



ISSN 1400-5719

Report RL 2001:31e

***Accident involving helicopter SE-JCA
at Vidsel airport, BD county, Sweden,
on the 7th of May 2001***

Case L-020/01

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

Translated by Dennis Lynn Anderson
From the original Swedish at the request of the Board of Accident Investigation.

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Swedish Civil Aviation Administration
601 79 NORRKÖPING

Rapport RL 2001:31e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on the 7th of May 2001 at Vidsel airport, BD county, Sweden, involving a helicopter with registration SE-JCA.

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

A translation to English of the report will be submitted.

Olle Lundström

Monica J Wismar

Henrik Elinder

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ABREVIATIONS

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APPENDIX

1	Extracts from Register of Licenses regarding the pilot (to the Swedish Civil Aviation Administration only)	
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Report finalized 2001-10-26

<i>Aircraft; registration and type</i>	SE-JCA , Aerospatiale AS 350 B2
<i>Class/airworthiness</i>	Normal, valid certificate of airworthiness
<i>Owner/operator</i>	Heli i Arjeplog AB/AB Norrlandsflyg
<i>Time of occurrence</i>	2001-05-07, 14:53 hours, in daylight
	Note: All times are given in Swedish daylight saving time= UTC + 2 hours
<i>Location</i>	Vidsel airport, BD county, Sweden (pos 6552N 02009E, 182 meters above sea level)
<i>Type of flight</i>	Utility aviation
<i>Weather</i>	Actual weather: wind 310°/24 km/h, variable from 260-330°, visibility > 10 km, no clouds below 5,000 feet, temp./dewpoint +14/+5 °C, QNH 1027 hPa.
<i>Persons on board: crew</i>	1
<i>passengers</i>	-
<i>Injuries to persons</i>	Minor
<i>Damage to aircraft</i>	Substantially damaged
<i>Other damage</i>	None
<i>Pilot in command:</i>	
<i>Age, certificate</i>	49 years old, Commercial Pilot's License (B) with Instrument Rating and Commercial Helicopter License (BH)
<i>Total flying time</i>	4,800 hours, of which 1,220 hours of helicopter time, of which 10 hours on the type
<i>Flying hours previous 90 days</i>	24 hours, of which 10 hours on the type
<i>Number of landings previous 90 days</i>	unknown, > 54 on the type

The Board of Accident Investigation (SHK) was notified on the 7th of May 2001 that an accident involving a helicopter with registration SE-JCA had taken place at Vidsel airport, BD county, Sweden at 14:53 hours on that same day.

The accident has been investigated by SHK represented by Olle Lundström, Chairman, Monica J. Wismar, Chief investigator flight operations, and Henrik Elinder, Chief technical investigator aviation.

The investigation was followed by Kåre Jernling, Swedish Civil Aviation Administration.

Summary

The pilot was to land the helicopter on a helicopter-landing trailer. After having accomplished a normal approach towards the trailer, the pilot hovered the helicopter forward overhead the trailer and then set down the helicopter onto the trailer bed. Subsequent to the touchdown he intended

to hover the helicopter slightly upwards in order to adjust the parking placement.

During the hover ascent he felt the right hand landing skid become caught on the trailer. When the landing skid broke loose from the trailer the helicopter began to yaw rapidly to the left. The pilot applied right rudder in order to arrest the yaw but did not experience the arresting effect that he expected and suspected that a fault had arisen in the tail rotor system. When the helicopter had rotated about 180 degrees and was at a height of approximately three meters over the ground the pilot chose to set it down on the ground.

Upon impact with the ground, the aft spring strut and the right-hand landing gear skid were broken off, which caused the helicopter to overturn and land on its right-hand side. The pilot received minor injuries but was able to evacuate the helicopter unassisted.

No technical fault has been found on the helicopter that could be considered to have influenced the course of events. SHK has, among other things, ascertained that the design of the helicopter-landing trailer was unsuitable for this type of helicopter and that a transient aerodynamic disturbance of the tail rotor function may have arose during the hovering.

The probable cause of the accident was that the pilot did not promptly enough and with sufficient rudder deflection, arrest the sudden left yaw that was initiated when the entangled flexible steel strip freed itself from the helicopter trailer. A contributory cause could have been a transient aerodynamic disturbance of the tail rotor function.

Recommendations

None.

1 FACTUAL INFORMATION

1.1 History of the flight

After a short flight the pilot was to land the helicopter on a helicopter-landing trailer at Vidsel airport. The trailer was parked in a direction of 210° on a parking area immediately west of the threshold of runway 11. After having accomplished a normal approach towards the trailer on a heading of 260°, the pilot hovered the helicopter forward, overhead the trailer and then sat the helicopter down onto the trailer bed. After the landing he thought that the helicopter stood a little off the centerline of the trailer to the right and decided to hover upwards and adjust the parking placement by yawing to the left.

When he hovered upwards he could feel that the right hand landing skid fastened onto the trailer. Then, when the landing skid suddenly broke loose from the trailer, the helicopter rapidly began to yaw to the left. The pilot applied right rudder in order to arrest the yaw, but did not experience the arresting effect that he expected and suspected that a fault had arisen in the tail rotor system. When the helicopter has rotated about 180 degrees and was at a height of approximately three meters over the ground the pilot chose to set it down on the ground.

The course of events proceeded rapidly and before the helicopter reached the ground the tail rotor struck the trailer. During the impact with the ground, the aft spring strut and the right-hand landing gear skid were broken off, which caused the helicopter to overturn and land on its right-hand side. In connection with this, the main rotor collided with the trailer hitch and the ground, shattering a rotor blade and separating the rotor transmission from the helicopter.

The pilot received minor injuries but was able to evacuate the helicopter unassisted.

The accident took place on the 7th of May 2001 at position 6552N 02009E, 182 meters above sea level.

1.2 Injuries to persons

	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>	<i>Total</i>
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	1	–	–	1
None	–	–	–	–
Total	1	–	–	1

1.3 Damage to aircraft

Substantially damaged.

1.4 Other damage

None.

1.5 Personnel information

The pilot in command was 49 years old at the time and held a valid Commercial Pilot's License (B) with an Instrument Rating and a Commercial Helicopter License (BH).

Flying hours

<i>latest</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
All types	2	24	4,800
This type	2	10	10

Number of landings this type previous 90 days: > 54.

Flight training on the type concluded during the month of April 2001.

Latest PFT (periodic flight training) carried out 2001-04-17 on the AS 350.

The pilot's helicopter experience, with the exception of the helicopter type in question, is based exclusively on types with counter-clockwise rotating main rotors.

1.6 Aircraft information

AIRCRAFT

<i>Manufacturer:</i>	Aerospatiale
<i>Type:</i>	AS350 B2
<i>Serial number:</i>	2619
<i>Year of manufacture:</i>	1992
<i>Gross weight:</i>	Maximum authorized 2,250 kg, actual 1,800 kg
<i>Center of gravity:</i>	Within allowable limits
<i>Total flying time:</i>	4,322 hours
<i>Number of cycles:</i>	
<i>Flying time since latest inspection:</i>	55 hours
<i>Fuel uplifted before event</i>	JET A1

ENGINE

<i>Manufacture:</i>	Turbomeca
<i>Model:</i>	Ariel 1D1
<i>Number of engines:</i>	1
<i>Engine</i>	
<i>Total operating time, hrs:</i>	4,270 hours
<i>Operating time since overha</i>	1,265 hours
<i>Cycles after overhaul:</i>	2,987

ROTOR

<i>Manufacture:</i>	Aerospatiale (clockwise rotation)
<i>Operating time since latest overhaul:</i>	4,322 hours

The aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

Actual weather: wind 310°/24 km/h, variable from 260-330°, visibility > 10 km, no clouds below 5,000 feet, temp./dewpoint +14/+5 °C, QNH 1027 hPa.

1.8 Aids to navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome information

Vidsel airport has an asphalt runway situated at 110/290 degrees and is the property of the Swedish military authorities. In order to utilize the airport, a special permission (PPR) is required, which the pilot had.

1.11 Flight recorders

There was no requirement to carry a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR) on board the aircraft and neither was fitted.

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

The accident site consists of an approximately 20 x 20 meter large asphalt parking ramp that is situated adjacent to runway 11. The helicopter-landing trailer was parked approximately in the middle of the west side of the parking ramp. The trailer, which is equipped with wheels, has a landing bed about ½ meter above the ground. The landing bed consists of two parallel plywood sheets, each measuring 1 x 4 meters, with a 0.9 meter open space between them.

1.12.2 Aircraft wreckage

After the accident the helicopter was lying on its right side and facing in a direction of approximately 240°. The tail boom of the helicopter was about one and one-half meters from the left side of the forward edge of the landing trailer. The engine mounting was battered. The transmission and the main rotor had separated from the helicopter and came to rest approximately six meters north of the aircraft. The tail rotor had separated from the tail boom and came to rest about one meter from the right rear edge of the helicopter-landing trailer. Helicopter parts of diverse sizes were lying spread around the helicopter within a circle with a radius of approximately 20 meters.



1.13 Medical information

Nothing indicates that the mental or physical condition of the pilot had been impaired prior to or during the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

The Emergency Locator Transmitter (ELT) of type Pointer 3000 was activated at the time of the accident. The pilot injured his right hand during impact.

1.16 Tests and research

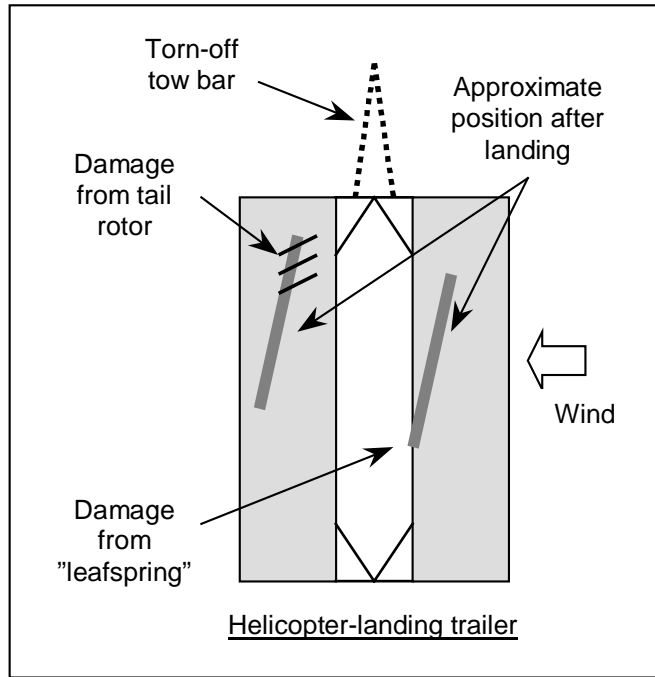
1.16.1 *The helicopter*

A preliminary investigation of the helicopter was accomplished at the accident site. Thereafter, an authorized helicopter maintenance shop carried out a complementary technical investigation, with special focus on the helicopter's control surface system. No faults or abnormalities were noted. All of the damage found on the helicopter was determined to have arisen in connection with the accident.

The pilot chair mounts in the cabin floor were the object of special scrutiny as the chair had come loose and the pilot suspected that the chair had possibly separated in connection with the initial left-hand yaw. However, the appearance of the damage unequivocally indicates that they originated as a consequence of the helicopter's impact against the ground.

1.16.2 *The helicopter-landing trailer*

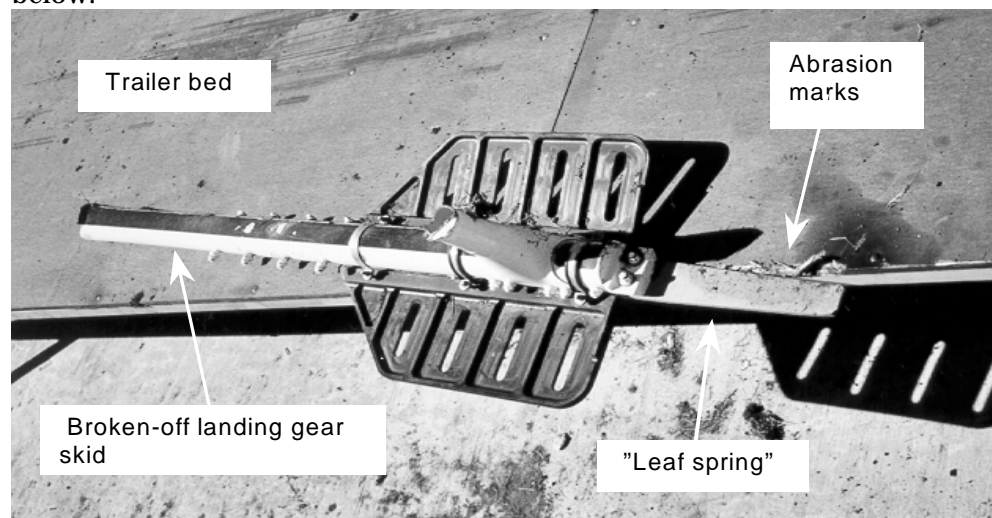
The trailer's tow bar was torn-off and was found approximately 25 meters from the trailer. Damage to the landing bed of the trailer was indicated by impact marks from the tail rotor and abrasion marks from the helicopter's landing gear flexible steel strip, as depicted in the sketch below.



Based on testimony from the pilot and the indicative damage on the trailer, the approximate position of the helicopter on the trailer after the initial landing has also been included in the sketch. The wind direction was variable, but primarily contacted the trailer from the right side.

1.16.3 Flexible steel strip

The landing gear of the helicopter was equipped with so-called Flexible Steel Strips. These consist of approximately 30 cm long "leaf springs" which are mounted on the aft edge of the landing skids. With no load on the landing gear these leaf springs extend somewhat downward in relation to the skids. The purpose of the springs is to reduce the risk of spontaneous turning in connection with landing on a rigid surface. Damage to the bed on the helicopter-landing trailer indicates that the leaf spring on the right-hand landing skid caught on the bed, which is depicted in the picture below.



1.17 Organisational and management information

The aviation company that operated the helicopter has its head office in Gällivare and remote stations in Björkliden, Kiruna, Kvikkjokk, Nikkaluokta, Ritsem and Uppsala. It holds a license for commercial air traffic with single and multi-engine helicopters. The company performs various types of helicopter missions, such as personnel transportation, cargo transportation, power line inspection, aerial photography, reindeer herding, etc. The operations include utility aviation according to VFR¹ as well as IFR².

The flight mission in question was performed on behalf of the military logistics department (FMV). The pilot was a permanent employee of this department but was at the time of the accident loaned-out to the aviation company to serve as pilot for the mission in question. Flight training on the helicopter type was administered by the aviation company, and had according to them, taken place without problems. This was the first time that the pilot had landed this type of helicopter on such a trailer.

1.18 Additional information

1.18.1 Tail rotor function

A helicopter's tail rotor serves two tasks: in part to create a torque moment that balances the torque that is caused by the driving of the main rotor, and in part to make it possible for the pilot to control the helicopter in the yaw plane. If the tail rotor function is disturbed, problems can arise in controlling the helicopter in the yaw segment.

Several types of aerodynamic disturbances can ensue in the function of the tail rotor in connection with low airspeed flight. If such disturbances are not attended to by the pilot and corrected in time, they can lead to the helicopter ending-up in an uncontrolled rotation around its vertical axis. Historically this has been the cause of several helicopter accidents and is something that has been brought to attention in publications, one of them the American Civil Aviation Administration's (FAA) publication, Advisory Circular, AC No. 90-95. "Unanticipated right yaw in helicopters".

In this publication, among other things, the following three wind cases are treated that can lead to loss of yaw control:

Wind from behind (Tailwind)

The helicopter's tail boom serves as a "weathervane" that strives to twist the helicopter into the wind. If, during a yaw, a helicopter enters a tailwind, the velocity of the yawing will normally increase.

Wind from the side (Crosswind)

Crosswind from the left on helicopters whose main rotors rotate counter clockwise results in the airflow through the tail rotor being pressed backwards and causes circulation of air through the rotor, which diminishes the effectiveness of the tail rotor. On helicopters whose main rotors rotate clockwise a similar risk applies with crosswind from the right.

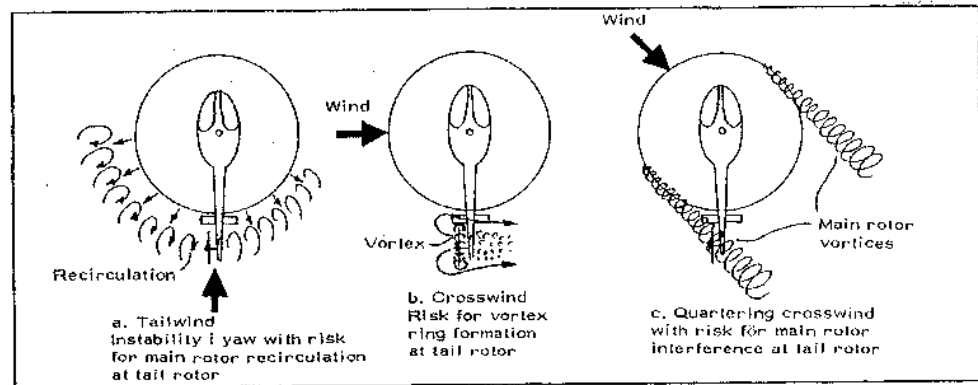
Wind diagonally from the front (Quartering crosswind)

With a quartering crosswind from the front, tip vortices from the main rotor blades are driven rearwards to the tail rotor and cause so-called vortex interference, which diminishes the tail rotor's effectiveness. On helicopters whose main rotors rotate counter clockwise the risk of this

¹ VFR – Visual Flight Rules

² IFR – Instrument Flight Rules

originates principally from a quartering crosswind from the left. On helicopters whose main rotors rotate clockwise a similar risk applies with a quartering crosswind from the right.



For certain types of helicopters these problems are addressed in the flight manual, however not in the flight manual for the helicopter type in question.

The pilot has stated that he was not fully aware of the complex of problems mentioned above.

1.18.2 The pilot chair

As previously stated the pilot chair came loose from the cabin floor as a consequence of the forces generated during the accident. As a consequence of this, after the accident the pilot was suspended from the safety belt, which was anchored directly to the cabin floor. According to verbal information from the operator, the pilot chair has come loose in a similar manner during earlier accidents involving this type helicopter.

2 ANALYSIS

2.1 The accident

No technical fault which can explain the occurrence has been found on the helicopter. Also, the pilot did not experience anything abnormal with the helicopter prior to the accident.

The pilot's intention was to correct the parking position of the helicopter on the trailer by hovering upwards, yawing somewhat to the left, and then setting the helicopter down on the trailer again. During the ascending hover the downward pointing flexible steel strip on the right-hand landing skid caught on the edge of the landing bed. Upon landing, the flexible steel strip happened to end-up outside of the landing bed surface. Its becoming caught was probably due to the fact that the pilot was already applying left rudder during the ascending hover in order to adjust the parking position. It cannot be ruled out that he, in addition to this, reflexively applied additional left rudder to compensate for the rotor torque during the ascending hover, which is the normal procedure for helicopters with counter clockwise rotating main rotors, i.e. the type helicopter he was most used to flying. As a result, during the ascending hover, the flexible steel strip was partially affected by a lateral force that counteracted the yaw to the left and partially by a friction coefficient that held the landing skid down.

Therefore, when the flexible steel strip freed itself from the edge, the helicopter suddenly began to yaw rapidly to the left. The pilot was taken unawares by the sudden yaw and everything points to the fact that at this point, he did not apply right rudder rapidly enough and with sufficient deflection in order to arrest it.

Contributory to this could have been, that initially during maneuvering the helicopter was in a right-quartering crosswind situation and as such was in a flight situation, that according to section 1.18.1 involves the risk of aerodynamic disturbance of the tail rotor function, with temporary diminished yaw control as a result. As is evident from this section, helicopters with clockwise rotation of the main rotor— as in the case of the helicopter in question— can be sensitive to right-quartering crosswind. The situation could also have been worsened when the helicopter entered a tailwind situation after 90 degrees of turn.

As recently as June 2001 SHK published a report (RL 2001:19) that deals with a similar accident where the pilot lost yaw control in connection with hovering in a crosswind at low altitude. Even in this case it was found that the pilot was not fully aware of the problem complex discussed above. This can be an indication that the subject of aerodynamic disturbance of tail rotor function perhaps should be given greater attention during basic helicopter training and during PFT.

It is understandable that the pilot, when he suspected that a serious problem had arisen concerning the tail rotor, chose to try to set the helicopter down on the ground. It has not been possible to reconstruct the sequence of events of the impact exactly; however, everything indicates that the helicopter initially collided with the helicopter-landing trailer. The damage on the trailer and the impact impressions on the ground would indicate that the tail rotor collided with the trailer bed after the helicopter had turned approximately $\frac{3}{4}$ of a revolution. Thereafter the helicopter impacted the ground with such a force that the right-hand aft spring strut broke off, causing the helicopter to overturn to the right. This, in turn, caused one of the main rotor blades to collide with and tear off the tow bar on the trailer. Thereafter, when the main rotor impacted the ground, the forces that were produced were so great that the rotor and the transmission separated from the helicopter.

2.2 The helicopter trailer

Landing a helicopter on a helicopter-landing trailer is a demanding precision maneuver, especially if the landing bed is small in proportion to the helicopter. In the case at hand the total surface area of the bed was certainly large, but it was divided-up into two smaller surfaces with an approximately 0.9 meter wide empty space between them, a fact that must be considered unsuitable from the standpoint of flight safety. In this case the empty space resulted in the ability of the downward pointing flexible steel strip to become fastened on the edge of the bed. Generally speaking, a helicopter-landing trailer, besides being sufficiently large and stable for the actual helicopter type, should have a landing bed surface that is entirely covered and designed so that minimal risk of entanglement exists.

3 CONCLUSIONS

3.1 Findings

- a)* The pilot was qualified to perform the flight.
- b)* The helicopter had a valid certificate of airworthiness.
- c)* No technical fault was found on the helicopter.
- d)* The right-hand landing gear skid fastened onto the helicopter-landing trailer.
- e)* The helicopter- landing trailer was unsuitably designed for this type of helicopter.
- f)* A transient aerodynamic disturbance may have occurred during the ascending hover.
- g)* During the accident the pilot's chair came loose from the cabin floor.

3.2 Causes

The probable cause of the accident was that the pilot did not promptly enough and with sufficient rudder deflection, arrest the sudden left yaw that was initiated when the entangled flexible steel strip freed itself from the helicopter trailer. A contributory cause could have been a transient aerodynamic disturbance of the tail rotor function.

4 RECOMMENDATIONS

None.