

AVIATION INVESTIGATION REPORT  
A00P0077

TAIL-ROTOR GEARBOX MALFUNCTION

CHINOOK HELICOPTERS LTD.  
BELL 47 G2 (HELICOPTER) C-FKNQ  
ABBOTSFORD, BRITISH COLUMBIA  
10 MAY 2000

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

## Aviation Investigation Report

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### *Summary*

The Bell 47 helicopter, serial number 2211, piloted by a student pilot and his flight instructor, took off from the south ramp of Abbotsford Airport in visual meteorological conditions at approximately 0850 Pacific daylight time. On departure, as the helicopter climbed through about 700 feet above ground level, still over the airport, it lost tail-rotor thrust and began to spin to the right. The nose then dropped and the spinning turned into a spiral. As it descended further, the helicopter appeared to be totally out of control. It struck the ground in a steep, nose-down attitude on the infield of the airport, broke apart, and a post-impact fire ensued. Both occupants were fatally injured by the impact forces.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

Inspection of the wreckage at the accident site revealed damage to the tail rotor consistent with that demonstrated by a tail rotor not turning on impact. It also revealed that the gears in the tail-rotor gearbox suffered heat distortion and the gears had uncoupled. Further inspection at the TSB regional wreckage examination facility and an independent engineering facility confirmed that the gears in the tail-rotor gearbox had overheated, smeared, and disengaged. No remnant of oil or burnt oil was in the tail-rotor gearbox. Inspection of the controls, including the forward cables for the horizontal stabilizer, revealed no anomalies.

During the afternoon of 09 May 2000, maintenance personnel conducted a 100-hour inspection on the helicopter. Among other details, this inspection required that the tail-rotor gearbox oil be changed. While the aircraft maintenance engineer (AME)<sup>1</sup> conducted other portions of the inspection, he assigned an apprentice AME the job of changing the oil. The apprentice AME drained the tail-rotor gearbox oil, inspected it for metal particles, and installed and lock-wired the drain plug. In addition to the normal actions of the 100-hour inspection, the forward section of the cables that move the horizontal stabilizer were replaced. The AME signed the aircraft journey log book as having completed the 100-hour inspection. The 100-hour inspection check sheet item that called for draining and refilling of the tail-rotor gearbox was initialled by the apprentice AME.

On the morning of 10 May 2000, the student pilot conducted a pre-flight inspection on the helicopter in the hangar. An item on the inspection was to visually check, through a small sight gauge (window), the oil level in the tail-rotor gearbox. It is sometimes difficult to tell whether there is oil behind the window. The instructor was not involved in the pre-flight inspection,<sup>2</sup> but was aware that a 100-hour inspection had been completed and a control cable had been changed. He joined the student in the helicopter after the student had started the helicopter.

The helicopter had been operating for about 15 minutes on the ground and about 2 minutes in the air before the loss of yaw control. The helicopter was at about 700 feet above ground level (agl) when it began spinning to the right, around its main-rotor mast. It then smoothly attained a nose-low attitude and started to descend. As the helicopter descended, the axis of rotation moved from the mast to a point beyond the nose. As the descent continued, the helicopter was rolling and pitching up to about 100 degrees from level. The main rotor appeared to be turning at normal speed, and the descent was more consistent with that demonstrated in a power-on descent than that of an autorotation.<sup>3</sup>

Two common techniques are taught to pilots to stop a helicopter from rotating should yaw control be lost as a result of a loss of tail-rotor thrust. One is to maintain enough airspeed or flow to allow the helicopter's vertical stabilizer to be aerodynamically effective enough to oppose the torque generated by the engine and main rotor. The other is to remove the engine torque by lowering the collective and, if required, shutting off the engine (enter autorotation). If yaw control is not re-established, it is easy for a pilot to become disoriented and not be able to coordinate control inputs to maintain other control parameters. For tail-rotor failures, the Bell 47 flight

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<sup>1</sup> Person responsible to conduct maintenance on the helicopter, for the operator.

<sup>2</sup> After students have gained some experience and have demonstrated proficiency in conducting these tasks, flight instructors normally delegate the pre-flight inspections to them.

<sup>3</sup> Autorotation is a state attained by a helicopter when main-rotor speed can be maintained without engine power, normally in a descent, at a specified airspeed range and main-rotor pitch angle.

manual stipulates to “immediately execute an autorotative descent. . .”

The helicopter was being operated within the limitations prescribed in the flight manual and the pilots were appropriately certificated for the flight. The student pilot held a student pilot permit and had logged about 50 hours of flight time on helicopters. The instructor pilot held a commercial helicopter pilot licence rated for class 3 flight instruction. He had about 2100 hours flight time on helicopters, about 600 of which was giving flight instruction. The apprentice AME had experience in the Canadian Forces as an aircraft technician and had just completed training for and received his commercial helicopter pilot’s licence. The AME had 23 years experience in conducting maintenance on helicopters, most of which involved the Bell 47.

Neither the pilots nor the maintenance personnel were on duty for any extraordinary time and had been rested the night before. Both occupants were wearing four-point personal restraint systems, but the impact forces were not survivable.

## *Analysis*

Since there was heat distortion of the gears and no remnant of oil in the tail-rotor gearbox, it is concluded that no oil was in the gearbox when the helicopter started operating on the morning of the accident. It is also concluded that, since the lack of oil was not detected prior to flight, the apprentice AME, the AME, the student, and the instructor did not check the oil level or erred in reading the sight gauge. As indicated earlier, it is sometimes difficult to tell whether there is oil behind the window.

It is likely that the pilot lowered the nose to increase airspeed in an attempt to arrest the rotation by making the vertical stabilizer/fin more effective. If that is the case, the technique was not effective, probably because of the helicopter’s relatively small vertical stabilizer/fin. Given the continued rotation, it is likely that the pilot’s control inputs became out-of-phase with the helicopter’s movements, and attitude control was lost.

## *Findings as to Causes and Contributing Factors*

1. Maintenance was conducted (100-hour inspection) on the helicopter just before the accident flight and oil was removed from the tail-rotor gearbox. The oil was not replaced; however, the inspection was signed as having been completed.
2. The apprentice AME, the AME, the student pilot, and the instructor pilot did not detect the lack of oil in the tail-rotor gearbox prior to the flight.
3. Due to the lack of oil, the gears in the tail-rotor gearbox overheated, smeared, and disengaged, and tail-rotor thrust and yaw control were lost.
4. When yaw control was lost, the helicopter began to spin to the right, and the pilot did not immediately execute an autorotative descent.
5. The pilot was unable to stop the helicopter from rotating and subsequently lost total control.

## *Other Findings*

1. The pilots were certificated by Transport Canada (TC) for the flight, and the AME was certificated by TC to conduct maintenance on the helicopter.
2. The helicopter was being operated within the limitations prescribed in the flight manual.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 12 October 2000.*