EMERGENCY LANDING AFTER ENGINE PROBLEMS

The aim in the Netherlands is to reduce the risk of accidents and incidents as much as possible. If accidents or near-accidents nevertheless occur, a thorough investigation into the causes of the problem, irrespective of who is to blame for it, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Board itself selects the issues it wishes to investigate, mindful of citizens' position of dependence with respect to public authorities and businesses. The Board recognizes a number of situations where (international) obligations require that the Board must perform an investigation.[1]

GENERAL INFORMATION

Identification number:	2010020
Classification:	Accident
Date and time[2]:	2 April 2010, 11.50 hours
Location of occurrence:	Rotterdam The Hague Airport (EHRD)
Aircraft registration:	D-HHLF
Aircraft model:	Eurocopter EC 120 B
Type of aircraft:	Helicopter
Type of flight:	Private
Phase of operation:	Takeoff
Damage to aircraft:	Serious
Flight crew:	One
Passengers:	One
Injuries:	None
Other damage:	None
Lighting conditions:	Daylight

SUMMARY

The helicopter departed from Rotterdam The Hague Airport for a 45 minute flight to Elst. During take-off the pilot heard a mechanical bang. At that moment the altitude was approximately 150 feet and the speed was 50 knots and increasing. At that moment the RPM decreased and the pilot

[1] The purpose of the Dutch Safety Board's work is to prevent future accidents and incidents or to limit their after-effects. It is no part of the Board's remit to try to establish the blame, responsibility or liability attaching to any party. Information gathered during the course of an investigation – including statements given to the Board, information that the Board has compiled, results of technical research and analyses and drafted documents (including the published report)- cannot be used as evidence in criminal, disciplinary or civil law proceedings.

[2] All times in this report are local times unless otherwise specified.

decided to make an autorotation landing[3] in the grass area, close to the runway. The pilot and the passenger vacated the helicopter without injuries, the helicopter was heavily damaged.

FACTUAL INFORMATION

The flight and the occurrence

On the day of the accident the five seat helicopter arrived at EHRD at approximately 10.45 hours, after a 1 hour 45 minutes flight from Kassel Airport in Germany with only the pilot on board. Before the flight, the aircraft was refuelled. When the helicopter departed from Kassel, 330 kg of fuel was on board (full tank). The average fuel consumption during flight is approximately 100 kg per hour. After arrival at EHRD the aircraft was parked and shortly thereafter repositioned to another parking position on the platform, to pick up a passenger. The pilot executed a pre-flight inspection, after which the passenger arrived. After boarding, the pilot briefed the passenger regarding safety issues as seat belts and doors. After permission from air traffic control the aircraft taxied to the heli aiming point (HAP)[4] for a 45 minute VFR flight to Elst, in Gelderland.

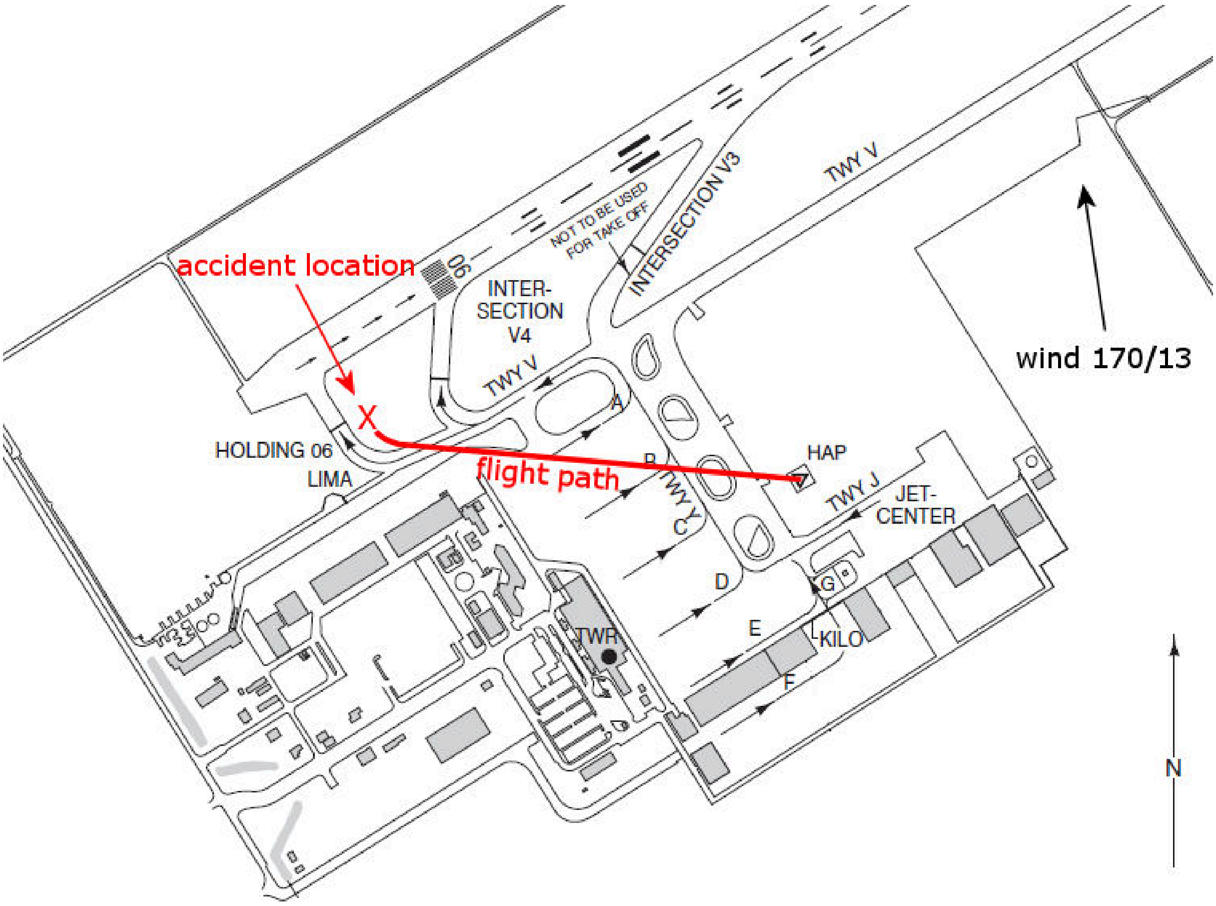

Figure 1: apron layout (source: AIP Netherlands)

[3] Autorotation is the state of flight where the main rotor is being turned by the action of air moving up through the rotor rather than engine power driving the rotor.

[4] The HAP is a well recognizable point on an aerodrome where all incoming helicopter flights arrive at before they are parked. All departing helicopter flights depart the aerodrome via this point.

At approximately 11.45 hours take-off clearance was received. The pilot decided to take off in the direction of the north west corner of the platform, approximate heading 270 to avoid over flying the airport building. The wind was from the direction 170 degrees with a speed of 13 knots.

During take-off the pilot heard a mechanical bang. At that moment the altitude was approximately 150 feet and the speed was 50 knots and increasing. The pilot stated he noticed a decrease in rotor RPM which was not accompanied by yaw. He pilot lowered the collective lever [5] and verified that the throttle was in the full open position.
At that moment he thought the rotor RPM increased again. He pulled the collective whereupon the RPM decreased. The pilot saw that the RPM was low but he did not hear the warning signal which is activated when the rotor RPM drops below 370. When he thereafter realized that the aircraft had only limited power available he concentrated on the emergency landing. At the moment of power limitation the aircraft was flying above the northwest corner of the platform. The pilot noticed several fuel trucks which were parked there. According to the pilot the only and nearest option for a safe emergency landing was the grass area between taxiway 'V' and runway 06. See figure 1. The pilot stated that he preferred a landing on the grass instead of on the concrete taxiway. Although the RPM was low during the auto rotation, the pilot stated that the aircraft felt controllable. During the flare the RPM did not increase. The forward velocity reduced, the pilot applied full collective and landed with a high vertical speed. At the moment of touchdown the rotor speed was low and the rotor blades bent downwards and struck the tail boom which was cut off. See figure 2.

When the aircraft came to a halt the pilot executed the evacuation procedure; closed the throttles and fuel supply, applied the rotor brake and switched off the battery. Both the pilot and his passenger evacuated the aircraft to the right hand aircraft door. They escaped the accident without injuries.
The emergency services were quick to arrive at the crash site and a moment later a medical helicopter also arrived. As a precautionary the pilot and passenger were taken to a hospital and were released after they were found to be okay.

Investigators of the Dutch Safety Board started their investigation on the accident site within hours after the occurrence.

The aircraft
The helicopter was a Eurocopter EC 120 B. It is a turbine powered single engine aircraft with a clock wise turning main rotor and a fenesteron[6] type tail rotor. The tail rotor is fitted to counteract the main rotor torque and for directional control of the aircraft.

There are no requirements for this aircraft to be fitted with any type of flight recorders with could aid the investigation. This helicopter was therefore not equipped with such a recorder.

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[5] The collective pitch control, or collective lever, is normally located on the left side of the pilot's seat with an adjustable friction control to prevent inadvertent movement. The collective changes the pitch angle of all the main rotor blades collectively (*i.e.,* all at the same time) and independent of their position. Therefore, if a collective input is made, all the blades change equally, and the result is the helicopter increases or decreases its total lift derived from the rotor. In level flight this would cause a climb or descent, while with the helicopter pitched forward an increase in total lift would produce an acceleration together with a given amount of ascent.

[6] A Fenestron is a shrouded tail rotor of a helicopter that is essentially a ducted fan. The housing is integral with the tail skin, and is intended to counteract the torque of the main rotor.

The aircraft take-off mass was well below the maximum of 1715 kg. There was approximately 150 kg fuel on board, sufficient to execute the planned flight.

The owner of the aircraft had just taken delivery of the aircraft that morning. The aircraft was extensively serviced and re-registered from a United Kingdom registration (G-LHCC) to its present German registration.

Figure 2: the aircraft shortly after the accident

The pilot
The pilot was an airline pilot who served in the navy as a pilot on multi engine helicopters from 1976 until 1981. From 1981 until presently the pilot is employed at a major Dutch airline were he operated various fixed wing aircraft and accumulated approximately 15,800 hours. In 2004 he regained helicopter flying. From 2004 until the day of the accident he logged approximately 300 flying hours on single engine helicopters, of which 250 on the EC 120 B.

Weather
The visibility was more than 10 kilometres with a cloud base of 4000 feet. The wind was from the direction 170 degrees with a speed of 13 knots.

INVESTIGATION & ANALYSIS

Technical investigation

Shortly after the accident the investigation in to the possible cause was started. A few weeks later the French investigation authorities from the Bureau d’Enquêtes et d’Analyses pour la Sécurité de l’Aviation civile (BEA) joined the investigation. Advisors from the aircraft and engine manufacturers also joined the investigation to assist the DSB.

The investigation concentrated on the power limitation which was reported by the pilot. The cause of this power limitation could not be determined at the facilities at Rotterdam The Hague Airport and it was decided to ship the engine to France for further investigation.

The technical investigation of the engine and its fuel control unit (FCU) was therefore performed by the engine manufacturer (Turbomeca), in presence of investigators of the BEA and the Dutch Safety Board (DSB).

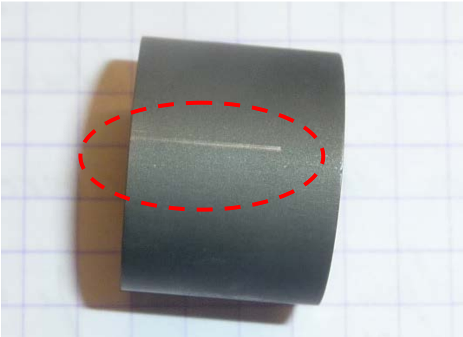
Engine
The examination of the engine did not reveal anything unusual. The gas generator and free turbine section where both able to rotate and a borescopic inspection was performed. Hereafter, the engine was bench tested. The gas generator vibration level was found slightly higher than the criteria. This could be explained by bearing deterioration due to the crash impact. These vibration levels could not be the origin of the accident. Knowing the engine performed well, the focus of the investigation shifted towards the FCU, which controls the fuel metering to the engine.

Fuel control unit
The standard acceptance test procedure (ATP), which is a static test on an FCU production test bench, did not reveal any unusual behaviour of the FCU. Therefore a dynamic test was performed on a special development test bench, which was introduced in 2010. Unlike the static test, the dynamic test shows the acceleration and deceleration responses of the FCU. It is a method to compare the concerned FCU with a calibrated FCU, which allows to identify unusual behaviour. It was introduced to detect unexplained cases of FCU behaviour, including sudden drops in rotor speed. However, this test cannot provide evidence of what the problem actually is, it can only conclude if an FCU works properly or not.

The dynamic test showed a slightly slower acceleration and deceleration response of the concerned FCU. However, when the FCU was attached to an engine for a bench test, the slower response of the FCU appeared to be within acceptable limits.

Disassembly of the FCU
The disassembly of the FCU was performed to find any traces of damage or pollution (debris). Eventually, a scratch on one of the subcomponents was found (see figure 3). The concerned subcomponent is the working piston, a piston which is positioned in the metering stage of the FCU, directly linked to the metering needle (see figure 4). The metering stage of the FCU links the demanded power through governor input with the fuel supply to the engine. The working piston is made of steel, with a soft coating to decrease its friction. This soft coating can easily be damaged if debris is present in the working piston housing. The damage found was a straight scratch, which indicates damage that had occurred during movement of the metering needle, most likely caused by a piece of debris. The scratch could have caused a delay or temporary blockage of the metering stage resulting in a mismatch between demanded and available engine power.

It is unclear where the debris came from. During the disassembly no pollution was found in the system, which suggests it had been washed away. All filters of the FCU were found clean, which means the pollution could have been dirt from outside which was small enough to get through the filters, or internal pollution which broke off somewhere in the FCU.
The cause of the ‘mechanical bang’ as described by the pilot could not be determined.



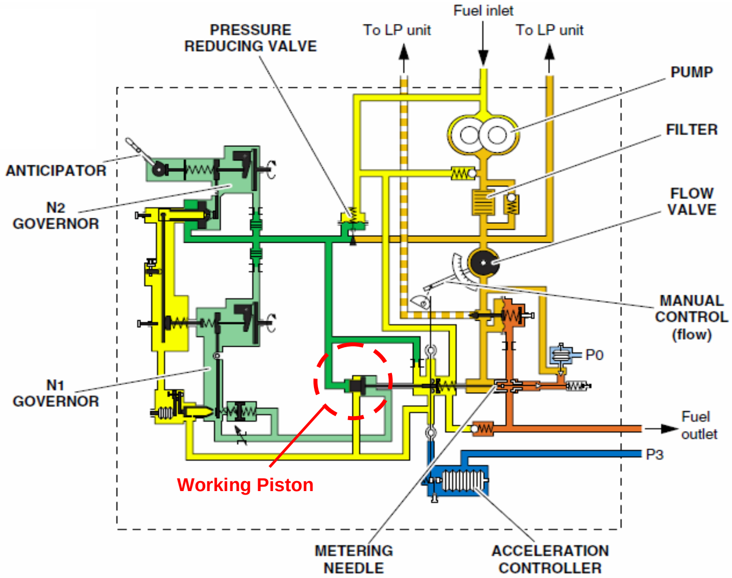


Figure 3: damaged to the working piston *Figure 4: position of the working piston in the FCU*

Probable sequence of events

Normally, when taking off with a helicopter, it first enters the hover in ground effect.[7] Hereafter, the helicopter increases its forward speed, which causes the helicopter to enter the area of translational lift. Translational lift takes effect when forward air speed is present, starting from approximately 15 knots. The rotor moves out of its vortices and enters into relatively undisturbed air. This causes the lift to increase with the increase of forward airspeed, causing the helicopter to gain altitude without commands of the pilot. The effect will increase till a speed of approximately 50 to 60 knots. During the translational lift the altitude will increase. Hereafter collective pitch is increased to gain more altitude, which also means more engine power is required due to the increased drag of the rotor blades. During this stage of flight, the working piston in the FCU could have been delayed or 'frozen' due to the pollution. As a result the required power which was commanded by the pilot could not be obtained and consequently the rotor speed dropped.

CONCLUSION

The accident was most likely caused by the fact that the required engine power could not be obtained as a result of pollution in the fuel control unit. The investigation was hampered by the fact that no flight recorder data nor video camera images were available.

Note: This report has been published in Dutch and English. If there are differences in interpretation the Dutch text prevails.

[7] Hover in ground effect occurs when the helicopter is close to the ground and stationary relative to the ground. Blade tip vortices are smaller here, as a result the power required to hover decreases.