*** | |
| Type | Fully articulated, three-bladed |
| Serial number | M 301 |
| Total operating time, hrs | 4 487.8 |

| | |
|---|---|
| ***Tail rotor*** | |
| Type | Fenestron, eight-bladed |
| ***Open remarks*** | None |

The aircraft had a Certificate of Airworthiness and a valid ARC.

### 1.6.2 Description of parts or systems related to the accident

*Equipment for sling load*

The helicopter was equipped with equipment for sling load with a cargo hook of type Talon LC Keeperless from Onboard International. According to the flight manual, the cargo hook is to be inspected with regard to electrical and mechanical release before every flight with a sling load.

Release can be performed in two ways, electrically or mechanically. Electrical release is performed by depressing the cyclic stick's upper right button. Mechanical release is performed by depressing a handle on the underside of the collective lever that is connected to a release cable.

*FLI*

The FLI is an instrument that, in flight, displays the most limiting of three operating values, namely NG (gas generator RPM), T4 (gas generator temperature) or TRQ (torque). The FLI scale is graduated from 0 to 11, while the respective operating values are displayed on the instrument's right side. At the value of 10, there is a red radial mark indicating the maximum take-off power, and at the value of 10.8, a red triangle indicating the maximum transient power (see Figure 1).

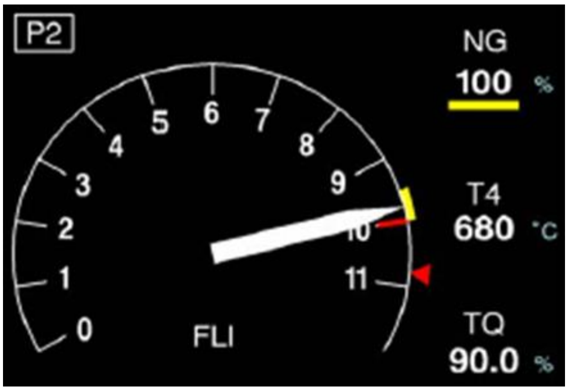


Figure 1. The FLI.

## 1.7 Meteorological information

### *1.7.1 General*

According to SMHI’s analysis: Wind north to northeast 15-25 kts, visibility down to 2 000 metres in snow or sleet, probable cloud bases between 1 000 and 2 000 feet, temperature/dew point +1/0 °C, QNH 1015 hPa.

It was daylight at the time of the accident and visibility was good outside snow showers.

### *1.7.2 Mechanical turbulence in mountainous terrain*

It is generally known that turbulence and downdraught occur on the leeward side of mountains.

Wind friction against an uneven ground surface causes disruption to the air stream, with turbulence as a result. The turbulence on the leeward side of a mountain means that air movement is no longer parallel to the ground, but behaves in a disordered manner. As a result of this, downdraught, among other things, can occur.

## 1.8 Aids to navigation

Not applicable.

## 1.9 Communications

Not applicable.

## 1.10 Aerodrome information

Not applicable.

## 1.11 Flight recorders

The helicopter was equipped with two GPS[7] units and a Vehicle and Engine Multifunction Display (VEMD). There are no CVR[8]/FDR[9] requirements for the helicopter type.

The GPS and VEMD units were placed on the instrument panel and exhibited no visible damage. The units contained memory circuits that retain recorded data even in powerless state.

### *1.11.1 Flight Data Recorder (GPS and VEMD)*

A GPS, which was of type Garmin 295, and VEMD have been secured and data read. The units were transported to the BEA, where

[7] GPS – Global Positioning System, often referred to as satellite navigation system.
[8] CVR – Cockpit Voice Recorder.
[9] FDR – Flight Data Recorder.

data were compiled and processed. See also Sections 1.16.1 and 1.16.2.

## 1.12 Accident site and aircraft wreckage

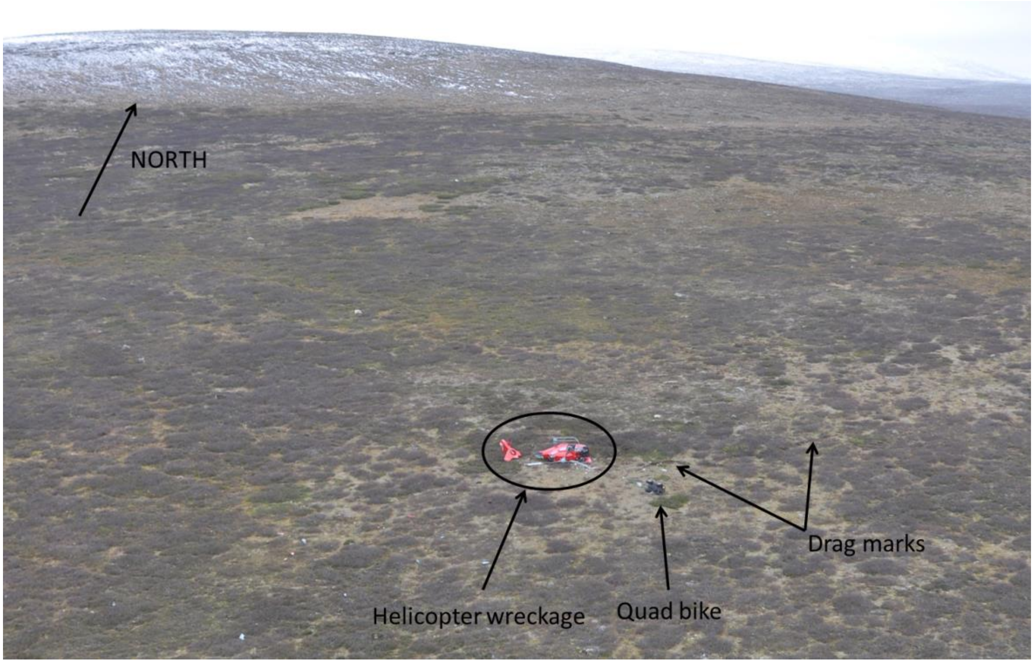


Figure 2. The accident site with the helicopter wreckage and quad bike/ATV. Photo taken the day after the event.

### *1.12.1 Accident site*

The accident site is located in low mountainous terrain, about 85 kilometres north of Kiruna, east-southeast of the Gaíku peak. Figure 3 below shows that the route from the completed turn up until the accident site went between the contour lines for 730 metres and 720 metres above sea level.

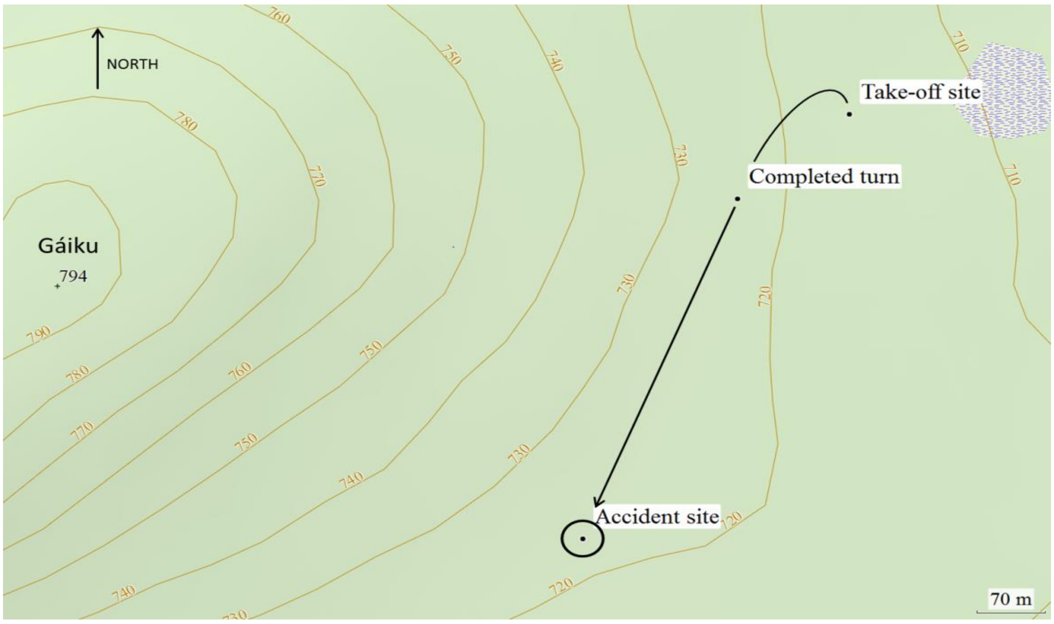


Figure 3. Map with route based on GPS data and contour lines. Image from Garmin BaseCamp and Recreational map Pro v3. Map data © Lantmäteriet Dnr R61749_13002.

### 1.12.2 *Aircraft wreckage*

The wreckage was examined on site by SHK the day after the event. The helicopter was lying on its right side, with the fuselage directed towards the northeast (see Figure 4 below).

The front part of the helicopter had damage to both front windows, the right front door pillar, the right part of the floor at the pilot seat and to the right landing skid. The right door had separated and was lying partly under the helicopter.

The rotor blades and rotor hub were damaged. Parts of the rotor blades had separated.

The tail boom had separated from the fuselage but was still connected to it by means of tubes and cabling.

Wreckage parts were found up to about 60 metres from the helicopter, mainly in a southwesterly direction. The pitot tube[10], which was mounted under the nose, had separated and was found about 10 metres to the northeast in front of the helicopter.

The quad bike had lighter damage and was still connected to the helicopter's cargo hook by the sling load cable and four straps. The cable was taut and ran from the cargo hook along the ground under the front part of the helicopter.

The pilot and passenger seats were intact. All safety belts were undamaged and fully functional. The pilot seat's collective lever was in its upper position with the throttle in the “flight” position. The pilot seat's collective lever, cyclic stick and pedals had become stuck in their positions. The left seat's pedals had full movement and were intentionally disconnected.

The instrument panel's components exhibited no visible damage. The button for arming the release of the cargo hook was depressed. The fuel shut-off handle on the ceiling was in the off position.

Following examination of the accident site, the wreckage was transported by helicopter to Kallax Flyg AB's hangar in Piteå.

[10]A pitot tube is a pressure sensor that enables measurement of an aircraft's airspeed.

Figure 4. The helicopter at the crash site with sling load cable and straps in the foreground (Photo Kallax Flyg AB).

## 1.13 Medical information

Nothing indicates that the mental and physical condition of the pilot was impaired before or during the flight.

## 1.14 Fire

There was no fire.

## 1.15 Survival aspects

### *1.15.1 The rescue operation*

Provisions on rescue services are found primarily in the Civil Protection Act (2003:778, Swedish abbrev. LSO) and the Civil Protection Ordinance (2003:789, Swedish abbrev. FSO).

According to Chapter 1, Section 2, first paragraph of LSO, the term “rescue services” denotes the rescue operations for which central government or municipalities shall be responsible in the event of accidents and imminent danger of accidents in order to prevent and limit injury to persons and damage to property and the environment. Central government is responsible for mountain rescue services, air rescue services, sea rescue services, environmental rescue services at sea, and rescue services in case of the emission of radioactive substances and for searching for missing persons in certain cases. In other cases, the municipality concerned is responsible for the rescue services (Chapter 3, Section 7, LSO).

When the accident became known at the aviation company, the Flight Operations Manager contacted SOS Alarm via 112. The call was forwarded to JRCC[11]. From the information provided, it emerged that a helicopter had crashed in the mountain area north of Kiruna and south of Råstojaure. No injuries to persons had arisen, and those on board were to be collected by their own aviation company.

From SOS Alarm, information about the event was provided to the rescue services in Kiruna. The head of the operation in Kiruna made the assessment that there was no basis for a municipal rescue operation in light of the information received. From JRCC, the Police Authority in Norrbotten was contacted and was informed of the crash, which had occurred within the area for mountain rescue services. The police assessed the event to be a workplace accident.

The ELT[12] of type KANNAD 406 AF-H was activated during the accident and was deactivated by the pilot.

### *1.15.2 Positions and injuries of those on board and the use of belts*

The assistant in the left front seat sustained a superficial cut to one hand during the evacuation. No other injuries arose. All on board, except the dog, had functioning safety belts fastened during the event.

### *1.15.3 Evacuation*

The evacuation was commenced immediately after the helicopter had stopped. The assistant, the passenger and the dog exited the helicopter first. The pilot shut down the engine and electrical system and then himself exited the helicopter, taking the fire extinguisher out with him.

## 1.16 Tests and research

### *1.16.1 Examination of the GPS*

Data from the GPS unit has been analysed by the BEA and converted into a file format that makes it possible to visualise the GPS track with the programme Google Earth (see Figure 5 below). Specified heights taken from GPS data are given in metres above sea level and are not accurate enough to be considered as precise values. The flight in question is shown in purple and the preceding landing in yellow. The GPS track of the flight in question shows that the route from the completed turn up until the accident site has a direction of approximately 200 degrees.

[11] JRCC – Joint Rescue Coordination Centre.
[12] ELT – Emergency Locator Transmitter.


Figure 5. Visualisation of GPS data. The crash site is in the bottom left. Image from Google Earth. Map data © Lantmäteriet Ref no R61749_13002.

### *1.16.2 Examination of the VEMD*

Data from the VEMD unit has been analysed by the BEA and shows no exceeded engine values, neither recorded failures during the flight in question and outside the accident sequence.

### *1.16.3 Examination of the helicopter wreckage*

*General*
After examination at the site the helicopter wreckage was left with the operator. A closer examination of the wreckage was performed some time thereafter at the operator's hangar in Piteå. Besides SHK, the examination was attended by the BEA's team and Kallax Flyg's Maintenance Manager.

*Fuel*
The wreckage was emptied of fuel. The fuel was measured to be about 95 litres, corresponding to 76 kg, and was clear and free from visible contaminants.

*Landing gear*
The right skid exhibited both impact and scrape damage to its front upward part. The right skid's tube was deformed at its front mounting. The deformation showed that the damage was caused by a longitudinal load that was compatible with the impact damage to the front upward part. The rear part of the right footstep had impact damage level with the rear cross-tube.

*Fuselage*
The front part of the fuselage was deformed. The left door could not be closed. Both windshields were smashed. The right door and associated front doorpost had separated from the fuselage. The nose of the fuselage was principally damaged on the right side. The right front

part of the cabin floor was damaged, and one of the pedals was broken off.

The tail boom was separated from the fuselage. Both the tail boom and parts of the engine cowling exhibited signs of damage from a main rotor blade.

*Seats*
The front seats, which are energy-absorbent, exhibited no signs of deformation.

*Main rotor*
The main rotor's three blades and associated components on the rotor hub are colour-coded in blue, yellow and red.

The three rotor blades exhibited substantial damage. The outer parts of the blade tips could not be found. The trailing edges of the blades were delaminated. The yellow and the red blades had damage to the leading edge, were broken off and exhibited traces of contact with the tail boom and engine cowling. The yellow blade's mounting exhibited fracture damage caused by a downward bending moment.

All components of the rotor head were correctly interlinked.

The blue frequency adapter had traction damage that was compatible with an inertia drag load. The rotor head had instances of damage that were consistent with the blades' great rotational and vertical movements. The pitch rods' lower fittings were bent. The drop restraining ring and drop restrainers exhibited severe damage, corresponding to the effect that could be expected of rotor blades moving downwards with high energy. This was especially true of the yellow blade.

*Main rotor gear*
The main rotor gear exhibited no visible damage and rotated freely. The oil level was normal. Filters and chip detectors had no contaminants.

*Main gear box support bars*
The two rear bars exhibited deformation in compression, which is consistent with a rotor blade contact with the ground in a position in front of the helicopter.

*Drive shaft for engine/main rotor gear and for tail rotor*
The drive shaft had been twisted off through overloading caused by a sudden blade stop. The tail rotor drive shaft exhibited damage that can have been caused by a rotor blade.

*Tail gear box and tail rotor hub*
These parts were undamaged. The oil had run out due to the helicopter overturning. The oil restrainer and chip detectors had no contaminants.

*Engine*
The engine's rear mount was damaged and partially broken off. The deformation shows that the engine has been subjected to a rearward force of the same character as the rotor gearbox. The engine's outlet pipe had come loose and exhibited damage caused by a rotor blade. Fuel and oil filters and chip detectors were free from contaminants. The engine's moving parts rotated freely and without abnormal sounds. The air intake grid was partially covered with small red particles from the engine cowling, which indicates that the engine was running during impact.

*Engine controls*
The throttle on the collective lever was locked in the flight position. The cable between the controls and the engine was bent, probably as a result of the impact, and blocked the throttle. The emergency fuel shut-off handle was in its rear, off position.

*Fuel system*
The fuel system exhibited no damage. The electrical starting pump functioned when powered up with an external power source.

*Control system and hydraulic system*
All components were in place and correctly interlinked. The collective lever and cyclic stick had freedom of movement and activated servos and rotor blades properly. The pedals were stuck, probably due to damage caused by the broken off tail boom and associated control cable.

The hydraulic system had been partially emptied of oil as a result of the helicopter overturning. The remaining oil, screen and chip detector were free from visible contaminants.

*External sling device*
The mechanical and electrical release functions of the sling hook were tested and worked without remark.

*Conclusions of the examination*
The examination has not shown any signs of malfunction prior to impact. All the damage has arisen as a result of ground contact at low energy with functioning drive units.

The BEA has reported the result of the examination that indicates the following probable sequence:

a) The impact took place at low energy with a nose-down attitude with roll to the right.
b) The helicopter turned over the nose.
c) The rotor blades were damaged by contact with the ground in front of the helicopter.
d) The overload on mechanical components damaged the engine's drive shaft and led to a torsion failure.
e) The yellow rotor blade flapped more than the two other blades due to the decreased rotor speed and to the helicopter overturning.
f) The yellow blade struck the engine cowling, the outlet pipe and the tail boom.
g) The helicopter turned over on the right side.

### *1.16.4 Examination of the helicopter's performance*

The operator has stated the gross mass to be 1 743 kg of which 65 kg was fuel. However, measurement of remaining fuel has shown that 76 kg of fuel remained after the crash. Fuel consumption during the flight in question has been calculated to be 4 kg, which means that the actual mass at take-off should have amounted to 1 758 kg, while the gross mass at the time of the accident was 1 754 kg. With an external sling load, the maximum authorised gross mass is 1 800 kg.

Hovering can be performed in or out of ground effect. Hovering out of ground effect denotes hovering at a height that exceeds the main rotor diameter.

The BEA has presented performance calculations that show that the rate of climb while hovering out of ground effect under the prevailing conditions could amount to more than 200 feet/min at maximum take-off power (103% TRQ, corresponding to FLI 10). The pilot has stated that maximum take-off power was used.

The helicopter type also has a maximum permitted transient power output that may be utilised and that amounts to 110% TRQ, corresponding to FLI 10.8. As a consequence, specific maintenance shall be applied after the flight.

If the power output had exceeded 103% during more than 1.5 seconds, this would have been leading to an audio signal in the pilot's headset. If the power output had exceeded 110%, this would have been registered on the VEMD unit.

A maximum raise of the collective stick would have led to a torque higher than 110% under the conditions in question and would theoretically have made possible a further improved rate of climb.

The operator has stated that the pilots had been informed orally of the two latter engine powers, and that their use is not included in the practical training as this entails mandatory maintenance measures.

The pilot has declared that he had never used these engine powers and that he assessed additional engine power not to be needed during the event in question.

## 1.17 Organisational and management information

Kallax Flyg AB engages in aerial work with helicopters and seaplanes. The company also engages in work with helicopters and aircraft that includes aerial photography, wildlife inventory, reindeer herding, power line inspection/troubleshooting and flights with sling load.

At the time of the event, Kallax Flyg AB had a valid AOC (Air Operator Certificate).

## 1.18 Additional information

### *1.18.1 Translational lift*

Translational lift constitutes an increased lift that arises in horizontal motion relative to the air mass.

### *1.18.2 Training in flying with sling loads*

The Swedish Transport Agency has not issued any regulation that describes what a training plan for flying with sling loads shall contain. The operator submits a draft training plan which is then approved by the Swedish Transport Agency.

The training plan that was valid at the time of the event did not contain any element in which the emergency release of a sling load is practised. The training plan also does not include any self-briefing, such as mental preparation, in immediate connection to flights with a sling load.

In interviews, the pilot has stated that he had not previously executed the emergency release of a sling load, either in practice or in a live situation.

### *1.18.3 Measures taken by the operator after the accident*

The operator has reported the event to the Swedish Transport Agency and declared that it has taken the measures below.

The company engaged a psychologist for debriefing with the pilot. Besides this, the company has entered an agreement with the same psychologist for future needs.

The company has revised its emergency response plan and action plan.

Theory briefings, inter alia, have been implemented with regard to aerodynamics, helicopter limitations, wind influence, vortex ring state and assignment preparations, particularly in terms of work with sling loads.

A mast (about 50 m) has been acquired for recurrent training with regard to long-line operations and vertical reference flight.

All pilots must perform drills of flying with a water bucket, which deals, inter alia, with maintaining position over water.

## 1.19 Special methods of investigation

Not applicable.

# 2. ANALYSIS

## 2.1 Circumstances

### *2.1.1 The pilot*

The pilot's training and experience met the requirements placed by the Swedish Transport Agency and the operator. The pilot had also carried out a proficiency check two weeks prior to the event, which included flight with a sling load. The pilot's decision to conduct the sling load operation during the last part of the sortie shows that he was aware of the limitations regarding actual gross mass.

### *2.1.2 The helicopter*

The technical examination of the helicopter at the crash site, and later at the hangar, has not shown that there were any malfunctions before the accident. SHK believes that the sequence presented in section 1.16.3 is very consistent with what has emerged through interviews and technical examinations.

## 2.2 The flight with a sling load

### *2.2.1 The take-off*

Analysis of the GPS tracks shows that the direction of take-off was westerly. The wind was gusty and variable between north and northeast. The pilot stated that he took off in head wind. This can be explained by the helicopter hovering up on a northerly heading and obtaining a positive speed increase in the headwind without any forward motion over the ground having time to be registered.

A contributing factor to the low power requirements for hovering before take-off was probably the gusty, variable wind that contributed translational lift.

### 2.2.2 Left turn in tailwind

When the pilot experienced the unexpected height reduction, which was countered by maximum power output, a left turn was initiated. The relative wind thereby went from a crosswind component to tailwind. The surrounding topography may also have entailed a certain downdraught.

The helicopter had a power reserve that was not utilised, which can be explained by the pilot assuming it was not necessary in the situation that had arisen.

The tailwind component, and probably the effect of a downdraught, resulted in the translational lift ceasing and the helicopter beginning to descend.

Once the quad bike began to drag in the ground, it constituted a resistance that completely prevented further flight.

The pilot brought the cyclic stick towards him in order to perform a flare before impact and thereby decreased the nose-down attitude. This probably contributed to mitigate the damage in the accident.

The pilot has stated that he perceived the terrain to be inclined. After closer examination, SHK is able to note that there is virtually no height difference in the terrain from the completed turn up until the place where the quad bike began to drag in the ground.

Misjudgements of the nature of terrain in connection with low-level flight can arise even under favourable weather conditions and over low-lying terrain. It cannot be ruled out that small changes in the vegetation, the lack of regular structure, a partially indistinct horizon and irregular snow cover affected the pilot's judgement through the creation of a visual illusion, i.e. a false perception, of inclined terrain[13].

### 2.2.3 Non-initiation of emergency release of the sling load

The pilot had two different possibilities for initiating the emergency release of the sling load, either by depressing a button on the cyclic stick or by operating a separate handle on the collective lever. Despite this, the load was not released before it gained contact with the ground.

In SHK's interviews, the pilot has given different details of why he did not release the sling load. He has recounted that he groped after the emergency release button but he has also expressed that he did not even have time to think about the cable. One likely scenario is that the pilot was so focused on flying the helicopter in the situation that had

[13] Zarchan. P. (2004) *Spatial Disorientation in Aviation*. American Institute of Aeronautics and Astronautics, INC.

suddenly changed for the worse that he never commenced any motor movement of the thumb to initiate emergency release.

The pilot had not previously executed the emergency release of a sling load in practice or in a live situation. He was therefore not prepared for instinctively implementing such a measure.

One factor that may have influenced the sequence is shortcomings in planning in the form of a mental review ahead of the specific assignment. Such planning would probably have facilitated decision-making, stimulated reaction patterns, but also supplied a readiness to act in the event of an emergency[14].

The prioritising of the pilot's focus on first improving the flying situation in preference to executing an emergency release of the sling load was a natural reaction. For this reason, SHK wants to stress the importance, ahead of similar assignments, of working methodically and proactively with a mental run-through in direct connection with flying but also of conducting realistic exercises to the extent possible in order to further stimulate the mental process towards instinctive action.

One of the accompanying persons was the driver of the quad bike that was being transported beneath the helicopter. This may have contributed to and influenced the pilot to more or less unconsciously attempt to save the quad bike, which may have constituted a further contributing factor to the non-initiation of emergency release of the sling load.

To prevent a similar event from occurring again, SHK believes that there is reason to promote safety measures that aim to supplement the training of helicopter pilots when flying with sling loads.

# 3. CONCLUSIONS

## 3.1 Findings

a) The pilot was qualified to perform the flight.
b) The helicopter had a Certificate of Airworthiness and a valid ARC.
c) Nothing indicates that there was any technical malfunction.
d) The cargo hook was armed, and the release functions were functional before the flight and at the subsequent technical examination.
e) The helicopter was flown into tailwind.
f) The load remained coupled.

[14] Smith. D. (2001). *Controlling Pilot Error*. New York.: McGraw-Hill.

## 3.2 Causes/Contributing Factors

The accident was caused by underestimation of the assignment's degree of difficulty.

Contributing factors were misjudgement of the wind direction and terrain inclination.

## 4. SAFETY RECOMMENDATIONS

The Swedish Transport Agency is recommended to ensure that:

- Operators engaging in flight with sling loads conduct practical exercises of simulated emergency release in their training. *(RL 2014:08 R1)*

SHK respectfully requests to receive, **by September 11 2014** at the latest, information regarding measures taken in response to the recommendations included in this report.

On behalf of the Swedish Accident Investigation Authority,

Jonas Bäckstrand                    Nicolas Seger