AVIATION OCCURRENCE REPORT

TRANSMISSION SPINDLE MOUNT FAILURE

TRANSWEST HELICOPTERS LTD.
BELL 214B-1 (HELICOPTER) C-GTWH
NEW DENVER, BRITISH COLUMBIA 10 NM SE
16 OCTOBER 1996

REPORT NUMBER A96P0231

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Summary

The Bell 214B-1 helicopter (serial number 28017) was engaged in heli-logging operations 10 nautical miles southeast of New Denver, British Columbia. At about 1500 Pacific daylight saving time (PDT), the helicopter was just beginning to pick up two logs when the pilots heard a loud bang from the rear of the aircraft; the helicopter continued flying briefly and then began to rotate in a clockwise direction. Ground witnesses who heard the loud bang observed that the tail rotor stopped turning. The pilot assessed that he had experienced a tail rotor failure and carried out the associated emergency procedures. He landed the helicopter at the edge of the logged area near a stand of small trees and beside a gully. The main rotor blades struck the trees, and the helicopter rolled over into the gully. The co-pilot was seriously injured, and the pilot received minor injuries. The ground crew assisted the pilots in evacuating the aircraft and then put out a small fire in the engine area. The helicopter was substantially damaged.

Ce rapport est également disponible en français.

[1] All times are PDT (Coordinated Universal Time minus seven hours) unless otherwise noted.

Other Factual Information

Records gathered during the investigation reveal that the pilot was certificated and qualified in accordance with existing regulations. He had returned to work the day prior to the accident after two weeks off. On the day of the accident, flying had begun at about 1030; a two-hour break had commenced about an hour later while the ground crew moved their equipment to a new logging area. The heli-logging operation had been underway in the new area for about 1½ hours before the accident.

Each pilot was wearing a flying helmet, but neither pilot was wearing his available shoulder harness. It was not practicable for the pilots to wear shoulder harnesses because the pilots needed to lean to the side of the cockpit and look down through an open door or bubble window to continually observe the longline, the load, the tail rotor clearance, and the ground.

An examination of the helicopter at the accident site revealed that the tail rotor drive shaft had sheared aft of the main rotor transmission gearbox at the point where the drive shaft enters a protective tunnel underneath the engine. The helicopter was transported to the operator's base for further examination. The left, upper transmission spindle mount (PN 214-030-606-005) was found to have broken and the fracture showed characteristics of fatigue. The broken transmission mount was sent to the TSB Engineering Branch Laboratory for microscopic examination.

It was found that fatigue cracking had occurred at the radius between the barrel and the shoulder portion of the spindle. The crack had continued to grow as a result of alternating stages of fatigue and overload until a critical stage was reached when the spindle failed. Neither the originating cause nor the time interval for the crack propagation could be determined. There was no evidence of a manufacturing defect, and the spindle met all specified dimensional criteria.

The transmission spindles installed in the Bell 214B are replaced on the basis of their condition and, therefore, have an unlimited service life. As a result, the spindles are not monitored by a component tracking system, and the complete service histories of these parts could not be determined. Upon initial delivery from the Bell Helicopter Textron Incorporated (BHTI) factory, the spindles were attached to a main rotor transmission with a different serial number. That transmission was later involved in an accident that caused a sudden main rotor stoppage, which would have imposed high stress loads on the spindles.

Because of the lack of component documentation, it could not be determined if the occurrence spindles were the same spindles as were on the transmission at the time of the previous accident. Both occurrence spindles showed evidence of reworking at some time in their service life.

The Bell 214B helicopter main rotor transmission requires an overhaul every 2,500 hours of service life. A newly overhauled transmission had been installed on the accident helicopter on 17 April 1996, and records show that

the helicopter had flown 810.3 hours since. The BHTI *Component Repair and Overhaul* (CRO) manual requires that the spindles be examined both visually and with a magnetic particle inspection (MPI) process during the overhaul.

The overhaul of the complete transmission was carried out by Transwest Helicopters in their own maintenance facility, and components requiring a non-destructive testing (NDT) process were sent to an independent, approved testing facility. The operator had purchased a time-expired, lower transmission case unit from another helicopter operator; they separately purchased an upper case with the spindles already attached, and sent it to the NDT contractor for inspection. The transmission upper case is constructed of aluminum and requires a different NDT process than the MPI that the spindles require. The records relating to the overhaul of this transmission do not indicate that the spindles received any MPI process. The maintenance check sheets used during the transmission overhaul were based on the CRO manual, and use of the sheets had been approved by Transport Canada. A review of the check sheets reveals that at least three different technicians had been involved in the overhaul.

An overhaul of the transmission requires cleaning, disassembly, inspection, repair as necessary, and reassembly of many components. Accordingly, the instructions contained in the CRO manual for the transmission overhaul were long and complicated. To help simplify and maintain control over the process, several overhaul organizations developed additional NDT check sheets to indicate which parts require NDT, and the type of NDT required. The helicopter manufacturer, BHTI, does not include such a check sheet within their CRO manual, nor is it required by regulation. At the time of this accident, Transwest Helicopters did not utilize such a check sheet; however, they developed and implemented their own additional NDT check sheet shortly after the occurrence.

Analysis

The failure of the transmission spindle mount would have allowed the transmission to pivot and become misaligned. This movement placed a bending load on the tail rotor drive shaft which rapidly led to failure. That the helicopter did not rotate clockwise immediately after the bang suggests that the noise was made by the instant failure of the spindle, while the failure of the tail rotor drive shaft was progressive and secondary.

The root cause of the spindle failure could not be determined. The indications of rework on the spindles suggest that they had been damaged earlier, perhaps in the earlier accident. The alternating bands of fatigue and overload cracking identified during the laboratory examinations suggest that the crack propagated slowly during normal operations and advanced quickly during overload such as large torque spikes.

Although the time interval from crack initiation to final failure could not be calculated, it is likely that the crack existed at the time of the transmission overhaul because of the earlier damage. It could not be determined if the crack would have been detected had the spindle received the MPI that was required. Omission of the MPI, however, reduced the chances of early detection.

The MPI process was omitted as a result of several factors relating to the control of the transmission overhaul.

That the upper case was purchased separately, and was sent out for NDT inspection with the spindles attached, created the confusion, since this was not the standard procedure. Furthermore, the overhaul was not supervised by one individual, but was carried out by three people working independently.

The overhaul instructions in the CRO manual were necessarily long. The use of an additional check sheet, identifying the components that require NDT, may have prevented the omission of the MPI. Many companies have recognized the need for an additional NDT check sheet, but since the CRO manual does not include one, each company must develop its own.

The following TSB Engineering Branch Laboratory report was completed:

LP 165/96 - Spindle Failure Analysis.

Findings

1. The spindle failed as a result of fatigue; the origin of the failure is unknown.

2. According to available component records, the spindle did not receive the required magnetic particle inspection at the last overhaul.

3. The omission of the magnetic particle inspection was the result of a lack of maintenance supervision during the overhaul process.

4. The failure of the spindle allowed the transmission to move, thereby creating bending loads on the tail rotor drive shaft which rapidly caused it to fail.

Causes and Contributing Factors

The tail rotor drive shaft broke as a result of the bending loads caused by the transmission misalignment when the spindle mount failed.

Safety Action

Following this accident, Transwest Helicopters amended its transmission overhaul procedures and facilities. This included adding hangar space to include an overhaul facility, making a full-time technician responsible for the overhauls, and amending the company overhaul manual to include additional NDT check sheets clearly identifying the level of inspection required for each component.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 23 July, 1997.