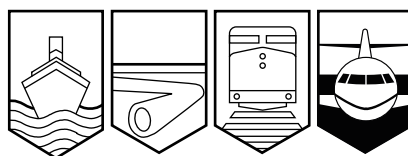


Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada



**AVIATION OCCURRENCE REPORT**

**LOSS OF DIRECTIONAL CONTROL**

**HIGHLAND HELICOPTERS LTD.  
BELL 206B JETRANGER II (HELICOPTER) C-GHHT  
WHITECOURT, ALBERTA 30 NM N  
07 MAY 1998**

**REPORT NUMBER A98W0086**

**Canada**

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 Occurrence Report

### Loss of Directional Control

Highland Helicopters Ltd.  
Bell 206B JetRanger II (Helicopter) C-GHHT  
Whitecourt, Alberta 30 nm N  
07 May 1998

Report Number A98W0086

### *Summary*

The pilot of a Bell 206B helicopter, serial number 2118, accompanied by a provincial forestry officer and a photographer, was flying in support of the video filming of a helicopter water bucketing operation near the Virginia Hills forest fire site, 30 nautical miles north of Whitecourt, Alberta. The forestry officer had requested video footage of a Bell 205 that was water bucketing. The Bell 206B pilot was flying above the trees in a westerly direction at about 30 miles per hour, just north of the pond being used for water-bucket pick-up, when the helicopter suddenly began to rotate to the right. The forestry officer was able to send a MAYDAY call on the radio. Attempts by the pilot to arrest the rotation were unsuccessful, and the helicopter entered the tree canopy while spinning. A main rotor blade cut off the tail boom, and the fuselage struck the forest floor in a nose-down attitude, resulting in substantial damage. The pilot received head injuries, while the passengers were not injured. Other helicopters in the area reported the accident to forestry dispatchers, and the occupants were picked up by helicopter and taken to hospital.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

The helicopter came to rest in a steep, nose-down, but upright, position. The nose of the helicopter was crushed, and the forward windscreen was broken. The main rotor blades were heavily strike-damaged. The tail boom had been cut off by a main rotor blade. The vertical fin, complete with the tail rotor gear box and tail rotor blades, separated and fell to the forest floor. The tail rotor blades did not display the usual heavy damage, although the leading edges indicated evidence of tree strikes, and the blade skin was torn. Both tail rotor blades were still attached to the root fittings and had been bent near their inboard ends. The tail rotor drive shaft segments were found to have numerous fractures, including one at a bonded coupler.

Examination of the tail rotor drive shaft fractures by the TSB Engineering Laboratory determined that there was a torsional overload failure at the number-4 shaft, indicative of a tail rotor strike. Examination of the bonded coupler indicated that the fracture had taken place after the tail rotor drive shaft had stopped rotating. The bonded coupler had been struck by a main rotor blade when the tail boom was cut off. A hole in the left engine cowl was found to be the result of an engine to transmission coupler fracture that typically occurs when the main rotor blades are stopped abruptly. Examinations of the freewheel and splines in the oil cooler fan shafting section of the tail rotor drive shaft did not reveal any pre-impact failures. The tail rotor control system was examined to the degree possible, and no evidence of a malfunction was found. Records indicate that the helicopter was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The helicopter's rotating descent into the tree canopy resulted in the tail rotor disc (located on the left side of the vertical fin) initially contacting the upper tree branches horizontally as the tail boom rotated in a clockwise direction, producing an unusual damage pattern. The tree strike damage to the leading edge of the tail rotor blades confirms that the tail rotor drive system was intact and rotating up to the point of tree contact. The TSB Engineering Laboratory examination of the tail rotor drive shaft determined that the direction of the torsional overload failure indicated a sudden stoppage of the tail rotor blades, with no evidence of any progressive failure. The torsional failure in the tail rotor drive shaft appears to have occurred early in the impact sequence, resulting in a sudden loss of drive to the tail rotor and a subsequent reduction in damage to the blades as compared to that normally seen.

The weather conditions at the time of the occurrence, at 1545 mountain daylight time<sup>1</sup>, were clear sky, visibility obscured in smoke, wind from the southwest at 6 miles per hour, temperature 25 degrees Celsius, and relative humidity 20 per cent.

The Bell 205 that was being video taped was flown in a westerly direction during the water bucket pick-up and climb-out. The Bell 205 pilot observed the Bell 206B on a parallel course about 300 feet horizontally off his right side, at low speed and just above the trees. The pilot of the Bell 205 indicated that his track, while flying toward the fire, may have converged with the course of the slower moving Bell 206B which was by then below and behind him in the rear

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<sup>1</sup> Coordinated Universal Time minus six hours.

right quarter. Studies have found that the rotor wash from a helicopter in forward flight forms a pair of rotating vortices that act exactly like those generated by a fixed wing aircraft. The turbulence intensity is directly proportional to the weight, and inversely proportional to the rotor span and speed of the helicopter. The trailing vortices settle or move downward with time, and they can be potentially dangerous for several minutes after the generating helicopter has left the scene.

A series of unexplained accidents and incidents in the U. S. Army OH-58 helicopter fleet involving loss of directional control resulted in a research project that identified a condition known as loss of tail rotor authority also called loss of tail rotor effectiveness or unanticipated right yaw. This can occur during certain wind conditions in flight operations of single rotor helicopters at airspeeds of 30 knots and less. It has been defined as the occurrence of an uncommanded right yaw rate which does not subside of its own accord and which, if not corrected, can result in loss of helicopter control. Four helicopter characteristics during low speed flight have been identified through

extensive flight and wind tunnel tests as contributing factors in loss of tail rotor authority. In one characteristic known as "Main Rotor Disc Vortex", there is a loss of tail rotor authority as a result of the tail rotor entering the main rotor vortex and causing a reduction in tail rotor blade angle of attack and thrust. The relative wind azimuth in this characteristic is from 285 to 315 degrees. This condition can culminate in a rapid, flat spin and sudden ground contact.

Recovery technique would normally require a collective pitch reduction; however, in this case there was insufficient height available to prevent obstacle contact.

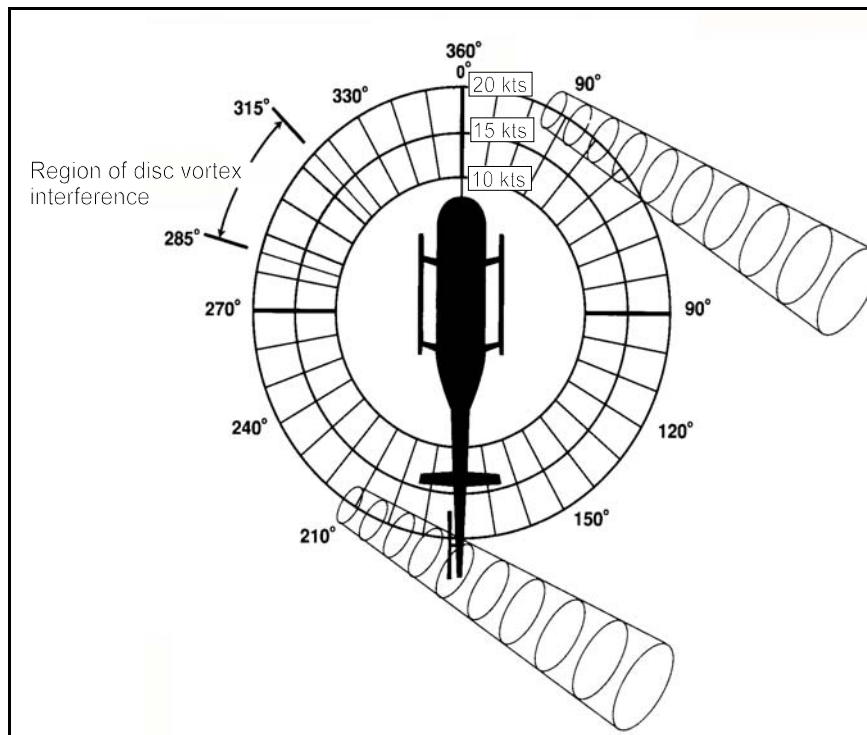


Figure 1 - Main rotor disc vortex interference.

The pilot was properly licenced and certified for the flight. He had flown a total of about 15 000 hours of which 4 000 hours were on Bell 206 aircraft. The pilot was not wearing a helmet, nor was he using the available shoulder harness. His facial injuries were the result of his striking the instrument glare shield during the impact sequence. The pilot indicated that he was just about to initiate a right turn when the helicopter spun four to five turns before striking the trees.

The forestry officer sitting in the front left seat was wearing the available shoulder harness and was uninjured. The photographer, who was in the rear seat, was using a special tether harness and had laid down across the back of the front seat bulkhead before the helicopter struck the trees. The rear-left door had been removed to provide the photographer with unobstructed video camera access. The passengers did not report any unusual noises or vibrations prior to the helicopter starting to spin.

The emergency locator transmitter (ELT) was mounted on the left side of the instrument console, and had not functioned during the occurrence. It was set to the ARM position but did not activate at impact. It was undamaged and, when removed and tested, it functioned normally.

## *Analysis*

Since there was no evidence found of pre-impact mechanical failure, the analysis will focus on the operational aspects of this occurrence.

The loss of directional control experienced by the pilot could have been the result of a self-generated loss of tail rotor authority, or the same effect may have been caused by encountering drifting main rotor vortices. While filming the Bell 205 picking up water with a bucket, the pilot of the Bell 206B was flying a slow, parallel course in a westerly direction, low over the trees on the right side. As the Bell 205 climbed away, it flew above and ahead of the Bell 206B. Since the wind was from the southwest, conditions were favourable for the main rotor vortices from the Bell 205 to drift into the path of the Bell 206B. These vortices could cause a sudden reduction in tail rotor thrust with a resultant uncommanded right yaw that could develop into a high rate of turn. The pilot's low height over the trees precluded the reduction of collective pitch to effect recovery.

A comparison of the facial injuries experienced by the pilot and the lack of injury to the forestry officer sitting in the left front seat following ground impact, leads the Board to conclude that use of a shoulder harness would have reduced the pilot's upper body injuries.

The following Engineering Branch report was completed:

LP 63/98 - Tail Rotor Drive Shaft Examination

## *Findings*

1. The pilot was qualified and certified for the flight in accordance with existing regulations.
2. Records indicate that the helicopter was certified, equipped, and maintained in accordance with existing regulations and approved procedures.
3. The pilot lost directional control and was unable to recover.

4. There were no pre-impact mechanical failures found.
5. The wind conditions and the helicopter's position and speed were favourable for a loss of tail rotor authority condition to develop.
6. The pilot was not wearing the available shoulder harness, and suffered facial injuries.

### *Causes and Contributing Factors*

It is likely that the loss of directional control experienced by the Bell 206B helicopter pilot resulted from a loss of tail rotor authority when he encountered main rotor vortices of the Bell 205 helicopter.

*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 10 February 1999.*