Statens haverikommission
Swedish Accident Investigation Authority

Final report RL 2020:06e

Accident at Vuoggatjålme, Norrbotten County, on 10 August 2019 involving the helicopter SE-JOA of the model Bell 206L-1, operated by Arctic Air AB.

File no. L-110/19

16 June 2020

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK´s web site: www.havkom.se

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This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.

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Content

General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or e.g. by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

Investigations of aviation incidents are governed mainly by Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and by the Accident Investigation Act (1990:712). The investigation is carried out in accordance with Annex 13 of the Chicago Convention.

The investigation

SHK was informed on 11 August 2019 that an accident involving a helicopter with the registration SE-JOA had occurred at Vuoggatjålme, Norrbotten County, on 10 August 2019 at 10:55 hrs.

The accident has been investigated by SHK represented by Mikael Karanikas, Chairperson, Tony Arvidsson, Investigator in Charge, and Stefan Carneros, Operations Investigator.

John M. Brannen II National Transportation Safety Board (NTSB) has participated as an accredited representative of the USA.

Jack Johnson has participated as an adviser for Rolls-Royce.

Magnus Axelsson has participated as an adviser for the Swedish Transport Agency.

The following organisations have been notified: The European Union Aviation Safety Agency (EASA), the European Commission, the NTSB, the Transportation Safety Board of Canada (TSB) and the Swedish Transport Agency.

Investigation material

Interviews have been conducted with the pilot and one witness. The accident site and the helicopter have been examined. Specific technical examinations have been conducted on the engine, the fuel and the IntelliStart+ system.

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Final report RL 2020:06

Aircraft:	
Registration, type	SE-JOA, Bell 206
Model	206L-1
Class, airworthiness	Normal, Certificate of Airworthiness and valid Airworthiness Review Certificate (ARC)[1]
Serial number	45548
Operator	Arctic Air AB
Time of occurrence	10 August 2019, 10:55 hrs in daylight Note: All times are given in Swedish daylight saving time (UTC[2] + 2 hours)
Location	Vuoggatjålme, Norrbotten County, (position 66 34N 016 21 E, 460 metres above mean sea level)
Type of flight	Commercial
Weather	According to SMHI's analysis: wind south-east 10 knots, visibility 10 km, variable cloud with base at 1 000 feet, temperature/dew point +13/+11°C, QNH[3] 1010 hPa
Persons on board:	1
Crew members including cabin crew	0
Passengers	0
Personal injuries	None
Damage to the aircraft	Slightly damaged
Other damage	None
Pilot in command:	
Age, licence	27 years, CPL(H)[4]
Total flying hours	619 hours, of which 301 hours on type
Flying hours previous 90 days	169 hours, of which 86 hours on type
Number of landings previous 90 days	321

[1] ARC – Airworthiness Review Certificate.
[2] UTC – Coordinated Universal Time.
[3] QNH – barometric pressure at mean sea level.
[4] CPL(H) – Commercial Pilot Licence Helicopter.

SUMMARY

The purpose of the flight was for the pilot to collect and transport six people who were staying around seven minutes' flying time from the helicopter base. Prior to take-off, there was around 100 litres of fuel in the tank.

After flying a couple hundred metres and at an altitude of around 25 metres, the helicopter started suffering yaw disturbances and a little later lost rotor rpm and lift. Because of the low altitude and speed, the pilot maintained the current collective pitch. Consequently, landing was performed with a little speed in the forward direction, which resulted in the landing gear braking against the soft ground and initially causing the helicopter to tip forward, before it returned to a level position. At the low rotor speed that remained following contact being made with the ground, the cyclic position, combined with the nose-down movement resulted in the downwind rotor blade coming into contact with the tail boom, which was then cut off by the rotor blade. The pilot has stated that he is uncertain about whether he shut down the engine himself or if it stalled because of the engine problem.

The technical examinations of the helicopter and the engine did not show anything that could have caused the loss of engine power. Nor could the loss of power be recreated during test run.

It can be established from the engine parameters that a problem in the form of fluctuations in the engine's torque (TRQ) arose during the flight. The major loss of power occurred immediately after these fluctuations.

The turbine outlet temperature (TOT) rose sharply in a later phase, which indicates that, at this stage, the engine was receiving an increased flow of fuel and that it was not completely shut down.

The data that has been analysed does not suggest that the loss of power was caused by the actions of the pilot.

The accident was caused by a major loss of engine power occurring in a flight phase in which the chances of landing safely were restricted by the low speed and altitude.

It has not been possible to establish the cause of the loss of engine power. This was probably a consequence of a temporary partial blockage of the fuel supply to the engine.

Safety recommendations

None.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Circumstances

The purpose of the flight was for the pilot to collect and transport six people who were staying around seven minutes' flying time from the helicopter base. Prior to take-off, the pilot filled up with 20 litres of fuel so that there were around 100 litres of fuel in the tank at the time of take-off. Visibility was good under the clouds but there was clouds in the higher terrain, which meant that the pilot had to follow some valleys during a previous flight that same day.

1.1.2 Sequence of events

The pilot hovered up and flew out over the take-off area, which consisted of a mire. After a couple hundred metres or so, and at an altitude of around 25 metres, the pilot felt that the helicopter began "wobbling" and suffering yaw disturbances. The wobbles were initially interpreted as mechanical turbulence, but was quickly felt to be larger than that, at the same time as the sound of the engine was experienced to be abnormal. The helicopter lost height and the engine power or rotor rpm was felt to be low. Because of the low altitude and speed, the pilot maintained the current collective pitch until contact was made with the ground. When ground contact was made, the helicopter still had forward speed, although this was low. When the landing gear hit the ground, it was sucked into the mire and this resulted in the helicopter starting to tip forward. At this point, the pilot reacted spontaneously and attempted to compensate for the nose-down movement he felt by pulling the cyclic towards himself. The downwind rotor blade made contact with the tail boom, which was cut off.

The pilot has stated that he is uncertain about whether he shut down the engine himself or if it stalled because of the engine problem. There were no personal injuries and the pilot was able to leave the site himself in order to get help after having turned off all systems and the emergency locator transmitter, which had been activated.

The accident occurred at position 66 34N 016 21E, 460 metres above mean sea level.

1.2 Personal injuries

	Crew members	Passengers	Total on board	Others
Deceased	-	-	0	-
Serious injuries	-	-	0	-
Minor injuries	-	-	0	Not applicable
No injuries	1	-	1	Not applicable
Total	1	0	1	-

1.3 Damage to the aircraft

Slightly damaged.

1.4 Other damage

None.

1.4.1 Environmental impact

None.

1.5 Personnel information

1.5.1 Qualifications and duty time of the pilot

Pilot in command

Pilot in command was 27 years old and had a valid CPL (H) with flight operational and medical eligibility.

Flying hours				
Latest	24 hours	7 days	90 days	Total
All types	6	26	169	619
On type	6	26	86	301

Number of landings, on type last 90 days: 321.
Type rating concluded on 27 June 2017.
Latest PC[5] conducted on 26 March 2019 on Bell 206L-1.

[5] PC – Proficiency Check.

1.6 Aircraft information

The Bell 206L is a light, two-bladed helicopter with a turbine engine and approved for one pilot and six passengers.

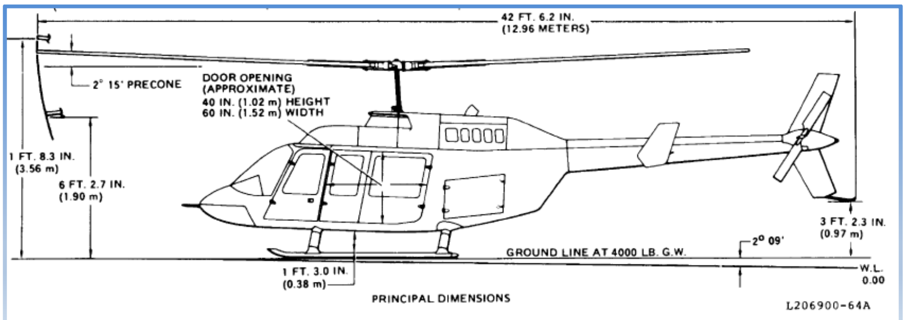


Figure 1. Schematic of the helicopter with dimensions. Image: 206L-1-FM-01FRM, Bell Helicopter Textron Inc.

1.6.1 Helicopter

TC-holder	BELL HELICOPTER TEXTRON CANADA
Model	206L-1
Serial number	45548
Year of manufacture	1980
Gross mass (kg)	Max. take-off mass 1 882, current 1 354
Centre of gravity	Within limits.
Total operating time (hours)	9 899
Operating time since latest inspection (hours)	32
Type of fuel uplifted before the occurrence	JET A-1
Engine	
TC-holder	ROLLS-ROYCE CORPORATION
Type	250-C28B
Number of engines	1
Serial number	860344
Total operating time (hours)	16 564
Operating time since latest inspection (hours)	32
Hold item list	None.

The aircraft had a Certificate of Airworthiness and a valid ARC.

1.6.2 Description of parts or systems related to the occurrence

Engine

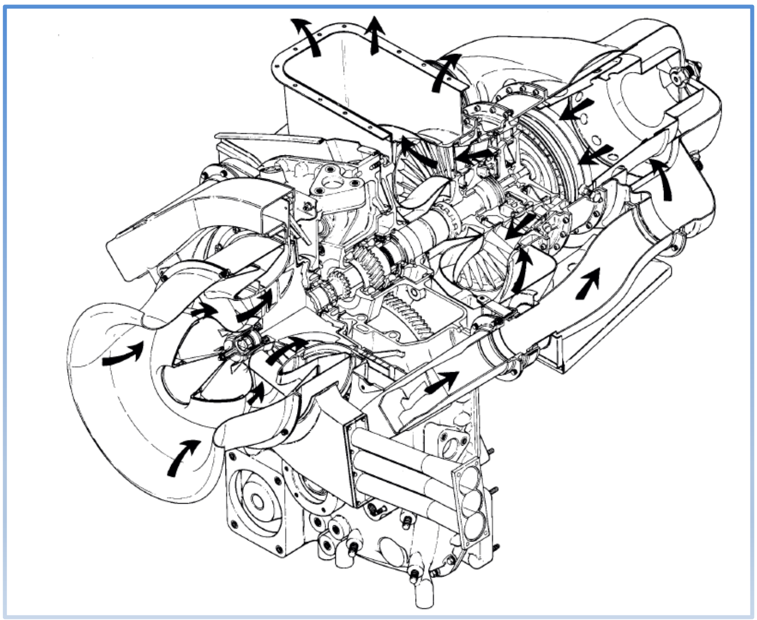


Figure 2. The engine, with arrows that show the airflow through it. Image: Rolls-Royce.

Rolls-Royce model 250-C28B is a turboshaft engine with a gas generator and a free turbine. The engine has a centrifugal compressor and a combustion chamber with one fuel nozzle. The turbine part contains a two-stage gas turbine (N1[6]) permanently mounted to the centrifugal compressor. The free turbine (N2[7]) also has two stages. The accessory gearbox contains a gear box function for the gas generator and the free turbine, which has an outgoing shaft that is in turn connected to the rotor system gear box.

The engine's fuel system

The gas generator's fuel control unit (FCU) is the key component of the fuel system. This hydromechanical unit controls the flow of fuel to the engine in order to achieve optimal acceleration during the engine start sequence and provide the correct power during operation. Increasing or decreasing the flow of fuel has a direct impact on the gas generator rpm (N1). The unit is driven mechanically by the engine's accessory gearbox, the rpm of which is proportional to that of the gas generator. The flow of fuel is affected by factors including the throttle in the cockpit, the incoming fuel pressure, the outlet pressure from the compressor and by regulated air pressure from the free turbine governor. The fuel control unit supplies fuel to the fuel nozzle, which atomises the fuel into the combustion chamber, where combustion takes place. When the throttle is turned from closed to idle during an engine start, the fuel control unit automatically controls the flow of fuel as a function of compressor discharge pressure and N1 rpm. Combustion in the engine

[6] N1 – abbreviation for low pressure compressor or, in this case, gas generator rpm.
[7] N2 – abbreviation for high pressure compressor or, in this case, free turbine speed.

begins and this accelerates and is stabilised at idle speed (c. 59–65 % N1). The fuel flow during this sequence is controlled by the fuel control unit.

The free turbine governor is used when rpm is above idle in order to control the flow of fuel and get the fuel control unit to maintain an N2 rpm that is as constant as possible. The free turbine governor and the fuel control unit are connected together with a system of tubes, so that the compressor’s discharge pressure controls, via the free turbine governor, the fuel control unit and thereby N2 rpm. This governor is powered by the free turbine via gears. There is fine-tuning of the rpm and a system that, among other things, reduces the risk of variations in N2 in the event of large movements of the collective lever.

Caution/warning system

The helicopter’s instrumentation and monitoring system includes a warning for engine failure (ENGINE OUT). This warning is activated when engine speed is less than 55 % N1. Upon activation, a visual indicator “ENG OUT” (see Figure 3) is shown on the caution/warning panel and there is an intermittent audio signal.

The caution system for low rotor rpm (ROTOR LOW RPM) is activated when main rotor rpm falls below 90 % NR and if the collective pitch is of the down stop. The low rpm of the main rotor activates the “ROTOR LOW RPM” light (see Figure 3) on the caution/warning panel and a continuous audio signal is heard.

Figure 3. The indicators for engine failure and low rotor rpm are located furthest to the right on the caution/-warning panel.

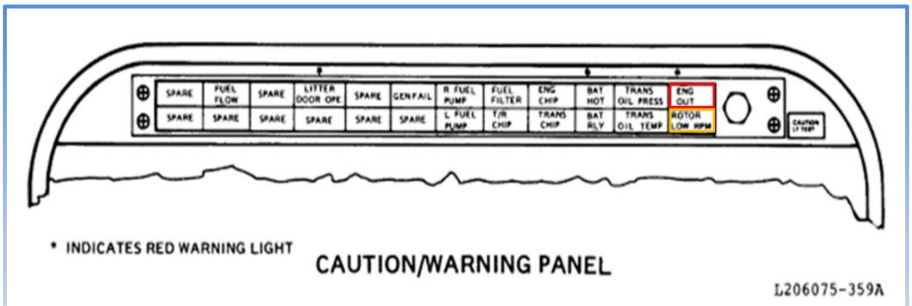
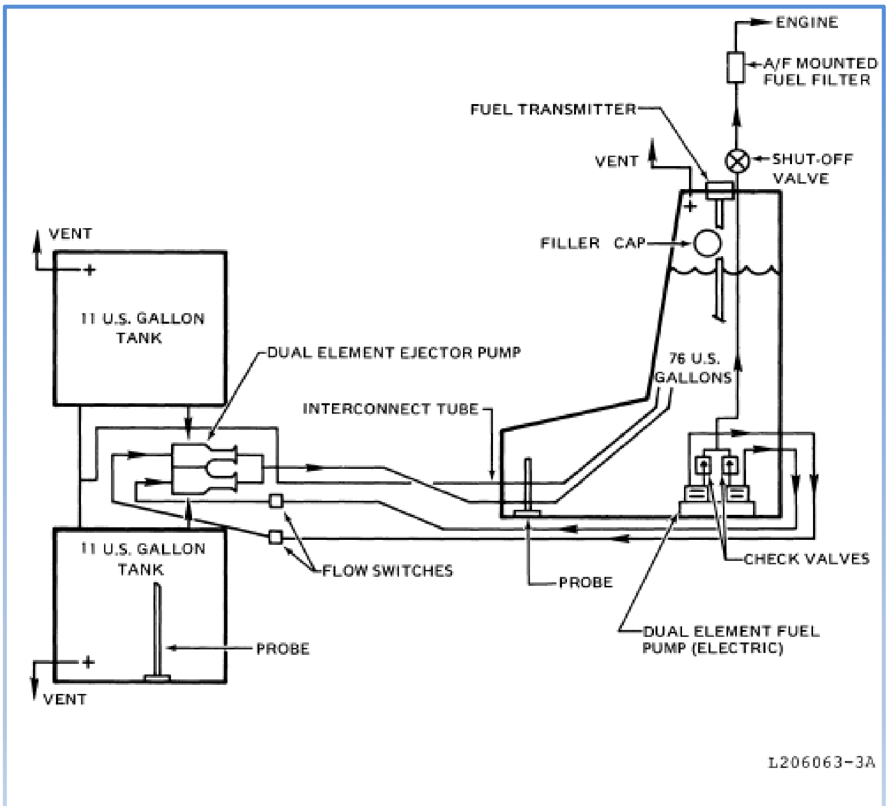


Figure 4. The caution/warning panel, which is located above the instrument panel. Image: 206L-1-FM-S02FRM, Bell Helicopter Textron Inc.

The helicopter's fuel system

The system is comprised of three interconnected fuel tanks with a total capacity of 374.6 litres. Two of the fuel tanks are a little smaller and are located forward of the larger tank. When the fuel level exceeds 154 litres in the aft tank, the two forward tanks are filled via a standpipe. Two electrical fuel pumps mounted in the lowest part of the aft tank move pressurised fuel to two ejector pumps that are located between the forward tanks, which in turn move fuel from the forward tanks to the aft tank. The electrical fuel pumps also supply the engine with pressurised fuel via a shut-off valve and a filter. Both of the forward tanks have sensors that measure the fuel flow through the ejector system. The fuel quantity system consists of probes in the left forward tank and in the aft tank. The fuel quantity caution "FUEL LOW" is illuminated when there is a remaining fuel quantity of just under 38 litres. The quantity of unusable fuel is 3.78 litres.

At normal engine power, the helicopter uses about 150 litres of fuel per hour, which corresponds to 2.5 litres per minute.



28-1. Fuel system schematic

Figure 5. Schematic of the helicopter's fuel system. Image: 206L-MM-CH28, Bell Helicopter Textron Inc.

Bulletin CASA 2018-11

According to a safety bulletin issued by Transport Canada on 31 December 2018, the type certificate holder is recommended to introduce a caution for fuel quantity below 20 US gallons, equivalent to about 75 litres, into the rotorcraft flight manual (RFM) even if a FUEL LOW caution light is installed. The reason for this is that there have been accidents involving the helicopter type that are linked to flying with a low fuel quantity and when the fuel is distributed unevenly in the tank in conjunction with sharp turns or uncoordinated flying during which the fuel pumps have been starved of fuel.

This caution was known to the pilot and the operator but the type certificate holder has not introduced any amendment to the RFM.

Start control

The IntelliStart+ system has a start control function for the engine. This function is activated during the start sequence and controls and restricts damaging temperature spikes in the hot section of the engine. Engine data is also registered and stored for trend analysis and shows what happened prior to, during and immediately after an exceedance or an event. If a flight were to end unexpectedly, engine data is available afterwards.

Some of the parameters that can be retrieved from the system are engine torque (TRQ), turbine outlet temperature, gas generator rpm (N1), free turbine rpm (N2) and the main rotor rpm (NR).

No parameter for engine fuel flow is registered in the unit in question. However, this function is available on newer versions of the system.

1.7 Meteorological information

According to SMHI’s analysis: Wind south-east 10 knots, visibility 10 km, with cloud base at 1 000 feet, temperature/dew point +13/+11°C, QNH 1010 hPa

The accident occurred in daylight.

1.8 Aids to navigation

Not pertinent.

1.9 Radio communications

Not pertinent.

1.10 Aerodrome information

Not pertinent.

1.11 Flight recorders

The helicopter was not equipped with a flight data recorder or cockpit voice recorder and nor was there any requirement for such equipment for the helicopter type in question. However, there was, as mentioned above, a start control system (IntelliStart+), which also register and stores engine data.

1.11.1 Flight recorders

The memory unit in the IntelliStart+ system was sent to the manufacturer for data retrieval under the supervision of a representative of the FAA[8]. The unit was tested without remark. A total of thirty hours and nineteen parameters were retrieved, selected parameters of which were analysed (see section 1.16.3).

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

The accident occurred on a mire, just outside of Vuoggatjålme in Norrbotten County (see Figures 6 to 8).

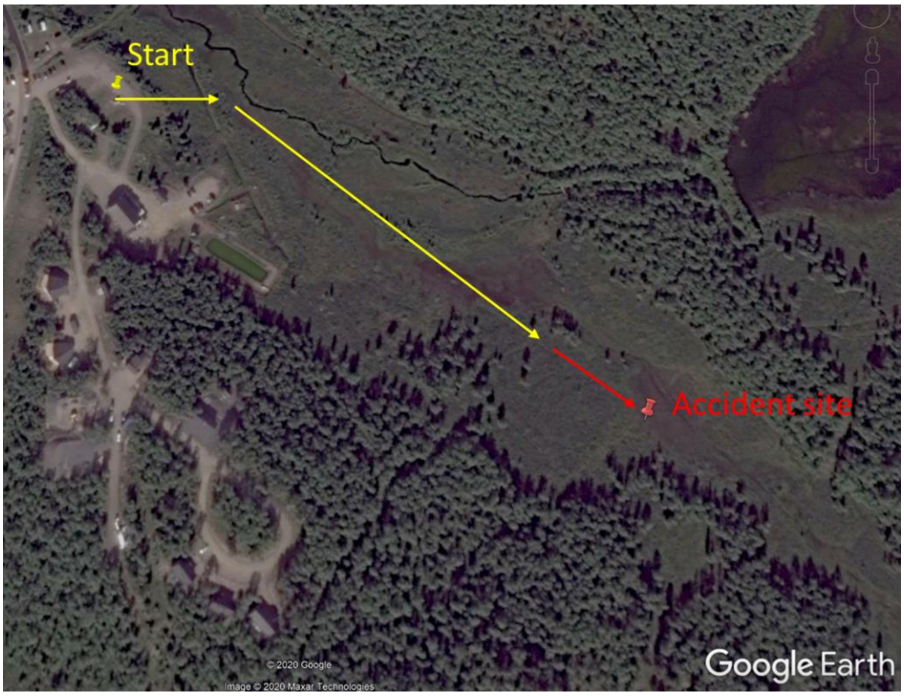


Figure 6. The accident site. The red arrow, marked by SHK, indicates the approximate direction of travel following the loss of engine power. Source: Google Earth.

[8] FAA – Federal Aviation Administration.

Figure 7. Part of the route. The accident site is marked with a red circle, marked by SHK. Publication permission from Lantmäteriet: LM2020/009370.

Figure 8. The site of the emergency landing, with the cut-off tail boom in front of the helicopter. Photo. The pilot.

1.12.2 *Aircraft wreckage*

The damage sustained on the helicopter was slightly limited. Following the occurrence, the helicopter was standing on its skids and a part of the tail boom with the tail rotor was lying a little way in front of the helicopter. There were indications that contact had been made with the mire on the mirror and the pitot tube that are mounted at the front of the nose. The main rotor blades had clear signs of having been in contact with the tail boom.

1.12.3 *Technical examination of the helicopter*

The technical examination of the helicopter was conducted on 13 August 2019 in the operator's hangar. The fuel gauge in the helicopter indicated that there were around 80 litres on board. The amount of usable fuel on board was emptied and measured to 100 litres. Fuel hoses, tubes, tube connectors and fuel filter for feeding fuel to the engine were visually inspected. The function of both of the electrical fuel pumps in the main tank was tested. The fuel flow from the forward fuel tanks to the main tank and to the mechanical fuel pump on the engine were satisfactory. A sample of fuel was taken from the tank for analysis (see section 1.16.2).

The engine was visually inspected from the outside without remark. Fuel tubes and tubes for reference pressure, as well as their nuts with colour markings, were visually inspected without remark. The filter in the fuel nozzle was inspected without remark. The engine was removed from the helicopter for further examination (see section 1.16.1).

1.13 Medical and pathological information

Nothing has emerged that the mental and physical condition of the pilot was impaired before or during the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 *Rescue operation*

The ELT[9] of the type Kannad 406AF-H was activated during the occurrence.

The JRCC[10] received information that an ELT had been activated and began alerting rescue units. Shortly thereafter, however, the operator contacted the JRCC and explained that this was not an emergency situation. The rescue operation was concluded following this call.

1.15.2 *Position of crew and passengers and the use of seat belts*

The pilot sat in the right seat and was using a four-point safety harness.

[9] ELT – Emergency Locator Transmitter.
[10] JRCC – the Swedish Maritime Administration's Joint Rescue Coordination Centre.

1.16 Tests and research

1.16.1 Examination of the engine at an authorised maintenance organisation

Under the supervision of SHK, an extensive examination and test run of the helicopter's engine has been conducted at an authorised aero engine workshop together with a representative of the type certificate holder for the engine.

No obvious damage to the engine or condition that would prevent the engine from producing nominal power was found during the examination of the engine. The engine started and was run normally and fulfilled all operational specifications. The engine produced normal power and responded to all power requirements, including sudden throttle and load changes. The loss of power reported by the pilot could not be recreated in the test cell.

1.16.2 Examination of the fuel

SHK has commissioned Element Materials Technology to conduct an analysis of the aviation fuel from the helicopter's tank. The fuel was of the JET A1 type. The characteristic distillation fulfilled the requirements under the specification for the fuel type.

The characteristics water content and water tolerance showed no signs of contamination and were normal for JET fuel.

1.16.3 Parameters from the memory unit in the IntelliStart+ system

Data from the memory unit showed that the engine's gas generator rpm (N1) at the start of the loss of power was at 91 %, the free turbine rpm (N2) was 98 %, the engine torque (TRQ) indicated 71 %, the turbine outlet temperature (TOT) indicated 661 degrees Celsius and the main rotor rpm (NR) was 98 %.

In the seconds preceding the loss of power, the engine data show that the engine torque (TRQ) has been at 71 % before dropping to around 60 %, only to then return to 71 % once more. The final increase from 60 % to 71 % occurs in a second (see Figure 9).

A sharp drop in the parameters gas generator rpm (N1), free turbine rpm (N2), the engine torque (TRQ), the turbine outlet temperature (TOT) and the main rotor rpm could be seen in the first second after the start of the loss of power. The engine torque was the parameter that dropped the fastest, followed by the turbine outlet temperature (see Figure 9). The caution that was activated first was low main rotor rpm (NR) because the rpm fell below 90 %, which occurred around 12 seconds after the first engine problems.

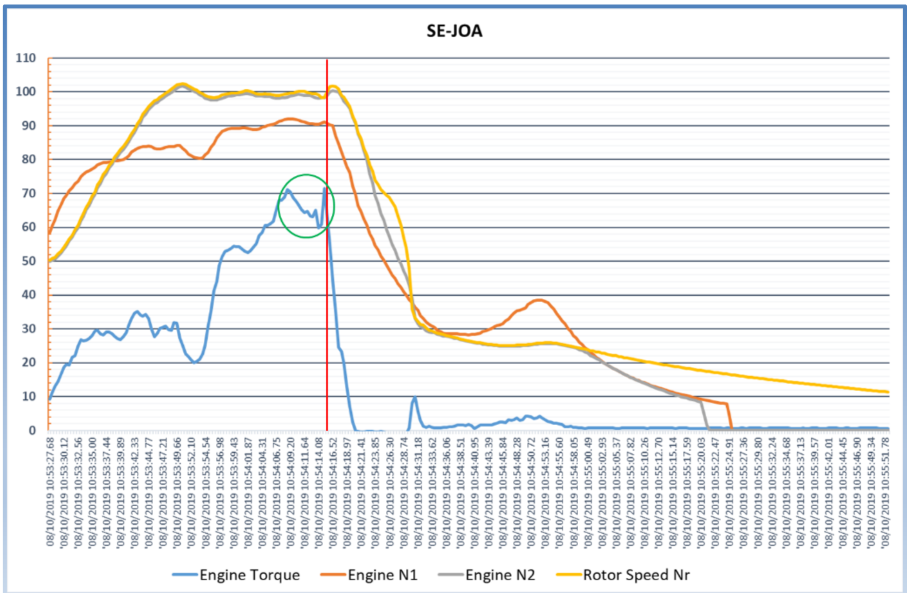


Figure 9. The engine data in the memory unit. The red line indicates the moment power was lost. The green circle marks the time of the fluctuations in the engine's torque, just before the loss of power.

Around seventeen seconds after the start of the loss of power, a distinct increase in turbine outlet temperature is seen, with a peak value of 929 degrees Celsius, before then falling again (see Figure 10). The engine's gas generator rpm (N1) also increases somewhat over the same period.

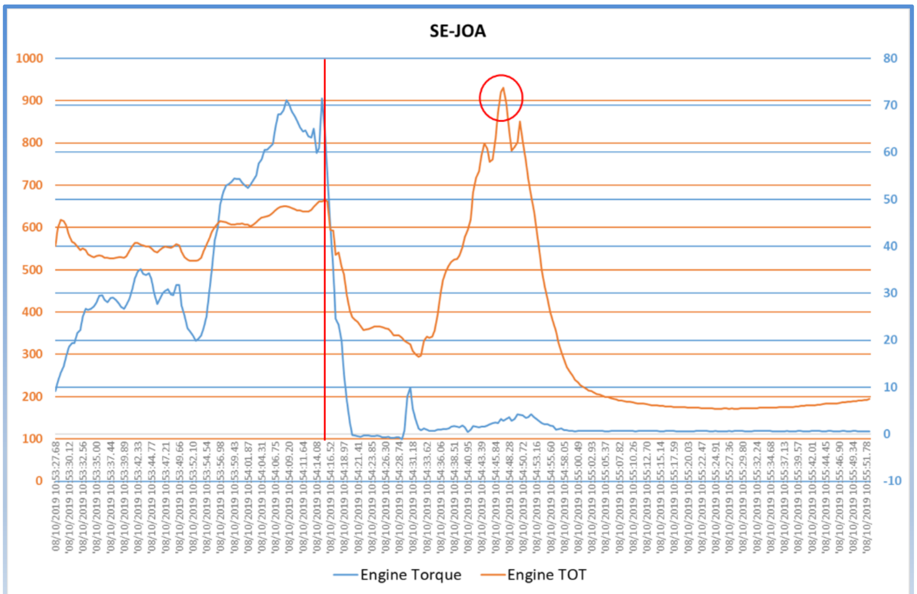


Figure 10. The engine data in the memory unit. The red line indicates the moment power was lost. The red circle marks the temperature peak in the turbine outlet temperature TOT.

1.17 Organisational and management information

Arctic Air AB, with permit number SE.DEC.0010, runs flight operations with helicopters from three bases, one of which is Vuoggatjålme. The business encompasses commercial specialised operations (SPO) and carriage of persons.

1.18 Additional information

1.18.1 Emergency procedures

Engine failure and autorotation

The procedure for engine failure and autorotation at low altitude describes how the throttle is to be closed, and flare to reduce excessive airspeed.

The collective is to be used in order to increase the blade angle of attack when the effect of the flare decreases in order to further reduce forward speed and make the landing soft. It is recommended that the landing is performed before the main rotor rpm falls below 70 %. When contact is made with the ground, the collective is to be lowered softly, while the cyclic is kept in a neutral or centred position.

Fault in the fuel control unit or free turbine governor

According to the procedure, a fault in the gas generator’s fuel control unit (FCU) or the free turbine governor will be noticed at an early stage through a change in either engine power or rpm. It is noted that there is no manual fuel control on the engine. The power is controlled using the throttle if the engine goes into overspeed.

It also states that rpm is maintained using the collective pitch if the engine rpm decreases.

If the power is low or if the engine must be shut down, autorotation is to be established and preparations made for a landing without engine power.

1.19 Special methods of investigation

None.

2. ANALYSIS

2.1 Fuel planning

The quantity of fuel the pilot took off with, around 100 litres, and an estimated consumption of 35 litres for the mission mean that the remaining quantity of fuel at the time of landing would have been around 65 litres, which is below the quantity, 75 litres, at which uncoordinated flying constitutes a risk of the fuel pumps not getting any fuel.

There is no prohibition against flying with such fuel margins, but taking into account the fact that there were to be six passengers and a certain amount of equipment, then you should consider if you plan to land with less than 75 litres of fuel, given the safety bulletin that was issued, which stated that less than 75 litres of fuel is to be deemed to constitute grounds for a caution for low fuel. Nevertheless, the low fuel margin has not influenced the sequence of events and the accident.

2.2 Sequence of events

The engine problems initially resulted in yaw disturbances and, a little later, loss of rotor rpm and lift. Consequently, the caution for low rotor rpm was not activated immediately. When the warning was activated, the helicopter was in the “intermediate range”, which means that, on the one hand, there was not enough altitude and speed to make a safe entry into autorotation and completive emergency landing, and on the other, the speed and altitude were too high to allow the helicopter to land immediately. Because the altitude and the speed were low, there was also no scope for the pilot to perform a flare (raise the nose and thus reduce the speed and increase the rotor rpm in order to enable a soft landing). Consequently, landing was performed with a little forward speed, which resulted in landing gear braking against the soft ground and initially causing the helicopter to tip forward, before it returned to a level position. In a situation such as this, a natural reaction is to spontaneously attempt to counter a perceived tip forward by pulling back on the cyclic.

At the low rotor speed that remained following contact being made with the ground, the cyclic position, combined with the nose-down movement resulted in the downwind rotor blade coming into contact with the tail boom, which was then cut off by the rotor blade.

In the absence of recordings or information from the pilot, it has not been possible to establish what made the engine finally stall. It may have been a consequence of the engine problems or because the pilot instinctively performed the motions required for this when the helicopter stood still on the ground.

2.3 Why did the engine loose power?

The examination of the helicopter and the engine conducted by SHK did not reveal anything that could have caused the loss of engine power. Nor could the loss of power reported by the pilot be recreated while testing the engine at the authorised aero engine workshop.

The engine parameters that could be retrieved from the memory unit (see section 1.16.3) and which SHK has analysed indicate that a disruption in the form of fluctuations in the engine torque (TRQ) occurred during the flight. Immediately after these fluctuations, the major loss of power occurred and the engine torque (TRQ) and turbine outlet temperature (TOT) drops rapidly. The other parameters also drop, but a little more slowly. Around seven seconds after the beginning of the major loss of power, the gas generator rpm drops below idle.

The fact that the engine's torque drops at the same time as the turbine outlet temperature falls rapidly has, most likely, been the result of some form of blockage in the fuel supply.

The turbine outlet temperature (TOT) falls sharply in a later stage when the engine's rpm N1 and N2 are low. The turbine outlet temperature peak indicates that, at this stage, the engine received an increased fuel flow and that it was not completely flamed out.

The data that has been analysed does not suggest that the loss of power was caused by the actions of the pilot.

A loss of engine power can have various causes. On the basis of the examinations that have been conducted, SHK makes the assessment that the most probable causes were a temporary partial blockage of the fuel supply to the engine.

3. CONCLUSIONS

3.1 Findings

a) The pilot was qualified to perform the flight.
b) The helicopter had a certificate of airworthiness and valid Airworthiness Review Certificate.
c) The engine lost power during the flight.
d) The caution for low rotor rpm was activated.
e) The fact that the tail boom was cut off was probably due to the cyclic being pulled back from a neutral position when contact was made with the ground.
f) The examinations of the helicopter and the engine did not show anything that could have caused the loss of engine power.
g) The loss of power reported by the pilot could not be recreated during testing of the engine.
h) The spike in turbine outlet temperature following landing suggest that the engine was not completely shut down.
i) It has not been possible to establish what caused the engine to finally stall.

3.2 Causes

The accident was caused by a major loss of engine power occurring in a flight situation in which the chances of landing safely were restricted by the low speed and altitude.

It has not been possible to establish the cause of the loss of engine power. This was probably a consequence of a temporary partial blockage of the fuel supply to the engine.

4. SAFETY RECOMMENDATIONS

None.

On behalf of the Swedish Accident Investigation Authority,

Mikael Karanikas Tony Arvidsson