ISSN 1400-5719

Report RL 2002:12e

Accident involving helicopter SE-JGK
at Sör-Mesjön, northwest of Örnsköldsvik,
Y county, Sweden
on 06 January 2001

Case L-002/01

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.

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

Translated by Bob Arnesen

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

Statens haverikommission (SHK) Board of Accident Investigation

Postadress/Postal address	*Besöksadress/Visitors*	*Telefon/Phone*	*Fax/Facsimile*	*E-mail Internet*
P.O. Box 12538	Wennerbergsgatan 10	Nat 08-441 38 20	Nat 08 441 38 21	info@havkom.se
SE-102 29 Stockholm Sweden	Stockholm	Int +46 8 441 38 20	Int +46 8 441 38 21	www.havkom.se

2002-05-08 L-002/01

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Rapport RL 2002:12e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on January 06, 2001 at Sör-Mesjön, northwest of Örnsköldsvik, Y county, Sweden, involving a helicopter with registration SE-JGK.

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.

Olle Lundström

Monica J Wismar Henrik Elinder

Contents

Report RL 2002:12e

L-002/01
Report finalised 2002-05-08

Aircraft; registration and type	**SE-JGK**, Aerospatiale AS 350 B2
Class/ airworthiness	Normal, valid Certificate of Airworthiness
Owner/operator	Air Lift Helicopter Sweden AB, Box 197, 824 24 Hudiksvall, Sweden
Time of occurrence	2001-01-06, at 14:35 hours in daylight *Note: All times are given in Swedish standard time (UTC + 1 hour)*
Place	Sör-Mesjön, northwest of Örnsköldsvik, Y county, Sweden (pos. 6338N 01803E, 300 m above sea level)
Type of flight	Utility, lime seeding
Weather	According to SMHI[1]´s analysis: wind from the east at 5 knots, visibility 2–4 km in haze or light snow, a solid base stratus cloud layer at 100–300 ft, temp/dewpoint –1/ –1 °C, QNH 1003 hPa
Persons on board: crew	1
passengers	–
Injuries to persons	Minor
Damage to aircraft	Destroyed
Other damage	Limited damage to forest
Pilot in command:	
Age, certificate	48 years old, Helicopter Commercial
Total flying time	3,162 hours, of which 535 hours on fixed wing and 2,627 hours on helicopter. Total of 2,130 hours on actual type.
Flying hours previous 90 days	35 hours, all on type
Number of landings previous 90 days	51

The Board of Accident Investigation (SHK) was notified on January 6, 2001 that a helicopter with registration SE-JGK had an accident at 14:35 hrs on that day at Sör-Mesjön northwest of Örnsköldsvik, Y county, Sweden.

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 Gun Ström, Swedish Civil Aviation Administration and by M Bernard Boudaille at the Bureau d´Enquetes-Accidents.

[1] SMHI = Swedish Meteorological and Hydrological Institute

Summary

The helicopter was being utilised to spread lime. After having delivered a series of loads the helicopter landed to be refuelled adjacent to the lime refilling station. During the refuelling the pilot remained in the aircraft and did not shut down the engine. When the refuelling was finished the pilot lifted into a hover and then departed to pick up the next newly loaded spreader. When at about 30 metres height above ground the engine suddenly failed.

The pilot commenced an autorotation and landing onto a road in the woods. The helicopter landed quite hard with some forward speed. The helicopter ended up in the ditch on the right side of the road where it tipped onto its right side. The pilot managed, inspite of one leg jammed, after considerable effort to free himself and escape the helicopter that shortly thereafter caught fire.

A technical fault that can explain the engine failure with absolute certainty has not been found. After the accident the fuel line that connects the fuel control unit with the combustion chambers injector wheel was partially clogged with coke that consisted of the carbonised remains of spent rubber and/or plastic.

The accident was caused by the engine failure occurring at low speed and height. The engine failure was most probably caused by a piece of plastic or rubber entering the engines fuel system, which in turn blocked the flow of fuel to the injector wheel in the combustion chamber.

Recommendations

None.

1 FACTUAL INFORMATION

1.1 History of the flight

During the morning of the 6th January 2001 the helicopter was being utilized to spread lime on the lake of Sör-Mesjön. The seeding was being carried out using a specially constructed lime spreader slung beneath the helicopter. After having delivered a series of loads the helicopter landed to be refuelled adjacent to the lime refilling station. During the refuelling the pilot remained in the aircraft and did not shut down the engine. When the refuelling was finished the pilot lifted into a hover and then departed on a south-easterly course into the wind with the aim of carrying out a right hand circuit and again approach the lime filling station into wind to pick up the next newly loaded spreader. When in the downwind part of the circuit at about 30 metres height above ground the engine suddenly failed.

The pilot commenced an autorotation and landing onto a road in the woods that was situated ahead and to the right of the helicopters flight direction. During the approach to landing the aircrafts speed and height above ground became so low that the pilot was unable to miss hitting some treetops on the side of the road. After hitting the trees the helicopters sink rate increased and it landed quite hard with some forward speed. The helicopter ended up in the ditch on the right side of the road where it tipped onto its right side.

The pilot was initially trapped in the aircraft, one of his leg being jammed in the wreck, but after considerable effort he was able to free himself and escape. Shortly thereafter the helicopter caught fire.

The accident location: 6338N 01803E; approx 300 m above sea level.

1.2 Injuries to persons

	Crew	*Passengers*	*Others*	*Total*
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	1	–	–	1
None	–	–	–	–
Total	1	–	–	1

1.3 Damage to aircraft

Destroyed.

1.4 Other damage

Limited damage to trees.

1.5 Personnel information

1.5.1 *The pilot*

The pilot was 48 years old at the time and had a valid Helicopter Commercial Licence.

Flying hours			
Latest	*24 hours*	*90 days*	*Total*
All types	3.5	35	3,162
This type	3.5	35	2,130
Fixed wing	–	–	535

Number of landings this type previous 90 days: 51.
Flight training on type concluded in 1995.
Latest PFT (periodic flight training) carried out in December 2000 on an AS 350.

1.5.2 *The pilot duty period*

During the week before the accident the pilot had the following duty period:

	Dutytime	*Flight time*
2001-01-01	Day off	–
2001-01-02	hr 14.00-15.00	0.6
2001-01-03	hr 09.00-17.00	2.2
2001-01-04	hr 09.00-17.00	2.1
2001-01-05	hr 08.30-16.00	1.5

1.6 Aircraft information

AIRCRAFT	
Manufacturer	Eurocopter
Type	Aerospatiale AS 350 B2
Serial number	2920
Year of manufacture	1996
Gross weight	Max authorised 2500 kg, actual 1630 kg
Centre of gravity	Within limits
Total flying time	1480 hrs
Flying time since latest inspection	22 hrs
Fuel loaded before event	Jet A1

ENGINE	
Manufacture	Turbomeca
Model	Arriel 1D1
Number of engines	1
Total operating time, hrs	1480
Operating time since overhaul	1480

ROTOR	
Manufacture	Eurocopter
Operating time since latest overhaul	1480 hrs

The aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

According to SMHI´s analysis: wind from the east at about 5 knots, visibility 2–4 km in haze or light snow, sky completely covered by a layer of stratus cloud based at 100–300 ft, temp./dewpoint –1/–1 °C, QNH 1003 hPa.

At the time of the accident there were no snowing according to the pilot and the persons at the site.

1.8 Aids to navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome information

Not applicable.

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 helicopter hit the ground on a local road leading through a pine forest, surrounded on both sides by approximately 25-meter high trees.

1.12.2 Aircraft wreckage

The helicopter was almost completely burned up.

1.13 Medical information

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

1.14 Fire

A severe and spontaneous fire broke out in the helicopter about a minute after it had come to rest in the ditch.

1.15 Survival aspects

The pilot sat in the aircraft using a four point safety harness. The cockpit was demolished when the helicopter tipped over and came to rest in the ditch. Despite being initially trapped in the wreck the pilot was luckily enough able to free himself and scramble to safety before the wreck caught

fire. The Emergency Locator Transmitter (ELT) of type Pointer 3000-10 was destroyed in the fire.

1.16 Tests and research

1.16.1 The helicopter

The helicopter wreckage was moved to a certified helicopter maintenance depot where it was examined under the supervision of SHK. With the exception of the aft section of the tail boom, the engine and various parts made of steel, most of the helicopter had burned up in the fire. As a result a full and complete investigation of all the helicopters systems that in some way control the engines function was not possible.

No fault or abnormality was found with those parts that had survived the fire that could explain the engine failure. Damage to the tail boom and the landing skids indicate that the impact with the ground was quite hard. The aircraft skin beneath the engine bay had been pushed in and cracked in such a fashion that indicated that a sharp object had pierced its way through the skin and into the engine bay area as it tipped over in the ditch, damaging the fuel line between the fuel pump and the engine fuel systems.

1.16.2 The engine

The engine was moved to the manufacturer Turbomeca's plant in France for a technical investigation. All work there was carried out under the supervision of SHK and a representative from the manufacturer. All parties agreed on a given order and flow to be followed during the disassembly of the engine so as to reduce the risk for missing any faults.

The engine had been severely damaged in the fire. The compressor and turbine sections had been so deformed that it was not possible to rotate the rotor drive shaft. Many of the engine components that were not manufactured from steel had either been consumed in the fire or were missing. Most of the rubber and plastic material had burned up. Thus a complete and thorough examination of the engine has not been possible, resulting in the inability to exclude some possible faults.

Special attention was given to the aircraft fuel control unit which was in reasonably good shape even if most of the bellows, membranes, seals etc. were charred. In those cases where uncertainty arose as to whether damage to parts had occurred before or as a result of the accident, they were sent to CSM Materialteknik in Linköping, Sweden for closer inspection. Analysis was also carried out on a white powder found on the engine. Most of this was shown to be fire-extinguishing agent while a small amount consisted of lime.

Other than a fuel line described in section 1.16.3, the investigation has been unable to demonstrate any faults or failures that could have adversely affected the engines performance or explain the engine failure. All the damage identified has occurred as a result of the fire. The engine appears to have been in good condition. The existence of small deposits of lime in the engine air intakes was evidence that the helicopter had been used in lime seeding operations, however the amount was deemed to be to small to have had any effect on the engine.

1.16.3 The fuel line

During further analysis of the fuel line connecting the fuel control unit with the combustion chamber, a fuel inlet union in the combustion chamber showed evidence of being clogged with black coke. The inlet union is situated between the Over speed and Drain valve and the Injection wheel in the

combustion chamber. Any clogging that occurs in this fuel line will either stop or reduce the fuel flow to the combustion chamber.

Fuel Inlet Union

The coke was analysed by CSM using spectral analysis and it was determined that it contained calcium, carbon, barium, magnesium, fluorine, in addition to traces of iron, sulphur and oxygen. According to their assessment these basic elements are not derived solely from the burning of jet fuel. Their most probable source would be from the carbonised remains of spent rubber and/or plastic.

1.17 Organisational and management information

The company has its headquarters in the city of Hudiksvall and has lime seeding as its primary task. At the time of the accident it only had the one helicopter.

1.18 Additional information

1.18.1 Lime seeding by helicopter

Lime seeding by helicopter

The specially designed lime spreader used in seeding operations has a cylindrical form and is made of fibre glass strengthened plastic. It is slung beneath the helicopter using two cables that are connected to the cargo hook under the fuselage. The pilot is able to open and close the lime release valve on the spreader from the cockpit

1.18.2 Refuelling procedures

The helicopter was refuelled from the same truck that was used to refill the spreaders with lime. The fuel tank on the truck can hold up to 1150 litres of jet fuel and has a separate drain valve. Fuel is transferred from the truck tank to the helicopter using an electric pump, the fuel passing through two fuel filters, each with its own drain valve. The refuelling tank is in turn refilled from a main fuel bowser capable of holding 30 m^3 of fuel and which also has its own drain valve. The following refuelling instruction has been drawn up by the company and was followed on the day of the accident:

Tanknings instruktioner

Varje morgon: Dränera dagligtanken på lastbilen. Först kondenskärlet, sedan filtren (obs: 2 st) med pumpen avstängd. Kontrollera totalmängd i tanken, tillse att kopplingar, slangar och munstycke är fria från läckage och smuts.

Varje påfyllning ifrån tanksläp till dagligtank: Dränera tanksläp (2 dräneringspunkter). Kontrollera nivå i facket som skall användas. Vid montage av sugslang mellan släp och dagligtank, kontrollera läckage och smuts. **OBS!!!** Innan pumpen slås igång skall det kontrolleras att överfyllnads-skyddet är monterat/aktiverat.

Vid användning av frostskydds-vätska: Kontrollera att rätt fabrikat och dosering/mängd används. Innan överfyllning påbörjas skall frostskydds-vätskan tillsättas i dagligtanken. **OBS!!!** Noggrann beräkning av mängd samt renlighet skall iakttagas vid påfyllning av frostskydds-vätskan.

Vid tankning till hkp skall påfyllnings-munstycket torkas av och kontrolleras. Efter avslutad tankning skall påfyllnings-munstyckets skydd monteras tillbaka. Tillse också att tanknings-pumpen stängs av.

AIRLIFT HELICOPTER SWEDEN AB

Translation by SHK:

Refuelling instructions

Every morning: Drain the aircraft refuelling tank on the truck. First drain the tank for condensation, then the fuel filters (note: total 2) with the pump turned off. Check the total amount remaining in the tank, ensure all lines are properly connected and that all hoses and nozzles are clean and free from leaks.

When refilling the aircraft refuelling tank from the main fuel bowser: Drain the bowser for condensation (2 drain points). Check the level in the bladder section to be used. When connecting the suction hose between the bowser and refuelling tank, ensure that it is clean and free from leaks. **Important !!!** Prior to switching the suction pump on ensure that the overfill protection is connected and turned on.

When using anti-freeze fluid: Check that the correct fluid is used and that the correct amount is added. Prior to transferring fuel from the bowser add the anti-freeze fluid to the refuelling tank. **Important !!!** Pay special attention to calculating the amount of the anti-freeze fluid to be added and that no impurities are allowed in.

When refuelling the helicopter: Check the refuelling nozzle for condition and that it is kept dry. When refuelling is complete always place the protective cover back on the nozzle. Ensure also that the refuelling pump is turned off.

AIRLIFT HELICOPTER SWEDEN AB

1.18.3 Aircraft maintenence

The helicopter was maintained in accordance with approved procedures. The helicopters maintenance records indicate that the fuel control unit was replaced on the 14th August, 2000. The aircraft then had a total operating time of 1269 hours. Thereafter no other maintenance was performed on the aircraft fuel system other than normal checks.

2 ANALYSIS

2.1 The engine failure

Despite the extensive investigation done on the aircraft engine no technical fault has been found that with absolute certainty can explain the reason for the engine failure. Those investigations carried out and the pilot's description of the events indicate that the engine suffered a so-called flameout,

meaning that combustion had ceased and that engine is no longer developing any power.

A flameout can be caused by external circumstances such as disturbances in the airflow around the engine air intake or if larger amounts of water or snow are ingested in the engine. The weather and flying conditions at the time were however such that neither of these factors could have been the cause.

A flameout can also be caused by contaminated fuel or disturbances in the flow of fuel. It can be reasonably assumed that the fuel was not contaminated with liquid water or any other substance. The daily maintenance of the helicopter was carried out according to approved procedures. The company had drawn up well-established procedures to ensure the removal of all condensation and water from the fuel during moving, refuelling and draining operations.

It is more feasible to assume that the flow of fuel was for some reason stopped or greatly reduced. The helicopters and especially the engines fuel system are complicated and contain many critical components crucial for proper operation. A small defect or even slight damage to a component such as the engine fuel control could well result in an unintentional reduction of fuel flow to the combustion chamber. Many of these components such as bellows, membranes and seals are manufactured from flammable material. As most of these parts were consumed in the fire it has been impossible to verify their condition. Therefore a sudden fault to any of these components could reasonably have been the cause for the flameout.

The technical investigation revealed that the fuel line between the fuel control unit and the injection wheel in the combustion chamber was clogged by coke, consisting of the carbonised remains of spent rubber and/or plastic. The only explanation for the existence of the coke is that spent rubber and/or plastic must have at some point gotten stuck in the fuel line and been carbonised by the fire. This would indicate that a small piece of plastic or rubber entering the engine fuel system and blocking the flow of fuel to the injector wheel could have caused the engine failure.

How and when such a piece of rubber or plastic could have entered the fuel system is impossible to say. It could well have occurred during final assembly of the fuel control unit or when it was installed in the engine about 200 hours prior to the accident. Experience has shown that it is not unusual for small pieces of O-rings and seals to be sheared off during assembly.

Such a small piece could have initially wedged itself in the fuel control unit without affecting its operation, until the actual flight when it could have been shaken loose and then clogged the fuel line.

2.2 The accident events

The helicopters low speed and height when the engine failure occurred did not give the pilot much of an opportunity to perform a controlled autorotation into a possible landing site. He was unable to prevent the helicopter hitting some tree tops and that the landing on the local road was made somewhat uncontrolled. When the helicopter slid down in the ditch the fuel line from the fuel pump was damaged. The fuel in the line was under pressure, which would explain the severe fire that started when the spilled fuel came in contact with hot engine parts.

3 CONCLUSIONS

3.1 Findings

a) The pilot was qualified to perform the flight.
b) The aircraft had a valid Certificate of Airworthiness.
c) A technical fault that can explain the engine failure with absolute certainty has not been found.
d) After the accident the fuel line that connects the fuel control unit with the combustion chambers injector wheel was partially clogged with coke that consisted of the carbonised remains of spent rubber and/or plastic.
e) When the helicopter slid down in the ditch a fuel line was damaged causing a heavy fuel leak in the engine bay.

3.2 Causes

The accident was caused by an engine failure occurring at low speed and height. The engine failure was most probably caused by a piece of plastic or rubber entering the engines fuel system, which in turn blocked the flow of fuel to the injector wheel in the combustion chamber.

4 RECOMMENDATIONS

None.