GENERAL INFORMATION

Occurrence:	2006060
Classification:	Accident
Date and time[1]:	19 May 2006, 20.41 hours
Location of occurrence:	Amstelveen
Aircraft registration:	PH-RPX
Aircraft model:	MBB BO 105 CBS-4
Type of aircraft:	Helicopter
Type of flight:	Test flight
Phase of operation:	En route
Damage to aircraft:	Serious
Flight crew:	Two
Passengers:	None
Injuries:	None
Other damage:	None
Lighting conditions:	Daylight

SUMMARY

After scheduled maintenance a pilot and an aircraft engineer performed a test flight. At an altitude of 800 feet a loud bang was heard, followed by a sudden loss of tail rotor control. The crew managed to make an autorotation landing without further damage. The tail rotor, together with its gearbox had separated from the tail.

FACTUAL INFORMATION

The flight and the occurrence

The objective was a test flight following a 50 hours inspection. On board were a pilot and an aircraft engineer. The pilot had approximately 1200 hours flying time on helicopters. PH-RPX took off at 20.35 hours from Amsterdam Schiphol Airport. About six minutes into the flight, at an altitude of 800 feet the pilot started preparations to perform a power check on engine #1. The power on both engines was reduced to 40% torque and the airspeed decreased from 90 to 80 knots as intended. Suddenly both occupants heard a loud bang and the pilot experienced an immediate loss of tail rotor control. The pilot immediately selected idle power and managed to make a safe autorotation landing in a field. Both occupants escaped without injuries.

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

Post accident inspection revealed the reason for the sudden lack of directional control. The complete tail rotor unit was ripped out of the vertical fin of the helicopter.

Illustration 1: PH-RPX after the accident

INVESTIGATION AND ANALYSIS

At the day of the accident the aircraft engineer involved performed a 50 hours inspection on the helicopter PH-RPX. To get access to the inspection items the vertical fin cowling was removed. The cowling is made of composite material and is connected to the structure by quick access fasteners. To close a fastener the pin is pushed through the fastener hole and turned a quarter turn with a screwdriver to secure it. The vertical fin cowling contains twenty-two fasteners, eleven on either side. The installation procedure for the vertical fin cowling is to lift the cowling, keep it into position and secure two lower fasteners on either side to prevent the cowling from dropping down. Next the remaining fasteners need to be secured. Because of the high location above the ground, a platform is required to reach the remaining fasteners. During the investigation the aircraft engineer declared that all fasteners of the vertical fin cowling were secured. Following the 50 hours inspection the aircraft engineer performed a walk-around inspection while the pilot performed a pre-flight inspection. No abnormalities were reported whereupon the helicopter was moved from the hangar to the platform for a post inspection test flight.

In cooperation with the Dutch Aviation Police, most parts of the helicopter were retrieved from the field were the emergency landing had been executed. One of the tail rotor drive shaft couplings was found with one bolt not in place. This bolt was not retrieved and could not be investigated.

Two separate investigations were conducted by the following organisations:

- Eurocopter, the manufacturer of the helicopter, and
- National Aerospace Laboratory NLR, The Netherlands.

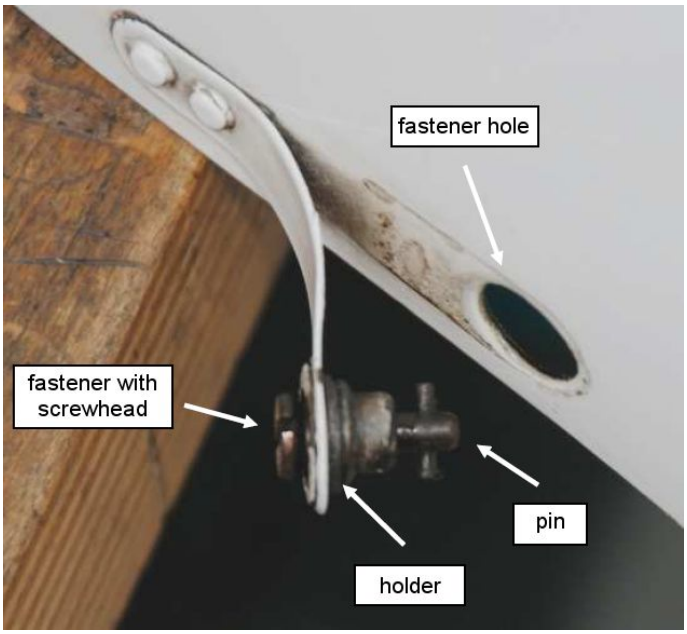

Illustration 2: quick access fastener (source: NLR)

Following is a summary of the investigation results of both Eurocopter and NLR:

- The tail rotor unit was ripped out due to an excessive unbalance situation. The failure mode of separation of the complete assembly just below the fin tip is known from other incidents (according to Eurocopter).
- The unbalance originated from the tail rotor blades. When a tail rotor blade loses some mass (especially in an area close to the blade tip) an unbalance will be generated. Because of the high rotation speed of the tail rotor even a small unbalance generates large forces and moments.
- According to Eurocopter, disintegration of a tail rotor blade or separation of a blade part without impact of a foreign object is extremely unlikely with the improved design blades that were fitted on the accident helicopter.
- There are no indications that the tail rotor drive mechanism was not fully operational at the time of the initial failure.
- Most likely the separation of the tail rotor assembly was initiated by a failure of the vertical fin cowling. The first seven quick access fasteners (counted from top to bottom) of the eleven fasteners on the right-hand side of the vertical fin cowling were not secured or in a locked position when the tail rotor assembly separated from the fin. All fasteners on the left-hand site appeared to be in a secured and locked position when the cowling failed. The break-up damage of the cowling showed further much resemblance to that with a BO 105 helicopter incident in Spain where it was known that seven fasteners on the right-hand side were not secured (source: Eurocopter).
- It is most likely that during cruise flight the cowling lifted on the right-hand side due to the dynamic pressure of the air stream and vibrations. During the power reduction prior to the intended power check on engine #1 the air stream changed due to a rudder pedal input causing the cowling to fail along the left-hand trailing edge.
- Witness marks on the cowling and the tail rotor blades revealed that the (rotating) tail rotor had contacted the cowling several times.
- Most likely the tip of one rotor blade became entangled with the cowling in a way that led to severe deformation of the tip cap and subsequently to the separation of a bigger piece of the blade tip. This part was later on found on the ground.

- The resulting forces and moments created by the unbalance led to the failure of the structure around the gearbox mount and to the subsequent separation of the tail rotor assy.
- The tail rotor unit diverted initially to the right, the still rotating tail rotor blades hit several obstacles amongst one was the tail rotor intermediate drive shaft.
- Loss of the tail rotor assembly led to the loss of directional control of the helicopter.
- This situation was handled professionally by the crew who conducted a safe autorotation landing.

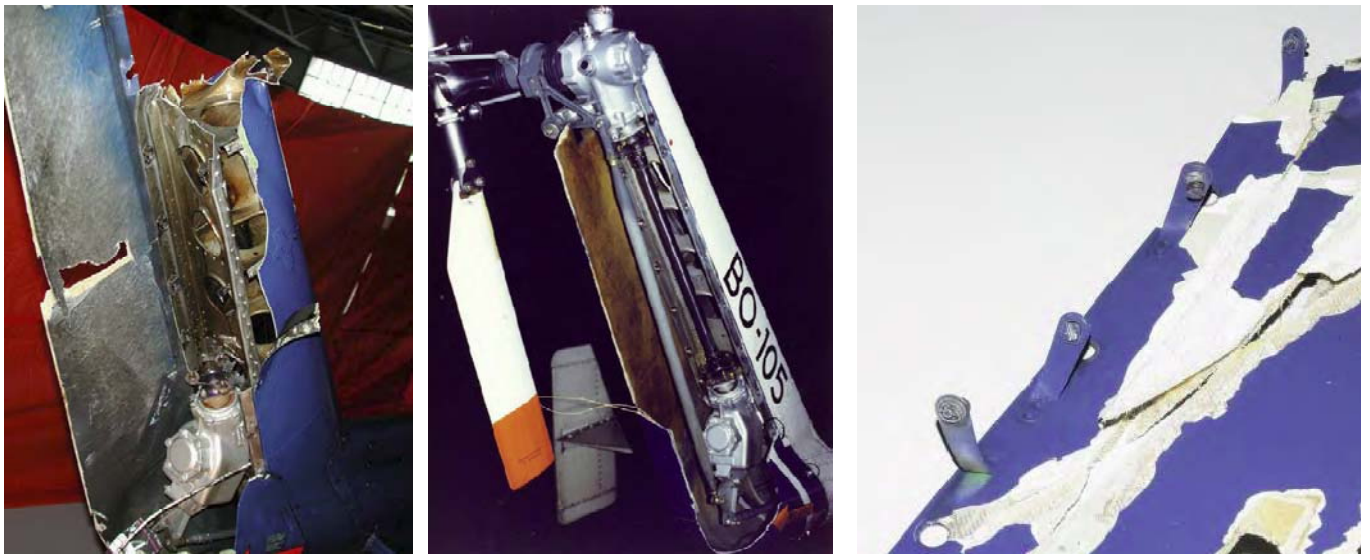

Illustration 3:
Left: fasteners on left-hand side PH-RPX still attached
Middle: similar fin cowling damage with Spanish helicopter
Right: fasteners on right-hand side PH-RPX in 'open' position (source: Eurocopter)

The manufacturer stated that inadvertent in flight opening of this type of fasteners is regarded as very rare but cannot be excluded for 100%. In the course of the investigation various reports were received about fasteners that opened during flight. Only one of the reports contained detailed information about the aircraft registration, date of flight etc. In this case the pilot stated he had checked the fasteners before the flight and noticed four fasteners were loose after the flight. This could not be confirmed. None of the reports mentioned as many as seven loose fasteners in one flight. Furthermore the fasteners of the accident aircraft were in good condition and did not show any wear or damage that could indicate the fasteners to be prone to inadvertent opening without the use of a screwdriver. It is unknown why the alleged fin cowling assembly error occurred and why it was not detected during the walk-around and pre-flight inspection.

Possible explanations are:
The upper fasteners were not easily accessible; to reach them a platform was required.

- Both walk-around and pre-flight inspection took place in the hangar with artificial lighting.
- Both fin cowling and fasteners were painted in the same (dark blue) colour which reduced the difference in perceptibility between an open and a closed fastener. As a precautionary measure after the accident the areas of the cowling underneath the fastener lips were painted orange to make an open fastener more noticeable.

CONCLUSION

Based on the Eurocopter and NLR investigations it is considered most likely that the seven fasteners were not closed before flight. Furthermore it is considered likely that the loose fasteners initiated the chain of events that resulted in the tail rotor separation. However, although there are no indications that the tail rotor drive mechanism was not fully operational at the time of the initial failure, it cannot be excluded that an internal drive train problem initiated the sequence of events of the accident. One of the tail rotor drive shaft couplings was found with one bolt not in place. Because the bolt was not retrieved after the accident, the cause of the absence of the bolt and the possible consequences for the sequence of events could not be determined.

Because of the professional reaction of the crew on the loss of tail rotor trust, including an immediate reduction of engine power to ground idle, a safe autorotation landing was executed. As a result there were no injuries and the aircraft sustained no additional damage.

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