THE DUTCH SAFETY BOARD

EMERGENCY LANDING AFTER TECHNICAL MALFUNCTION

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:	2011026
Classification:	Accident
Date, time[2] of occurrence:	11 May 2011, approximately 15.15 hours
Location of occurrence:	Veghel
Aircraft registration:	PH-HHF
Aircraft model:	Schweizer 269D
Type of aircraft:	Helicopter
Type of flight:	Commercial
Phase of operation:	Cruise
Damage to aircraft:	Burnt out
Cockpit crew:	One
Passengers:	None
Injuries:	None
Other damage:	Fire damage to grass of field
Lighting conditions:	Daylight

SUMMARY

During cruise flight at approximately 1000 feet the pilot heard a noise, directly followed by a pitch up and left roll motion of the helicopter. The pilot recovered helicopter control, rolled off the throttle to idle and entered an autorotation which resulted in a hard landing in a field. After the pilot had shut down the engine, switched off the electrical systems and removed some items from the helicopter, a post crash fire destroyed the helicopter almost completely. The pilot suffered no injuries.

[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 given in this report are local unless stated otherwise.

FACTUAL INFORMATION

History of the flight
The helicopter with registration PH-HHF was on a return flight from Kempen Airport (EHBD) to its home base Lelystad Airport (EHLE) with the pilot as sole occupant. Near Veghel the pilot heard a noise directly followed by a pitch up and left roll motion of the helicopter. The pilot's first thought was he had hit a bird. After realizing that he had not seen birds in the area he treated the situation as a tail rotor drive failure and decided to make an emergency landing. The throttle was closed to idle and the pilot steered the helicopter to the right to a large field. The rotor RPM was 400 and the airspeed approximately 70 knots. The pilot stated that there was no reaction on rudder pedals input and insufficient reaction on collective input. The helicopter made a hard tail wind landing and came to rest in the grass field. The pilot reported the engine kept running. During engine shutdown the throttle detent release system[3] did not work. As a result the pilot had to pull the fuel cut off knob to shut down the engine. The pilot left the helicopter but returned shortly thereafter to switch off the necessary switches and to take out some items. Soon after, the helicopter caught fire and burned down to the ground (figure 1). The pilot was checked by medical personnel and suffered no injuries.

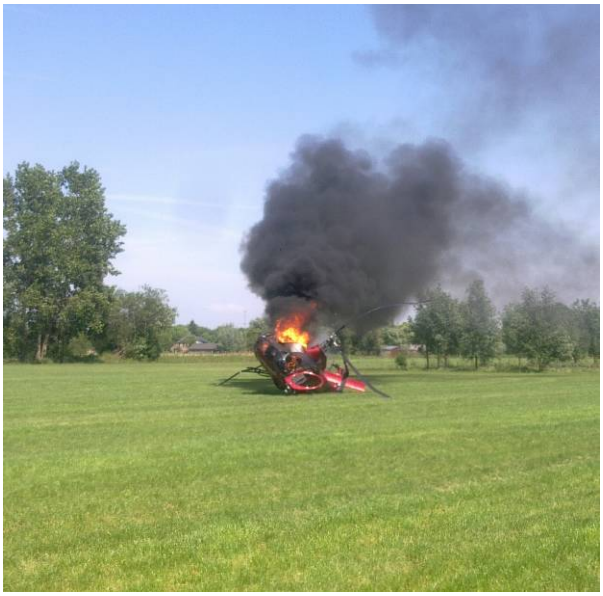


Figure 1: PH-HHF burning (source: Brabants Dagblad)

The crew
The pilot possessed a valid Commercial Pilot Licence (CPL(H)) to operate the flight.

Total hours on type	757
Hours on type last three months	130
Total hours on fixed wing aircraft	6600
Total hours on rotary wing aircraft	8895

Table 1: flying experience pilot

Helicopter information
PH-HHF was delivered as a Schweizer 269D, configuration 330 and was later converted to a 269D configuration A 333 to the benefit of useful load and performance improvement. At the time of the accident, PH-HHF had accumulated a total of 6938 service (flight) hours of which 2599 hours as A 333. A 400 hour inspection was performed at 6929 flight hours.

[3] To prevent inadvertent movement of the throttle from idle to the cut off position, an electrically operated detent release system is installed.

The weather
The weather information was received from the Royal Netherlands Meteorological Institute (KNMI). At the accident location visual meteorological conditions prevailed. Visibility was more than 10 kilometres and there were no clouds. The wind was westerly with a speed of 7 knots.

INVESTIGATION AND ANALYSIS

The technical investigation was conducted with assistance from the National Aerospace Laboratory of the Netherlands (NLR), the National Transportation Safety Board (NTSB) and experts of the helicopter manufacturer and engine manufacturer.

Helicopter damage assessment
The majority of the airframe had been consumed by the post crash fire. There was significant structural damage from initial impact. The landing gear exhibited indications of high vertical velocity impact (figure 2).

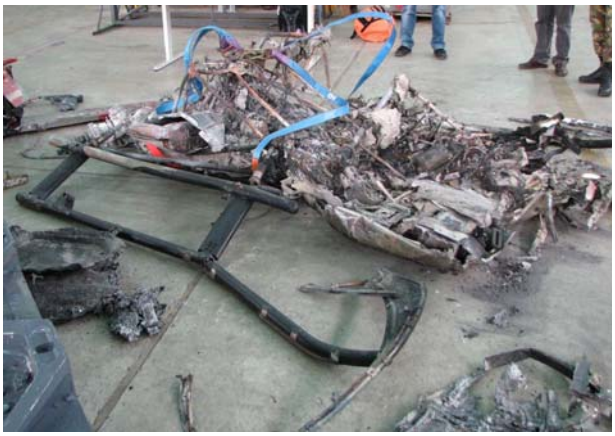


Figure 2: landing gear collapsed


Figure 3: tail boom and tail rotor

The tail boom had been separated from the airframe by a main rotor blade strike just forward of the vertical stabilizer. The tail rotor gear box remained attached to the tail boom. Both tail rotor blades remained attached with one blade having been broken partially off in a downward direction, toward the blades trailing edge. Little rotational impact evidence was present on either blade (see figure 3).

All three main rotor blades remained attached to the rotor head. Two of the three exhibited span wise bending and skin wrinkling with the third blade having been mostly consumed by fire. Damage to the main rotor blades indicated low rotor RPM at impact.

Engine drive shaft
To transfer engine power to the gearbox a driveshaft is used. To allow for some movement of the engine on its mounts, flexible couplings (KaFlex couplings) are used on both sides. Investigation revealed that the engine to main gearbox drive train was interrupted. The reported nose pitch up and left roll movement were likely caused by the short delay in reduction of collective (main rotor blade pitch) after the loss of engine power, resulting in a corresponding decrease in rotor RPM. Loss of RPM happens quickly in conditions of high blade pitch. With a decrease in blade airspeed on the retreating side, the retreating blade stalls[4], which is characterized by nose pitch up and left roll movement of the helicopter. Because of the post crash damage the reported lack of tail rotor steering by the pilot could not be verified.

[4] Retreating blade stall is a flight condition in helicopters and other rotary wing aircraft, where the rotor blade rotating away from the direction of flight stalls.

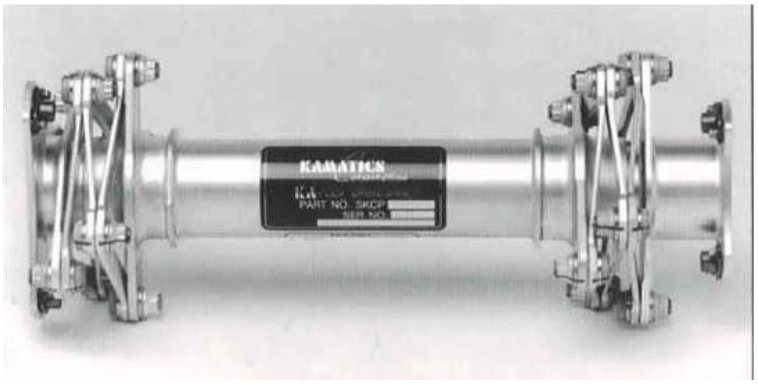
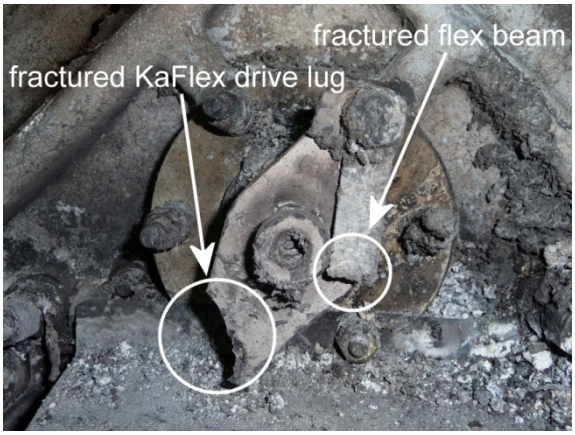


Figure 4: driveshaft with KaFlex couplings (source: www.kamatics.com)

Examination of the engine drive shaft revealed a broken KaFlex coupling at the engine to lower pulley drive shaft. The forward KaFlex was attached to the drive adapter and remained installed in the engine power takeoff. It exhibited a fracture at one of the forward drive lugs and fractures of several flex beams (figures 5 and 6).



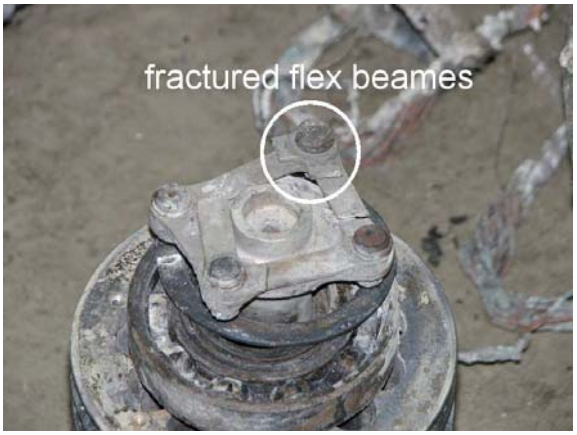


Figure 5 and 6: KaFlex fracture at engine power takeoff and main drive shaft

The lower pulley contained the aft KaFlex and the aft portion of the forward KaFlex fitting with fractured flex beams. The separated piece of the drive lug, bolt and portions of flex beams were not found.

An initial investigation of the fracture surface of the KaFlex drive lug was performed by the NLR in the Netherlands. Findings indicated metal fatigue as a possible cause of failure. To confirm the initial findings the fractured drive lug was sent to the NTSB in the USA. Investigation findings indicated that the fracture appears very similar to a fractured KaFlex coupling from another event. There are fatigue cracks on the drive side adapter lug that are originating near, but not at, the bolt hole. Correct drive shaft alignment is important to prevent fatigue. Misalignment can be caused by sagging of engine isolation mounts.

Engine drive shaft history
The service life of the KaFlex drive shaft was 7600 hours as part of a 269D Configuration A 333. When the shaft failed, PH-HHF had flown 2599 hours as 269D Configuration A 333. The remaining life for the shaft was 5001 hours (7600-2599). The shaft on the helicopter of the other event mentioned above had approximately 4712 hours of operation when it failed.
The last inspection was performed at 6929 flight hours. Check sheet sign offs indicated the KaFlex was inspected and the alignment checked as part of the inspection process.

The engine
As recovered the engine was entangled in wiring and airframe material. Upon separation from the airframe, the engine was found to have received some impact damage to the exhaust collector stacks however the majority of damage was thermal in nature as a result of post crash fire. All engine lines were either broken or showed thermal damage. The compressor, accessory gearbox, turbine module, combustion section, oil system and accessories were examined as far as possible.

There was no evidence of a pre impact mechanical failure discovered during the investigation which would have precluded the engine from normal operation.

Engine shut down
As a result of the initial impact the battery support failed, resulting in a displaced battery. The displacement of the battery created the possibility of a short circuit or a broken electrical cable. This may have prevented the use of the electrical cut off detent mechanism to shut down the engine. Furthermore the distortion of the fire shield and cabin wall may have interfered with the throttle control. It is concluded that the attempt to close the throttle to cut off the engine failed most probably as a result of a loss of electrical power or throttle linkage damage due to impact or a combination of both.

Post crash fire
Examination of photographs of the early stages of the post crash fire indicates the fuel supply and ignition were likely on the right side of the helicopter and on the upper portion of the wreckage as it came to rest. It appears that the fuel hose end was hit or pulled during the impact sequence with enough force to fracture the aluminium housing. The fuel tank is mounted above the engine and the released fuel dripped on the hot engine, exhaust pipe or shorted electrical devices where it was ignited.

Actions taken by the helicopter manufacturer
To prevent similar occurrences the helicopter manufacturer has issued ASB[5] DB-043, on 26 April 2012, instructing customers to perform an engine alignment check with a prescribed tool within 90 days or 100 flight hours. Thereafter the same alignment check has to be performed every 25 flight hours.

CONCLUSIONS

- The sudden disruption of the drive to the main rotor resulted in an immediate drop in rotor RPM. The abrupt decay of rotor RPM caused a pitch up and left roll movement.
- The helicopter impacted at a high vertical velocity during the emergency landing, resulting in a collapsed landing gear and significant structural damage. Released fuel was ignited, causing a post crash fire.
- The KaFlex forward coupling drive lug fractured as a result of metal fatigue.
- The cause of the metal fatigue could not be positively identified.
- Maintenance data indicated that scheduled maintenance was performed on the drive shaft according to manufacturer specifications.
- The helicopter manufacturer has lowered the alignment inspection intervals and tightened the inspection procedures.

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

[5] An alert service bulletin (ASB) identifies the source of malfunctioning aircraft equipment and the necessary steps required to replace or repair them.