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# *Report RL 2000:12e*

## *Accident involving helicopter SE-JES, 03 April 1999, in the vicinity of Lake Kamasjaure, 25 km. northeast of Torneträsk, BD county, Sweden*

**L-25/99**

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The report is also available on our Web site: www.havkom.se

Translated by Bob Arnesen
From the original Swedish at the request of the Board of Accident Investigation.
In case of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

2000-03-23 L-25/99

Swedish Civil Aviation
Administration
601 79 NORRKÖPING

**Report RL 2000:12e**

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The Swedish Board of Accident Investigation (Statens haverikommission, SHK) has investigated a helicopter accident, aircraft registration SE-JES, which occurred on 3 April 1999, by Lake Kamasjaure, approximately 25 km. northeast of Torneträsk, BD county, Sweden.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board submits herewith a final report of the investigation.

S-E Sigfridsson Monica J Wismar

Henrik Elinder Jan Mansfeld

# Contents

**APPENDICES**

***Report C 2000:12e***
**L-25/99**
Report finalised 2000-03-23

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| | |
|---|---|
| *Aircraft: registration and type* | **SE-JES, Sikorsky S-76A** |
| *Classification, Airworthiness* | Normal, valid airworthiness certificate |
| *Owner* | ABN Amro Leasing/ ABN Amro Bank AB<br>Box 7335, 103 90 Stockholm<br>Norrlandsflyg AB<br>Box 24, 982 21 Gällivare |
| *Time of incident* | 3 April 1999 at approx. 0120 hrs. in darkness<br>*Note:* All times in the report are given in Swedish summer time (SST) = UTC + 2 hour |
| *Place* | Kamasjaure, approx. 25 km. northeast of Torneträsk, BD County, Sweden.<br>(pos 6828N 2014E; approx 700 m. above sea level) |
| *Type of flight* | Commercial/ Medical Evacuation |
| *Weather* | As observed at Katterjokk near Riksgränsen at 0200 hrs.: wind 270/25 knots, visibility 1,000 meters in snow, cloud was not observed because of the snow, temp. -1º C, dewpoint -2º C, QNH 1014 hPa. |
| *Numbers on board: crew* | 2 |
| *passengers* | 2 ( a doctor and a nurse ) |
| *Personal injury* | The doctor received a minor back injury |
| *Damage to aircraft* | Substantial |
| *Other damage* | None |
| *Commander´s age and licence* | 59, DH |
| *Commander´s total flying hours* | 19,230 hours, of which 9,230 hours were on helicopter and 1,280 hours on type |
| *Commander´s flying hours and number of landings previous 90 days* | 95 hours /170 landings, all on type |
| *First Officers´s age and licence* | 24, BH with an instrument rating |
| *First Officer´s total flying hours* | 580 hours, of which 466 hours were on helicopter and 132 hours on type |
| *First Officer´s flying hours and number of landings previous 90 days* | 74 hours /105 landings, all on type |

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The Board of Accident Investigation (SHK) was notified on 3 April 1999 that an accident with a helicopter registered SE-JES had occurred near Lake Kamasjaure, BD county, on the same day at 0120 hrs.

The accident has been investigated by SHK represented by S-E Sigfridsson, chairman, Monica J Wismar, Chief investigator flight operations, Henrik Elinder, Chief technical investigator (aviation) and Jan Mansfeld, Chief investigator rescue services.

Assisting in the investigation were Lennart Samuelsson, flight operations expert, and Gunnar Jarsjö, meteorological expert.

The investigation was followed by the Swedish Civil Aviation Administration (Luftfartsverket or LFV) represented by Alf Svensson.

SHK investigates accidents and incidents with regard to safety. The sole objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of this activity to apportion blame or liability.

## SUMMARY

A helicopter ambulance with four persons onboard departed from Gällivare at 0036 hrs. to evacuate two burn victims who had been fishing together with a group at Lake Kamasjaure in the hills north of Kiruna. The weather at the evacuation site was cloudless with a very strong north-westerly wind causing heavy blowing snow and considerable ice crystals in the air. When the helicopter crew made visual contact with the headlights from the fishermen's snowmobiles in the blowing snow they set up for a right hand landing circuit to land into wind towards the snowmobiles, using the headlights as a landing reference.

The surface wind was estimated to be from the north-west at 45 knots. During the right hand turn to final the commander lost visual contact with the headlights from the snowmobiles in the blowing snow, just as the first officer reported 100 ft. radio altitude. Shortly thereafter the helicopter struck the ground about 300 m. south-east of the snowmobiles and rolled over on it's left side.

One of the passengers received a minor back injury while the others were uninjured. Additional rescue services were then called upon to assist and the first rescue helicopter arrived at the accident site at 0707 hrs.

No technical fault was found with the helicopter. SHK determined amongst other things that the company had no established cockpit procedures for a two-pilot operation in VFR flight[1] and that the NORDRAD weather radar system was not being used optimally.

The accident was caused by the pilot attempting to land without sufficient landing site reference, causing a misjudgement of the height over ground during the final turn and subsequent collision with the ground. The company`s failure to establish cockpit procedures for two-pilot operation in VFR flight also contributed to the accident.

## Recommendations

It is recommended that the Swedish CAA :

- act to ensure that companies certified for helicopter operations establish and implement standard cockpit procedures for two-pilot operation in VFR flight, in the same way they exist for IFR flight[2] (*RL2000:12 R1*); and
- in co-operation with the Swedish National Weather Service (SMHI) spread information about the existence of "NORDRAD" and make it accessible for both private and commercial aviation (*RL 2000:12 R2*).

[1] VFR = Flight in accordance with Visual Flight Rules

[2] IFR = Flight in accordance with Instrument Flight Rules

# 1. FACTUAL INFORMATION

## 1.1 History of the flight

*The Flight*

The commander, who was on duty with the ambulance helicopter stationed in Gällivare, received a priority 1 primary alert (PRI01-alert[3]) at 2351 hrs., from the Swedish SOS Alarm Centre. The mission entailed the medical evacuation (medevac) of two burn victims who were members of a party fishing at Lake Kamasjaure in the hills 70 km. north of Kiruna. The commander had earlier that day flown from Abisko to Gällivare and was aware of the existing heavy winds in the area. He advised the Alarm Centre that there was a risk that he would not be able to land in the area but that he would try. He therefore requested that a ground rescue party also be activated as a backup to the aerial medevac. When the briefing was finished the commander went to the hangar to prepare for the flight, where he was later joined by the first officer, a doctor and a nurse. No formal weather briefing was done.

The flight departed Gällivare at 0036 hrs. and flew to the medevac site via Kiruna using GPS navigation. The weather conditions and ground references during the first part of the flight were good. However approximately three minutes before arriving at the site they came in over a large snow covered area above the tree line, with little or no ground references. The sky was clear and the heavy winds were causing considerable blowing snow and ice crystals in the air. The commander then climbed the aircraft to 600 ft. above ground to improve the forward visibility, as the fishermen had promised to turn on their snowmobile headlights upon hearing the approach of the helicopter.

The crew finally made visual contact with the headlights in the blowing snow and flew over the site at about 500-600 ft. above ground. A right hand landing circuit was commenced so as to land into wind using the snowmobile headlights as both a ground and landing reference point. They advised the Alarm Centre by radio that they were attempting to land at the site and would contact them when airborne again. The doctor and nurse were also advised of the landing attempt.

Using the GPS as a reference the surface wind was estimated to be 45 knots from the north-west. Turbulence increased as the flight descended and the helicopter`s airspeed was decreased to 60-70 knots on the downwind leg. During the turn to base leg the “lower landing gear” warning was activated whereupon the first officer extended the gear. About the same time the commander asked the first officer to equalise the power on both engines. During the turn to final the first officer advised that they had reached 100 ft. on the radio altimeter. At about the same time the commander lost contact with the headlights in the blowing snow. Shortly thereafter the helicopter struck the ground about 300 m. south-east of the snowmobiles and rolled over on it’s left side. The pilots stated that the engines quit themselves and everything then became quiet.

The crew immediately turned off all aircraft electricity and checked to see if anyone was seriously injured. The commander exited the aircraft and determined that no fuel leakage had occurred. The crew decided to stay at the accident site inside the helicopter and wait for better weather, as they felt that they could easily get lost in the heavy blowing snow trying to find the fishermen.

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[3] PRI01-alert = when human life is at risk, to either bring medical aid to the individual or transport him to it.

They transmitted a "mayday" emergency message over the aircraft radio and at the same time determined that their own emergency locator transmitter (ELT) had been activated. They were unable to use their mobile telephones as they were outside the area for signal coverage. The doctor was suffering from a minor back injury and was taken care of by the nurse.

At about 0700 hrs. when the wind had subsided somewhat and the visibility had improved, some of the fishermen arrived on their snowmobiles. They then drove the commander and the nurse to the two burn victims so that they could be treated. Several minutes later a police helicopter arrived at the accident site.

The accident occurred on 3 April 1999 at 0120 hrs. at position 6828N 2014E at 700 m. above sea level.

*The events leading up to the rescue*

The SOS-Centre in Luleå (SOS-BD) contacted the police's special mountain rescue co-ordinator in Gällivare at 0024 hrs. The police's own communications logbook indicates that they were at that time advised of the two burn victims at Kamasjaure (Gamasjärvi). The police however did not at the time react by sending out a ground rescue team . The alarm log from SOS-BD did not indicate whether the police in Gällivare had received the correct alarm code at that time to commence a mountain rescue operation. The police stated that they later made several attempts to employ civilian mountain rescuers during the night. They were partly successful in these attempts however none of the teams contacted were in the area of the rescue site.

At 0109 hrs. the commander informed SOS-BD that he would attempt a landing at the rescue site and would call again when airborne. When after half an hour had passed and no word had been received from the helicopter, attempts were made to contact them by radio and telephone with no success. The Alarm centre then contacted the police and it was decided that a ground rescue party would be sent in and that the police helicopter temporarily stationed in Dundret would be ordered to the site. About a half an hour later a two-man police patrol departed Gällivare for Kiruna, were two more members would be picked up. The four-man team would then attempt to reach the accident site over land.

The Air Rescue Co-ordination Centre (ARCC) in Gothenburg was contacted by the SOS-BD at 0217 hrs. and informed that an accident in all probability had occurred. The ARCC was then able to summon additional rescue resources in the form of another ambulance helicopter temporarily stationed in Hemavan and a military rescue helicopter stationed in Luleå.

The police helicopter took off northbound at 0423 hrs. and the crew could not hear any signals from the downed helicopter's ELT. The ambulance helicopter departed Hemavan towards Kiruna at 0455 hrs. and the military rescue aircraft departed at 0649 hrs.

The ARCC received confirmation from a satellite monitoring station in Bodö, Norway at 0505 hrs. that an ELT signal was coming from the accident area. The signals position was relayed to all the parties on their way to the site.

The police helicopter started to receive the ELT signal as it approached the accident site and they made visual contact with the downed helicopter at 0707 hrs.

As the weather at the site had improved they were able to land close-by. Within half an hour the other two helicopters had arrived at the site and at 0840 hrs. the ambulance helicopter departed with the two burn victims and the injured doctor onboard.

## 1.2 Personal injuries

| | *Crew* | *Passengers* | *Other* | ***Total*** |
|---|---|---|---|---|
| Fatal | - | - | - | - |
| Seriously injured | - | - | - | - |
| Slightly injured | - | 1 | - | 1 |
| No injuries | 2 | 1 | - | 3 |
| **Total** | **2** | **2** | **-** | **4** |

## 1.3 Damage to the aircraft

Substantial.

## 1.4 Other damage

None.

## 1.5 The crew

*1.5.1 The crew's flying experience*

*The commander* was 59 years old at the time and had a valid DH Licence.

*Flying hours*

| *Previous* | *24 hrs* | *90 days* | *Total* |
|---|---|---|---|
| All types of helicopters | 2 | 95 | 9,230 |
| This type of helicopter | 1.5 | 95 | 1,280 |
| Total on all types | 2 | 95 | 19,230 |

Number of landings this type previous 90 days: 170.
Initial flight training on A/C type completed on 01 July 1993.
Latest PFT (periodic flight training) carried out in 19 October 1998 on a Sikorsky 76.

*The first officer* was 24 years old at the time and had a valid BH Licence with an instrument rating.

*Flying hours*

| *Previous* | 24 hrs | 90 days | Total |
|---|---|---|---|

| | | | |
|---|---|---|---|
| All types of helicopters | 1.5 | 74 | 466 |
| This type of helicopter | 1.5 | 74 | 132 |
| Total on all types | 1.5 | 74 | 580 |

Number of landings previous 90 days: 106.
Initial flight training on A/C type completed in December1998.
Latest PFT (periodic flight training) carried out 21 December 1998 on a Sikorsky S-76A.

Two passengers, a doctor and a nurse, were onboard.

*1.5.2 The crew's previous duty periods*

During the week before the accident the pilots had worked the following duty periods:

*The commander*

| | | |
|---|---|---|
| Monday – Wednesday | | off duty |
| Thursday | ambulance stand-by | 13 hours duty including 1.9 hrs. flying |
| Friday | ambulance stand-by | 12 hours duty including 1.5 hrs. flying |
| Saturday | ambulance stand-by | day of the accident |

*The first officer*

| | | |
|---|---|---|
| Monday – Tuesday | | off duty |
| Wednesday | | 2 hours flying in another capacity |
| Thursday | ambulance stand-by | 13 hours duty including 1.9 hrs. flying |
| Friday | ambulance stand-by | 12 hours duty including 1.5 hrs. flying |
| Saturday | ambulance stand-by | day of the accident |

## 1.6 The aircraft

*1.6.1 General*

| | |
|---|---|
| *Owner:* | ABN Amro Leasing/ABN Amro Bank AB,<br>Box 7335, 103 90 Stockholm/<br>Norrlandsflyg AB<br>Box 24, 982 21 Gällivare. |
| *Type:* | Sikorsky S-76A |
| *Serial number:* | 760190 |
| *Year of manufacture:* | 1981 |
| *Gross weight:* | Max allowed 4,763 kg. , actual 4,275 kg. |
| *Centre of gravity:* | Within limits |
| *Engine manufacture:* | Allison |
| *Engine model:* | 250-C30S |
| *Number of engines:* | 2 |
| *Fuel loaded before event:* | Jet A-1 |
| *Aircraft flying time:* | 7,052 hrs. |
| *Flying time since latest periodic check:* | 32 hrs. |

| *Engines operating time* | *Nr. 1* | *Nr. 2* |
|---|---|---|
| *Total operating time* | 6,532 hrs. | 5,315 hrs. |
| *Flight hours since Last overhaul* | 682 hrs. | 2,651 hrs. |
| *Cycles since last overhaul* | 734 | 1,761 |
| *Time since last rotor overhaul: main rotor* | 7,052 hrs. | |
| *Tail rotor* | 7,052 hrs. | |

The aircraft had a valid Certificate of Airworthiness.

*1.6.2 The aircraft type*

The S-76A helicopter is equipped with retractable undercarriage and is used for both the transport of personnel and for special purpose missions. In the standard version it carries two pilots and 12 passengers. The actual aircraft was IFR-eqipped including a SAS II autopilot. It was also modified for use as air ambulance. In the cabin there was room for a removable stretcher, three separate seats and advanced medical equipment.

## 1.7 Meteorological information

1.7.1. *Weather Analysis*

A low pressure area over the Arctic ocean was moving east, giving strong north-westerly winds over the northern part of Scandinavia. This resulted in an abundance of snow showers moving across the area north of Torneträsk. A cold front moved south-east and should have passed Kamasjaure at about 0200 hrs. Winds were estimated to be from the west and north-west at about 20-30 knots.
Northwest of Lake Kamasjaure the terrain rose over a distance of a couple of kilometres to a height of 200-300 m. above the snow covered terrain around the lake. This geographic feature would most probably have resulted in leeward wind effect, with the wind sweeping down in waves and increasing in strength to about 45 knots and giving considerable blowing snow.

### *1.7.2 Weather observations*

Weather observations from reporting stations in northern Sweden at 0200 hrs.:

*Katterjokk* near Riksgränsen (manual reporting):
Wind 270° at 25 knots, visibility 1,000 m. in snow showers, no cloud or vertical visibility was reported, temperature -1° C, dewpoint -2° C, QNH 1014 hPa.

*Nikkaluokta* east of Mount Kebnekaise (automatic reporting, does not report weather, clouds or air pressure)
Wind 300° at 15 knots, visibility 45 km., temperature +1° C, dewpoint -6° C
*Note*. The reporting station is situated on the leeward side of the mountain when a north-westerly wind is blowing.

*Naimakka* near the Finnish boarder north-east of Kamasjokk (automatic reporting, does not report air pressure)
Wind 300° at 15 knots, visibility 9 km. in snow showers, clouds 1/8 at 1,500 ft., 3/8 at 2,000 ft., 5/8 at 2,600 ft., 8/8 at 4900 ft., temperature 0° C, dewpoint -2° C.

*Karesuando* south-east of Naimakka (manual reporting)
Wind 270° at 10 knots, visibility 75 km., clouds 8/8 at 6,000-8,000 ft., temperature 0° C, dewpoint -2° C, QNH 1009 hPa.

### *1.7.3 Resources available for weather observation*

In Northern Sweden a civilian meteorologist is available around the clock in Sundsvall for all flight crew requiring their services. Meteorologists are also on duty weekdays during normal office hours at the Luleå-Kallax and Östersund-Frösön military air bases and can provide limited services.

When operating in the mountainous areas of northern Sweden, changes in weather can occur rapidly both in time and over space. Forecasts that are issued for the area are generally treated by the local operators as being general and not always detailed enough. It has become common practice to contact residents living in the different areas before a flight to obtain more detailed local weather conditions.

SMHI has together with the Swedish military built a network of weather radar stations around the country called NORDRAD. In northern Sweden there are stations situated in Kiruna, Luleå, Östersund and Örnsköldsvik. Through this system meteorologists have access both to the individual pictures obtained from each station and to the pictures generated through the lapping together of a number of smaller ones, showing broader developments over different areas of the entire country (in part even across boarders). These pictures are updated every 15 minutes.

These pictures are sold on a commercial basis to a variety of customers such as the National Dept. of Highways (Vägverket) and The National Rail Service (Banverket). Within aviation there is a pilot project being run together with the ATC Tower service at the Visby airport, who obtain the radar maps through the internet. At the time of the accident this service was unknown to the company in question.

## 1.8 Navigational aids

Other than the normal IFR navigation aids, the helicopter was also equipped with a radio altimeter and a Trimble TNL 2000 GPS.

## 1.9 Radio communications

All radio communication was carried out with the SOS Alarm Centre, who was also responsible for maintaining the flight watch for the mission. When passing the Kiruna the crew made a blind transmission on the ATC Tower frequency, which at the time was unmanned.

## 1.10 Airport data

Not applicable.

## 1.11 Flight and sound recorders

A flight data recorder was neither carried onboard nor was it a requirement. The aircraft was however equipped with a Fairchild A100 cockpit voice recorder (CVR). The readout is contained in appendix 2.

## 1.12 Site of accident and aircraft wreckage

*1.12.1. The accident site*

The helicopter struck the ground on a flat and relatively even snow covered surface comprised of a layer of about 75 cm. of hard packed snow. Other than light reflections from the snow's surface there were no ground reference points or objects within a radius of 300 m. from the accident site.

*1.12.2. The aircraft wreckage*

The helicopter came to rest on its left side with the nose pointing on a compass heading of about 250 degrees. The belly of the aircraft received some damage. The tail boom was twisted and the left undercarriage was bent forward. Both the main rotor and the tail rotor were either bent or broken off, pieces being spread over an area of up to 20 m. from the wreck.

## 1.13 Medical information

Nothing indicates that the mental or physical condition of the crew had been impaired during the flight. The commander had slept for about an hour prior to the alarm. The first officer did not sleep and had been awake for the previous 16 hours.

## 1.14 Fire

There was no outbreak of fire.

## 1.15 Survival aspects

The pilot seats were designed with a shock absorbing function to withstand the vertical acceleration stresses of an accident and prevent back injuries. The pilots were at the time fastened in their five-point harnesses. The rear seats had four-point harnesses and were mounted directly to the aircraft structure, the seat cushions being comprised of 10 cm. of foam rubber. The doctor was sitting on the left side of the aircraft facing the direction of flight. She was the only person onboard who was injured, receiving a minor back injury, and stated that at the moment of impact she was leaning slightly forward. The nurse was sitting on the right side of the aircraft and stated that she was sitting upright upon impact. During their training for duty onboard the helicopter they had been instructed to, at all times during takeoff and landing, sit with their four-point harnesses fastened. At the moment of impact they only had their waist belts done up.

The outside air temperature was -1° C and everyone had winter overalls on. During the more than five hour wait prior to their rescue they remained inside the wreck and thus managed to avoid freezing.

The aircraft's Pointer ELT was activated upon impact which was heard quite clearly on the aircraft's own radio. The radio antenna was however damaged during the accident and the ELT transmitted with reduced effect. The ARCC received a call first at 0505 hrs. pinpointing the location of the accident through satellite coverage. The police helicopter was finally able to get a bearing on the ELT when only 3 km. from the accident site.

Attempts by the pilots to use their mobile telephones were unsuccessful due to the lack of signal coverage.

## 1.16 Special tests and investigations

1.16.1 *Technical investigation*

No technical fault was found with the helicopter.

1.16.2. *Simulation of the landing*

SHK has together with the company's chief pilot simulated a number of landings under the same weather and visibility conditions at the time of the accident, using a six-axis helicopter simulator. The exercise showed that it was extremely difficult to carry out a safe landing, with no outside references other than a few headlights, using the chosen landing procedure.

## 1.17 The airline's organisation and management

1.17.1 *General*

The company had it's main base in Gällivare with remote bases in Björkliden, Kiruna, Kvikkjokk, Nikkaluokta, Ritsem and Uppsala. They had a permit to operate both single and multiengine commercial helicopter operations. They company provided a variety of services such as personnel and cargo transport, power line inspections, aerial photography, mass herding of reindeer, amongst many things.

The company's operations entail both VFR and IFR operations. Instrument flight is performed only on the Sikorsky S-76A. The company's Flight Operations Manual (FOM) and Operations Manual Supplement (OMS) contain all the detailed instructions and flight procedures to be followed.

1.17.2 *The FOM and OMS*

The FOM contains the company's general policy and procedures for single and dual pilot operations. The OMS is a complement to the FOM and refers to all company IFR operations. A well established system for two-pilot operation is described for all phases of IFR flight. All challenge-and-response call-outs to be used are clearly specified. During IFR flight it is the responsibility of the non-flying pilot to monitor the instruments and to immediately report any deviations to the flying pilot using established phraseology. It is further the responsibility of the flying pilot to respond to all challenges by acknowledging them and to state his intentions. In this fashion both pilots actively participate in the progress of the flight, keeping them "in the loop". Similar published company procedures for two-pilot VFR operations did not exist at the time of the accident.

A detailed PRE TAKEOFF and PRE LANDING checklist is used on the Sikorsky S-76A during IFR flight. The checklists are quite clear in their distribution of responsibility between the pilots. A reduced checklist is prescribed for use in VFR operations on the S-76A.

Since the accident the company has implemented new procedures to reduce the risk for it occurring again.

1.17.3 *JAR-OPS 3*

The regulations governing commercial helicopter operations in Europe are contained in the Joint Aviation Requirements (JAR) – OPS 3 Manual, where ambulance flights are covered under the section Helicopter Emergency Medical Service (HEMS). According to the regulations prescribed in HEMS it is possible, as an alternative to a two-pilot crew, operate with one pilot and a medic who has received additional training to perform certain cockpit duties. The company was at the time of the accident operating according to Swedish Air Regulations. The FOM was in the process of being changed to reflect the new regulations contained in JAR-OPS 3, however not with regards to two-pilot operation.

1.17.4. *The aircraft onboard equipment*

The helicopters medical equipment was either fixed or strapped to the aircraft interior. None of this equipment, except for a few smaller items such as forceps, scissors and binders, came lose or dislodged during the accident. On-board safety pamphlets were placed in the seat pockets in the cabin (appendix 3). Certain pictures were however not representative of the helicopter's actual appearance and could have given the impression of the existence of only two-point waist safety belts.

According to the information contained in AGARD[4]-AG-305(E), the safest position in a seat with both a waist and shoulder harnesses installed is to sit with all belts fastened correctly and to sit upright and erect, with the head and neck placed backwards against a head or neck rest. The existence of this report was not known by the company and presumably not widely distributed in Sweden.

## 1.18 Other information

1.18.1 *Flight in mountainous terrain*

[4] AGARD = Advisory Group for Aerospace Research and Development

The Swedish army has published a widely used handbook for helicopter flying in mountainous terrain, "Handbok HU", which describes how different situations should be approached. With regard to landing in difficult conditions it is recommended to first fly by the landing site in a simulated landing profile down to about 100-300 ft. above ground to ascertain wind, visibility, required thrust, amongst other things, prior to executing the actual landing.

#### 1.18.2 *Mountain rescue*

In accordance with the Swedish National Law Concerning Civilian Rescue Services (Law NR. 1986:1102), the police in designated mountainous areas are required to initiate rescue operations when they become aware that an individual or individuals can be presumed to be in life threatening danger or there is a serious risk to their health and wellbeing. The same applies when someone has been injured or is suffering from severe illness.

In order to be able to respond to these rescue situations the police in these designated mountainous areas have a network of contracted volunteers who live in the area, are very familiar with the terrain and are well versed in the demands involved. All volunteers are also required to participate in a formal course in mountain rescue procedures. They are required through their contract to participate in a rescue once called upon. These civilian rescuers are however neither required to hold any stand-by duty or maintain any telephone watch with the police. Many of the rescuers voluntarily keep the police informed of their whereabouts and how they can be reached, especially on weekends or when circumstances dictate that a rescue operation in all likelihood could occur.

# 2 ANALYSIS

## 2.1 The flight

Even prior to the departure from Gällivare the commander had good reason to believe that a landing at the medevac site would be difficult, if not impossible. Based on this, his request to also dispatch a ground rescue was correct. As the commander had previously that day flown through the actual area and was aware of the prevailing weather conditions, no formal weather briefing was performed prior to the flight. SHK can well understand the crew's eagerness in getting underway. It is however SHK's opinion that one of the pilots should have taken the time to retrieve the latest forecast from the meteorologist in Sundsvall or obtained the latest weather reports through company channels. Weather in mountainous areas changes rapidly and being in possession of the latest weather reports and forecasts is important from a flight safety point of view, even if these reports often are more general in nature and experience shows that local variations do occur.

The first part of the flight was routine and was carried out using the many ground reference points available and through the use of GPS navigation. The pilots could have used this part of the flight to better discuss and plan for their arrival at the medevac site and for the ensuing landing, which they knew ahead of time would be carried out under demanding wind and visibility conditions. It seems this was not done and can have been a contributing factor to what happened later on.

## 2.2 The accident

When the helicopter arrived at the medevac site the crew determined that the existing weather conditions were extremely difficult, with both heavy and gusty winds and heavy blowing snow. Darkness prevailed and the area was devoid of any visual ground references, other than the headlights from the snowmobiles which could be weakly seen through the blowing snow. Despite these demanding conditions none of the pilots considered delaying the landing and waiting for better conditions.

Bearing in mind the commander's considerable experience operating helicopters in mountainous areas, it is surprising that he decided to commit to a direct approach and landing in such demanding conditions after overflying the landing site. It seems reasonable that a simulated approach and landing should first have been carried out to a specified height over the landing site to better ascertain parameters such as wind and visibility. Thereafter a normal landing circuit could have been flown prior to the planned landing. This method is also recommended in the Swedish army's widely used handbook on helicopter flying in mountainous terrain; "Handbok HU".

Besides the difficult landing conditions, the approach seems to have been flown in an hurried and abrupt fashion, with no discussion at any time between the pilots or any directives from the commander as to how he would attempt to land. No proper pre-landing checklist seems to have been performed. The commander's only instructions were to ask the first officer to equalise the power on the engines and, when the landing gear warning sounded, instructed him to extend the undercarriage. Shortly before the aircraft struck the ground the first officer reported on his own initiative that the height above ground was below 100 ft.

It can be determined afterwards that even the most experienced pilot would find it almost impossible to land in such extreme conditions without the active support of the other pilot or other advanced landing aids. The visibility was such that the commander was unable at any time during the approach to take his eyes off the headlights from the snowmobiles, while at the same time there were no visual references outside the aircraft to judge height. This became quite apparent in the simulations performed by SHK in the flight simulator.

Besides the conclusion that at least one simulated landing circuit should have been carried out, the commander should have carefully briefed the first officer as to his intentions and directed him to provide active assistance during the whole landing procedure. In this fashion he could have continually provided the commander with for example speed and height information, which could have had a significant bearing on the on the success of the landing or a decision to perform a go around.

The end result was that the commander most probably misjudged the aircraft height above ground, with the aircraft striking the ground before he could stop the downward vertical and horizontal acceleration. The tail boom was bent and twisted during the accident and the left landing gear collapsed, causing the helicopter to roll over on its left side, also causing the rotor blades to contact the ground and break up.

Nothing in the investigation indicates that there was any technical fault with the aircraft prior to the accident.

## 2.3 Two pilot operation

In the helicopter ambulance role all flights are flown with two pilots as specified by the customer. The company has established extensive procedures and instructions for

two-pilot IFR operation. These instructions clearly specify the distribution of responsibility in the cockpit and all the necessary call-outs to be performed. Similar written instructions for two-pilot VFR operation do not appear to have existed at the time.

After discussions with both pilots it appears that it was the commanders prerogative to decide which routines were to be followed in the cockpit during VFR flight. A policy of leaving this to the discretion of the commander will of course result in a wide variance in operational practices, depending on the commanders personality, experience and background. The very fact that many helicopter pilots have gained a large part of their operational experience flying single pilot VFR, leaves one to believe that some of these will naturally find it difficult to see the advantages of an effective two-pilot VFR operation.

Bearing in mind that it at times can be more demanding flying VFR in mountainous areas than flying IFR, it is the opinion of SHK that it was unfortunate that the company, from a flight safety standpoint, did not at an earlier stage realise the value of establishing written procedures to actively including the first officer (or a HEMS-crewmember) in the operation of the aircraft during VFR flight.

SHK believes that it is of the utmost importance that helicopter flying performed with a two-pilot crew in VFR flight should be done in a fashion similar to that already established for IFR flight. This would be to the commander's advantage as he will carry less of the burden through sharing responsibility with the first officer, creating a greater margin for safety by actively including him in the progress of the flight. There would also be great benefits gained in increasing the experience level of the first officer and make his position onboard more stimulating.

## 2.4 Survival aspects

It can be safely said that ambulance helicopter flying can at times be demanding and not totally without risk. When the mission implies saving human life it is understandable that the risk for accidents increases as crews push both themselves and their aircraft to the limit. In these situations it is very important that everyone onboard understands the risks involved and that everyone actively participates to reduce the chances of an accident occurring as much as possible.

The impact absorbing pilot seats played a very important roll in the safety and survival of the pilots. Due to the fact that ambulance flights usually carry passengers in the cabin, those seats should also be of the same standard and construction. These types of seats are unfortunately space demanding, which already is at a premium, making this goal hard to achieve. All the seat harnesses in the cabin were of the four-point type which was advantageous from an impact point of view. However, even though the doctor and the nurse had been instructed to sit properly fastened in their harnesses for take off and landing, they sat with only their waist belt done up during the accident.

It can be assumed that the doctor most probably would not have suffered the back injury she received upon impact if she had been sitting properly fastened, instead of leaning forward as was the case. It is difficult to determine whether this is the result of the passengers failure to follow established procedure or the failure of the crew to ensure everyone was correctly fastened in their seats prior to landing. The flaws found in the company's onboard safety brochure could very well be an indication of the latter and that not enough thought had been given to cabin safety.

The aircraft's ELT was activated upon impact but its power output was reduced when the antenna cable was damaged in the accident. This could have reduced the

range of the signal output and delayed the time until it was finally picked up by the satellite. Flight crews undergoing type conversion training should be made aware of the fact that the ELT and its antenna cable are two separate parts.

In situations where flights are dispatched into mountainous areas where signal coverage for the normal mobile telephone network is not sufficient, thought should be given to carrying equipment making satellite communication possible.

## 2.5 Meteorological information

When flying in mountainous regions and especially at low altitudes, it is of vital importance from a flight safety standpoint that the pilots have a good knowledge of the latest weather situation. Due to the lack of observation stations and the fact that local variations occur, it has become common knowledge for crews that SMHI has difficulty in providing the detailed information they need.

As pointed out earlier in section 1.7, SMHI compiles and updates the radar pictures obtained through NORDRAD every 15 minutes, showing the distribution of precipitation throughout the whole country. The information gained here does not give a total picture but would nevertheless be of value to companies operating in wilderness areas to help them follow weather trends in their theatre of operations. In time it could be possible for crews to further complement the information they receive from the meteorologist and to reasonably predict how the weather will be based on their experience of comparing the radar information with actual local conditions.

As a system for disseminating weather radar information via internet already exists today, then the Swedish Civil Aviation Authority [5] and SMHI could act in conjunction to further spread this information so that reaches out to commercial and private operators.

## 2.6 The rescue services

When the ambulance helicopter advised that they were attempting to land at the medevac site, the SOS Centre was aware that radio communication would be lost until the helicopter became airborne again. It is understandable that they did not begin to suspect that the ambulance helicopter had been involved in an accident until after thirty minutes had passed, based on the difficult weather conditions at the site and the unclear state of the burn victims. The measures taken and the decisions then made by the SOS Centre, together with the ARCC, were both relevant and correct. Within a little more than six hours after the alarm went to the ARCC, three helicopters were on scene and a land rescue party was on it's way by snowmobile to the accident site. This can be seen as acceptable considering the difficult weather in the area, that the alarm came during the night and that the distances covered were considerable.

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[5] Swedish Civil Aviation Authority = Luftfartsverket or LFV

It is the opinion of SHK that valuable time was lost when a civilian volunteer rescue worker, who was near the accident site, was for some reason not contacted. SHK has not been able to ascertain why and under what circumstances this was allowed to happen. The police's own response log indicated that all the criteria for initiating a mountain rescue existed as early as 0024 hrs. SHK was however unable ascertain when the police actually began to alert rescue workers and which volunteers they were unable to contact.

# 3 CONCLUSIONS

## 3.1 Findings

*a)* The pilots were qualified to perform the flight.
*b)* The helicopter was airworthy.
*c)* No technical fault was found with the helicopter.
*d)* Landing conditions were difficult.
*e)* Established procedures for operating two-pilot crews in VFR did not exist.
*f)* Faults existed concerning safety in the aircraft cabin.
*g)* The commander´s request for a backup ground rescue was not carried out.
*h)* The NORDRAD radar system is not used optimally.
*i)* The were communication deficiencies in the alarm process.

## 3.2 Causes of the incident

The accident was caused by the commander attempting to land without adequate ground references and misjudging the aircraft height, resulting in the aircraft striking the ground. A contributing factor was that the company had at the time no established procedures for two-pilot operation in VFR.

# 4 RECOMMENDATIONS

It is recommended that the Swedish CAA :

- act to ensure that companies certified for helicopter operations establish and implement standard cockpit procedures for two-pilot operation in VFR flight, in the same way they exist for IFR flight (*RL2000:12 R1*); and
- in co-operation with the Swedish National Weather Service (SMHI) spread information about the existence of NORDRAD and make it accessible for both private and commercial aviation (*RL 2000:12 R2*).