Statens haverikommission
Swedish Accident Investigation Board

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# *Report RL 2006:16e*

## Accident involving helicopter SE-JUJ at Skräckskär, Gryts skärgård, E County, Sweden, on 18 September 2004

Case L-46/04

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



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

Translated by Tim Crosfield, M.A. from the original Swedish at the request of the Swedish Accident Investigation Board. In the case of any discrepancies between the English and the Swedish texts, the Swedish is to be considered the authoritative version.

Statens haverikommission (SHK) Swedish Accident Investigation Board

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04.07-2006 L-46/04

Swedish Civil Aviation Authority

SE-601 73 NORRKÖPING

Sweden

**Report RL 2006:16e**

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an accident that occurred on 18 September 2004 at Skräckskär, Gryts skärgård, E County, Sweden, involving a helicopter with registration SE-JUJ.

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

The Board will be grateful to receive, by 10 January 2007 at the latest, particulars of how the recommendations included in this report are being followed up.

Göran Rosvall

Sakari Havbrandt Henrik Elinder

# Contents

## Abbreviations

| | |
|---|---|
| ARCC | Aeronautical Rescue Co-ordination Centre |
| ATPL | Airline Transport Pilot Licence |
| ºC | Degrees Celsius |
| CPL | Commercial Pilot Licence |
| CVR | Cockpit Voice Recorder |
| DH | Decision Height |
| EADI | Electronic Attitude Director Indicator |
| EHSI | Electronic Horizontal Situation Indicator |
| ELT | Emergency Location Transmitter |
| FDR | Flight Data Recorder |
| FMS | Flight Management System |
| FOM | Flight Operations Manual |
| FPL | Flight plan |
| GPS | Global Positioning System |
| HEED | Helicopter Emergency Evacuation Device (S*mall tube for breathing air)* |
| HEMS | Helicopter Emergency Medical Services |
| hPa | Hectopascal |
| HUET | Helicopter Underwater Escape Training |
| IFR | Instrument Flight Rules |
| JAR | Joint Aviation Requirements |
| JAR-OPS | JAR on Flight Operations |
| MEL | Minimum Equipment List |
| MUST | (Defence Forces Intelligence and Security Service) |
| OGE | Out of Ground Effect |
| OPC | Operator's Proficiency Check |
| PC | Proficiency Check |
| PF | Pilot Flying |
| PNF | Pilot Not Flying |
| QNH | Air pressure at mean sea level |
| RAWS | Radio Altitude Warning System |
| SAR | Search and Rescue |
| SMHI | Swedish Meteorological and Hydrological Institute |
| SOP | Standard Operating Procedure |
| UTC | Universal Time Co-ordinate |
| VFR | Visual Flight Rules |

# Report RL 2006:16e

Case L-46/04
Report finalised 04-07-2006

| | |
|---|---|
| *Aircraft; registration, type* | SE-JUJ, Sikorsky S-76C |
| *Class, airworthiness* | Normal, regarding certificate of airworthiness |
| *Owner/Operator* | AB Norrlandsflyg<br>Box 24, 982 21 GÄLLIVARE |
| *Time of event* | 18-09-2004, 22.54 hrs during darkness<br>*Note:* All times given in Swedish summer time (UTC + 2 hours) |
| *Place* | Due East of Skräckskär, E county, (pos. 5810N 01660E; at sea level) |
| *Type of flight* | Commercial air transport, HEMS |
| *Weather* | According to SMHI analysis: wind south/approx 15 knots, visibility 5-10 km, somewhat hazy and rain with scattered dry periods, cloudy, no cloud below 5000 feet, temp./dewpoint +10/+9 °C, QNH 1010 hPa |
| *Persons on board:* | |
| *pilots* | 2 |
| *additional crew members* | 3 |
| *Injuries to persons* | None |
| *Damage to helicopter* | Extensive |
| *Other damage* | None |
| *Captain:* | |
| *Sex, age, licence* | Man, 43 years, ATPL (H) |
| *Total flying time* | Approx. 8000 hours, of which approx. 2000 hours on type |
| *Flying hours, latest 90 days* | 75 hours, all on type |
| *Number of landings, previous 90 days* | 70, all on type |
| *Co-pilot* | |
| *Sex, age, licence* | Man, 37 years, CPL (H) |
| *Total flying time* | Approx. 2000 hours, of which 935 on type |
| *Flying hours, latest 90 days* | 90 hours, of which 22 on type |
| *Number of landings, latest 90 days* | 55, of which 54 on type |

The Swedish Accident Investigation Board (SHK) was informed on 19 September 2004 that an accident involving a helicopter with registration SE-JUJ had occurred directly east of Skräckskär, E county, on 18 September, at 22.54 hrs.

The accident has been investigated by SHK represented by Göran Rosvall, chair, Mats Överstedt, chief operational investigator until 14 February 2005, subsequently Sakari Havbrandt; and Henrik Elinder, chief technical investigator.

SHK was assisted by Lennart Samuelsson as operational expert.

The investigation was followed by the Civil Aviation Authority in the person of Magnus Axelsson.

## Summary

The helicopter with a crew of five on board took off from Gotland to pick up a person with an acute heart condition on Häradsskär and fly him to Linköping University Hospital. The weather was judged to be good and the sortie viewed by the crew as a routine mission. The flight took place under VFR in darkness with the commander as pilot flying (PF).

During the approach to the island the pilots located the house where the patient was staying through the light from the windows. Apart from this the only external reference point in the area was the light from the lighthouse only. The commander decided, after passing the island, to make a right turn and then approach it from the north and into the wind.

As the helicopter approached the final the commander stated that he intended to make a relatively steep approach. He felt that the initial glide towards the island was without problems even though he lacked visual contact with the ground and the strong light from the lighthouse at times masked the weaker light from the house windows. Shortly after the pilot had made visual contact in his spotlights with some skerries in the direction of flight, the co-pilot reported that the helicopter had sunk below 100 ft in altitude.

A few seconds later the winch operator saw in the light from the spotlights that the helicopter was rapidly approaching the water level and that the waves "were going in the wrong direction". He shouted. "We're moving backwards!" which the commander interpreted as "Watch out!" – the Swedish words "*Vi backar*" and "*Akta*!" sounding very similar. Before the commander could react, the helicopter struck the water.

The helicopter rapidly filled with water and all on board except the commander evacuated it. Trapped in the cabin, the commander managed only after several unsuccessful attempts to free himself and leave the helicopter before it sank. All were later rescued by the military rescue helicopter stationed at Berga.

The investigation has revealed that the pilots underestimated the difficulty of landing under circumstances then prevailing, and that the procedures and the technical equipment available for them to be able to perform a safe landing were not employed. In addition, departures were made from the operational procedures in force which, moreover, are judged to have been inadequate regarding HEMS flight.

The accident was caused because of a lack of adequate routines and procedures for the activity in question, and existing procedures were not followed completely.

## Recommendations

The Swedish Civil Aviation Authority is recommended to:

- act to ensure that operators who fly to places which are not established takeoff and landing grounds possess, and follow, operational procedures for such flights similar to those used for IFR-flights *(RL 2006:16e R1),*

- act to ensure that operators flying under VFR, with two pilots or with an HEMS crew member, develop and follow some form of crew cooperation for VFR flight corresponding to that in use for IFR flights *(RL 2006:16e R2),*

- seek internationally to ensure that requirements for the use of FDR and CVR are introduced for this category of helicopter operation *(RL2006:16e R3),* and to

- review the Authority's routines so that accepted flight safety recommendations are implemented within a reasonable time (RL *2006:1e6 R4)*.

# 1 FACTUAL INFORMATION

## 1.1 History of the event

### *1.1.1 The accident*

The helicopter and crew were stationed at the airline company's base station on Gotland and were available for rescue flights (SAR) and medical transport flights (HEMS). There had been no sorties during the day in question and the crew – consisting of two pilots, a winch operator and a surface-rescue diver – had been engaged in some flight training.

At around 21.50 hrs, an alarm was received from the Aeronautical Rescue Co-ordination Centre, ARCC, with the information that a person suffering from a heart condition, located on the island of Häradsskär in the Gryt Skerries, needed emergency helicopter transport to Linköping University Hospital. After refuelling and taking a nurse on board, the helicopter took off directly for Häradsskär with five people on board.

The weather on the way and in the planned landing area was judged to be good and the mission was regarded by the crew as routine. The flight was carried out under VFR in darkness, with the captain as pilot flying (PF). During the flight to the area, on autopilot, the pilots were informed that the patient was alone in a house about 400 metres NNE of the Häradsskär lighthouse. It was the only house on the island to have indoor lights on. The crew discussed how they would plan the landing and how they would pick up the patient. The approach checklist was completed approximately five minutes before reaching Häradsskär.

While the helicopter was approaching the island, the pilots were informed that the patient's condition had worsened and that it was difficult for him to talk on the telephone. The captain states that this did not significantly affect the remainder of the flight. The co-pilot states that he experienced an increase in the level of stress in the cockpit work.

The landing approach to the island was on an approximately north-westerly course at an altitude of 500 feet above the water, and the pilots were easily able to identify the house containing the patient by the light from the windows.

The outer points of reference in the area comprised only the light from the lighthouse and the illuminated house windows. The captain decided to turn right, after passing over the island, and to approach the planned landing area from the north and into the wind.

The altitude warning signals in the helicopter's radio altitude warning system (see 1.6.4) were, according to the pilots, set to 20 feet according to the procedure in force. In accordance with the landing checklist, the helicopter's radar was turned off prior to the approach.

During the right turn onto final, the captain instructed the assistant pilot, here called the co-pilot, to keep an eye on the instruments with the order, "You look in, I look out."

When the helicopter was approaching final, the captain stated that he intended to make a fairly steep approach flight so as not to be distracted by "rocks and skerries lying in the approach flight path". The captain began to decrease speed during the approach and when the helicopter was on final and was beginning to lose height, he disconnected the autopilot. He considered that the initial glide down towards the island went without problems even though he lacked visual contact with the ground and the strong light from the lighthouse sometimes interfered with the weaker light from the house windows. .

When the captain had obtained visual contact by the light of the spotlights with some skerries to the right of the flight path, the co-pilot stated

that the helicopter was passing the 100 foot level, which the captain acknowledged. Somewhat later, the co-pilot issued the warning, “Check rpm”, which the captain dealt with by raising the climb stick a little. According to the co-pilot’s recollection, the helicopter’s attitude was then approximately 15 degrees nose-up.

A few seconds later, the winch operator saw, in the light of the spotlights, that the helicopter was rapidly approaching the water surface and that the waves were going “the wrong way”. He called out, “We’re going backwards! *(Vi backar!)”,* which the captain misheard as “Be careful, be careful! *(Akta! Akta!)”.*

Before the captain could react, the helicopter struck the water. For both pilots, the crash was a total surprise. The helicopter filled rapidly with water after the crash and tipped over, at first onto its right-hand side and then upside down.

All on board, with the exception of the captain, managed rapidly to get out of the helicopter as it tipped over in the water. The captain was unable to find the emergency release control for his door and was trapped in the cabin. He finally managed to extricate himself after several unsuccessful attempts and, with the aid of the portable breathing apparatus (HEED), was able to get out of the helicopter before it sank to the bottom at a depth of approximately 8 metres.

With the help of an inflatable raft, the group managed, with great difficulty in the bad weather, to swim to a nearby rocky islet which they scrambled up onto. They activated their portable emergency transmitters and emergency lights. They found that only two of the lights were functioning, and they were uncertain whether the emergency transmitters were working.

### *1.1.2 The rescue service*

When contact with the helicopter was lost, the ARCC alarmed the helicopter division at Berga at 23.07 hrs and notified them that they feared that the rescue helicopter from Visby had crashed in the vicinity of Häradsskär. At 23.26 hrs, the military rescue helicopter took off from Berga and flew towards Häradsskär. They were able to locate the persons in distress at 00.44 hrs with the help of signals from one of their emergency transmitters. They were all suffering considerably from hypothermia. After a difficult rescue operation on the islet, as a result of darkness and a high wind, the rescue helicopter was able to leave the site after no more than ten minutes with all the persons from the crashed helicopter on board and to fly to the hospital in Visby.

Transport of the sick patient from Häradsskär was delayed as a result of the accident but this had no serious consequences.

## 1.2 Injuries to persons

| | *Crew* | *Passengers* | *Others* | *Total* |
|---|---|---|---|---|
| Fatal | – | – | – | – |
| Serious | – | – | – | – |
| Minor | 1 | – | – | 1 |
| None | 4 | – | | 4 |
| Total | 5 | – | | 5 |

## 1.3 Damage to the helicopter

Extensive.

## 1.4 Other damage

No other damage occurred. The accident had no effect on the environment.

## 1.5 Personnel information

### 1.5.1 The captain

The captain, a man, was 43 years old at the time and had a valid ATPL (H) certificate.

| *Flying time (hours)* | | | |
|---|---|---|---|
| *Latest* | *24 hours* | *90 days* | *Total* |
| All types | 3 | 75 | Approx. 8000 |
| This type | 3 | 75 | Approx. 2000 |

Number of landings this type latest 90 days: 70.
Type training carried out 1996.
Latest OPC carried out 30-06-2004 on S-76 C.
Latest PC (Proficiency Check) carried out 14-12-2003 on S-76 C.
The captain had not undergone prescribed company training in landing in HEMS, or in selecting landing sites from the air, since the commander flying, judged that his earlier flight experience was sufficient.

*The pilot's duty schedule*
Prior to the accident, the captain had been awake for approximately fifteen hours and had flown approximately one hour during this period. During this time the crew had practised winching, amongst other matters. The captain had slept more than eight hours during his most recent rest period.

### 1.5.2 The co-pilot

The co-pilot, a man, was 37 years old at the time and had a valid CPL(H) certificate.

| *Flying time (hours)* | | | |
|---|---|---|---|
| *Latest* | *24 hours* | *90 days* | *Total* |
| All types | 2 | 90 | Approx. 2000 |
| This type | 2 | 22 | 935 |

All landings this type latest 90 days: 54.
Type training carried out 30-03-2000.
Latest OPC carried out 26-08-2004 on S-76 C.
Latest PC carried out 09-03-2004 on S-76 C.
The co-pilot had two years' experience as co-pilot in HEMS but for landing in darkness on non-established landing sites, the captain was always the pilot flying.

*Duty schedule*
The co-pilot had been awake approximately fifteen hours prior to the accident and had flown approximately one hour during this period, during which time the crew had practised winching, amongst other matters. During his most recent rest period, he had slept more than eight hours.

### 1.5.3 The winch operator

The winch operator, a man, was 40 years old at the time and a flight technician. He was trained as a winch operator in 2003 and has worked regularly in that capacity since then.

### 1.5.4 The surface rescue diver

The surface rescue diver, a man, was 29 years old at the time. He trained as a surface rescue diver in the Defence Forces and has worked in that capacity with the airline company since 2002.

### 1.5.5 The nurse

The nurse, a man, had the training required for service on HEMS missions.

## 1.6 Helicopter information

### 1.6.1 General

| | | |
|---|---|---|
| *THE HELICOPTER* | | |
| *Manufacturer* | Sikorsky | |
| *Type* | S-76C | |
| *Serial number* | 760424 | |
| *Year of manufacture* | 1994 | |
| *Gross mass* | Max permitted take-off weight 5300 kg, present 4790 kg | |
| *Centre of mass* | Within permitted limits | |
| *Total flying time* | 6528 hours | |
| *Number of cycles* | 28728 | |
| *Flying time since latest periodical inspection* | 4 hours | |
| *Fuel loaded before event* | JET A1 | |

| | | |
|---|---|---|
| *ENGINES* | | |
| *Engine manufacturer* | Turbomeca | |
| *Engine model* | Arriel 1S1 | |
| *Number of engines* | 2 | |
| *Engine* | Nr 1 | Nr 2 |
| *Total operating time, hours* | 5569 | 4491 |

| | |
|---|---|
| *ROTOR* | |
| *Rotor manufacturer* | Sikorsky |
| *Rotor operating time since new:* | |
| *Main rotor* | 5206 hours |
| *Tail rotor* | 6735 hours |

The helicopter had a valid certificate of airworthiness, and was equipped according to basic specification.

### 1.6.2 Helicopter type

The helicopter type has two engines and, in its standard configuration, room for two pilots and twelve passengers. It has a retractable undercarriage and is used both for transport of passengers and for special missions of various kinds.

This individual helicopter was equipped for instrument flying. For HEMS and SAR missions, it could be fitted with various types of medical equipment including a removable stretcher. It had inflatable emergency floats with manual release. An externally mounted winch was mounted on the helicopter's the right-hand side.

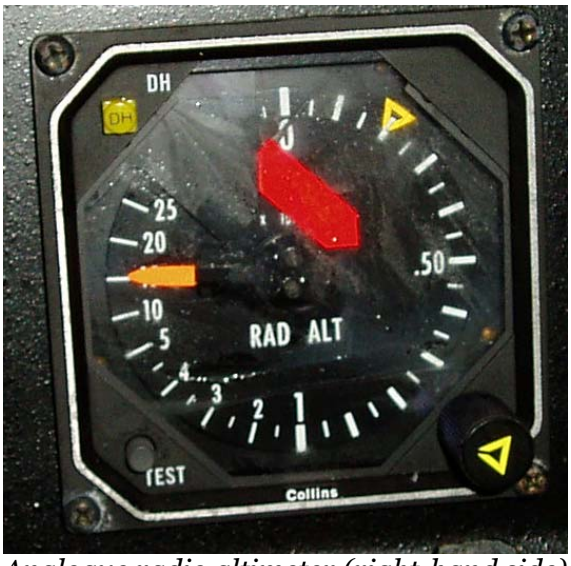

### 1.6.3 *Attitude presentation (EADI, EHSI)*

The helicopter had extensive instrumentation for performing various types of special task, even under adverse weather conditions. The instrument systems included two electronic attitude indicators (EADI) and two electronic course gyros (EHSI). The systems are identical for both pilot seats. Both systems consist of a symbol generator which generates information, a control panel on which the pilot can choose various presentations on two display monitors. On this individual helicopter speed and altitude information were presented in the EADIs.

For low-speed flying and while hovering, the equipment permitted presentation of speed and directional information for the helicopter's movement on a hover indicator in EHSI. This function was not activated at the time of the accident.

### 1.6.4 *Altitude warning systems*

The helicopter was equipped with double, mutually independent, radio altimeters (left and right) to show the altitude of the helicopter above the ground below. The altitude information was presented in the EADI and the EHSI as well as on separate analogue instruments in the instrument panel (see illustration below).




*Analogue radio altimeter (right-hand side)*

The left-hand system was presented in the left-hand pilot's EHSI ("approach to hover mode") and EADI and in the right-hand pilot's analogue instrumentation. The right-hand system was presented in the right-hand pilot's EHSI ("approach to hover mode") and EADI and in the left-hand pilot's analogue instrumentation.

Each radio altimeter offers the option of setting a 'decision height' (DH). When the helicopter, at descend, passes the set height, the system provides a visual warning in the form of a light which lights up on the instrument. The warning is also displayed on the EADI connected to the system. For all VFR flying, according to the company's routines, the DH must be set at 20 ft. on both instruments.

The helicopter was. in addition, equipped with two separate altitude warning systems, RAWS. This system was integrated with the regular radio altitude systems and always gives visual and audio warnings when the helicopter goes below the 30-foot radio altitude. The system also gives warning when the radio altitude meters are not functioning or when the autopilot detects an uncontrolled change in climb stick attitude when flying on automatic thrust control. RAWS was switched off at the time of the accident.

### *1.6.5 Special SAR equipment*

The helicopter was equipped with an autopilot adapted for SAR missions. The system can automatically control the helicopter from normal level flight to hovering at a given height over a particular target. As flying altitude during automatic approach and hovering refers to radar altitude, this automatic system is best suited to approaches over water. Automatic approach and hovering over a particular target requires, in preparation, extensive programming by the pilot.

The helicopter was also equipped with a radar able to display an image of the coastline or terrain in front of the helicopter, in addition to the range and bearing of various targets such as islands and vessels. This radar can also display the extent of certain types of cloud and precipitation in the direction of flight.

The helicopter had six spotlights for missions in darkness. Two of these were permanently mounted on the main undercarriage. Beneath the helicopter there were three, manoeuvrable individually. In addition, there was a powerful moveable searchlights on the left side, of type Spectrolab SX-5 Starburst, rated 500W.

### *1.6.6 AIS transponder*

The helicopter carried an R4 AIS transponder system. The system is a GPS-based navigation and position-reporting system developed primarily for commercial shipping. The system registers and reports data such as the position, speed and course of its own vessel, while at the same time receiving information about the position, speed and course of other vessels in the vicinity. The system reduces the risk of collision between vessels and facilitates traffic control. It is also of assistance for controlling air and sea rescue operations.

The system was used in the helicopter only on infrequent occasions, and then mainly in order to identify radar echoes. It was then operated only from a laptop in the cabin.

## 1.7 Meteorological information

According to SMHI analysis: wind south/approx. 15 knots, visibility 5-10 km, somewhat hazy with scattered rain, overcast but no cloud below 5000 feet, temp./dew point+10/+9 °C , QNH 1010 hPa.

Wave height was estimated to 2 metres and surface water temperature to +12 °C.

## 1.8 Navigational aids

In addition to the normal instrumentation for IFR flying, the helicopter was fitted with GPS and FMS which can be programmed regarding the search area, SAR approaches and other functions.

## 1.9 Radio communications

During the flight from Gotland to Häradsskär, the pilots had radio contact with the ARCC on several occasions. Shortly before the accident, the pilots reported that they intended to land on Häradsskär.

## 1.10 Aerodrome information

Not applicable.

## 1.11 Flight data and voice recorders

### *1.11.1 Flight data recorder (FDR)*

None on board, and not required.

### *1.11.2 Cockpit voice recorder (CVR)*

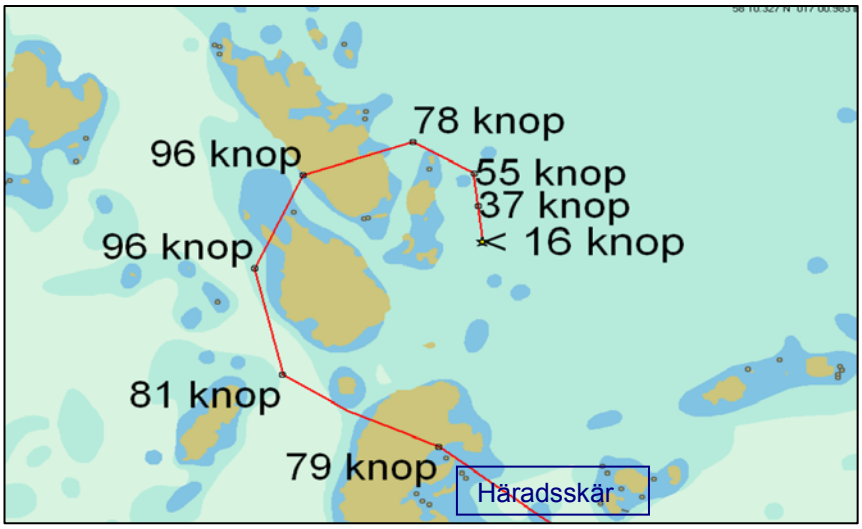
There was no CVR on board and it was not required (the requirement for CVR ceased when the company changed over from operating in accordance with BCL to operating in accordance with JAR-OPS3).

### *1.11.3 Radar plot*

The entire flight was registered using ground radar. The records show that the helicopter flew directly from Visby to Häradsskär on a straight course and at a height of 300 metres. There it began a right turn before the radar echo disappeared. The flight altitude was then about 150 metres and the course approximately 170 degrees.

### *1.11.4 AIS recording*

The helicopter flight path was recorded by the National Maritime Administration Control Centre via the AIS system. The approach path towards Häradsskär and the calculated speed are shown on the map below.




*Approach flight according to AIS records*

## 1.12 Accident site

### *1.12.1 The accident site*

The helicopter struck the water approximately 500 metres north of Häradsskär. Häradsskär lighthouse is located on the southern part of Häradsskär. The patient was in a house situated roughly in the middle of the island.


*Approach to Häradsskär seen from the north*

### *1.12.2 Helicopter wreckage*

The helicopter sank to the bottom at a depth of roughly 8 metres, where it ended up upside-down. It was located four days after the accident and salvaged with the assistance of Coast Guard resources, and transported to a helicopter workshop for technical investigation.

## 1.13 Medical information

Nothing has emerged to indicate that the crew's mental or physical condition was impaired prior to or during the flight.

## 1.14 Fire

No fire broke out.

## 1.15 Survival aspects

### *1.15.1 The Crash*

When the crash occurred, the crew were in their normal places for landing. the pilots were buckled in with five-point safety belts and the nurse with a four-point belt. The surface rescue diver and the winch operator were kneeling on the floor to operate the moveable searchlights and to look out of the windows on their respective sides. The surface rescue diver and the winch operator were anchored to the ceiling with their respective harnesses. None of the seats in the helicopter was of an energy-absorbing design, but they had cushions with some energy-absorbing function.

The impact on the water was relatively gentle and none of those on board was seriously injured. The helicopter's emergency floats were armed but not activated by the pilots prior to impact.

After the crash, the crew underwent severe trials and risks before being picked up by a rescue helicopter nearly two hours later.

### *1.15.2 Evacuation*

All those on board, except for the captain, were able to release themselves quickly and leave the helicopter before it sank. The co-pilot left the helicopter by the left-side pilot's door which he himself opened with the emergency handle. The crew in the cabin got out via a 'push-out' panel in the left-side cabin door.

The captain, who was seated in the right-hand pilot's seat, was unable to open the pilot's door as he could not find either the normal handle or the emergency handle. When he tried to leave the helicopter through the left-side pilot's door, he became caught up on something. He only managed to free himself after several attempts and was then able to get out through the door and up to the water surface. He has said that he would probably not have managed this without the portable breathing equipment, which he emptied completely.

### *1.15.3 Emergency equipment*

The helicopter carried the following

| emergency equipment | Experienced function |
|---|---|
| Emergency floats with manual activation | Not activated |
| ELT Helicopter – Artex HM110 | Unknown (sank with helicopter) |
| Raft cockpit – RFD LRU-23/P (one-man) | Worked well |
| Raft cabin – RFD Navigator 4/6-man) | Not used |
| MOB marker – ACR SM-2 | Not used |
| Floating flashlight – Pelican Aqua King Lite | Not used |

| The crew had the following emergency equipment: | Experienced function: |
|---|---|
| Survival suit, all – Ursuit 5030 | Worked well |
| Helmet, all – Gentex SPH-5 | Worked well |
| Life jacket cockpit – Switlik HV-35 | Worked well |
| Life jacket cabin – LSC Pro-vest | Worked well |
| Air, all – HEED III | Worked well |
| Portable emergency transmitter – ACR MiniB2, all | Function unknown |
| Flashlights, all – ACR Firefly2 | Varied in function |
| Pocket knife, all | Not used |
| Signal mirror, all – LSC | Not used |
| Whistle, all – LSC | Not used |
| Pocket torch – Mini Maglite | Not used |

The following personal emergency equipment was recovered from the accident:

- One portable emergency transmitter (1) with a note stating “Worked for about 15 minutes; light went out”. (BAT DATE 5/2008)
- One portable emergency transmitter (2) with a note stating ”Blinked sporadically.” (BAT DATE 5/2008)
- One flashlight (1) with note stating ”Flashlight did not work! Lost.”
- One flashlight (2) with note stating ”Did not work”.

These objects were tested in an instrument workshop with the following results:

| | |
|---|---|
| Emergency transmitter 1 | Worked, no comment |
| Emergency transmitter 2 | Worked, no comment |
| Flashlight 1 | Did not work with original batteries (waterdamaged) |
| Flashlight 2 | Did not work with original batteries |

### *1.15.4 Emergency training*

All the crew members except the nurse had received theoretical and practical training in emergency evacuation of a helicopter under water, (HUET), including the use of emergency breathing equipment, (HEED). Refresher training was planned to take place every third year.

### *1.15.5 Measures taken to revise emergency routines*

Since the accident the airline has supplemented its routines and equipment for emergency evacuation in water, based on experience gained from the accident. Among other measures the handles for the emergency door opening system have been modified and emergency evacuation lighting has been installed.

## 1.16 Tests and research

### *1.16.1 Documentation before salvage*

The helicopter and its position on the bottom were photographed and videotaped by divers before salvage operations commenced. Apart from pieces knocked off the main rotor and the tail rotor with its propulsion unit, the helicopter was otherwise largely intact. The landing gear was lowered. Before salvage commenced, the helicopter was turned over and then lifted by the rotor hub.

### *1.16.2 Helicopter structure*

Apart from a fracture to the tail boom near to where it joined the cabin, the cabin section was mainly intact. The sheet metal on the undersurface was dented in a few places. The forward emergency floats had opened out but were not filled with gas. On the metal strips of the front windshields there was abrasion damage after mechanical contact, presumably with the main rotor blades.

### *1.16.3 Rotors and control systems*

All the main rotor blades had broken off the main rotor hub near their points of attachment to the hub. Abrasion damage as a result of mechanical contact was noted on the lower surface, about half way along the span, of the two blades which were found on the bottom near the helicopter.

The tail rotor system 90°-gearbox in the tail boom had cracked and separated from the boom. Of the four tail rotor blades, one had broken and the others had split. The tail rotor transmission shaft had broken away from the forward clutch plate as a result of high torsion.

The helicopter's control systems were checked as far as practically possible. No faults or abnormalities judged able to have affected the accident were noted.

### *1.16.4 Engines*

There is nothing to suggest otherwise than that both engines were functioning correctly and providing their normal power until the helicopter hit the water.

### *1.16.5 Instruments*

The static and dynamic systems were filled with water and it has not been possible to pressure-test them. A visual inspection of the systems revealed no defects or abnormal damage.

The mechanical air-speed indicators, altimeters and variometers were dismounted from the helicopter and have been examined in an instrument workshop. All the instruments were severely corroded and it has not been possible to test them. A visual inspection revealed no defects or abnormalities that could have affected their working. Both altimeters were set at 1013 hPa.

After the accident the DH on the left and right radio altimeters was found set to 30 feet.

The two vertical gyros of the helicopter, which control attitude information to the EADI system were tested and found to give the correct attitude information.

### 1.16.6 Landing spotlights

The switches for all the spotlights were in the ”ON” position after the accident. The fixed-position landing spotlight on the right undercarriage was twisted forward in the direction of movement. One of the retractable moveable landing spotlights under the cabin had broken off from its fitting and was missing. A metallurgical analysis of the fracture surface reveals that the fitting was broken by overloading as a result of a forward-directed force.

### 1.16.7 Emergency floats

The helicopter’s emergency floats were armed but not actuated.

### 1.16.8 Summary

To summarise, no technical faults have been found on the helicopter that can be deemed likely to have affected the course of the accident. All systems were functioning normally, and the helicopter was configured for landing. The damage reveals that the helicopter hit the water somewhat nose-high, at a moderate vertical speed and a certain backward speed.

## 1.17 Organisational and management information

### 1.17.1 General

Section 1.17 refers to conditions prior to the accident.
The airline has its main base in Gällivare and outstations in Sundsvall, Visby and Göteborg. At the bases in Gällivare and Göteborg (Säve airport) most of the work involved HEMS missions. In Sundsvall and Visby, most was SAR assignments.

The company is licensed for commercial aviation with multi-engined helicopters. This work includes flying under VFR and IFR. Detailed instructions on the conduct of flights are given in the company’s operational handbook (FOM).

### 1.17.2 Flight Operations Manual (FOM)

*General*
The FOM deals with the general routines and procedures for operational work. The basis of the FOM is the applicable set of regulations for commercial helicopter operations JAR-OPS 3 (see *1.18.1)*.
JAR-OPS 3 contains specific regulations for HEMS but not for SAR.

The FOM regulates the operation of the company helicopters in different situations and weather conditions. It specifies how co-operation between crew-members is to take place. After a previous accident involving the company in conjunction with an HEMS-mission (see 1.18.6), the instructions were revised and a more detailed system for crew co-operation was introduced.

SHK has studied selected sections of the FOM in order to form an opinion on the routines and procedures used by the company at the time of the accident, both as regards flying under IFR and SAR-flights and as regards HEMS-flights under VFR.

*Flying under IFR and SAR-flights*
For flying under IFR and SAR-flights, routines and procedures (SOP) exist. They include clear instructions concerning cooperation between pilots and communication by “callouts” during different phases of the flight.

*Flying under VFR*
Flying under VFR, both in daylight and darkness, is described in general terms and with few specific direction values. The callouts that are defined are of a general nature and require the pilot flying (PF) to have informed the pilot not flying (PNF) how the flight is to be performed so that the latter can provide the relevant deviation callouts and effective operational support.

*HEMS flights*
There are special instructions for flights classified as HEMS. Among these, the risk that pilots might become stressed by information regarding a patient's status is described, and how this should be dealt with. It points out particularly the importance of the captain providing a clear briefing to his crew prior to the approach flight, concerning the planned landing procedure.

All HEMS-landings must be preceded by at least one 360-degree reconnaissance circuit over the planned landing site, regardless of circumstances. The PNF must during the landing phase report the engine thrust situation and if required adjust their relative outputs. In darkness the PNF who is not responsible for manoeuvring the helicopter (PNF) has to report on the power settings of the engines and trim their relative powers. In darkness, the PNF must report sinkrate, speed and radar altitude below 500 feet with increasing frequency as the helicopter nears the ground.

An appendix states what deviations of speed, height, bank angle, rate of descent and course require the PNF to make a callout, a "significant deviation call". It does not, however, specify what standard values these deviations are to be measured from as regards speed and height during a VFR approach.

If power is sufficient, a reconnaissance hovering should be performed without ground effect (OGE) before the helicopter finally sinks to the touchdown site.

It has been decided to integrate into the company's PC/OPC the prescribed requirement for a special line check of the pilot's capability to "select from the air" non-established landing sites

## 1.18 Additional information

### *1.18.1 JAR-OPS 3*

The European regulations for aviation, Joint Aviation Requirements (JAR) –OPS 3, which concern commercial helicopter activities describe ambulance flights under the heading Helicopter Emergency Medical Service (HEMS). In Supplement ACJ-1 to JAR-OPS 3.005 d), a description is provided concerning the differences between Medical Transport, HEMS and SAR.

*Medical transport*
Medical transport is considered as a normal transport flight of a patient, for example between hospitals, where the accepted risk should be no higher than for other forms of passenger transport. The rules for flights of this type are therefore the same as for taxi flights, for example.

*HEMS*
HEMS are defined as flights the purpose of which is to fetch sick or injured patients, blood, organs, medical necessities or medical personnel where "immediate and rapid transport is essential". For such purposes, a higher

risk level is accepted and this comprises, amongst others, the following relaxations of the regulations in force:

- Lower requirements concerning altitude and visibility.
- Lower requirements concerning helicopter performance and size of landing site.
- Lower requirements concerning landing site.

For HEMS, however, the following special requirements include:

- Information concerning start- and landing procedures on previously non-reconnoitred, non-established landing sites must be provided in the operations manual.
- Pilots must receive training in ”assessment from the air as to whether non-established landing sites are suitable”.
- During the line check, the pilot’s capacity to choose non-established landing sites from the air for HEMS must be checked in particular.

For HEMS it is further stipulated that the operational manual must contain instructions for the execution of the flight, suitably modified for the field of activity and providing the following at the least:

- Operational minima.
- Recommended routes for regular flights to previously reconnoitred non-established landing sites (including minimum flying altitudes).
- Guidance for the choice of non-established landing sites for HEMS in cases of flights to non-established landing sites not reconnoitred in advance.
- Stated safe height for the overflown area, and procedures to be followed in the case of involuntary entry into cloud.

As regards non-established landing sites for HEMS, the following is included:

A non-established landing site must always have an area equal to at least 2 x the rotor diameter (D) in both length and width. Non-established landing sites which have not been reconnoitred and which are used operationally in darkness must be a least 4 x D in length and 2 x D in width.

HEMS flights are normally performed under VFR. Beyond the recommended size of non-established landing sites, SHK has been unable to find any special requirements in the existing regulations for particular operational procedures for commercial VFR flights in darkness.

*SAR*

SAR is defined as flights with specially equipped or commissioned aircraft and crew intended for rescue missions in distress situations or in emergencies that have occurred on land or at sea.

There are no international regulations for SAR operations. It is the responsibility of the national authorities to produce such if considered necessary. In Sweden, these operations follow special military regulations when performed as military operations. When performed as civil operations, they are conducted according to the operator’s FOM produced in consultation with the Civil Aviation Authority and the Swedish Maritime Administration in cooperation and approved by the Civil Aviation Authority.

### *1.18.2 Reconstruction flights*

To obtain a clear picture regarding the flight in question and the appearance of the ground near the planned landing site, SHK has performed two reconstruction flights over Häradsskär and it’s near vicinity.

The first flight was performed in daylight, on 24 June 2005, with a military rescue helicopter of type AS 332M Super Puma (hkp 10) from Berga.

The following are some of the points noted during the flight:

- reconnoitring from the air prior to the approach was at a distance of approximately 300 metres north of the intended landing site,
- the approach turn was started almost immediately after the fly-over and was relatively sharp, and
- the ground is uneven, offers few flat open areas and is crossed by many power and telephone lines.

*The area where the summer cottage with the patient was situated*

The second flight took place in daylight on 17 August 2005, with the same type of helicopter as the subject of this report, a Sikorsky S-76. Several approaches to the island were made. During the approaches, which largely followed the same flight path and speed as the accident flight it was noted:

- the right turn onto final was felt to be ”sharp”,
- the rate of descent on final was high, and
- visual contact with the house containing the patient was obscured by high ground on the island when the helicopter descended below approx. 250 feet.

An automatic approach-to-hover over a beach on the east side of Häradsskär was performed without difficulty.

### *1.18.3 Measures taken following the accident regarding operational routines*

Since the accident the airline company has modified its FOM and amended the relevant checklists in several places to make VFR landings in darkness safer;

- Darkness minima have been introduced, which specify that the radio altimeter must always be set at a decision height (DH) of 150 feet before an approach in darkness may be started. To continue an approach below 150 feet, sufficient visual references must be seen, corresponding to those required for hovering with only external visual references.

- Requirements have been introduced for callouts when the 150-foot level is passed. At this height, the PF is to decide whether to continue the approach.
- Rules for the use of RAWS have been introduced.
- A requirement to follow up the GPS distance to the landing ground during the approach has been introduced.
- It is generally recommended that all available aids be used to determine the attitude and movement of the helicopter during the approach.

### *1.18.4 The task of the Swedish Maritime Administration*

The Swedish Maritime Administration is the rescue service authority responsible for search for and rescue of people in distress at sea, as well as the conveyance of patients from shipping within the Swedish area of responsibility (SAR). The Swedish Maritime Administration has had an agreement with the Swedish Defence Forces since 1992 for this purpose and since 2002 also an agreement with the relevant operator to provide helicopter services for air/sea rescue purposes.

The operational mission description produced by the Swedish Maritime Administration for this work primarily concerns the actual search and rescue service. For flight operational requirements and safety regulations, reference is made to existing directions and procedures as specified by the military and civil aviation authorities respectively.

The Swedish Defence Forces have long experience of rescue missions comprising such tasks as searching for and winching up distressed persons at sea. In the civil helicopter aviation, competence built up in recent years has been based on military experience but following civil procedures and using technical equipment.

### *1.18.5 Prior accident in connection with HEMS flight*

The airline company suffered an accident on 3 April 1999 at Lake Kamasjaure in northern Sweden in connection with an HEMS mission with a helicopter of type Sikorsky S-76.

The SHK final report, RL 2000:12, identifies the following cause of the accident:
*"The accident was caused by the pilot misjudging the flying height while landing without sufficient ground references and colliding with the ground. Contributing to the accident was the fact that the airline company lacked a developed two-pilot system for VFR flying."*

The following recommendation was sent to the Swedish Civil Aviation Authority**:**
*The Swedish Civil Aviation Authority is recommended to:*
*- seek to ensure that operators which fly under VFR with two pilots or with an HEMS crew member develop and follow a two-pilot system for VFR flying corresponding to that used on IFR flights (RL 2000:12 R1).*

The National Administration's accident meeting on 3 May 2000 decided as follows as a result of the recommendation received:
Recommendation R1: *"The recommendation will be adopted by the implementation of JAR OPS Subpart B, Appendix 3.005 (d).*
JAR OPS Subpart B, Appendix 3.005 (d) was implemented and the company was certified in accordance with JAR OPS.

The Board has not found that this decision has so far resulted in any safety-enhancing measures on the part of the authority.

# 2 ANALYSIS

## 2.1 The Mission

The flight was a HEMS mission in which a patient was to be transported from an island in the archipelago to a hospital on the mainland. The nature of the possible landing ground was unknown and it was dark at the time.

Generally speaking, a flight of this nature places great demands on methods and equipment. The crew did not feel that the mission was particularly difficult, probably because they were trained for and accustomed to more complicated rescue missions in their SAR work.

## 2.2 The Accident

Just before the helicopter reached Häradsskär, the pilots received a message informing them that the patient's condition had worsened and that there was no time to lose. Although the captain states that this did not affect him, it is nevertheless likely that it contributed to making the planning of the landing somewhat strained.

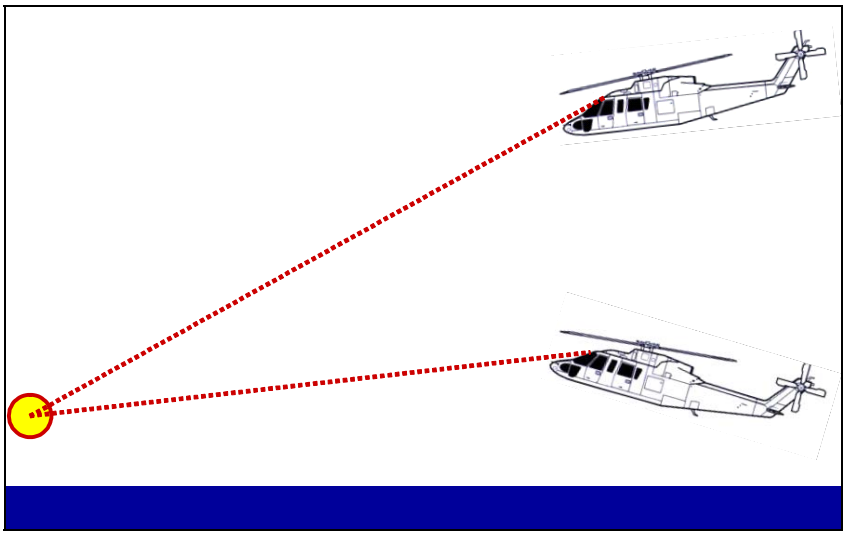
The co-pilot was tasked to check the instruments, but received no other information concerning the plan of the approach and landing or what was expected of him. This was a departure from the company's written routines and means that the captain did not fully exploit the operational support available to him.

The captain flew the helicopter with outer references comprising mainly the intermittent light from a lighthouse and the light from a house window. When the more powerful light from the lighthouse was shining, it was hard to see the light from the window.

The landing circuit was relatively sharp and the turn onto final occurred during reduction of height and speed. On final the pilot had a faulty understanding of the helicopter's altitude and attitude. He thought it was higher and had a lower nose position than was the case.

Experience shows that it is practically impossible, with only a few light sources in front of a helicopter as references, to determine its position and movement with any certainty.

The illustration below shows the problem of attempting to determine flight attitude using just one light source. The light source has the same position in the windscreen in both cases. The difficulty of determining the helicopter's attitude is particularly serious during speed reduction, which is usually accomplished with a successive raising of the nose position.



At the accident site, moreover, the light from the window was obscured by the terrain when the altitude was below 250 feet. If the helicopter passed the 250-foot level when the lighthouse was shining, the light from the window did not reappear when the lighthouse beam passed on. It is possible that the captain understood this to mean that the helicopter was so high on its planned glidepath that the light was hidden by the helicopter nose, and so he reduced speed and altitude. When the pilot became aware of the helicopter's true height he had no possibility of being able to avoid impact on the water.

The co-pilot, whose task it was to monitor the instruments, called out when the helicopter passed the 100-foot level and thereafter understood the readings of the instruments to show that the captain was performing a normal landing. He did not therefore react when speed and height approached zero.

The damage to the helicopter and the observations of the winch operator indicate that the helicopter struck the water relatively gently with a moderate backward speed.

## 2.3 Crew cooperation

The captain had long experience of flying multi-engined helicopters in instrument weather conditions and darkness, and had received extensive training in SAR flying. He had, however, limited experience of HEMS flying and was not trained to land in darkness under VFR, which is required according to the company FOM.

The co-pilot, however, had relatively long experience of HEMS flying but less of instrument flying than the captain.

The captain had been the instructor when the co-pilot was trained for company SAR work a few months previously and it can be assumed that the co-pilot had great respect for his previous teacher.

This situation, together with the reports on the patient's condition, can have contributed to prevent the co-pilot from reacting to the somewhat hurried approach or to the deviations made by the captain from the procedures prescribed by the company.

From the pilots' statements and study of the helicopter's flight path one can assume that they had differing views on what sight the approach was to be made. Since there was no communication regarding the planning of the approach and landing this was never discovered.

It cannot be overlooked in this connection that the accident occurred late in the evening and that the pilots had previously been awake for 15 hours and carried out flight duty. Fatigue may therefore have reduced the pilots' capacity.

## 2.4 Available aids

### *2.4.1 Radio altimeter*

The adjustable warning altitudes for the radio altimeters were set at zero, in accordance with company routines for VFR landings. (They were recovered after the flight showing 30 feet and 20 feet respectively). This meant that the warning came too late to permit measures to prevent the accident: the sink rate in the terminal phase was approximately 500 ft/min). SHK considers it appropriate to use a higher decision height (DH) in conjunction with VFR landings when visual references are limited.

### 2.4.2 RAWS

RAWS was switched off in accordance with company routines for VFR-landings. SHK considers it appropriate to use the system in conjunction with VFR-landings when visual references are limited.

### 2.4.3 Radar

The helicopter's radar was switched off in accordance with company routines for VFR landings. In this particular case, the radar would have helped the pilots see the distance to the shoreline and thus given them a better understanding of the helicopter's position.

### 2.4.4 GPS

The helicopter was equipped with a GPS. The screens which show a map with the helicopter position were admittedly dismantled but other GPS functions were available and could have been used for determining position and distance.

## 2.5 The airline company's operational routines

The company's procedures for VFR landings on unknown sites prescribed a 360-degree circuit over the intended landing site, and that the captain should brief the entire crew on how the landing was to proceed. These were not done, which can indicate deficiencies in the company's operational routines and also that the captain felt the landing to be relatively simple and that these measures would take unnecessary time.

The co-pilot is required by company routines to provide information concerning speed, altitude and engine readings when the helicopter has passed below 500 feet. It is not clearly stated, however, at what intervals or in which order. In this particular case, the co-pilot reported only at the start of the final phase and when the helicopter passed the 100 foot level, and shortly thereafter that the rotor r.p.m. was too high.

There were no minimum values, limits or instructions as to when a landing procedure should be aborted if no clear visual contact with the landing site could be established.

There were no fully-established standard operating procedures (SOP) with directives for the pilots' cooperation and communication with call-outs during the different phases of the flight, for either HEMS flights or other VFR flying. Neither was the use of available technical aids prescribed although this can increase flight safety.

SHK considers that safety can be greatly increased if, in principle, all VFR operations are planned and performed more systematically, with better defined points of decision and minima similar to those used in IFR flights and with the optimal use of the equipment on board. This applies in particular to operations with poor visual references.

The supplements made by the airline company concerning procedures for VFR flights in darkness are considered relevant and to have contributed to increased safety on VFR flights.

## 2.6 Summary assessment

The resources available in the form of crew experience and technical equipment were not used appropriately. The safety of the flight was based solely on the visual judgment of the captain. There was nothing that could detect an error of judgment. This indicates insufficient awareness, during

production of the company's operational routines, of the difficulties of landing on an unknown site with limited visual references. The rules that did exist, though incomplete, were not completely followed, either.

Even though it should be possible to conduct a VFR flight with only external references to support navigation and attitude maintenance, this does not automatically mean that available support resources should be disregarded.

The company's departure from the line-check requirement to check particularly the pilot's ability to judge the suitability of non-established landing sites, suggests that the difficulties of doing so have been underestimated. The Board considers it unfortunate that JAR-OPS3 places no requirement on the use of CVR and FDR for this type of flight operation. Had data of this type been available for the present investigation the examination would have been simplified and the conclusions probably more exact.

## 2.7 Response to previously issued recommendation

The present accident shows several similarities to that suffered by the operator in 1999. SHK notes that the recommendation made in Final report RL 2000:12 (recommendation 1) concerning that accident did not lead to any measures taken by the authority and designed to increase flight safety.

Since the recommendation stated is also relevant to the present accident, there is reason to repeat it in this Report.

The Civil Aviation Authority should therefore review its routines for dealing with the Board's accepted flight safety recommendations so that the measures necessary for implementation are in fact taken.

## 2.8 The rescue Service

The accident resulted in five persons ending up in the sea, in a high wind and heavy seas. It was dark at the time and the distressed persons could hardly see land. That all on board were rescued without serious injury occurring can be attributed to several favourable factors:

- The helicopter was equipped with extensive emergency equipment for a possible crash at sea.
- All the crew were wearing survival suits fitted with personal emergency transmitters and signal lights.
- The crew were well trained and acted correctly as a group.
- There was an islet nearby and the crew were able to swim to it despite the difficult conditions.
- ARCC realised quickly that an accident had occurred and alerted the Berga helicopter.
- The rescue helicopter was able to take off quickly from Berga and fly to the accident site.
- The rescue helicopter crew were able to locate the crew from the crashed helicopter by radio-direction-finding of one or more functioning emergency transmitters.
- The rescue helicopter was able to land on a difficult landing site, take all the distressed persons on board and transport them to hospital.

# 3 CONCLUSIONS

## 3.1 Findings

*a)* The pilots possessed formal certification to carry out the flight.
*b)* The helicopter had a valid certificate of airworthiness.
*c)* The landing was planned to be carried out under VFR, in darkness, and with limited external visual references.
*d)* The difficulty of landing under the conditions at the time were underestimated.
*e)* The procedures and technical equipment available for the pilots to carry out a safe landing were not used.
*f)* Departures were made from the operational procedures in force.
*g)* The operator's operational procedures for HEMS flights were insufficient.
*h)* Recommendation *RL 2000:12 R1* issued in Report RL 2000:12 has not resulted in any measures on the part of the Civil Aviation Authority to enhance flight safety.

## 3.2 Causes of the accident

The accident was caused by the absence of sufficient routines and procedures for the particular operation, and the fact that existing routines were not fully followed.

# 4 RECOMMENDATIONS

The Swedish Civil Aviation Authority is recommended to:

- act to ensure that operators who fly to places which are not established takeoff and landing grounds possess, and follow, operational procedures for such flights similar to those used for IFR-flights *(RL 2006:16e R1),*

- act to ensure that operators flying under VFR, with two pilots or with an HEMS crew member, develop and follow some form of crew cooperation for VFR flight corresponding to that in use for IFR flights *(RL 2006:16e R2),*

- seek internationally to ensure that requirements for the use of FDR and CVR are introduced for this category of helicopter operation *(RL2006:16e R3),* and to

- review the Authority's routines so that accepted flight safety recommendations are implemented within a reasonable time (RL *2006:16e R4).*