Statens Havarikommisjon for Transport

REPORT

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This investigation is limited in its extent. For this reason, the AIBN has chosen to use a simplified report format. The report format indicated in the ICAO annex 13 is only used when the scope of the investigation makes it necessary. The report has been translated into English and published by the AIBN to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

All times given in this report are local time (UTC + 2 hours) unless otherwise stated.

Aircraft information:	
- Type and reg.:	Eurocopter EC 135 P2, LN-OOD
- Manufacturing year:	2004
- Engine(s):	2 Pratt & Whitney Canada PWC206 B2
Operator:	Norsk Luftambulanse AS (NLA)
Date and time:	Thursday, 13 April 2006, time 1112
Location:	Liagardene, Ål municipality in Buskerud, Norway (60°45'N 008°35'Ø)
Type of occurrence:	Aircraft accident, material damage during landing
Type of flight:	Commercial, ambulance flight (HEMS)
Weather conditions:	Wind: 010° approx. 5 kt. Visibility: 2-8 km. Overcast. Temperature: 0 °C. QNH: 990 hPa
Light conditions:	Daylight, “flat” light over snow-covered ground
Flight conditions:	VMC
Flight plan:	None
No. of persons onboard:	1 pilot and 1 HEMS crew member
Injuries to persons:	None
Damage to aircraft:	Considerable damage to tail rotor (Fenestron)
Other damage:	None
Commander:	
- Sex and age:	Male, 46
- Licence:	ATPL (H)
- Flight experience:	Total Flight time: 5,876 hours. Flight time in last 24 hours/3/30/90 days: 0:50/8:30/22:00/125:15 hours. Number of landings in last 90 days: 420. Number of landings on type in last 90 days: 303
Information sources:	Report form NF 382 from commander, report from the operator NLA and AIBN’s own investigations

FACTUAL INFORMATION

The flight in question was an ambulance flight to Liagardene just north of Ål. A man had called to report a boy trapped under a snowmobile. The commander, HEMS crew member and doctor were onboard the helicopter when it took off from the base at Ål at time 1055. However, because of "flat" light and poor visual references, it was not possible to land in the immediate proximity of the snowmobile. The commander decided to land 50-60 metres away, near a tree where the references were good. He briefed the two other onboard on the route he would follow if it should prove necessary to abort the approach due to whiteout[1]. The doctor was sitting with the door open, looking back to the right in order to monitor the distance between the ground and the tail, while the HEMS crew member was looking to the left. The terrain comprised deep loosely packed snow, and on landing, the commander moved the collective lever up and down a little until the helicopter had all its weight on the skids. At this point, the tail bumper touched the ground, but with good clearance for the Fenestron (tail rotor which is a ducted fan, see fig. 2).

The doctor got out and went to the accident site, while the commander and HEMS crew member remained seated in the helicopter. The commander maintained full rotor speed and collective engaged as there was a possibility that the ground might not have sufficient bearing capacity. It was agreed that, if necessary, the doctor would find another landing site closer to the snowmobile and act as a visual reference.

The doctor and the man at the accident site did not manage to lift the snowmobile and release the boy. The doctor then checked the terrain in the area and indicated a landing site approx. 30 metres from the snowmobile. The ensuing take-off whipped up some of the loosely packed snow. The commander has explained that he made a 200-300 metre long delay turn and established long final to allow the snow to settle again. The doctor, the snowmobile and a wooded area were regarded as sufficiently good visual references. The commander intended to minimise hover at the end of his approach to avoid a snow flurry and subsequent whiteout before landing. Forward speed was adapted so that he just held the snow flurry which the main rotor was generating behind him. This enabled him to keep sight of the references, and he landed approx. 2 metres in front of the doctor. It was the commander's impression that there was no more than 4-5° nose-up attitude during landing. The landing was harder than he had expected, but there was no indication that anything abnormal had occurred. The doctor was also not aware of any abnormality. The landing time was 1112.

They had landed across a hard packed snowmobile track with approx. 25 cm of loose snow on top of it. The HEMS crew member jumped out and checked that the helicopter was standing secure. He noticed that the tail bumper had come into contact with the ground during the landing, but did not observe any damage. The engines were now pulled back to idle and the collective lever was lowered. The HEMS crew member and doctor went straight to the patient, while the commander spent a short time completing his work in the helicopter before stopping the engines and joining them. As he left the helicopter, he looked back to ensure it was standing secure. At that moment he realised that something was wrong. The cover of the hub in the Fenestron was missing and when he came closer he saw considerable damage to the Fenestron and the surrounding tunnel (fig. 2). Parts of the cover were scattered on the snow on both sides of the Fenestron.

[1] Impaired height/distance judgment and spatial orientation which can occur over white, undefined surfaces in overcast weather and during helicopter take-offs and landings when loose snow is whipped up.

The mission was called off, and the boy, who was virtually uninjured, was removed from the location on another snow snowmobile.

On the basis of tracks in the snow, parts found at the site, photographs taken by the commander just after the landing and close examination of the material damage, the following facts were established (ref. fig. 1-5):

- The hub cover in the Fenestron had loosened and been sucked into the fan where it was cut into bits.
- All or parts of four of the six clips with bolts holding the cover in place were found at the site. All the clips had rubber coating and the bolts were tightened.
- There was various chipping and damage to several of the stator and rotor blades in the Fenestron.
- The tips of all ten rotor blades were deformed (bent out to the right by 1-3 cm).
- The two rotor blades positioned “singly” between the groups of four suffered most bending.
- The composite structure in the tunnel surrounding the Fenestron had various holes and gashes.
- There were traces of the tail bumper contacting the ground in the last few metres before touchdown.
- There was no trace of lateral movement of skids during landing.
- There was a pile of loose snow on the ground to the right of the tail bumper/Fenestron.
- There were traces of snow spray on the ground on the left side of the Fenestron.
- There was a snow mark a little way up on the right side of the Fenestron.

The hub cover was held in place by six retaining clips in a lip around the inner circumference of the Fenestron hub (ref. fig. 5-6). The clips are tightened with bolts. The commander was sure that the cover had been in the correct position and had not rotated in relation to the hub when he made his routine inspection prior to take-off. A painted-on guiding mark makes it easy to see any rotation.

Closer investigation showed that the Fenestron hub does not retain its circular shape if the blade tips are bent out manually over right side until flush with the tunnel opening. This is due to the fact that the blades go into the hub through bushings, with movement in the blades transferred to the hub via these bushings (see fig. 6b). Ovality was measured while the tips of four blades were held in tension. There was 7-8 mm flexing. The hub with an original diameter of 370 mm changed its shape to an ellipse with symmetrical lines of 363 mm and 378 mm.

The Tail Bumper ground clearance on EC 135 is 66 cm. With the current landing gear, the bumper will contact the ground if the helicopter has an 11° nose-up attitude while on skids on level ground. It is possible to mount higher landing gear on the current helicopter type, and there are also special snow skids available. The maximum nose pitch allowed is not dependent on landing gear type. The landing gear on LN-OOD was fitted with settling protection, with smaller area than snow skids.

The tail bumper is actually part of the aerodynamic stabilising vertical tail surface and is mounted a little diagonally of the helicopter's longitudinal axis. The airflow goes through the Fenestron from right to left.

Fig. 1 Note the pile of snow to the right of the tail bumper (brightness/contrast adjusted to show details in snow)

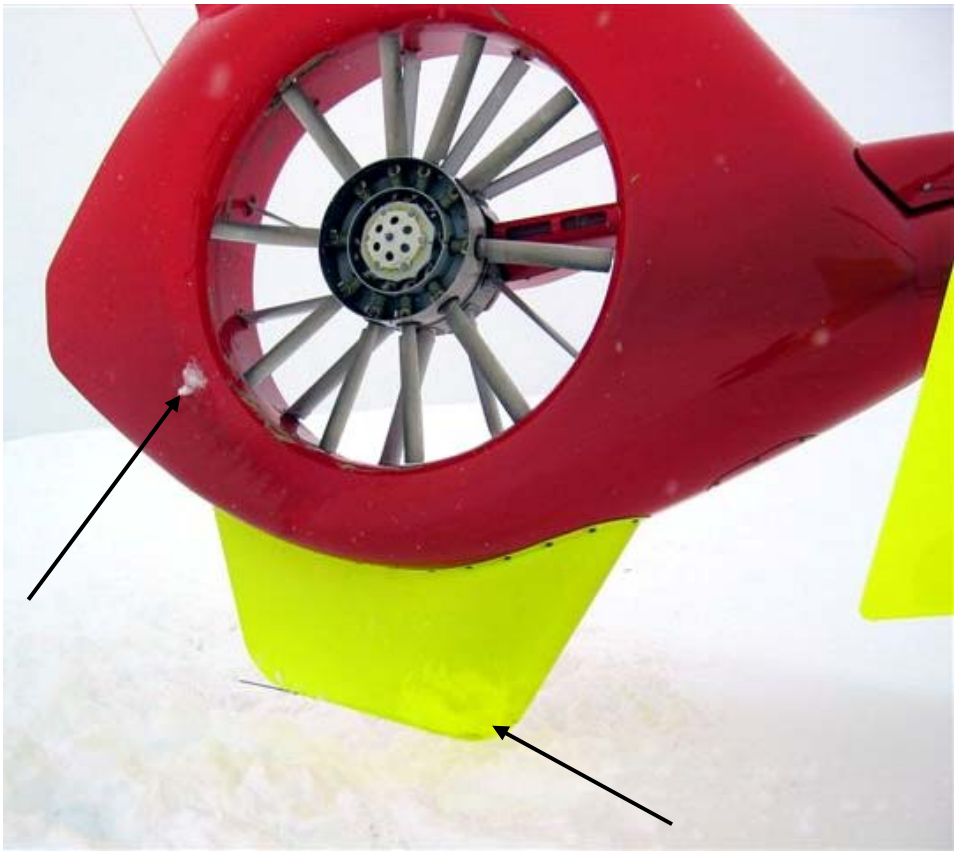

Fig. 2 Fenestron. Note the missing hub cover, the snow mark on the side and "clean" marks on the bumper

Fig. 3 Left side

Fig. 4 Damaged tunnel and deformed blade tips

Fig. 5a Pieces of the hub cover

Fig. 5b More pieces of the cover and clips with bolts

Fig. 6a Illustration photo: Cover with retaining clips (bolt not mounted)

Fig. 6b Illustration photo: Undamaged mounted cover with guiding mark

After the accident, Flight Operations Management in NLA expressed that they considered the particular approach to involve risk factors. Approach directly to touchdown keeping the snow flurry behind requires very precise manoeuvring. They emphasized in particular that all flare must be completed/nose lowered before touchdown, and the descent rate at touchdown must be minimized. After the accident NLA formalized that approaches for landing EC 135 type helicopters on soft terrain – typically snow or marshy ground, must end in hover. Landing must be made vertically and with caution from stabilised hover to reduce the likelihood of the tail contacting the ground, risking damage of the Fenestron from snow/water etc.

The FAA-approved EC 135 Flight Manual does not contain any special warnings concerning a low Fenestron over snowy/wet terrain. Eurocopter Deutschland GmbH has stated that it does not have any current plans to issue a separate chapter on winter operations with the EC 135 as the areas of application for this helicopter type are too diversified. The manufacturer has also emphasized that

during EC 135 pilot training at Eurocopter Deutschland GmbH the approach procedures and the correct flare avoiding too low tail attitude is part of the curriculum.

Eurocopter Deutschland GmbH has said that it is studying the possibilities to improve the fixation of the Fenestron hub cap. A final solution is not yet in place.

COMMENTS FROM THE ACCIDENT BOARD

The tracks at the landing site show that the helicopter's nose attitude immediately prior to landing was high enough to allow contact between the tail bumper and the snow-covered terrain. The tracks also show that the bumper ploughed up loose snow, which collected on the right side of the tail and was sucked through the Fenestron.

The AIBN has concluded that a considerable amount of snow passed through the lower part of the Fenestron during landing, resulting in permanent deformation of all the rotor blades. The phenomenon is well known in cases where a rotating propeller suddenly operates in a medium which is denser than air – water or snow, for example. The tips are then bent forward. In this case the snow only passed through the lower part of the Fenestron, which meant that the loads were very uneven, and a pulsating force could be generated.

Available information indicates that the hub cover was fixed as required. It is AIBN's opinion that the dislodging of the cover can be explained by the identified flexibility in the hub. The pulsating forces that bent the blades were transferred to the hub, which assumed an oval shape. The clips then become disengaged from the edge in rapid succession and the correctly mounted cover "popped" out of the Fenestron hub. The cover was sucked into the rotor where it was chopped to bits, causing extensive damage to the blades and surrounding tunnel.

The commander had considerable experience of demanding operations on many helicopter types. In this case, he used his crew and his own skills and experience to respond to the challenge of insufficient references in what he perceived to be a good way. It is AIBN's opinion that it would have been difficult for him to foresee that his response would introduce the risk factors which the accident exposed. Although the Fenestron in many aspects protects the tail rotor, it may imply risk when the tail bumper hits snow. Through the commander's alertness, the damage was discovered before the next take-off, during which control problems could have arisen.

The operator NLA's response of ordering vertical landings from stabilised hover appears to take care of the operational aspects needed to prevent recurrence in NLA. As a consequence of the improved safety margins, some more tasks may not be possible to carry out due to white-out.

SAFETY RECOMMENDATIONS

The following safety recommendation is issued by the Accident Investigation Board Norway[2]

Safety recommendation SL no. 2007/37T

The accident has revealed that the hub cover of the Fenestron on EC 135 can loosen when the rotor tips are bent out. A loosened cover will be sucked through the Fenestron and cause extensive damage. AIBN recommends that Eurocopter consider whether the fixing mechanism between the cover and hub could be changed to prevent loosening.

[2] The Ministry of Transport and Communications forwards safety recommendations to the Norwegian Civil Aviation Authority and/or other involved ministries for evaluation and monitoring, see Norwegian Regulations regarding public investigations of accidents and incidents in civil aviation, § 17.