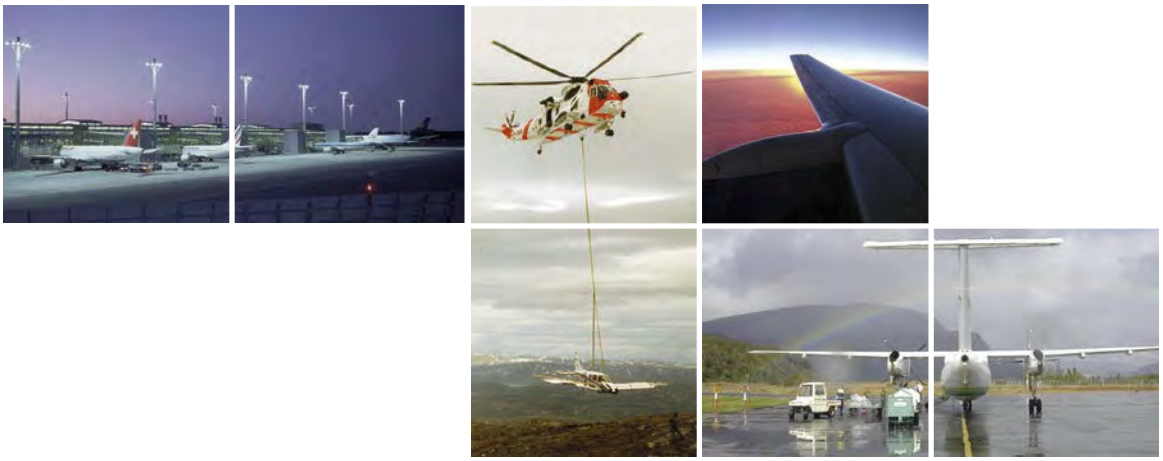
aibn Accident Investigation Board Norway

Issued December 2013

REPORT SL 2013/30



REPORT ON AIR ACCIDENT SOUTHEAST OF MOSJØEN NORWAY 11 JANUARY 2012 WITH ROBINSON HELICOPTER R44, SE-JPZ, OPERATED BY JÄMTLANDS FLYG AB

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As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photos: AIBN and Trond Isaksen/OSL

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AIR ACCIDENT REPORT

Aircraft:	Robinson Helicopter Company R44 II
Nationality and registration:	Swedish, SE-JPZ
Owner:	Jämtland Helikopter AB, Sweden
Operator:	Jämtlands Flyg AB, Sweden
Accident site:	Southeast of Mosjøen, Nordland County, Norway (65°46'46''N 013°18'21''E)
Accident time:	Wednesday, 11 January 2012 at 1707 hours

All hours stated in this report are local time (UTC + 1 hour) unless otherwise indicated.

NOTIFICATION

On 11 January 2012 at 1839 hrs., Bodø Air Traffic Control Centre called and notified the officer on duty at the Accident Investigation Board Norway (AIBN) that a Robinson R44 helicopter with registration SE-JPZ with two persons on board was missing. The helicopter was operated by Jämtlands Flyg, Sweden and was on a reindeer herding flight near Mosjøen. The company notified the Air Traffic Services when the GPS tracker (flight-following system) on SE-JPZ stopped transmitting. At the same time, the Joint Rescue Coordination Centre in Northern Norway (HRS N) received an emergency transmitter signal from the area and notified AIBN. Two accident inspectors from AIBN and an accident inspector from the Swedish Accident Investigation Authority (SHK) went to the crash site the next day.

In accordance with ICAO Annex 13, Aircraft Accident and Incident Investigation, the AIBN notified the authorities in state of manufacture, the US, and the state of registry, Sweden, about the incident. The US National Transportation Safety Board (NTSB) and the SHK appointed accredited representatives to assist in the investigation.

SUMMARY

A Swedish helicopter of the Robinson R44 type had been hired to herd reindeer from an area south of Mosjøen to Sjåmoen. Two of the reindeer owners herded the reindeer by snowmobile and the third reindeer owner was on board the helicopter. The work was concluded at about 1520 hours on the first day. On the second day, the work continued in darkness under adverse weather conditions, and with visibility at times being reduced by snow showers. The Accident Investigation Board believes that it is probable that the commander lost control of the helicopter in darkness due to loss of visual references. The helicopter hit the ground with a large left roll and at a steep angle. The two persons on board died immediately as a result of extensive injuries. No technical faults on the helicopter were found to explain the accident.

The Accident Investigation Board has not made any safety recommendations in connection with the investigation.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The reindeer herd of three reindeer owners had for a period been in the lowlands a few kilometres south of Mosjøen. The intention had been to herd the animals to Sjåmoen northeast of Mosjøen earlier in winter, but this work had become delayed. In the last days preceding the flight, several reindeer had been hit by the train, and moving them was considered urgent (see Figure 1).

1.1.2 The three reindeer owners had hired Jämtlands Flyg and the commander from Sweden several times before to help them drive the reindeer with helicopter. The helicopter arrived from Laisholm, Hemavan-Tärnaby in the morning of 10 January and the fuel tanks were full before the helicopter left the base. Driving the reindeer started at about 0850 hours. The reindeer herd was first gathered to prepare for driving them up and northeast the next day. Two of the reindeer owners drove the reindeer with snowmobiles. The third reindeer owner assisted the commander on board the helicopter. When the work had been concluded at about 1520 hours on the first day, the helicopter was flown towards Trofors and parked on the property of one of the two reindeer owners who drove the snowmobiles. The helicopter company's tracker shows that SE-JPZ landed there at 1527 hours. The commander spent the night at the house of the reindeer owner who was on board the helicopter.

1.1.3 The same commander had driven reindeer for the same reindeer owners in October the previous year. He then had two 200-litre barrels of fuel brought to the area. In connection with the job in January, the barrels were driven to the Granneset farm[1], which was used as a refuelling base. The commander also brought several 20-litre jerry cans in the helicopter when he arrived (see also Item 1.18.1). These were used to refuel the helicopter before departure from the reindeer owner's home on 11 January at 0933 hours.

1.1.4 During the night, another six reindeer had been killed by the train, and the job was urgent. According to the helicopter's GPS, the work continued until 1231 hours when the commander interrupted the work and landed on the farm to refuel from the barrels. The helicopter returned at 1250 hours and the reindeer driving continued. There was a lot of snow in the area, and snowmobile tracks were made in the snow to make it easier for the reindeer to move. There were several snow showers during the course of the day, and the helicopter often whirled up a lot of new snow.

1.1.5 At 1541 hours, the helicopter again returned to the Granneset farm to refuel. The commander then filled the remaining fuel. It is, however, probable that he put a full jerry can in the helicopter's cabin. The helicopter was on the ground for 6 minutes before lifting off again.

1.1.6 In time, the daylight faded (see Item 1.7.2.4). Briefly before the accident, the reindeer had been driven into flatter and more open terrain west of Svarttjønna. The commander then landed the helicopter in the snowmobile tracks behind the reindeer herd. The two reindeer owners who drove the snowmobiles are not entirely certain what was going on. However, they saw the rotor turning and that the passenger sat in the helicopter while the

[1] *Granneset lies along the E6 highway approx. 5 km south of Mosjøen and approx. 2 km west of the crash site (see also Fig. 1).*

commander disembarked and went back to the fuel tank. One of the reindeer owners has explained that the commander most likely was refuelling with one of the jerry cans on board the helicopter.

1.1.7 According to the helicopter's GPS, it was on the ground from 1657 to 1703 hours. The helicopter then took off and made some turns over the reindeer herd before continuing south (see Item 1.11.2). Due to darkness, the commander intermittently turned on the landing lights in the helicopter's nose. Sight of the helicopter was lost due to the terrain, but the two persons on the ground could clearly hear the sound of the engine. They assumed that the helicopter was following the tracks of a smaller breakaway herd when they heard a crash and everything went quiet. One of the snowmobile drivers described the sound as a large tree falling.

1.1.8 The two reindeer owners feared that the helicopter had crashed and drove the snowmobiles 50 – 100 metres in the direction where the helicopter disappeared. They hailed the reindeer owner in the helicopter using walkie-talkies, but received no reply. As they could not see or hear anything, they alerted the police and reported a possible helicopter crash. The also called the on-duty telephone at Jämtlands Flyg to report that something could have gone wrong.

1.1.9 The reindeer owners continued looking in the area, and smelled fuel after a while. By following the smell for about 50 metres they found the helicopter. When they got there, they saw that both persons on board had been killed.

Figure 1: Map of the area. The outskirts of Mosjøen can be seen at the top of the map. The railway is the black line on the east of the Vefsna river. Mosjøen airport Kjærstad lies west of the Vefsna river. The crash site is marked by a black arrow. The refuelling base on the Granneset farm lies about 2 km west of the crash site. Map data: Statens kartverk, Geovekst og kommuner

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatalities	1	1	2	
Serious				
Light/none				
TOTAL	1	1	2	

1.3 Damage to aircraft

The aircraft was destroyed, see 1.12 for details.

1.4 Other damage

Damage to some small trees.

1.5 Personnel information

1.5.1 The commander, a 62-year-old man, received his Private Pilot Licence for airplanes in 1983 and for helicopters in 1992. In 1993, he received his Commercial Pilot Licence (CPL(H)) for helicopters. The commander had previously worked for other helicopter companies in Sweden, including Lapplandsflyg and West Helicopter. He became an employee of Jämtlands Flyg AB in 2007. The commander had flown reindeer driving flights for the same reindeer owners also before becoming an employee of Jämtlands Flyg.

1.5.2 The commander was rated for the helicopter types AS 350, EC 120 and R44. He was rated for flying in darkness, but had no instrument rating. The rating for R44 was renewed on 26 November 2011 with a proficiency check (PC).

1.5.3 The commander held a class 1 medical certificate valid until 15 March 2012. The medical certificate had the limitation "VML – Shall wear multifocal lenses and carry a save set of spectacles." The medical certificate also had some limitations as regards commercial passenger transport[2].

1.5.4 According to the operative permits of Jämtlands Flyg AB, the commander had the following relevant permits associated with R44:

- Flying in darkness
- Low flying
- Flying in winter conditions
- Flying in mountainous terrain
- Reindeer driving

[2] *General limitations for everyone aged 60 or more*

1.5.5 The commander was the base manager at the company's Laisholm base in Hemavan-Tärnaby and performed most of the flights from this base. In addition to his occupation as a helicopter pilot, he was active in his community, where he operated a forestry machine, construction machines and snow clearing machinery. It had snowed a lot in Tärnaby when he was asked to fly reindeer driving flights in Norway, and he had stated that he had a bit too much to do. The commander was by many considered to be a committed and service-minded person. In retrospect, it has been pointed out that the commander's hesitation indicated that he was very busy.

1.5.6 The reindeer owners who hired the commander for the assignment described him as the best reindeer driver available.

1.5.7 The common-law wife of the reindeer owner who died in the accident has explained that the commander went to bed at 2300 hours in the evening before the accident. They ate a good breakfast the next morning and prepared lunches which they brought with them.

Table 2: Flying hours

Flying hours	All types	Relevant type
Last 24 hours	7	7
Last 3 days	16	16
Last 30 days	80	74
Last 90 days	204	191
Total	10 698	Not stated

1.6 Aircraft information

1.6.1 General information

1.6.1.1 Robinson R44 II is a light, piston-engine powered helicopter with four seats, two in front and two behind. The minimum crew is one pilot, sitting in the right front seat. The prototype first flew in 1990. The helicopter type has a two-blade main rotor rotating counter-clockwise, seen from above, and hydraulic-assist flight controls. The helicopter type has become very popular. In 2012, R44 was one of the most-produced helicopter types in the world with 286 aircraft.

1.6.1.2 SE-JPZ had an artificial horizon, but was otherwise not equipped for instrument flying. The helicopter type was not approved for flying under icing conditions. SE-JPZ was approved for flying in darkness and had instrument lights, as well as landing lights installed in the nose.

1.6.1.3 The company has stated that the helicopter typically uses about 55 litres of fuel per hour during reindeer driving. The helicopter's fuel tanks take 185 litres.

1.6.2 General data

Manufacturer and model:	Robinson Helicopter Company R44 II
Serial No.:	11407
Year of manufacture:	2006
Airworthiness Review Certificate:	Valid until 10 June 2012

Total flying hours:	1 416.5 hours[3]
Engine:	Lycoming Engines IO-540-AE1A5 of 245 hp
Diameter main rotor:	10.06 metres
The main rotor, maximum speed:	408 rpm
Fuel:	Avgas 100LL

1.6.3 Mass and balance

1.6.3.1 The helicopter was last weighed on 8 November 2010. It then had an empty mass of 696 kg with an arm of 105.5 inches. Below, the Accident Investigation Board has prepared mass and balance calculations based on discretionary assessments of equipment and fuel on board.

Table 3: Assumed mass and balance at the time of the accident

	Weight (kg)	Mass (pounds)	Arm (inches)	Longitudinal moment (pounds x inches)
The helicopter's mass empty	696	1 534.4	105.5	161 879.2
Pilot and equipment (HF)	87+4	200.6	49.5	9 929.7
Passenger and equipment (VF)	93+4	213.8	49.5	10 583.1
Equipment (HB)	15	33	79.5	2 623.5
Fuel	25	55.1	106	5 840.6
Mass	**924**	2037	**93.7**	190 856

1.6.3.2 With the relevant mass, the limitations for the location of the centre of gravity (arm) are 92 – 102.5 inches. Maximum take-off mass is 1 134 kg. Both mass and balance were therefore within the applicable limitations.

1.6.4 Maintenance

All maintenance on SE-JPZ was performed under the auspices of the company's Part 145 organisation at the main base in Östersund. The following relevant inspections/maintenance tasks had recently been performed on the helicopter:

- On 16 December 2011, at 1 352.0 hours total: 100-hour inspection and Lycoming Service Bulletin 388. The inspection included spark plug and magnet inspection and control of the ignition timing. No spark plugs were replaced in connection with the inspection.

- On 4 January 2012, at total 1 387.2 hours total: 50-hour inspection. The inspection included changing the engine oil and replacing the oil filter. There is no requirement for checking the spark plugs unless there have been problems with the ignition system.

[3] *There is uncertainty pertaining to the dating and completion of the flight log for SE-JPZ for the last two days.*

- 10 January 2012, at 1 409.5 hours total: Most recent inspection before the crash. The inspection form was signed by the commander at the helicopter base in Laisholm near Tärnaby. According to the flight log/technical log, there were no technical problems or faults with the helicopter at the time.

1.7 Meteorological information

1.7.1 General

The Accident Investigation Board has obtained weather information from the Norwegian Meteorological Institute, the weather service for Northern Norway. In a report prepared in connection with the accident, the general weather situation at the time of the accident is described as follows:

> *A low pressure of 970 hPa in the sea midway between Helgoland and Iceland moved east. This low pressure resulted in wind from the southwest on Helgoland, with wind speed at ground level of up to 35 knots on the coast, and up to 20 knots inland. There were heavy snow and hail showers in the area with a lot of CB activity, and up to 1400 hours, there was also some thunder.*
>
> ---
>
> *ENMS reported calm wind conditions during the time of the crash (1715 hours). The wind direction was varying from the south-southeast, and the wind speed was 7 knots or less for the entire afternoon. The mountain anemometer located at 412 feet altitude showed only 2-4 knots. However, there were snow showers in the area throughout the day with varying visibility, with the lowest observed visibility being 1000 metres towards the south at 1450 hours. The temperature at the airport was -1 to -2 degrees C. Due to instability, we believe that the temperature fell by 1 degree per 100 metres up into the atmosphere. During the 12-hour period from 11 January at 0700 hours to 11 January at 1900 hours, 5 mm of precipitation fell in Mosjøen, 11 mm at Laksfors (25 km south of ENMS) and 6 mm in Varntresk by Lake Røssvatnet.*
>
> *Enclosed radar image of precipitation shows that snow showers were passing over the Mosjøen area at 1700 hours. These showers covered the area somewhat west of the airport and east towards Lake Røssvatnet. At 1715 hours, it stopped snowing at the airport, but the shower still covered the area just east of the airport and extending some distance over Lake Røssvatnet. At 1730 hours, the image was approximately the same. Mosjøen lies at the extreme reach of the radars on Røst and in Rissa, and some precipitation in this area is therefore not captured on the radars due to distance to the radars and mountains. However, the radar images showed heavy snow showers in the area.*

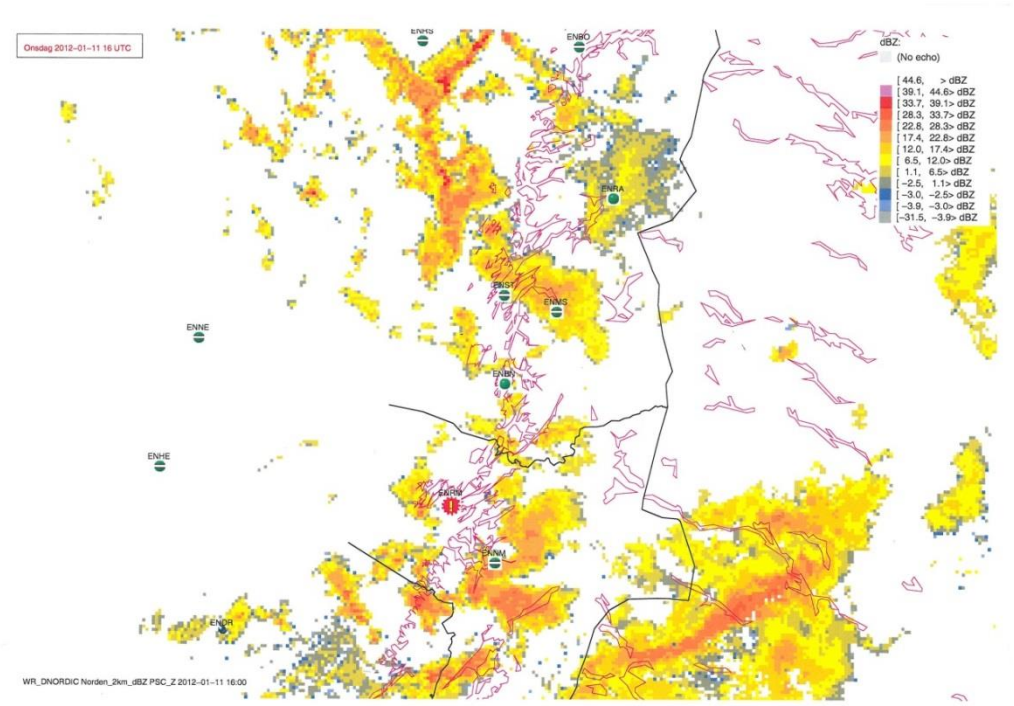

Figure 2: Radar image of precipitation in the Mosjøen (ENMS) area at 1700 hours. Source: Norwegian Meteorological Institute

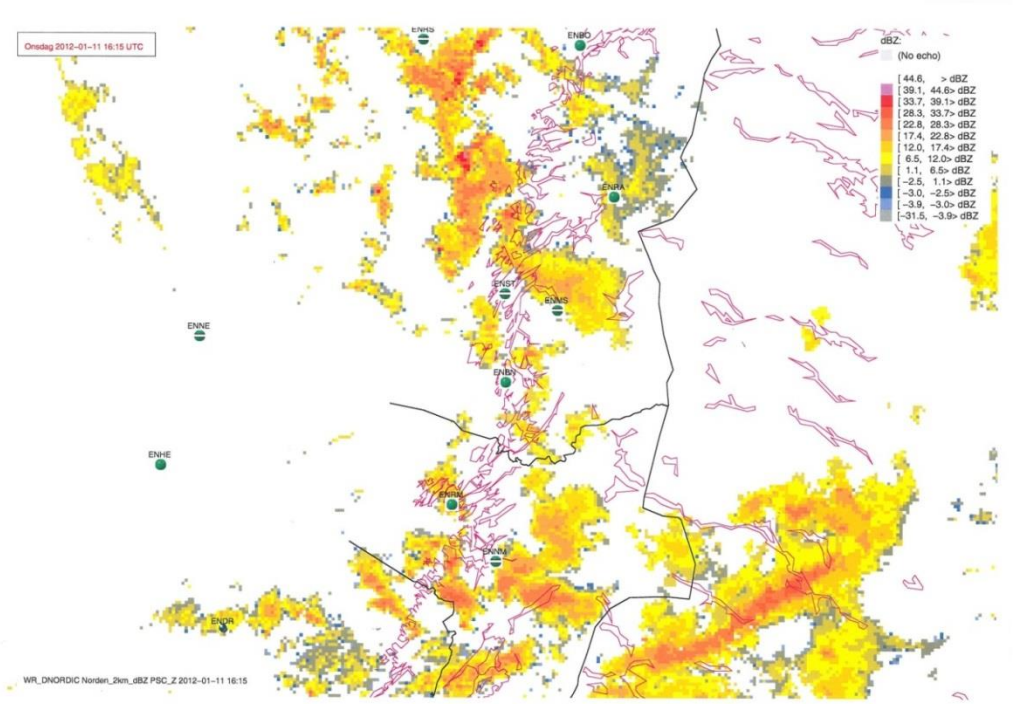

Figure 3: Radar image of precipitation in the Mosjøen area 15 minutes later at 1715 hours. Source: Norwegian Meteorological Institute

1.7.2 Official flight weather data[4]

1.7.2.1 *METAR (the accident happened at 1607 hours UTC)*

ENMS 111550Z VRB02KT 6000 -SN SCT009 BKN016 M01/M02 Q0990 RMK WIND 412FT VRB02KT=

ENMS 111650Z VRB02KT 9999 VCSH SCT024 M02/M03 Q0991 RMK WIND 412FT 18003KT=

1.7.2.2 *TAF*

TAF is not published for Mosjøen airport Kjærstad.

1.7.2.3 *IGA Prognosis*

ZCZC
FBNO45 ENMI 111301
IGA PROG VALID 111400-112400 UTC Jan12 NORWAY FIR N OF N6500

NORDLAND COASTAL AND FJORD DISTRICTS
WIND SFC.....: S-SW/05-20KT, LCA 30KT COT
WIND 2000FT.....: SW/10-35KT
WIND/TEMP FL 050....: 240/20-40KT/MS08
WIND/TEMP FL 100....: 240/25-45KT/MS19
WX.....: SHSN/SHNSRA/SHSNGS. RISK TS COT S PART
VIS.....: 0.3-6KM IN WX, ELSE +10KM
CLD.....: SCT/BKN 2000-4000FT, LCA TCU/CB 1200FT, LCA BKN/VV 0400-1000FT IN WX
0-ISOTHERM.....: SFC-2500FT
ICE.....: LCA MOD ASSW TCU/CB
TURB.....: LCA MOD
OUTLOOK FOR TOMORROW: S OF N6600: EARLY W-NW/25-40KT, SHSN/SHSNGS, RISK TS. LATER N/10-20KT. SCT SHSN COT.
N OF N6600: NE-SE/10-20KT. WX NIL.

1.7.2.4 *Sunset*

The sun went down at 1421 hours at the crash site on the day of the accident. Dusk lasted until 1543 hours[5].

1.7.3 Witness observations

1.7.3.1 The two reindeer owners saw some snow showers during the day, but this did not cause them to stop driving the reindeer. The helicopter also whirled up some snow when it was close, so that the snow in the air was not noticed much. Blue sky was observed intermittently. They could not specify when it grew dark, but noted that the helicopter

[4] *Decoding of meteorological abbreviations, see: https://www.ippc.no/ippc/help_met.jsp and https://www.ippc.no/ippc/help_metabbreviations.jsp*
[5] *Source: Tables issued by the U.S. Naval Observatory in Washington DC*

used its landing lights intermittently before the accident. When the landing lights were not lit, they clearly saw the red, green and white navigation lights on the helicopter.

1.7.3.2 The reindeer herd passed a witness some time before the accident. He explained to the Accident Investigation Board that there was both snow and hail in the air, and that visibility at times was down to 100 metres. Visibility was good when the snow showers abated. Over the course of the morning, an estimated 10 cm of snow fell, which he was out clearing when he heard the helicopter. He has explained that the sound of the helicopter ceased abruptly at a time which correlates well with the time of the accident.

1.7.3.3 The commander of WIF756, who landed at Mosjøen airport Kjærstad (ENMS) at 1722 hours, has described the weather as follows:

> *We flew in from the south on flight WF756 from TRD. Hardly any wind, but reduced visibility due to dense snow showers. A colleague flying ahead of us just managed to get the necessary visual references, and landed. We came right behind him, but could not see lights or the runway and executed a standard missed approach procedure. After some minutes holding over Laksfors NDB, the shower abated and we landed on runway 34. It then snowed for a while, and we had to de-ice the aircraft before departure. When it was time for our departure, the shower had passed and we took off towards the north on runway 34 with good visibility.*

1.7.3.4 A helicopter pilot familiar with the area stated after the accident that flying a helicopter in the area on the day in question had at times not been safe, due to the sporadic heavy snow showers in the area.

1.7.3.5 A helicopter from State Air Ambulance Service destined for the crash site took off from Brønnøysund Airport (ENBN) at 1747 hours. The crew had planned to follow the standard flight path via Ylvingen, Tjøtta, Vefsnfjorden and in to Mosjøen. However, on approaching Tjøtta they had to turn back due to snow showers and poor visibility. An attempt to fly on top at 7 000 feet was not successful due to solid cloud cover above Mosjøen. The mission was therefore cancelled at approx. 1815 hours.

1.7.3.6 One of the Armed Forces' Sea King SAR helicopters took off from Bodø Main Air station (ENBO) at 1750 hours. They encountered some small showers during the flight, but had no trouble operating VFR in the Mosjøen area with night vision goggles (NVG).

1.8 Aids to navigation

Navigation was by visual references, possibly supported by GPS.

1.9 Communications

1.9.1 The commander had been in contact with Air Traffic Services at Mosjøen airport Kjærstad early in the day. The Air Traffic Services therefore knew that the helicopter was engaged in driving reindeer at low altitude in the Traffic Information Zone (TIZ). There was no contact between Air Traffic Services and the commander in the time prior to the accident.

1.9.2 The reindeer owners on the ground and the reindeer owner in the helicopter had two-way radio communication (walkie-talkie), which they used to coordinate driving the reindeer.

The communication units were connected to ear plugs inside the ear protection to enable communication in spite of the noise from the snowmobiles and the helicopter. The commander and the reindeer owner in the helicopter could communicate via the helicopter's intercom.

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

1.11.1 Flight recorders were not mandatory and not installed in this type of aircraft.

1.11.2 The helicopter was equipped with a Garmin 296 GPS. Data obtained from the tracker in the unit has shown the following (see also Figure 4):

- The helicopter was on the ground for a brief period between 1657 and 1703 hours
- The last registration was at 17:07:34 hours. The helicopter was then approx. 230 feet (70 m) above ground with a heading of approx. 020º.
- In the last 20 seconds before the crash, the helicopter rose 318 feet (97 metres), initially almost vertically.
- 8 seconds before the last registration, the helicopter rose by 625 ft/min, but this became a descent of 260 ft/min over the last three registered seconds.
- Over the last 22 registered seconds, the helicopter turned from a heading of approx. 216º to 020º.
- Over the last 22 registered seconds, the ground speed of the helicopter was 49 kt on average.
- Over the last three registered seconds, the ground speed was 58 kt on average.
- The last registered position was 65º 46’ 42.53” N 013º 18’ 17.10” E.

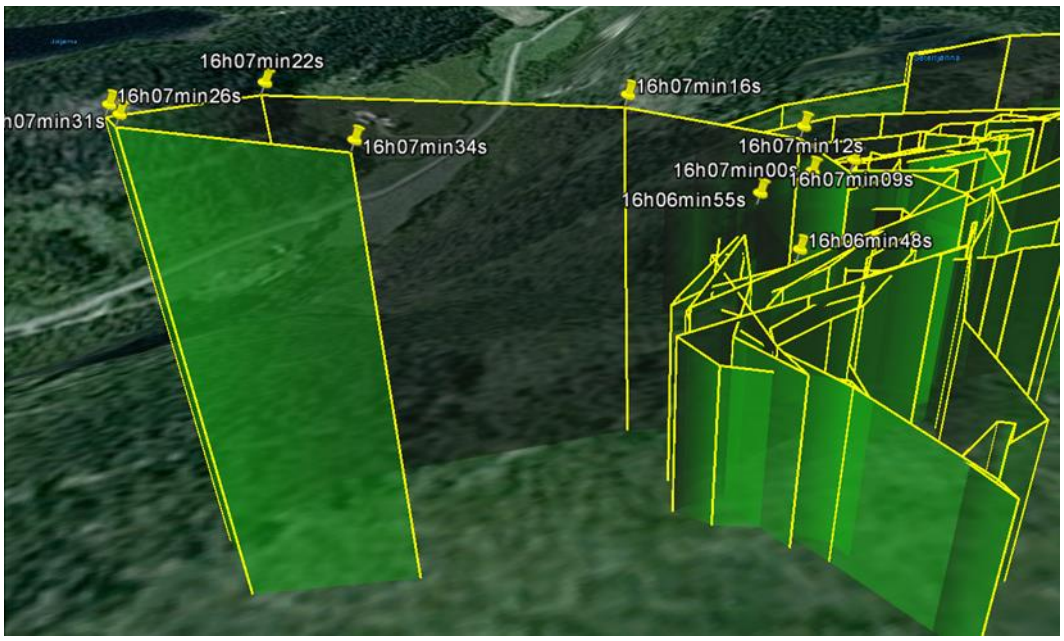

Figure 4: The last waypoints from the flight were registered by the helicopter's GPS and entered in a Google Earth map. The time (UTC) is given for the last ten points. The map is oriented to the west and the E6 highway can be seen in the background. The pattern from some of the flight before the crash can be seen on the right.

1.12 Wreckage and impact information

1.12.1 The crash site

1.12.1.1 The helicopter crashed in sloping terrain covered by low young growth. The wreckage ended up between several 4–5 metre high birch and fir trees. Only the top of one tree had been cut off. A small tree just next to the wreckage had been snapped off. Small branches and bark had been scraped off a few other trees, but there was otherwise little damage to the trees. There was an estimated 50 – 70 cm of snow in the area. Before the Accident Investigation Board arrived at the crash site, another 10 cm of snow fell.

1.12.1.2 The crash site was approx. 410 metres (1 345 ft) above the sea. The crash site was approx. 800 metres east of the E6 highway and approx. 4.2 km east of Mosjøen airport Kjærstad.

Figure 5: The crash site seen against the east. The helicopter tail boom can be clearly seen between two of the people in the picture. Photo: Per Vikan, Helgeland Arbeiderblad

1.12.2 The helicopter wreckage

1.12.2.1 The helicopter wreckage ended up lying on the left side, mainly in one piece and with the nose pointing at 050º. The left skid had been knocked off. Otherwise, all significant parts were still attached to the helicopter. The cockpit was very deformed, in particular on the left side.

1.12.2.2 The main rotor blades, hereinafter referred to as blades A and B, were both attached to the rotor head.

- Blade A was pointing forward in relation to the helicopter wreckage. It had snapped about 70 cm from the hub. Further out on the blade, the spar on the leading edge had separated from the rest of the blade over a length of 220 cm. The outer half of the blade had been bent backwards in a large arc (see Figure 6).

- Blade B was pointing backwards in relation to the helicopter wreckage. The tip of the blade had been pushed into the ground and was stuck on the left of the tail boom. The blade had snapped 150 cm from the hub.

- Snow/ice had frozen on the leading edge of both blades. This was particularly the case for the leading edge of the outer part of blade A (see Figure 6).

Figure 6: The upper side and leading edge of main rotor blade A with frozen snow/ice. The spar has partially separated from the rest of the blade. Photo: AIBN

1.12.2.3 The tail boom had snapped 30 cm from the attachment point on the fuselage, but was still connected to the helicopter. The rest of the tail boom, including the tail rotor, the tail rotor gear box and the tail surfaces were seemingly undamaged.

1.12.2.4 There was a smell of fuel at the crash site and fuel colouration in the snow. The helicopter contained a jerry can squashed flat, a refuelling funnel with a suede skin filter and a lunch box.

1.13 Medical and pathological information

1.13.1 The two persons on board were autopsied at St. Olavs Hospital in Trondheim. No signs of illness or intake of alcohol, narcotic substances or drugs were found. No signs of monoxide poisoning were found in the commander. It was found that both persons had empty stomachs.

1.13.2 The examination showed that the two persons died immediately as a result of extensive injuries.

1.14 Fire

No fire occurred.

1.15 Survival aspects

1.15.1 One of the reindeer owners driving the snowmobiles alerted the police about a possible helicopter accident at approx. 1720 hours. At 1722, the police and the Joint Rescue Coordination Centre for Northern Norway were in contact. The Joint Rescue

Coordination Centre could then confirm that signals from an emergency beacon at 65º 47' N 013º 18' E had been registered[6] at 1715 hours. Air Traffic Services at Mosjøen airport Kjærstad received no distress signals from the helicopter. However, during the period, at about 1755 hours, an aircraft from Widerøe (WIF733) registered clear signals from an emergency transmitter just after departure from the airport.

1.15.2 The Joint Rescue Coordination Centre called a general alert and requested assistance from the State Air Ambulance Service in Brønnøysund and The Armed Forces' Sea King SAR helicopter in Bodø. The local fire and rescue service, ambulance and volunteer rescue service were also notified. At 1728, one of the reindeer owners reported to the police that they had found the helicopter wreckage and it became clear that both persons on board had been killed.

1.15.3 The two persons on board were secured by four-point seat belts. None of them wore a helmet.

1.15.4 The helicopter was equipped with a Kannad 406 AF-COMPACT emergency beacon. This activated automatically and functioned as intended.

1.16 Tests and research

1.16.1 The helicopter wreckage was transported to the Accident Investigation Board's premises at Lillestrøm for closer examination. The following was ascertained:

- The flight controls on the passenger side were not installed.
- All light bulbs in the warning lights lit up when tested. The light bulb filaments were inspected using a microscope. Filaments that are hot (lit) during a crash can be lengthened and permanently deformed. None of the filaments had such clear deformation, although the filament for the clutch light had been lengthened somewhat more than the others.
- The cabin heater handle had been pulled out by 5 cm (on).
- The switch for adjusting the instrument lights had been set at about 50 per cent.
- The left fuel tank had bumps typical for fuel tanks exposed to large G loads while containing fuel.
- No marks were found on fairings in connection with the rotor mast (i.e. no signs that the rotor mast had moved abnormally in relation to the fuselage).
- The attachment bolt of main rotor blade A had been bent.
- All breakages in the flight controls were clearly caused by overload, consistent with loads caused by the crash.
- All faults and damage to the main rotor were consistent with damage that can be caused by overload in connection with a crash.

[6] *Cospas/Sarsat*

- The breakage in the tail rotor axle was a clear overload breakage, consistent with loads that can arise in connection with a crash.

- Several clear scratch marks were discovered in connection with rotating components, indicating that these were rotating when the helicopter hit the ground. This was particularly the case for starter ring gear, the cooling fan and the tail rotor transmission shaft. Examples of this are shown in Figure 8.

- 1–2 ml of bluish liquid was found in the fuel strainer. The fluid was seemingly pure, smelled of petrol and no water was found in the fuel strainer. The filter in the fuel strainer was clean.

- The left ignition magnet (installed on the helicopter's right side) was timed 23º before TDC[7]. The breaker gap was normal.

- The right magnet had been knocked loose, making it impossible to verify the ignition timing. The breaker gap of the magnet was somewhat narrow (slightly outside the tolerance range).

- All 12 spark plugs were worn with an electrode opening of 0.022" or more.

- The engine oil filter was not visibly contaminated and there were no metal chips on the magnet plug in the engine's oil sump.

Figure 7: Examples of worn spark plugs. Photo AIBN

Figure 8: Scratch marks on the upper belt pulley. Photo: AIBN

1.16.2 The following components were sent to Norrønafly Rakkestad AS for inspection:

- The ignition magnets were bench-tested and functioned satisfactorily.

- All spark plugs were tested in a plug tester. Eight of the spark plugs gave no spark while tested under pressure. Four of the spark plugs gave a weak spark while tested under pressure.

[7] *Correct ignition timing is 20° before TDC*

1.16.3 To better test the condition of the spark plugs under realistic loads, they were installed in the engine of an R44. When running the engine and hovering at low altitude, there was no sign of failure in the performance of the engine.

1.16.4 The engine could be turned freely and functioned normally as regards powering the cam shaft and magnets. A compression check of the engine with an added pressure of 80 psi gave the following results for the six cylinders:

1: 75 psi, 2: 70 psi, 3: 78 psi, 4: 74 psi, 5: 72 psi, 6: 60 psi

Values of less than 65 psi must be considered unacceptable on an operative warm engine[8].

1.17 Organisational and management information

1.17.1 General

1.17.1.1 SE-JPZ was operated by Jämtlands Fly AB in Sweden. The company had a Swedish Air Operator Certificate (AOC) No SE-111 for the following types of operations: A1-Passenger, A2-Cargo and Aerial work. The approval covered the helicopter types Eurocopter AS 350 B2, Eurocopter EC 120 B and Robinson R44. The operation type Aerial Work was limited to "*D2 – VFR day/night only".*

1.17.1.2 The company has its main base in Göviken, Östersund and bases in Laisholm, Hemavan-Tärnaby and Funäsdalen, Härjedalen. At the time of the accident, the company had the following functions approved by Swedish aviation authorities:

- Accountable Manager
- Quality Manager
- Nominated Postholder Flight operations, Crew training and Ground operations
- Nominated Postholder Continuing Airworthiness

1.17.1.3 At the time of the accident, the company operated nine helicopters.

1.17.2 Provisions

1.17.2.1 In order for a foreign helicopter company to engage in commercial aviation of the type Aerial Work in Norway, it must submit an application to the Civil Aviation Authority, Norway in accordance with AIC-I 5/00. In a fax to Jämtlands Flyg AB dated 10 January, the Civil Aviation Authority, Norway issued a permit for the company to engage in reindeer herding in the relevant area. The following conditions were communicated:

> *It is assumed that flights in Norwegian airspace are performed in compliance with the provisions included in AIP Norway, BSL and other announced operative provisions. Reference is also made to the Act of 10 June 1977 relating to motor traffic on uncultivated land and in watercourses, and BSL D 1-2, Item 4.*

[8] *20% loss, cf. FAA AC 43.13*

- If the assignment entails flying under applicable minimum altitudes, a special permit must be obtained from the Civil Aviation Authority. Cf. BSL F 1-1, Ch. III, Section 3-5.

1.17.2.2 In 2013, the Civil Aviation Authority, Norway has stated that they at the time did not issue special permits to operators which would perform assignments entailing flying under minimum altitudes. This assumed that the operating company had approved internal standard operating procedures for performing the assignment. The Civil Aviation Authority's procedures were, however, changed in the autumn of 2012, so that flying under applicable minimum altitudes must be specifically applied for.

1.17.2.3 The conditions for flying VFR night in Norway with single-engine airplanes/helicopters in commercial activities have been detailed in AIC-N 07/11. In order to permit such flying, a series of requirements have been set as regards training programme, minimum weather conditions and equipment in the aircraft, as well limitations relating to carrying passengers. Permits for such flying can only be granted following application to the Civil Aviation Authority, Norway.

1.17.3 Previous accidents in Jämtlands Flyg AB

1.17.3.1 In the ten-year period preceding the accident, the company had been involved in several accidents:

- *Accident with helicopter SE-JHZ west of Glensjön, Jämtland, county code Z, on 24 September 2003*. SHK report, RL 2004:19 The helicopter was standing on sloping ground and tipped over while the rotor was turning on low rpms.

- *Accident with helicopter SE-JAV in Röstvålen north-west of Ramundsberget, county code Z, on 13 July 2005*. SHK report, RL 2005:25 Commander lost control of the helicopter at low altitude and crashed. There were relatively strong winds in the area. The accident took place while driving reindeer.

- *Accident with helicopter SE-JKZ NW Ramsele, county code Y, on 18 June 2007*. SHK report, RL 2008:02 The helicopter crashed after colliding with a crossing power line while inspecting power lines.

- *Accident on 6 November 2008 with helicopter SE-JNZ near Sulsjön in Åre municipality, Jämtland County*. SHK report, RL 2012:09 The helicopter collided with a power line and crashed during a low-speed flight in poor visibility.

1.17.3.2 In the report for the accident on 6 November 2008, the Swedish Accident Investigation Authority was very critical to the management in Jämtlands Flyg. The Swedish Accident Investigation Authority also believed that the Swedish Transport Agency's supervision of the company had been insufficient to uncover the flight safety deficiencies in the company.

1.18 Additional information

1.18.1 Fuel

It is somewhat uncertain how much fuel the commander had available before the reindeer driving started in the morning of 10 January. The police has stated that they found two barrels containing about 5 litres of remaining fuel after the accident. In addition, 10

empty jerry cans were found. However, the exact number of jerry cans has not been confirmed.

1.18.2 Tracker

1.18.2.1 The company had installed a GPS-based tracker in each helicopter for flight following. The helicopter's position and altitude was regularly, depending on the movement pattern and speed, transmitted to the company in order to monitor the helicopter's operation. The data transfer took place via GSM telephone or satellite communication, depending on the telephone coverage in the area. When the company became aware that something was possibly wrong, the helicopter's activity was checked via the tracker. It showed that it had been on the ground at 1654 hours and that the symbol for the helicopter had then disappeared from the screen.

1.18.3 Regulatory requirements

1.18.3.1 BSL F 1-1 Section 2-37 Minimum requirements for flight visibility and distance to clouds for VMC states (unoff. translation):

> *For helicopters, flying can take place with flight visibility equal to or greater than 800 metres, assuming that the speed is adapted so that the commander has sufficient time to discover other aircraft or obstacles in time to avoid a collision.*

It emerges from the introduction to the same section that the aircraft must be clear of clouds and have visibility of the ground. These requirements are identical in the Swedish regulations.

1.18.4 Swedish companies engaged in Aerial Work[9] must comply with LFS 2007:49 "The Swedish Civil Aviation Agency's regulations and general recommendations for commercial helicopter flights" (unoff. translation). In Chapter 2, Operational provisions, Section 28 states (unoff. translation):

> *Flying during darkness cannot continue if clear ground references can no longer be obtained or if the weather conditions are such that flight visibility is less than 5 km and the 500 feet flight altitude cannot be maintained.*

In the same regulations in Chapter 4, supplementary provisions for certain flight conditions and flight activities, Section 8 states the following:

> *For flight operations where the flight altitude is mainly below 250 feet, or where the helicopter mainly is in the critical speed/altitude area in the relevant auto-rotation diagram, flight crew and passengers (Category A in accordance with Addendum 2) must*
>
> *1. be secured with seat belts with a belt over each shoulder, and*
>
> *2. use a flight helmet.*

1.18.5 The company's operational procedures

1.18.5.1 Jämtlands Flyg's operation manual (OM-A) has no direct references to LFS 2007:49 referred to above. As regards operational provisions relating to visibility and distance to

[9] *Called "bruksflyg" in Sweden.*

clouds, reference is made to general provisions (see Item 1.18.3). In the further mention of planning minimum, it emerges that the company's provisions concern en-route flying and not aerial work.

1.18.5.2 In its OM-A, Jämtlands Flyg describes a risk assessment of reindeer driving. Using helmets is mentioned as a risk-reducing measure. The Accident Investigation Board cannot see that the company's OM-A mentions flying in darkness in combination with Aerial Work.

1.18.5.3 According to OM-A, pilots in the company are permitted to fly for 14 hours over a 24-hour period. Over a revolving period of 48 hours, pilots in the company can fly for 24 hours.

1.18.6 Measures implemented by the company after the accident

After the accident, Jämtlands Flyg has implemented several measures to prevent recurrences. The following can be mentioned:

- The company has held training sessions for companions/reindeer owners to provide them with more insight into the use of helicopters when driving reindeer, and thereby contribute to safer flying.

- All pilots in the company flying R44 have been given a two-day course held by Robinson Helicopter. The course, held in Västerås, included both theory and practice.

- The company has connected an alarm to the helicopters' tracker. If a helicopter is in motion less than 45 minutes before darkness falls, the on-duty officer in the company will receive an automated call.

1.19 Useful or effective investigation techniques

No methods qualifying for special mention have been used in this investigation.

2. ANALYSIS

2.1 Introduction

The investigation has been demanding as there were no witnesses to the accident, both persons on board died, and the helicopter had no flight recorders on board. Much of the investigation has therefore been based on findings at the crash site, wreckage examination, GPS information, information from the two reindeer owners who participated in the work and information about the weather conditions at the time of the accident. The analysis below focuses primarily on findings at the crash site, how the assignment was performed and the framework conditions under which the reindeer driving took place.

2.2 The crash site and helicopter wreckage

2.2.1 The helicopter was in mostly one piece on its left side in between several small trees. The fact that the trees right next to the crash site were unharmed indicates that the helicopter hit the ground at a steep angle. The helicopter's main rotor with a 10-metre diameter rotates at approx. 400 rpm. It is therefore completely unlikely that the helicopter could approach the ground in an approximately horizontal position without nearby trees being hit by the rotor blades. If so, the rotor must have been standing almost still. The probability of the rotor rotating is analysed in Chapter 2.4 below

2.2.2 The damage to the helicopter was greatest in front, especially on the left. An examination of the crash site and damage patterns indicates that the helicopter hit the ground with a left roll of about 70–90º and at a steep angle, estimated at 45–70º. This indicates that the helicopter was out of control when it hit the ground. It is highly unlikely that the helicopter would have hit the ground in this way if it had been flown in a controlled manner, but inadvertently too low. It is also highly unlikely that the helicopter would have hit the ground in this way if the commander was making a controlled emergency landing which failed in the final phase.

2.2.3 The main rotor blades of a helicopter hitting the ground with a roll of up to 90º will impact the ground with great force. The kinetic energy in the blades would be directed towards the ground. Any parts that are struck loose from the rotor blades will remain relatively gathered, unlike a rotor which hits the ground horizontally, where parts can easily be thrown far away. If the helicopter hits the ground in a steep bank, the main rotor blades will hit the ground relatively near the area where the actual fuselage impacts. Furthermore, the impacts against the ground will be aligned with the longitudinal direction of the helicopter. This correlates well with the observations at the crash site, where one rotor blade ended up forward in relation to the wreckage and the other blade hit the ground back near the tail boom.

2.3 Ground stop four minutes prior to the accident

It has not been possible to establish what happened during the ground stop four minutes before the helicopter crashed. A rough estimate indicates that the commander had 780 litres of fuel in barrels, cans and in the fuel tanks before the work started. Based on flying hours and a fuel consumption of 55 litres per hour, the consumption over the two days may have been an estimated 735 litres. One possibility is that the commander put a full jerry can in the helicopter during the last refuelling stop at the farm at 1541–1547 hours.

The reason for this is unknown, but it may have been to save time or to have a known reserve for the trip home. It is also possible that he later realised that this reserve also had to be used, and that this was the reason for the brief ground stop at 1657 hours. This would explain why there was an empty jerry can in the cabin of the helicopter when it crashed. This, combined with the fact that no sign of technical problems has been found, leads the Accident Investigation Board to believe that the helicopter was refuelled during the ground stop.

2.4 The helicopter's technical condition

2.4.1 No technical faults in the helicopter were found to explain the loss of control. All significant functions relating to the flight controls and rotors were intact when the helicopter hit the ground. Scratch marks on the starter ring gear and belt pulleys indicate that both the engine and the rotor were turning when the helicopter hit the ground. Overall, this describes a helicopter that was intact and controllable before the accident.

2.4.2 Most losses of engine power in piston engines in aircraft can be attributed to faults with the fuel supply or the ignition system. In this case it was found bulges in the fuel tank, fuel leaks at the crash site and fuel in the fuel strainer. When considering this in light of the probable refuelling of 20 litres from a jerry can just minutes before the crash, there is no basis for assuming that lack of fuel was a problem.

2.4.3 All spark plugs in the engine were worn and had a spark gap requiring adjustments before further usage. Although the spark plugs would not have met the requirements for further flight unless adjusted, the test in a similar helicopter engine showed that they yielded the expected engine power. Similarly, a deviation of 3° in ignition timing does not yield a significant output loss. As a result, the Accident Investigation Board has not uncovered faults which would necessitate an immediate emergency landing.

2.4.4 Engine power failure can, unless handled quickly and correctly, result in low engine rpms, major relative movements between the rotor mast and the fuselage (mast bumping) and an accident. No signs of such movement between the rotor mast and the fuselage were found, and the Accident Investigation Board therefore believes that the crash cannot have been caused by engine power failure.

2.5 Icing

2.5.1 The helicopter operated in an area with snow showers, at temperatures just below freezing and with little difference between temperature and dew point. This can result in icing both in the engine and on the rotor blades.

2.5.2 The engine of SE-JPZ was equipped with fuel injection and only ices under extreme conditions, which was not the case on the day of the accident. During icing conditions, ice can also form on the rotor blades. This may lead to vibrations and reduced aerodynamic effect. At the extremes of the blades, ice will not normally form due to the heating from aerodynamic friction. The outer part of one of the main rotor blades on SE-JPZ had frozen snow and ice along the leading edge (see Figure 6), indicating that this part of the main rotor was warm and free of ice when it ended up in the cold snow after the crash. Some of the snow then melted and the water later froze onto the blade.

2.5.3 The Accident Investigation Board is of the opinion that any icing on the rotors would have resulted in noticeable vibrations before the flying characteristics would have been

significantly impaired. If so, it would have been possible to land before the icing problem became serious.

2.6 Meteorological information and darkness

2.6.1 Several sources show that the weather varied with heavy snow showers and poor visibility during the period prior to the crash. A radar image of the area shows that a heavy snow shower passed over Mosjøen at 1700 hours, and that this was still present at the crash site 15 minutes later. A general situation of unstable weather with snow showers and partly poor visibility has been confirmed by several witnesses.

2.6.2 It is not possible to ascertain how good or poor the flight visibility was when the helicopter crashed. Accordingly, any discussion of whether visibility was within or exceeded given minimum values will be hypothetical. However, there is no doubt that the flight took place in darkness and below 500 feet altitude immediately before the accident. The flight did therefore not comply with the applicable requirements (see Item 1.18.4).

2.6.3 It can be questioned whether the visibility and weather conditions were suitable for driving reindeer, even when light conditions were good, on the day of the accident. The Accident Investigation Board believes that the commander pushed the limits too far when he continued to fly even after darkness. Even with good visibility, driving reindeer in the dark must be characterised as high-risk.

2.6.4 Flying in the dark requires significantly better visibility and visual references than corresponding flights in daylight. It can be especially challenging if there are no well-defined sources of light, such as road lights, outdoor lighting, lit buildings, etc. Under such circumstances, one can easily fly into clouds or snow showers and lose references. In the case in question, the situation may have been made worse by the commander's occasional use of the helicopter's landing lights. This may have resulted in the lights reflecting on the snow and disturbing the night vision.

2.7 Loss of control

2.7.1 The fact that the helicopter hit the ground with high vertical speed and roll, indicates that it was out of control at the time. There is nothing to indicate that the loss of control was due to technical faults. The Accident Investigation Board believes that it is probable that the commander lost control of the helicopter due to loss of visual references and then got vertigo[10]. The situation can have arisen for multiple reasons. One obvious explanation could be that the helicopter accidentally entered clouds during the last climb, causing the commander to lose visual references. Loss of visual references will in a matter of seconds result in loss of the control unless the pilot is trained in instrument flight and the helicopter is adequately equipped. One instance where a helicopter pilot accidentally entered clouds and completely lost control has been covered in the Accident Investigation Board's report SL 2009/16

2.7.2 The commander can also have been susceptible to sensory illusion due to sudden head movements in combination with performing turns. Looking for reindeer using landing lights, but without other good visual references, may also have resulted in sensory illusions and loss of control of the helicopter.

[10] *Sensory illusion where the brain's perception of up and down and movements deviate from reality.*

2.8 Human factors

2.8.1 There is much to indicate that the commander engaged in reindeer driving under conditions that were unsuitable from a flight safety perspective on the day of the accident. An important question is why the work continued after dark. The Accident Investigation Board sees several possible contributing factors:

- The commander and the reindeer owners knew each other well and this may have motivated the commander to make an extra effort.

- The chance of success in reindeer driving increases when the herd is gathered in one place where it can settle down before the work is concluded for the day. It was accordingly important to gather the animals up on the clearing before concluding the work.

- There is much to indicate that the commander had too much on his plate during this period, and that he was interested in finishing the assignment as quickly as possible.

- Darkness falls gradually, and if defined times are not stipulated for when the work must be concluded, it is easy to continue "just a few minutes more".

- The commander had a lot of experience from reindeer driving and may, over time, have gained too much confidence in his own assessment and ability to handle difficult situations (overconfidence).

- The commander worked very independently in relation to the company he was employed in. This is analysed in more detail in Chapter 2.9 below.

2.8.2 The working day was not particularly long before the accident took place. On the day of the accident, the commander had been working for about 7.5 hours. Although the commander therefore was formally within the service time limitations set by the company, it is not improbable that he was tired or weary.

2.8.3 Several factors may have increased the load on the commander. There is much to indicate that his general work load was high in the period, due to various jobs at home. In addition, reindeer driving is intense, taking place at low altitude and requiring constant alertness. A lunchbox was found in the helicopter, and the fact that both persons on board had empty stomachs indicates that the commander was hungry when the accident happened. In addition, the Accident Investigation Board cannot see that the commander took sufficient breaks during the working day. The commander was 62 years' old, and the Accident Investigation Board generally believes that a relatively high age can reduce the ability to handle high workloads.

2.9 Framework conditions

2.9.1 The commander was stationed at the company's base in Laisholm, Hemavan-Tärnaby. Regardless of which forms of contact the company uses, there is reason to believe that the commander's association with the company's operational management was looser than for corresponding personnel working at the main base in Östersund. The commander also had a lot of experience from reindeer driving and had worked in two other helicopter companies earlier. He had accordingly established routines and a customer following

before becoming an employee of Jämtlands Flyg. Overall, this may have resulted in the commander being given too much freedom and trust in the company. The large physical distance and large trust may have created challenges as regards operational control, which in turn can lead to safety-related challenges.

2.9.2 The Accident Investigation Board commends the company for having installed trackers in all helicopters. The equipment can strengthen operational control and be of great help if something goes wrong. The company therefore had a tool to notify the operational management that the helicopter continued driving reindeer after darkness had fallen. The Accident Investigation Board does not expect the company to monitor all flights in realtime, but a review of data from selected flights could have revealed that e.g. reindeer driving in the dark had taken place. Close follow-up of reindeer driving should generally be a key topic for both involved aviation authorities and helicopter operators. A number of helicopter accidents in both Sweden and Norway has shown that this activity entails high risk[11].

2.9.3 The commander must have been aware that the flying with SE-JPZ could at all times be monitored by the company's operational management. The fact that he, in spite of this, continued to fly in darkness, may indicate that he was willing to push the limits far. It can also indicate that his experience was that the company silently accepted such operations. Both alternatives provide a basis for stating that Jämtlands Flyg faces a major safety challenge.

2.9.4 It can be discussed which regulatory requirements applied for the Swedish company when it engaged in reindeer driving in Norway. A general rule is that the strictest regulations apply. Regardless of interpretation, it seems to clear that the intentions of the regulations was that an operator would never, under any circumstances, have permission to fly at night below applicable minimum altitudes with the relevant instrumentation, while carrying passengers. The Accident Investigation Board is of the opinion that the company's OM-A procedures relating to reindeer driving should be improved and clarified. For example, the procedure should have contained clearer descriptions and requirements relating to weather, use of helmet and factors relating to companions/reindeer owners who travelled on board. The company has initiated several safety work measures after the accident which the Accident Investigation Board considers to be positive.

[11] *The AIBN has earlier investigated the following relevant accidents: SL 1996/10 with SE-HTC, SL 2003/22 with SE-JAV, SL 2006/12 with SE-HSI, SL 2008/06 with SE-HLP and SL 2012/10 with LN-OBN*

3. CONCLUSION

The accident happened under adverse weather conditions, with visibility at times being reduced by snow showers. The flight took place in darkness, and the Accident Investigation Board believes that it is probable that the commander lost control of the helicopter due to loss of visual references. No technical faults in the helicopter were found to explain the accident.

3.1 Investigation results

a) The helicopter was registered according to regulations and had valid airworthiness documentation.

b) The commander had valid licences and privileges to fly the helicopter.

c) The helicopter was within applicable limitations as regards mass and balance.

d) The commander was experienced in reindeer driving.

e) The commander had previously driven reindeer for the same reindeer owners on several occasions.

f) The reindeer driving had been delayed and reindeer being hit by the train increased the pressure to get the job done.

g) The accident happened on the second day of the assignment, just before the reindeer had been gathered up on a clearing.

h) The weather conditions were adverse and it had become dark when the accident happened.

i) The flying took place below 500 feet and in darkness. This was in violation with applicable Swedish regulations.

j) There were no witnesses to the accident.

k) It is probable that the commander lost control of the helicopter due to loss of visual references.

l) The helicopter hit the ground with a large roll and at a steep angle.

m) Both persons on board were killed instantly. Quick localisation and emergency medical care could as a result not have changed the outcome.

n) No technical faults in the helicopter were found to explain the accident.

o) It is unlikely that icing played a role in the course of events.

p) The helicopter was equipped with a tracker which enabled the company to monitor the helicopter's movements.

4. SAFETY RECOMMENDATIONS

The Accident Investigation Board Norway has not issued any safety recommendations in connection with this investigation.[12]

The Accident Investigation Board Norway

Lillestrøm, 17 December 2013

[12] The Ministry of Transport and Communications ensures that safety recommendations are presented to the aviation authorities and/or other relevant ministries for assessment and follow-up, cf. Section 17 of the Regulations relating to public investigation of air traffic accidents and incidents in civil aviation.

APPENDICES

RELEVANT ABBREVIATIONS

AIC	Aeronautical Information Circular
BKN	BroKeN – weather code for broken clouds
BSL	Bestemmelser for sivil luftfart (Norwegian Civil Aviation Regulations)
CB	Weather code for cumulonimbus
ENMS	ICAO code for Mosjøen airport Kjærstad
FT/ft	Feet - 0.304 metres
G	Vertical load caused by the acceleration of gravity 1G corresponds to the gravity acceleration on earth.
GPS	Global Positioning System
GSM	Global System for Mobile Communication
hPa	hektopascal
M	Minus – weather code for temperatures below 0 °C
N	North
psi	pounds per square inch (.068 atm)
RMK	ReMarK – supplementary information in weather codes
SAR	Search and rescue
SCT	ScatTered – weather code for scattered clouds
SHK	Statens haverikommission - Swedish Accident Investigation Authority
AIBN	The Accident Investigation Board Norway
SHSN	SHowerSNow – weather code for snow shower
SN	SNow – weather code for snow
TDC	Top Dead Center – stamped on top of the cylinder
UTC	Universal Time Coordinated
VCSH	ViCinityShowers – weather code for rain in the vicinity
VFR	Visual Flight Rules
VRB	VaRiaBle – weather code for variable
E	east