



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

LOG 2527

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Date: August 11, 1994

In reply refer to: A-94 -149 and -150

Honorable David R. Hinson  
Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

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The National Transportation Safety Board recently investigated two accidents involving the loss of tail rotor authority on military surplus helicopters that were performing logging operations. The most recent accident occurred on February 23, 1994, when a Bell Helicopter Textron (Bell) TH-1L helicopter, N204AP, crashed during an emergency autorotation near Etna, California. The operator reported that the helicopter had just begun to lift a load of logs when a high frequency vibration was felt in the auto torque (tail rotor) pedals. The pilot released the logs and proceeded to a landing area less than 1 mile away. The vibration increased, then the helicopter began to spin to the right, forcing the pilot to enter an autorotation from about 100 feet above the ground. The helicopter landed hard and slid into a creek. During the hard landing, the tailboom was severed by the main rotor blades. Although the helicopter sustained substantial damage, the pilot and a crewmember were not injured.

The operator reported that the intermediate (42-degree) gearbox (P/N 204-040-003-37, S/N A13-2115) of the tail rotor drive shaft had failed. At the time of the accident, the gearbox reportedly had accumulated 249 hours in service since it had been overhauled. The gearbox was sent to the Safety Board's materials laboratory for examination. Disassembly of the gearbox revealed that a portion of the input spiral bevel gear had separated from the remainder of the gear and had penetrated the bottom on the gearbox case. Fracture of the gear was caused by fatigue cracking that initiated from a gear tooth root radius. The examination noted no defects that may have contributed to the initiation of the fatigue cracking.

The other recent accident occurred on November 12, 1993, when a Bell UH-1B helicopter, N91NW, crashed near North Bend, Washington. The pilot reported hearing

6407

a grinding noise and losing directional control while lifting a load of logs. He jettisoned the load and initiated an emergency forced landing. The aircraft sustained substantial damage, and the pilot received minor injuries. The operator reported that the tail rotor drive shaft (42-degree) gearbox had failed and that the gearbox had been in service 125 hours since its overhaul. Metallurgical examination of the broken input gear at the Safety Board's materials laboratory revealed that it fractured in a manner very similar to the input gear from the accident in Etna, California.

From 1986 to 1989, the Safety Board investigated four additional accidents involving separation of the input spiral bevel gear in the tail rotor drive shaft 42-degree gearbox on military surplus Bell UH-1 or TH-1 series helicopters.<sup>1</sup> Of the pilots and crewmembers involved in the accidents, one sustained fatal injuries, two sustained serious injuries, and two sustained minor injuries. In all four cases, fracture of the gear was the result of fatigue cracking that initiated from a gear tooth root radius. According to maintenance records, the time in service for the gearboxes ranged from 195 to 444 hours between overhaul and the accidents. The helicopters from these four cases were also involved in logging operations.

The failure history of the 42-degree gearbox input gear during military use of Bell UH-1 and TH-1 series helicopters was discussed with the U.S. Army accident investigation group in Corpus Christi, Texas. Three in-service fatigue fractures of the input gear of the 42-degree gearbox were reported, dating back to 1988. The cracking in one of the gears initiated from corrosion pitting. In the other two cases, no specific defect was found at the origin area of the cracking. The military's nondestructive inspection program has also detected cracks in other 42-degree gearbox input gears. Representatives of Bell and military accident investigation groups have indicated that the military failure history of this component is not considered to be a significant problem considering the large number of UH-1 and TH-1 series helicopters in military service.

The helicopters involved in the six civilian accidents cited above were military surplus and had been certificated for civil use in the "Restricted" category. Helicopters in the "Restricted" category may not be used to carry passengers or to fly over populated areas. In the United States, about 400 Bell UH-1 and TH-1 series helicopters have been converted to civil use in this category. As a part of the certification of these helicopters for civilian use, maintenance must be in accordance with the appropriate military technical manuals. The military maintenance manual for the Bell UH-1 and TH-1 series helicopters specifies an overhaul interval of 1,500 hours for the 42-degree gearbox. The overhaul includes a magnetic particle inspection of the input gear. All of the components in the gearbox have infinite life; that is, they are removed from service only on condition.

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<sup>1</sup> (a) SEA 86-F-A137 (Wenatchee, Washington; May 31, 1986; Bell UH-1L, N4964N), (b) ATL 88-F-A213 (Waltersboro, South Carolina; July 12, 1988; Bell TH-1L, N465JR), (c) SEA 88-L-A143 (North Bend, Oregon; August 4, 1988; Bell UH-1E, N151LC), (d) SEA 89-F-A111 (Baring, Washington; June 14, 1989; Bell UH-1L, N157LC).

Because of this, there is no tracking of the total service time or history on these gearboxes.

According to a representative of Bell, the UH-1 series helicopters were designed for basic utility missions in military use, including observation, transportation of troops, reconnaissance, and external sling applications. The Bell TH-1 series helicopters were intended for military training use. The design of these helicopters was specified to withstand four maximum power (torque) applications per hour of operation. The typical use of these helicopters in military service was discussed with a representative of Bell and a Safety Board employee who has flown extensive and varied military missions as a pilot of UH-1 helicopters. Both reported that maximum engine torque is rarely used during typical military missions.

A logging operation would be expected to put a much more severe load spectrum on the UH-1 and TH-1 series helicopters than does a typical military utility mission. Each time a helicopter picks up a load of logs, the engine torque (and tail rotor torque) can increase to, or near, the torque limit. Further, a helicopter performing logging operations could be expected to accumulate far more of these high-torque excursions (as many as 30 or more per hour) than it would during typical military use. Because all of the 42-degree gearbox failures that have occurred in civilian service have involved logging operations, the Safety Board believes that the cause of these fatigue failures is related to the large number of high-torque applications encountered in logging operations.

The failure history of the input gear in the helicopters used in logging operations has clearly demonstrated that the 1,500-hour overhaul interval for the gearbox is insufficient to detect cracking in the input gear. Considering the time in service since overhaul at which the failures occurred, the Safety Board believes that the inspection interval should be reduced to an interval substantially below 200 hours.

The Safety Board also considered the possibility that the torque limit of the engine is being exceeded when helicopters involved in logging operations lift excessively heavy loads or when helicopters are misused by quickly applying large amounts of collective. The demands of logging operations increase the probability that pilots are exceeding the torque limit of the engine during repeated heavy lift operations, and the Safety Board believes that application of excessive torque could also be contributing to the premature initiation and rapid propagation of cracking in the 42-degree gearbox input gear.


Operators and pilots of UH-1 and TH-1 series helicopters used in repeated heavy lift operations may not be fully aware of the dangers associated with the continuing use of the helicopter at or above the engine's torque limit. Consequently, the Safety Board believes that the FAA should inform appropriate operators of the accident histories highlighted in this letter and urge the operators to caution their pilots regarding the possible consequences of exceeding the torque limit on the engine.

Because of these concerns, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an Airworthiness Directive to require that the input spiral bevel gear in the tail rotor drive shaft intermediate gearbox (P/N 204-040-003-37) on military surplus Bell Helicopter Textron UH-1 and TH-1 series helicopters involved in repeated heavy lift operations be periodically subjected to a magnetic particle (or equivalent) inspection of the gear teeth. Based on the failure history, the interval between inspections should be substantially less than 200 hours. (Class II, Priority Action) (A-94-149)

Notify operators of Bell Helicopter Textron UH-1 and TH-1 series helicopters used in repeated heavy lift operations of the accident histories resulting from the failure of the tail rotor drive shaft gearbox, and urge the operators to caution their pilots about the dangers of exceeding the torque limit on the engine. (Class II, Priority Action) (A-94-150)

Acting Chairman HALL, and Members LAUBER, HAMMERSCHMIDT, and VOGT concurred in these recommendations.

  
By: Jim Hall  
Acting Chairman