Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2005:26e

Accident involving helicopter SE-JHJ at Orremossen in Vättlefjäll, north-east of Göteborg, O County, Sweden, on 11 September 2004

Case L-45/04

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 case of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

Statens haverikommission (SHK) Swedish Accident Investigation Board

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2005-11-14 L-45/04

Swedish Civil Aviation Authority

SE-601 73 NORRKÖPING

Sweden

Report RL 2005:26e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an accident that occurred on 11 September 2004 at Orremossen in Vättlefjäll, north-east of Göteborg, O County, Sweden, involving a helicopter with registration SE-JHJ.

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 15 May 2006 at the latest, particulars of how the recommendations included in this report are being followed up.

Göran Rosvall Sakari Havbrandt

Henrik Elinder Urban Kjellberg

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Report finalised 14-11-2005

Aircraft: registration, type	SE-JHJ, Robinson R44
Class, airworthiness	Normal, valid certificate of airworthiness
Owner/operator	HM-Jansson Åkeri AB
Time of event	11-09-2004, 14.00 hrs in daylight *Note.:* All times are given in Swedish daylight saving time (UTC + 2 hours)
Place	Orremossen in Vättlefjäll, O County, Sweden (pos. 5749N 01205E; 140 m above sea level)
Type of flight	Private
Weather	According to SMHI analysis: south-westerly wind 10-12 knots, visibility 1 500 m, 8/8 stratus with base 200-400 feet, temp./dew point +16/+15 °C, QNH 1008 hPa
Persons on board:	
crew members	1
passengers	2
Injuries to persons	All those on board lost their lives
Damage to helicopter	Total wreck
Other damage	Minor petrol and oil leakage. Negligible environmental impact
Pilot:	
Sex, age, licence	Man, 31 years, PPL-H
Total flying time	90 hours, of which 39 on type
Flying hours, latest 90 days	39, all on type
Number of landings previous 90 days	149

The Swedish Accident Investigation Board (SHK) was notified on 11 September 2004 that an accident involving a helicopter with registration SE-JHJ had occurred at Orremossen in Vättlefjäll, O County, Sweden, at 14.00 hrs on that day.

The accident has been investigated by the Board represented by Göran Rosvall, chairman, Sakari Havbrandt, chief operational investigator, Henrik Elinder, chief technical investigator, and Urban Kjellberg fire and rescue services investigator.

The Board was assisted by Thijs Kroondijk as operational expert and Lars-Peter Peltomaa as technical expert.

The investigation was followed by Magnus Axelsson, Civil Aviation Authority.

Summary

At about half-past-one the pilot took off from Alingsås for Göteborg. The course was initially directly towards Göteborg at an altitude of approximately 1000 ft above sea level. As he approached Vättlefjäll, north-east of Göteborg where the terrain is hilly and somewhat higher, he started to turn in various directions and to fly in circles. About 16 minutes after takeoff the pilot contacted Säve tower and asked about the weather. He also stated that he was going to attempt to fly through a patch of rainy weather.

A witness who heard the helicopter flying around in the area heard a report about 9 minutes later, whereafter the noise of the helicopter suddenly ceased.

The course of events, the crash site, the helicopter wreckage and the technical investigation indicate that the pilot involuntarily came into cloud and then lost control of the helicopter. The helicopter then entered an uncontrolled state which caused the main rotor, through some form of mast-bumping, to strike the forward portion of the helicopter before the latter struck the ground.

The accident was caused by the rapid deterioration of the weather during the flight and the pilot's failure to realise in time that there was thus no possibility to complete the planned flight in view of the weather, terrain, the helicopter's equipment and his own flying experience.

Recommendations

SHK recommends that the Civil Aviation Authority:

- revise the provisions for VFR minima in BCL-D 4.1 so that their interpretation becomes simple and unambiguous *(RL 2005:26e R1),*
- consider introducing into the operational provisions for private flying higher weather minima regarding both planning and operation for pilots with low total or current flying experience *(RL2005:26e R2),*
- seek to ensure that applicants receive their certification immediately after passing their examination (RL2005:26e R3).

1 FACTUAL INFORMATION

1.1 History of the flight

The pilot intended during the day to take some friends on a flight from a helicopter landing pad in central Göteborg. At lunch time he and two other people flew to Alingsås aerodrome to refuel since the adjacent refuelling station at Göteborg/Säve aerodrome was temporarily shut.

After refuelling the pilot took off from Alingsås at 13.35 hrs for Göteborg. The approximately 15 Nm flight initially followed a course straight for Göteborg at an altitude of about 1000 ft. above sea level. As he was approaching Vättlefjäll north-east of Göteborg, where the terrain is hilly and somewhat higher, the pilot started turning in different directions and flying in circles. Approximately 16 minutes after takeoff the pilot contacted Säve tower and enquired about the weather. At the same time he stated that he intended to attempt to fly through some rainy weather.

About nine minutes later a witness who heard the helicopter flying around in the area heard a report, whereafter the noise of the helicopter suddenly stopped. Using his mobile telephone, the witness reported the event to the emergency services and later located the wrecked helicopter.

The helicopter struck the ground violently whereupon the three people on board lost their lives immediately.

The accident occurred at position 5749N 01205E; 140 metres above sea level.

1.2 Injuries to persons

	Crew members	*Passengers*	*Others*	*Total*
Fatal	1	2	–	3
Serious	–	–	–	–
Minor	–	–	–	–
None	–	–	–	–
Total	1	2	–	3

1.3 Damage to helicopter

Total wreck.

1.4 Other damage

There was minor leakage of oil and petrol. Any environmental impact should be considered as insignificant.

1.5 Personnel information

1.5.1 The pilot

The pilot, a man, was 31 years old at the time and held a valid JAA PPL-H. He had no authorisation for IFR[1] flying

[1] IFR: Instrument Flight Rules.

Flying time (hours)			
Latest	*24 hours*	*90 days*	*Total*
All types	1	39	90
This type	1	39	39

Number of landings on this type the latest 90 days: 149.

Type training carried out during June 2004 and completed with a successful flight test on 23-06-04.

The pilot had undergone basic training and all flying up to 50 hrs on helicopter type Robinson R22, at a flying school in Florida, USA. Training on the Robinson type R44 took place in Sweden during June 2004.

The pilot's certificate was administered by the civil aviation authorities in Great Britain and comprised class authorisation for the Robinson R22. The intention was for the Swedish civil aviation authorities to take over administration of the certificate when authorisation for the Robinson R44 was introduced. On 23 June the pilot had submitted to the Swedish Civil Aviation Authority all the necessary documents for obtaining type authorisation At the time of the accident the administrative process was not complete, which meant that, formally, the pilot lacked class authorisation for the helicopter type in question. The Civil Aviation Inspectorate has stated that the reason for the long handling time was that the British civil aviation authority had not sent the necessary documents despite several reminders.

According to the pilot's flight logbook, he resumed flying the Robinson R44 on 17 July.

The pilot held a valid medical certificate.

1.6 Helicopter information

1.6.1 General

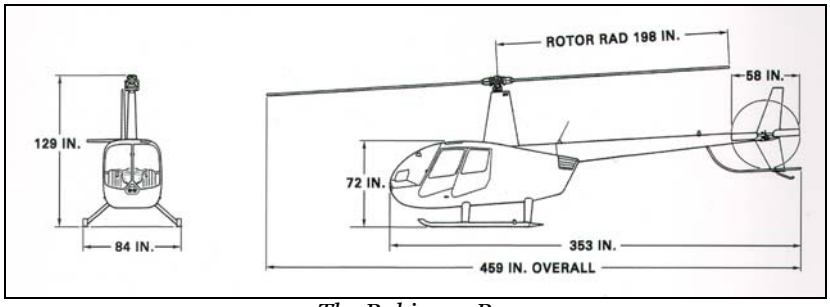
THE HELICOPTER	
Manufacturer	Robinson Helicopter Company, USA
Type	Robinson R44
Serial number	1382
Year of manufacture	2004
Gross mass	Max permitted takeoff weight 1189 kg, present approx. 1100 kg
Centre of mass	Within permitted limits
Total flying time	45 hours
Number of cycles	Unknown
Flying time since latest inspection	20 hours
Fuel loaded before event	AVGAS 100LL

ENGINES	
Engine manufacturer	Lycoming
Model	O540
Number of engines	1
Total operating time	45

ROTOR	
Rotor manufacturer	Robinson
Total operating time:	
Main rotor	45 hours
Tail rotor	45 hours

The helicopter was not equipped for, or certified for, IFR flying.
The aircraft had a valid certificate of airworthiness.

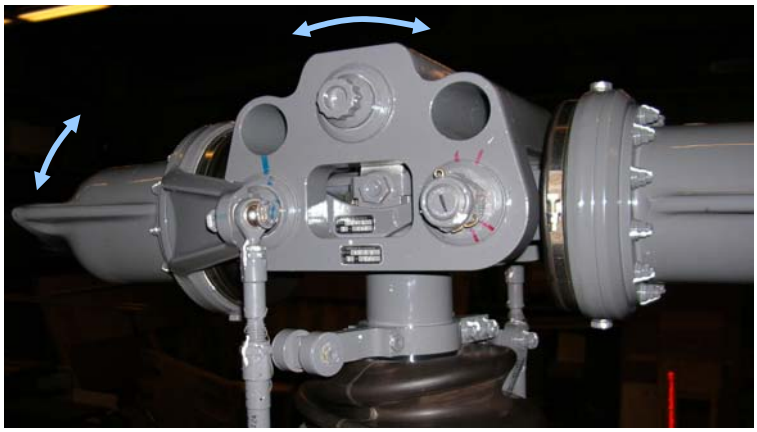
1.6.2 Rotor system/rotor hub



The Robinson R44

The helicopter type has a twin-bladed main rotor and a tail rotor with the geometry and dimensions shown in the above drawing. The main and tail rotor blades are trimmed mechanically via a linkage system.

The main rotor is of semi-rigid design, meaning that the hub has a certain mobility in relation to the main rotor mast. The two rotor blades are mounted in the hub, also with certain mobility in the same plane in relation to the hub (tri-hinge rotor).



Rotor hub

The motion of the rotor hub in relation to the main rotor mast is limited by mechanical stops consisting of two hard rubber blocks, termed flap stops, mounted on the mast. The motion of the main motor blades in relation to the hub is limited by a “supporting arm” on each blade, termed droop-stops, that rest on supports on the rotor hub when the rotor is standing still.

1.7 Meteorological information

1.7.1 Relevant forecasts

The current low-altitude and high-altitude forecasts showed that visibility would exceed 10 kilometres, that the cloud base would be 1,000 feet at the lowest and that there could be scattered showers.

1.7.2 Current weather

According to SMHI analysis:
South-westerly wind 10-12 knots, visibility 1 500 m, 8/8 stratus with base 200-400 feet, temp./dewpoint +16/+15 °C, QNH 1008 hPa.

General weather situation:
A warm front came in over the Swedish west coast from the south west and crossed the area at around 14.00 hrs. This brought overcast weather with some rain locally, but primarily a rapid and surprising deterioration with regard to cloud base and visibility. In a large area behind the front, the cloud base sank around 13.30 h from over 1000 feet to 200-500 feet, and visibility from 30 km to between 1 and 4 km, with subsequent further deterioration including fog in some places on high ground.

The SMHI analysis of the current weather tallies well with information received from witnesses with flying experience.

1.8 Aids to navigation

Not applicable.

1.9 Radio communications

The following radio communications took place between SE-JHJ (SHJ) and Säve tower (TWR). Times given are in UTC (Swedish daylight saving – 2 hrs).

11:01:58	TWR		Hotel Juliet good afternoon.
11:01:59	SHJ		Good afternoon. I'm over Kärred, we are three on board and wish to fly east to leave Bohus control zone.
11:02:10	TWR		Yep. You're cleared for Bohus below 1500, special VFR, QNH 1007, southerly wind, 180 12 knots.
11:02:20	SHJ		Cleared for Bohus below 1500 feet, Hotel Juliet.
11:03:27	TWR		[TWR reads out the TAF for another person via telephone and discusses solo flying and other things]. Southerly wind, 09-18z, that's CAVOK in ground position, becoming 220 degrees 12 knots, briefly now for the whole afternoon up to 8 this evening rain cloud base 1000, or scattered 1000 and broken 2500.
11:08:06	SHJ		Säve tower helicopter Hotel Juliet.
11:08:11	TWR		Hotel Juliet over.
11:08:13	SHJ		Now I've left Bohus control zone, I'm at 700 feet.
11:08:18	TWR		Hotel Juliet yes, 'bye, then.
11:08:20	SHJ		Good bye.
11:10:55	TWR		Helicopter Hotel Juliet tower.
11:50:52	SHJ		Säve-tower helicopter Sierra Echo Juliet Hotel Juliet
11:51:02	TWR		Hotel Juliet over.
11:51:04	SHJ		My position just east of the control zone and I'd like to know what visibility you have at Säve now?
11:51:13	TWR		Well its gone down so it's around five … four …five and it was about the same as when you left here before, then cloud base and visibility both went

			down and that's where they are now. On the other hand you can make out some light through the cloud cover so there may be swings to and fro so that it it'll be better for a bit now and then.
11:51:33	SHJ		Okay, so now I know. We have rain up here to the east so I'll see if I can get through it, then, I've been circling round here a bit so I don't have to fly through bad visibility.
11:51:47	TWR		Yes, you better take it carefully, then it'll be just fine.
11:51:50	SHJ		Yes, understood, Hotel Juliet.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

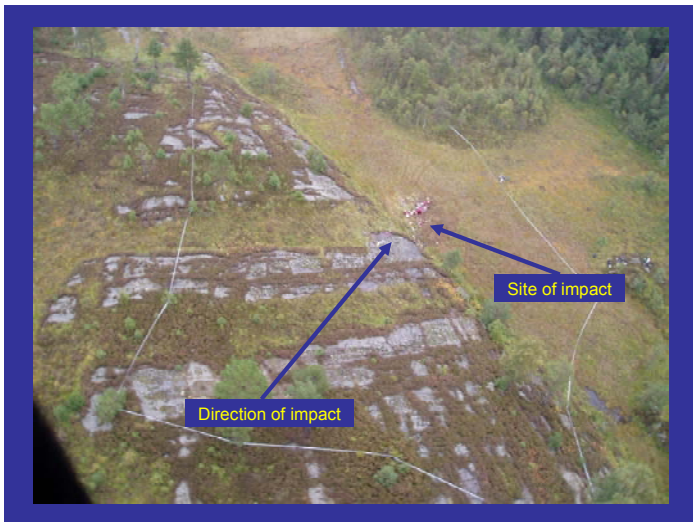
None on board. Not required.

1.12 Accident site and helicopter wreckage

1.12.1 The accident site

The area round the accident site is hilly, consisting of open rock, forest and moorland. The main impact was on open rock at the edge of a fairly small moor, Orremossen.

The main portion of the wreck had first crashed into rock, whereafter it slid down, ending up on moorland about 10 m from the rock. Marks on the ground show that the impact occurred in an approximately easterly direction and was steep. Within an area under the path of impact, about 100 m long and 200 m broad, wreckage was found from the forward part of the cabin and the main rotor. This included numerous centimetre-sized pieces of plexiglass, fibreglass and parts of the pneumatic flight instruments over 100 m from the main wreck.



Main wreckage

1.12.2 The helicopter wreckage

The helicopter was very much broken up. The cabin had been demolished. The forward part, including control systems and instrument panel, were partly fragmented. The tail boom was fractured in several places. The engine and transmission mounting was twisted. Parts of the cabin and the main rotor had separated from the helicopter prior to impact.

1.13 Medical information

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

1.14 Fire

No fire occurred.

1.15 Survival aspects

The impact was so violent that there was no possibility for survival.

The Pointer 3000-10 emergency transmitter was activated when the helicopter crashed and deactivated by the pilot of a police helicopter.

1.16 Technical investigation

1.16.1 General

The helicopter wreckage was documented at the accident site. The dispersal of larger wreckage that had separated from the helicopter before impact and was found under the path of the impact was roughly documented.

The wreckage was subsequently collected and transported to a workshop for further technical investigation. The damage to the helicopter, however, is so extensive that a complete technical investigation of the systems affected has not been possible.

1.16.2 The cabin

Damage to the metal shell of the cabin and undercarriage skids show that the helicopter's first contact with the rock surface was with a steep tilt to the left and with a low nose position.

Damage to the forward part of the cabin shows that it was cut through at right angles to the longitudinal direction of the helicopter, in two places. The cuts were inclined steeply backwards in the direction of the helicopter's travel and the distance between them was approximately 30 cm. The forward cut ran through the instrument panel and the cabin structure forward of the pedal support. The rear cut ran rear of the front screens and the pedal support. (See photo below).

1.16.3 Engine

The engine was removed from the helicopter wreckage and examined at an authorised aircraft engine workshop. Nothing faulty or abnormal was discovered.

1.16.4 Control system

The helicopter was disassembled so that the control system could be freed. It has been examined and its function tested as closely as practically possible. Nothing faulty or abnormal that could have affected the course of events was discovered.

1.16.5 Main and tail rotor drives

The rotor drive systems were examined and functionally tested as far as practically possible. Nothing faulty or abnormal that could have affected the course of events was discovered.

1.16.6 Rotors

Both main rotor blades were seriously damaged and deformed. One blade had been broken. The leading edges of the middle portions of both blades exhibited extensive mechanical damage. Parts of the composite structure of the blades behind the supporting leading edge beam had separated from the blade. Certain of these parts were found under the impact path, more than 50 metres from the point of impact. The tail rotor was complete and had partly worked its way into the boggy ground at the final crash site.

1.16.7 The rotor hub

Both flap stops on the rotor hub were squeezed right through, showing that violent mast bumping – see 1.18.2 – had occurred. See illustrations below.

Undamaged flap-stop

Flap-stop in question

Heavy wear damage was noted to the droop stops of both main rotor blades and their corresponding support heels on the rotor hub. The damage indicates that the blades were bent downwards with great force.

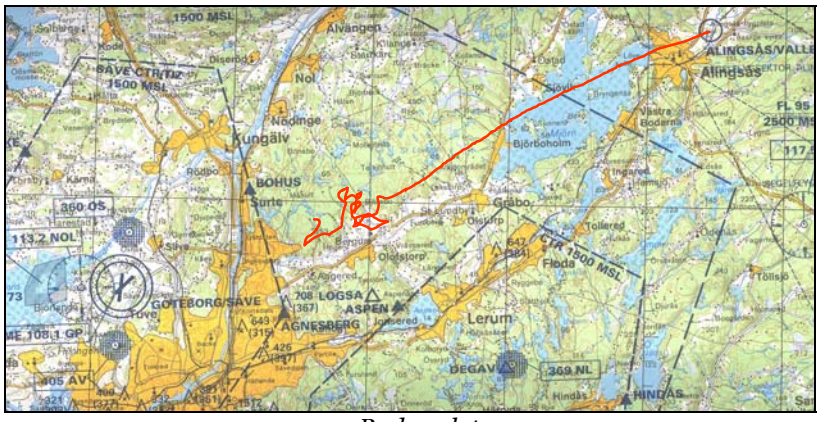
1.17 Organisational and management information

Not applicable.

1.18 Additional information

1.18.1 Radar and radio recording

The flight was recorded by MUST[2]. The radar plot below shows the helicopter's route.



Radar plot

The radar plot shows that the flight was initially on a direct course to Göteborg. Speed was steady and altitude above sea level approximately 1,000 feet. As the helicopter approached Vättlefjäll just north-east of Göteborg, where the terrain is hilly and somewhat higher, the helicopter started to turn and fly in tight circles, at the same time greatly varying its speed. At 11.51 hrs the pilot contacted Säve tower and asked about the weather. He stated that he would try and fly through some rainy weather. The last radar plot was 20 seconds before impact, when the helicopter's altitude above sea level was 1460 feet.

[2] MUST: Swedish military intelligence and security service

1.18.2 Mast-bumping

Mast-bumping is a known phenomenon that may occur in practically all types of helicopter with main rotor and tail rotor and where the main rotor is fully-articulated or semi-rigid. Many fatal accidents have occurred as a consequence of mast bumping. The respective handbooks contain warnings about the problem and type training includes instruction on how it can be avoided.

In the helicopter type in question the main rotor rotates anti-clockwise seen from above, generating a torque which when the engine is producing power seeks to turn the nose to the right. This is counteracted by the tail rotor which provides a thrust to the right, thus seeking to turn the nose to the left.

If the joystick is brought rapidly forward in flight so that the helicopter's flight path changes to a dive, the g-load is reduced markedly ($g < 1{,}0$). This also causes main-rotor torque to sink, since the rotor needs to generate less lift. If this is not compensated for at the same time through the pedals, the tail rotor, which functions to counteract main-rotor torque, will maintain its lateral thrust even though there is no longer any torque to counteract. It will thus turn the nose to the left.

The helicopter will then veer to the left. This, combined with a low nose position, will cause the helicopter to lean to the right. If there is still a low g-load and the joystick is moved to the left, a natural manoeuvre for a pilot, only the main rotor will move towards the horizontal plane. The fuselage will initially remain in a tilt to the right. This can result in the creation of such a large angular difference between rotor disc and fuselage that the rotor hub strikes the rotor mast flap stops.

When the rotor hub strikes the mast on the left-hand side it is perceived as a force applied upwards on the left-hand side of the rotor disc. As a consequence of the rotor's giro force, this causes the rotor to tip forwards as if the force had been applied 90 degrees later in the direction of rotation.

If this sequence takes place with large movements and forces, the phenomenon can in the worst case result in the main rotor colliding with the forward part of the helicopter's fuselage.

1.18.3 VFR [3] regulations

For flying according to BCL-T, the following applies in the case in question: that visibility is not less than three kilometres, that the aircraft is free from cloud and that the pilot can see the ground. In addition, the aircraft must maintain a minimum altitude of 500 feet above ground level, which means that the cloud base must exceed 500 feet.

For helicopters the following exception is made:
Helicopters may however be flown in lower visibility conditions if the flight is performed at such a low speed that there are good prospects of detecting other aircraft or obstacles in time to avoid a collision.

In addition, rules exist in BCL-D 4.1 with the following wording:

6.5	**Weather conditions**
6.5.1	***General***
6.5.1.1	A flight intended to be made under known or anticipated conditions of ice formation may not be commenced unless the helicopter is provided with the equipment necessary for flying under such conditions.
6.5.1.2	Takeoff may not be made with remaining ice, snow and/or rime on a helicopter's main rotors, stabiliser or manoeuvre organs except where this is permitted according to the maintenance or flight handbook for the helicopter type in question.

[3] VFR: Visual flight rules

6.5..2	***VFR flying***
6.5.2.1	Cancelled
6.5.2.2	Distance flying in daylight according to VFR may not be commenced until available meteorological observations/information show that weather circumstances along the route are such that visibility is at least 5 km and that the cloudbase height permits flying at an altitude of at least 150 m (500 ft).
6.5.2.3	For commencement of flying in darkness, visibility must for all operations be at least 8 km and cloud-base at least 300 m (1000 ft). In addition it must be possible to obtain clear ground references. *Note. For distance flying see BCL – Terms (Begrepp)*
6.5.2.4	Flying above cloud – "on top" – may not be performed as night flying. In daylight such flying may not be commenced until available meteorological information shows that the requirements specified below will be met during the flight in question: a) Along the route the extent and stratification of the cloud must be such that it is possible to perform the flight during VMC. b) At the intended landing site or in the area in which the intended landing site is situated, and at the estimated time of landing, the cloud coverage in the stratification over which the flight is intended to take place may not exceed 4/8. c) At the intended landing site or in the area in which the intended landing site is situated, and at the estimated time of landing, visibility must not be below 1.5 km for commercial aviation or below 5 km for private flying. Cloud coverage must permit flying at an altitude of at least 150 m (500 ft).
7.	**FLIGHT PROCEDURES**
7.1	**Weather follow-up**
7.1.1	***VFR flying***
7.1.1.1	A flight may not be continued to its destination unless the latest available meteorological information together with observations concerning the weather made during the flight show that weather conditions along the route or available alternative routes are such that the helicopter can be conducted safely with clear ground references and in accordance with the regulations in clause 6.5. above.
7.1.1.2	A flight that has been commenced when ice formation has been reported or is anticipated may be continued provided that a strict watch is kept for possible ice-formation and that the flight is so planned that it can be broken off immediately should ice-formation occur
7.1.1.3	Cancelled

According to the list of definitions held by the Civil Aviation Inspectorate, a distance flight is one extending more than 25 NM from the point of takeoff.

These rules apply to private flying irrespective of the pilot's experience or certification.

1.18.4 The rescue operation

Rescue service work consists of injury-preventive and damage-limitation measures in connection with accidents and imminent danger of accidents. There are certain exceptions to the municipalities' obligation to conduct rescue services. This applies for example to the air rescue service, which is a state obligation for which the Civil Aviation Authority is responsible. One duty of the air rescue service is to search for missing aircraft. When a crashed aircraft has been located on land, responsibility for rescue switches to the municipal rescue service.

A message came in on emergency number 112 to the SOS Emergency Centre at 14.00 hrs (ref. time[4]: + 0 min) on 11 September 2004. It emerged from the call that a private person who was north of Göteborg at Drisstjärn, on Vättlefjäll, had heard a helicopter circling in the air, followed by a powerful report and then silence. According to the informant, the area of forest

[4] In what follows, reference times are given in relation to the first 112-call received – the call at 14.00 hrs.

was very inaccessible, with no roads suitable for motor traffic in the vicinity. The exact place could not be given and the informant had not seen the helicopter. After a two-minute interview the emergency operator connected the call to the Civil Aviation Authority Aeronautical Rescue Coordination Centre (ARCC) in Göteborg. The air rescue leader at the ARCC again interviewed the informant, for about three minutes more.

The ambulance helicopter was alerted about a possible helicopter crash at 14.10 hrs (ref. time: + 10 min) at its base at Säve aerodrome in Göteborg.

At the police helicopter base at Säve aerodrome the police helicopter was alerted. At the time, the police helicopter was in Kallebäck in Göteborg. The pilot, who was alone in the helicopter, took off at once for the area specified at about 14.10 hrs (ref. time: + 10 min).

The Greater Göteborg Rescue Service Emergency and Control Centre was informed at 14.10 hrs (ref. time: + 10 min) by the air rescue director at the ARCC of a possible helicopter crash in the vicinity of Angered in Göteborg. It was decided in consultation that the Rescue Service should delay turnout and prepare itself while awaiting more details of the accident site position. The staff at the Rescue Service Emergency and Control Centre informed the command at the relevant fire station in Angered of the unclear information. That command was requested to prepare material and vehicles for a possible turnout.

The ARCC flight rescue director notified SOS Alarm and the Rescue Services Emergency and Command Centre that the ambulance helicopter had found the accident site at 14.30 hrs (ref. time: + 30 min). According to the air rescue director, the rescue service was not urgently needed at the accident site since there was no fire. The rescue director was to return with details of help needed.

Kommentar [UK1]:

The personnel in the ambulance helicopter, who judged that the crashed helicopter was a two-seater, reported to the ARCC at 14.35 hrs (ref. time: + 35 min) that there were two dead persons at the helicopter wreck. It was medically established that both were dead and the medical personnel noted that there was no need for emergency medical care at the accident site.

The ambulance helicopter left the accident site at 14.38 hrs (ref. time: + 38 min).

The police helicopter arrived at the accident site before the ambulance helicopter left.

The air rescue director telephoned the Rescue Service Emergency and Control centre at 14.40 hrs (ref. time + 40 min) and informed them that a force was needed at the accident site since there were two fatalities and possibly also fuel spill from the helicopter.

The Rescue Service action force left Angered fire station at 15.16 hrs (ref. time: + 1 hr 16 min). This was 36 minutes after the Rescue Service Emergency and Control centre had been notified by the air rescue director at the ARCC that a force was needed at the accident site. The Action force arrived at the site at 16.12 (ref. time: + 2 hrs 12 min), after a private person had shown them the way. On arrival at the unguarded accident site one private person was found at the place.

Rescue Service personnel helped the police and Accident Investigation Board staff to look for parts from the helicopter in the vicinity of the accident site. No action was taken regarding the fuel spill from the crashed helicopter.

The police helicopter pilot remained at the site of the accident for about one hour. Thereafter police personnel and staff from the Accident Investigation Board were fetched from Säve aerodrome. During this time the accident site was left unguarded since the helicopter pilot was alone in the police helicopter and no Rescue Service personnel had made their way through the terrain.

The policeman at the accident site reported to the ARCC air rescue director at 16.35 hrs (ref. time: + 2 hrs 35 min) that a third fatality had been found in the very broken-up helicopter wreckage.

2 ANALYSIS

2.1 The weather situation

Both the low-altitude forecast for the area and the aerodrome forecast for Säve aerodrome were relatively good. Visibility was expected to exceed 10 km and cloud base would be 1 000 feet at the lowest. In fact, however, the weather became considerably worse. Visibility sank to 1.5 km and the cloud base sank to 200-400 feet above ground level and, locally, may have been near the ground. During the passage of a warm front the weather may vary over the area or behave as waves that come and go.

The rapid and unexpected worsening of the weather may have surprised the pilot during the flight.

2.2 The flight

The radar plot of the flight from Alingsås to Göteborg shows that it initially went according to plan, on a straight course and at a steady speed. As the helicopter was nearing Göteborg it began to turn in different directions and to fly in circles. Speed also started to vary appreciably. This, together with the pilot's radio communication with Säve tower, indicates that the helicopter had entered a troublesome weather situation.

When the front from the southwest was met, it is also possible that the route back to Alingsås was blocked by low cloud. The hilly terrain renders it probable that the cloud base varied, which can lead to involuntarily getting into cloud if, with poor visibility, one is flying towards rain curtains.

It is evident that the pilot attempted to find better weather in some direction, or possibly to find a place to land temporarily. It is impossible to know whether he considered an emergency landing. The local terrain does not invite landings since the only free surfaces of any size consist of moorland. A landing on a bog with unknown bearing capacity is risky, which can be the reason why the pilot did not make an emergency landing, even if he considered so doing.

According to the radar plot the helicopter's altitude increased successively during the last part of the flight and at the last recording was 1460 feet above sea level, corresponding to approximately 1000 feet above ground level. Since the cloud base above ground level at the time of the accident was below 500 feet, this indicates that the helicopter was then in cloud.

A pilot without training and equipment for flying in cloud has very little chance of maintaining control of the flight for more than a few seconds if he unintentionally flies into cloud. The pilot in this case lacked this training; nor was the helicopter equipped for instrument flying.

The course of events, the accident site and the technical investigation indicate that the pilot did unintentionally get into cloud and then lost control of the helicopter. The machine then went out of control, which led to the main rotor, through some form of mast-bumping, striking the forward part of the helicopter before it hit the ground.

2.3 The pilot's competence

2.3.1 Formal certification

While at the time of the accident the pilot lacked formal certification to conduct the flight, all the conditions for receiving certification had been met. His flight log book shows that, after his approved test flight, he had not flown at all for 25 days. It is not known why he then decided to fly even though he lacked formal certification. However, it is understandable that, under the circumstances, he was very eager to make a start on flying his new helicopter.

Newly-qualified pilots are usually urged to start regular flying so as not to lose the knowledge and flying trim gained during their training. In view of this, the Board considers it very unsatisfactory in terms of flight safety that a pilot should need to wait more than two and a half months after his test flight before being able to use his certification.

2.3.2 Practial competence

The pilot had successfully performed all the items required for being competent to fly the helicopter. That he lacked the formal certification is therefore judged not to have affected his ability to conduct the helicopter.

The major portion of the pilot's flying experience and training had been acquired in Florida, USA. His experience of Swedish flying weather was limited to the summer months. This may have contributed to his not appreciating in time the problem of rapidly worsening weather.

Since the pilot had no training in IFR flying, his chances of controlling the helicopter in cloud were non-existent.

2.4 Provisions in force

The provisions in BCL-d 4.1. regarding weather minima are hard to interpret. Clause 6.5.2.2 states that a distance flight may not be commenced unless available meteorological information shows that visibility is at least 5 km and cloudbase at least 500 ft.

Clause 6.5.2.4 describes the conditions under which flight above cloud, i.e. out of sight of the ground, is permitted.

Clause 7.1.1.1 specifies, among other things, that the flight may not be continued to the destination aerodrome unless weather conditions are such that the helicopter can be conducted safely with clear ground references and in accordance with the provisions of clause 6.5.

It is hard to find a logical interpretation of the rules where for example clause 6.5.2.4 permits flying without sight of the ground and clause 7.1.1.1 forbids it. It is also hard to interpret the rules for a local flight where clause 7.1.1.1 refers to 6.5 which expressly relates to, among other things, distance flying.

A further possible interpretation is that only BCL-T applies to local flights, which would imply that there is no lower limit for flight visibility when flying according to VFR.

According to the provisions in force the same weather minima apply to the flight in question regardless of the pilot's experience and competence. It is probable that a more experienced pilot would have discovered the extent of the deterioration in weather earlier, and would also have had greater chances of managing the situation. It is possible that the pilot in this case would have terminated the flight earlier if the weather minima that applied to him had been higher.

Against this background the Board considers that flight safety would be enhanced by the introduction of differentiated weather minima related to different pilots' total and current experience.

2.5 The rescue operation

The 112 call to SOS Alarm about a possible helicopter crash was put through to the ARCC following current routines. Interviews and alerts were conducted routinely despite unclear information about a possible helicopter crash in inaccessible terrain where the exact position was unknown.

When the ambulance helicopter found the accident site at 14.30 hrs, the rescue service was informed by the air rescue director at the ARCC. Shortly thereafter the director also informed the rescue service control centre that an action force was needed at the site. When the site of an accident becomes known, as in the present case, responsibility for the rescue operation at the accident site passes to the municipal rescue service. The air rescue director was clear and stated that a turnout was required from the municipal rescue service. Even without an explicit directive from the air rescue director, the municipal rescue service is itself responsible to turn out to an accident site once its geographical situation has become known and that a municipal turnout is what is required. To save time it may also in certain circumstances be efficient to move up the action force to a place adjacent to a presumed accident site.

Once the air rescue director had announced the need for an action force, 36 minutes elapsed before the previously alerted force at Angered fire station reported that they were on the way to the accident site. This must be considered an unusually long time. It is also surprising in view of the fact that the first warning of a possible helicopter crash came to the knowledge of the rescue service about an hour before the turnout was effected. The final result of the turnout was not, however affected by the delay in time.

The ambulance helicopter, which was first at the accident site, remained only eight minutes before taking off again. During this time the medical personnel established that no acute medical care was required at the site. The personnel's search of the accident site could have been more thorough since the third fatality was not discovered. This person, however, also had injuries that had caused his immediate death on impact.

The police helicopter pilot stayed about an hour at the accident site. He then left to fetch other staff by helicopter. It is very unusual for an accident site to be left unguarded before the immediately necessary work has been completed. That it was an isolated site probably contributed to the judgement when the helicopter was used to transport necessary personnel to the very inaccessible accident site. Better coordination between those participating in the operation could have allowed other rescue or police personnel to be brought to the accident site before the police helicopter left. The rescue work, however was not negatively affected by the site being left unguarded.

3 CONCLUSIONS

3.1 Findings

a) The pilot lacked formal certification to perform the flight.
b) The pilot had undergone the prescribed training, flight test and medical examination with approved results.

c) The Civil Aviation Authority had for just over two and a half months been unable to complete processing of the pilot's application documents.
d) The helicopter had a valid certificate of airworthiness.
e) The actual weather became worse than what relevant forecasts had stated.
f) The pilot had limited flying experience and was not trained to fly in cloud (instrument training).
g) No technical fault was found on the helicopter.
h) The helicopter was subjected to violent mast-bumping and disintegrated in the air before crashing.
i) Inward and outward alerting of the community rescue organs was carried out according to provisions and routines in force.
j) The medical staff in the ambulance helicopter discovered only two of the three fatalities at the accident site.
k) After the rescue service had been informed that an action force was needed at the accident site, 36 minutes elapsed before the force reported that it had left the fire station.
l) The accident site was left unguarded when the police helicopter left to fetch other personnel to the site.
m) The rules for VFR flying with helicopters are hard to interpret.

3.2 Causes of the accident

The accident was caused by the rapid deterioration of the weather during the flight and the pilot's failure to realise in time that there was thus no possibility to complete the planned flight in view of the weather, terrain, the helicopter's equipment and his own flying experience.

4 RECOMMENDATIONS

SHK recommends that the Civil Aviation Authority:

- revise the provisions for VFR minima in BCL-D 4.1 so that their interpretation becomes simple and unambiguous *(RL 2005:26e R1),*
- consider introducing into the operational provisions for private flying higher weather minima regarding both planning and operation for pilots with low total or current flying experience *(RL2005:26e R2),*
- seek to ensure that applicants receive their certification immediately after passing their examination (RL2005:26e R3).