



## **Engine, Transmission Failures Lead Causes of Accidents in U.S. Helicopter Logging Operations**

*More than half the accidents in U.S. helicopter logging operations in 1983 through 1999 involved failures of engines or transmission systems. Metal fatigue and external-load problems also were major causes of accidents.*

—  
*Patrick R. Veillette, Ph.D.*

Helicopter operations in support of logging activities in the United States typically are conducted in remote areas where rugged terrain and adverse flight conditions present unique risks for flight crewmembers and ground crewmembers. In 1983 through 1999, 83 accidents occurred during helicopter logging (heli-logging) operations; 23 accidents were fatal, and 29 crewmembers were killed.

To identify accident causes and potential methods of improving U.S. heli-logging safety, the author conducted a study that included the following:

- Analysis of U.S. National Transportation Safety Board (NTSB) reports on U.S. heli-logging accidents from January 1983 through December 1999 (see “Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999,” page 5), interviews of some accident investigators and some witnesses, and inspections of some accident sites;
- Examination of training documents and training courses;
- Examination of operations specifications and operations manuals;
- Observation of several heli-logging operations; and,
- Examination of heli-logging helicopters.



The study produced the following major findings:

- All the accident helicopters were carrying loaded external lines or unloaded external lines;
- Most accidents (88 percent) occurred while helicopters were being maneuvered in work areas; and,
- Mechanical failure caused more than half (57 percent) of the accidents.

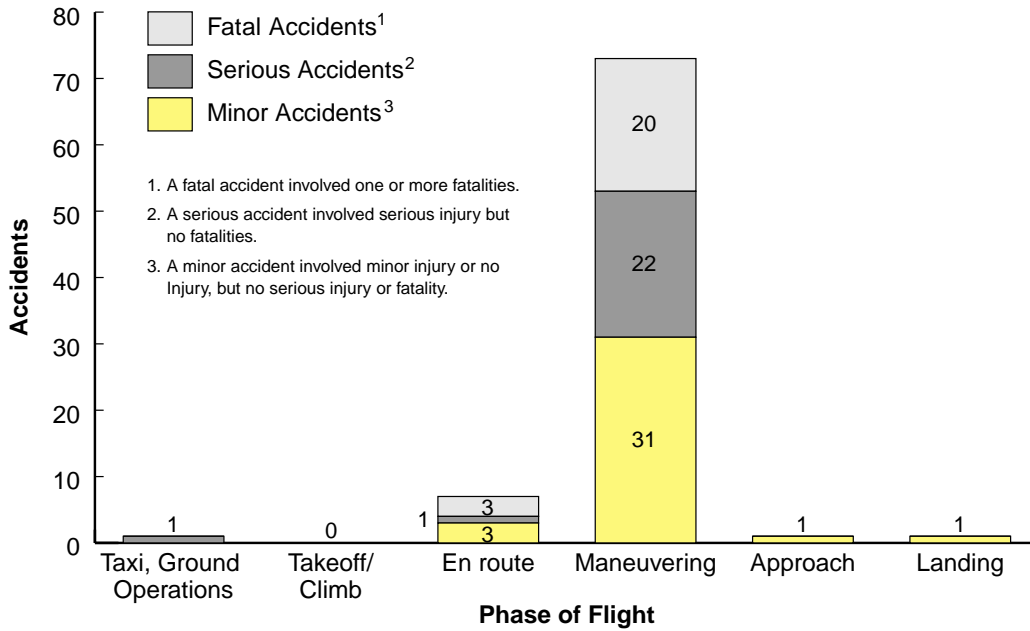
Figure 1 (page 2) shows that 73 accidents involved helicopters being maneuvered in work areas; 20 accidents resulted in fatalities, and 22 accidents resulted in serious injuries.

Figure 2 (page 2) shows that 46 maneuvering-phase accidents were caused by mechanical failure and that 27 maneuvering-phase accidents were caused by human error (other than human error during maintenance).

Maneuvering typically is conducted for extended periods at low altitudes over steep, mountainous terrain. Helicopters often are flown close to terrain and obstacles that limit maneuvering room. High density altitude often reduces hovering capability. Maneuvering at low altitudes and slow airspeeds reduces the probability of a successful autorotative landing following a powerplant failure.

*Continued on page 4*

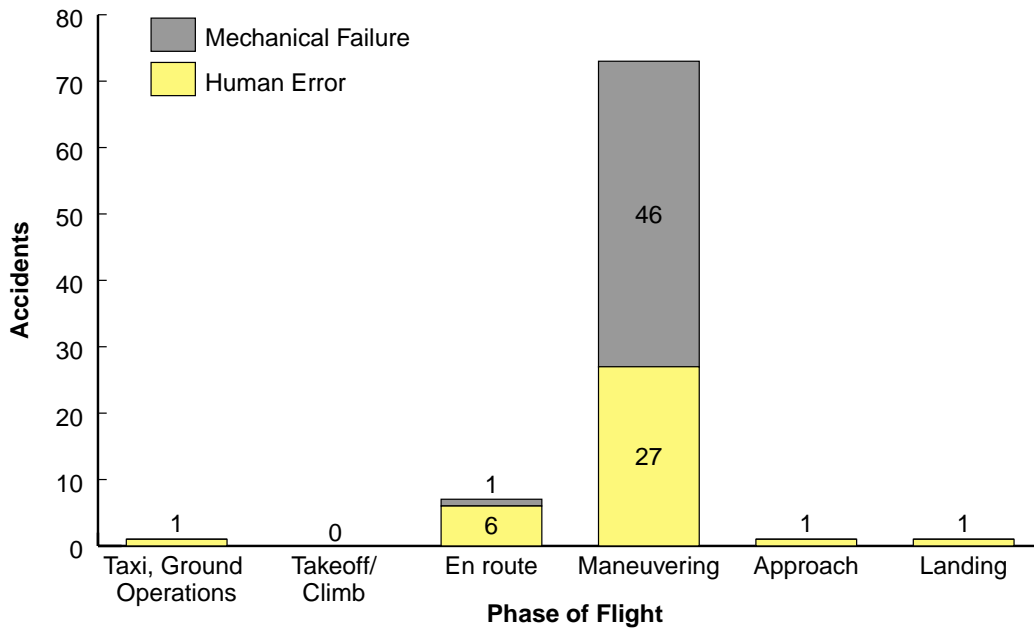
### Phase of Flight for 83 U.S. Helicopter Logging Accidents, 1983–1999



Source: Patrick R. Veillette, Ph.D., from reports by the U.S. National Transportation Safety Board

**Figure 1**

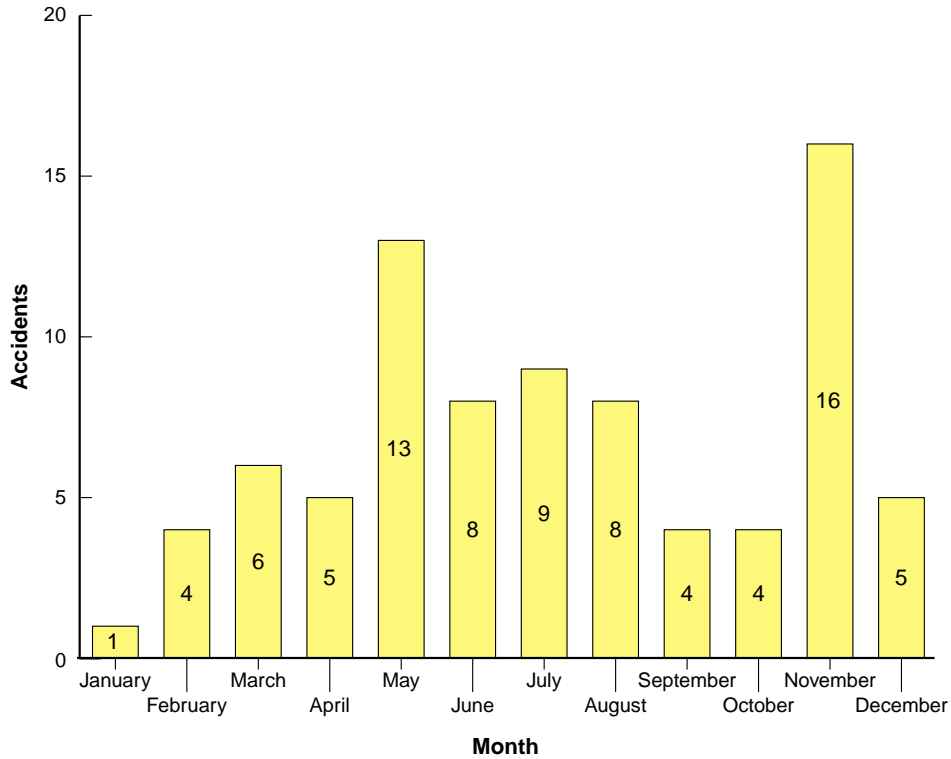
### Involvement of Mechanical Failure and Human Error by Phase of Flight in 83 U.S. Helicopter Logging Accidents, 1983–1999



Source: Patrick R. Veillette, Ph.D., from reports by the U.S. National Transportation Safety Board

**Figure 2**

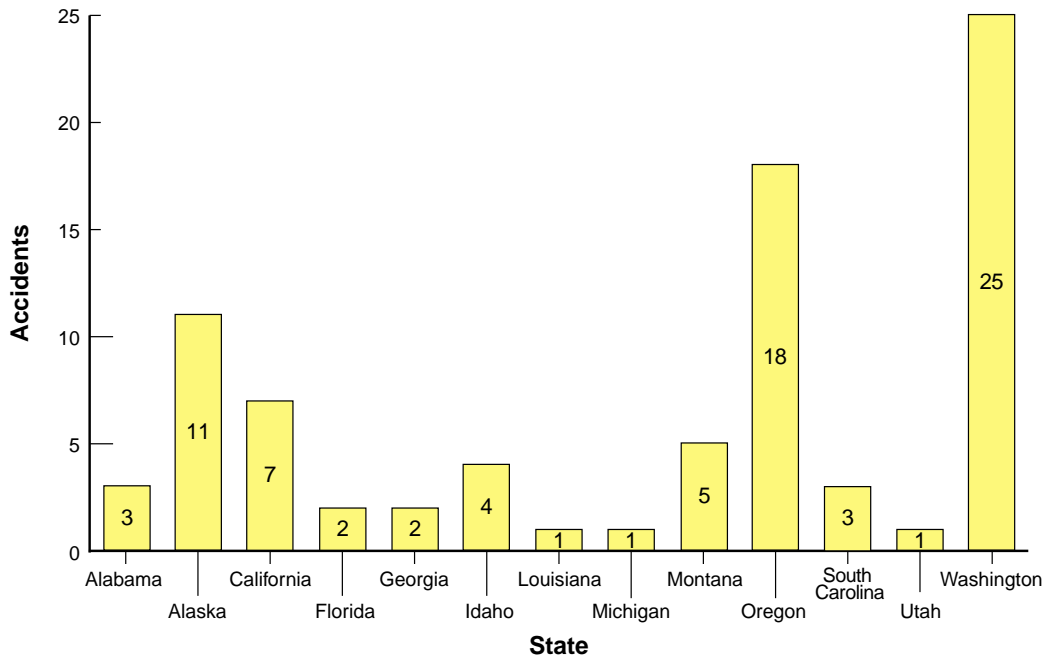
### Distribution by Month of 83 U.S. Helicopter Logging Accidents, 1983–1999



Source: Patrick R. Veilette, Ph.D., from reports by the U.S. National Transportation Safety Board

**Figure 3**

### Distribution by State of 83 U.S. Helicopter Logging Accidents, 1983–1999



Source: Patrick R. Veilette, Ph.D., from reports by the U.S. National Transportation Safety Board

**Figure 4**

Seven accidents occurred during the en route phase of flight — that is, while helicopters were being flown between staging/refueling areas and work areas. Three en route accidents resulted in fatalities. Six en route accidents involved human error.

Engine failures were involved in 22 accidents, including 15 accidents involving mechanical failure, five accidents involving fuel starvation or fuel exhaustion, and two accidents involving fuel contamination. All the engine-failure accidents occurred while the helicopters were being flown at low altitudes and/or low airspeeds. Four accidents resulted in fatalities; eight accidents resulted in serious injuries.

Eleven accidents involved metal fatigue that caused mechanical failure of tail-rotor drive-shaft systems. Six accidents involved failure of the 42-degree gearboxes in Bell UH-1 (and related) series helicopters. The NTSB report on the Bell TH-1L accident July 12, 1988, in Walterboro, South Carolina, said that, although the U.S. Federal Aviation Administration (FAA) had certified the military-surplus helicopter for civilian external-load operations, the helicopter was not designed for repeated heavy lifting. The report said that the accident helicopter had accumulated more than 13,000 lift cycles in 380 heli-logging flight hours.

Seven accidents occurred when external lines became entangled with tail-rotor systems.

Three accidents involved fatigue-induced failures of vertical stabilizers on Garlick UH-1/TH-1 helicopters. [Garlick Helicopters refurbishes Bell UH-1/TH-1 helicopters for civilian use. UH-1 (utility) series helicopters and TH-1 (training) series helicopters are military versions of the Bell 204 and 205.]

Four accidents involved main-rotor system failures. One accident occurred when the main-rotor system separated from a Southern Aero UH-1B helicopter in Skykomish, Washington, on Aug. 27, 1997. NTSB said, in its final report, that the probable cause of the accident was a main-rotor mast fatigue fracture.

Eleven accident reports said that the pilots attempted to release their external loads after experiencing problems in flight. External loads are attached to cargo hooks on helicopter external lines. The cargo hooks must be designed to enable pilots to use either electrical systems or manual systems to release external loads in normal operations and emergency situations. The release mechanisms operated properly in eight accidents and malfunctioned in three accidents.

Four accidents involved ground crewmembers who were struck and killed by external loads that were released accidentally or because of malfunctions of devices containing the loads.

Twelve accidents occurred when external loads or unloaded external lines struck trees or the ground while the helicopters

were being maneuvered. Seven accidents occurred when helicopters struck obstacles (typically trees) while being maneuvered; five accidents occurred when tail rotors struck trees. All the tree strikes occurred while the pilots were conducting vertical-reference work, which typically involves leaning outside the cockpit and looking down.

Improper coordination between flight crewmembers or between flight crewmembers and ground crewmembers was cited in 12 accident reports. Two accidents involved relatively inexperienced pilots. Two accidents involved relatively inexperienced ground crewmembers.

Heli-logging activities are conducted year-round. Figure 3 (page 3) shows the monthly distribution of heli-logging accidents during the study period.

Figure 4 (page 3) shows the distribution by state of heli-logging accidents. Two-thirds of the accidents occurred in Alaska, Oregon and Washington.

The remote areas in which some heli-logging operations are conducted are far from company headquarters and maintenance facilities. Poor maintenance oversight was cited in seven accident reports; five of the accidents involved improper installation of retaining nuts and bolts.

The rugged terrain over which most heli-logging operations are conducted provides limited choices of landing sites for pilots who experience power problems or control problems. Unsuitable terrain for (forced) landings was cited in 53 accident reports. Twenty-seven accidents involved pilots who attempted to conduct autorotative flight to suitable landing sites but had to land elsewhere because of insufficient altitude and/or airspeed. Seventeen accident reports said that the pilots attempted to “stretch glides” to suitable landing sites and allowed main-rotor speed to decay.

Four accident helicopters descended into water in rivers or swamps. All the water-accident reports said that crewmembers had difficulty exiting the helicopters. Some crewmembers were hindered by injuries, disorientation, in-rushing water or obstacles. None of the crewmembers was wearing a personal flotation device.♦

### ***About the Author***

*Patrick R. Veillette, a professional pilot with more than 11,500 flight hours, is a Boeing 727 flight engineer for a U.S. air carrier. Veillette earned a bachelor's degree in aeronautical engineering at the U.S. Air Force Academy and a doctorate in civil engineering at the University of Utah. He has conducted research projects on cockpit automation and human error in high-risk environments. Veillette has an airline transport pilot certificate and is a former U.S. Federal Aviation Administration designated pilot examiner.*

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Aug. 20, 1983	Shaver Lake, California	Boeing Vertol BV-107	destroyed	2 fatal
<p>A ground crewmember heard noises and saw the rotor blades fragment as the pilot began to fly the helicopter away from the pickup area with a log that weighed between 8,000 pounds and 9,000 pounds (3,629 kilograms and 4,082 kilograms). The no. 3 synchronizing shaft in the rotor-drive system had failed at a fatigue crack that originated at a rivet hole. The shaft had accumulated 17,492 service hours, including 435 service hours since overhaul. The report said that the quality of the surface finish on the rivet holes was unsatisfactory.</p>				
May 10, 1984	Clermont, Florida	Bell UH-1B	minor	1 fatal, 1 serious, 1 none
<p>The pilot was not aware that two ground crewmembers were holding the external line. The external line inadvertently was released from the helicopter, and both crewmembers fell to the ground. Examination of the external-line attachment hook showed no evidence of failure or malfunction. The report said that similar incidents have occurred with civilian and military helicopters equipped with hooks.</p>				
Dec. 10, 1984	Carrabelle, Florida	Sikorsky UH-34J	substantial	none
<p>The pilot was flying the helicopter in a hover at about 175 feet above ground level (AGL) when the engine lost power. The pilot said that the engine operated intermittently and that black smoke exited the exhaust pipe. The engine then failed, and the pilot conducted an autorotative landing in a creek. The main-rotor blades were destroyed, and the tail boom separated from the fuselage.</p>				
June 11, 1985	Juneau, Alaska	Bell UH-1B	substantial	1 fatal
<p>The helicopter lost power while transporting a load of logs over mountainous and densely forested terrain. The pilot conducted an autorotative landing in tall trees. The report said that the spacer between the no. 5 compressor and the impeller had not been seated properly during the last engine overhaul. During the accident flight, the spacer slipped into its proper position, thus releasing an accumulated compressive torque load. The compressor assembly then uncoupled and forced the impeller into its magnesium housing. This resulted in an overtemperature condition and breakup of the turbine assembly.</p>				
June 25, 1985	Hoquiam, Washington	Bell UH-1B	minor	1 fatal, 1 none
<p>The pilot was flying the helicopter in a hover when the external-load sling broke and a block of wood struck and killed a ground crewmember.</p>				
Aug. 8, 1985	St. James, Louisiana	Bell UH-1B	substantial	1 fatal
<p>The helicopter was being flown in a hover at 150 feet AGL to pick up a log when the engine lost power. Witnesses heard a "loud bang," and the pilot radioed, "Get out of the way." The pilot conducted an autorotative descent with very low rotor rpm through tall trees. The helicopter struck the ground at a high vertical speed. The report said that the engine had severe internal damage. Four compressor blades from the fourth-stage rotor had experienced progressive-fatigue failure.</p>				
March 3, 1986	Bullard, Georgia	Bell 214-B1	substantial	1 minor
<p>The helicopter was lifting a log when a loud explosion was heard and the engine lost power. The pilot conducted an autorotative landing. The engine had experienced an uncontained failure of the first-stage turbine disk. Debris damaged the engine cowling and the main-rotor blades. The report said that the turbine disk had been installed improperly.</p>				
March 7, 1986	Siletz, Oregon	Aerospatiale SE-318C	substantial	1 fatal
<p>The pilot tried unsuccessfully to use the helicopter to lift a 1,597-pound (724-kilogram) load of cedar blocks. The report said that the load would have increased the helicopter's gross weight to approximately 880 pounds (399 kilograms) over the maximum gross weight with an external load. The pilot was setting the load back on the ground, so that some of the cedar blocks could be unloaded by ground personnel, when the engine lost power. The helicopter then struck the ground with the external-load line still attached. The engine had experienced a compressor stall, and the turbine section had been burned because of improper engine operation by the pilot, the report said.</p>				
May 31, 1986	Wenatchee, Washington	Bell UH-1L	destroyed	1 fatal
<p>The helicopter was lifting a sling load when ground crewmembers told the pilot that smoke was coming from the tail-rotor area. The pilot released the sling load and said that he would land the helicopter. The pilot then lost tail-rotor control and attempted a run-on landing in a densely wooded area. The report said that the 42-degree gearbox, which had been overhauled 195 service hours before the accident flight, had failed when the input-pinion gear fractured because of corrosion-induced fatigue.</p>				
Nov. 13, 1986	Winlock, Washington	Hughes 369D	substantial	none
<p>The helicopter was being used to load Christmas trees onto a truck. The pilot was flying the helicopter to the pickup area when the sling on the external line contacted treetops. The sling rebounded into the tail rotor and damaged the tail-rotor gearbox. The pilot conducted an autorotative landing.</p>				
April 21, 1987	Bay Minette, Alabama	Bell UH-1B	substantial	none
<p>An internal failure caused the engine to lose power during a logging operation. The pilot conducted an autorotative landing on water, and the helicopter sank. The engine had accumulated about 980 service hours after its last overhaul.</p>				
May 13, 1987	Siletz, Oregon	Aerospatiale SA-315D	substantial	1 minor
<p>The report said that chockers (devices used to pick up logs) were not attached properly to the external line and disconnected from the line during a logging operation. The external line then became entangled with the tail rotor, causing failure of the tail-rotor system. The helicopter spun to the ground.</p>				

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Jan. 28, 1988	Stockton, Alabama	Bell 204B	substantial	1 serious
<p>The helicopter was being flown from a logging site to a refueling barge when the engine lost power. The pilot landed the helicopter in a swamp. The report said that there was no fuel in the fuel tank when the helicopter was recovered. The pilot was relatively inexperienced in flying the helicopter, which had a larger engine than a similar helicopter operated by the company. The report said that the accident helicopter's fuel-quantity gauge was inaccurate and that the pilot identified the fuel-low warning light as a 20-minute light.</p>				
July 5, 1988	Joseph, Oregon	Kaman HH-43	substantial	1 serious
<p>The pilot was maneuvering the helicopter into position for the first external-load pickup of the day when the main-rotor blades struck a tall tree.</p>				
July 12, 1988	Walterboro, South Carolina	Bell TH-1L	substantial	1 serious
<p>The 42-degree gearbox failed when the military-surplus helicopter was lifting a load of logs. The pilot conducted an autorotative landing. A gear tooth on a quill pinion had failed because of fatigue. The report said that there was no evidence of preexisting damage or improper overhaul procedures. The helicopter had accumulated more than 13,000 lift cycles in 380 hours of service in logging operations. The helicopter was certified for external-load operations by the U.S. Federal Aviation Administration (FAA), but the manufacturer said that the helicopter was not designed for repeated heavy lifting. The report said that surplus UH-1/TH-1 helicopters were involved in two similar accidents during logging operations.</p>				
July 13, 1988	Oakridge, Oregon	Aerospatiale SA-315B	substantial	1 serious
<p>The pilot lost control of the helicopter after a log in the external-line sling struck a tree. The helicopter then descended to the ground.</p>				
Aug. 4, 1988	North Bend, Oregon	Bell UH-1E	substantial	1 minor
<p>During a logging operation, the pilot perceived a transmission malfunction and conducted an autorotative landing on rough terrain. The tail-rotor-drive input gear in the 42-degree gearbox had failed from fatigue. The military-surplus helicopter had accumulated 373 service hours since overhaul.</p>				
March 3, 1989	Forest Grove, Oregon	Schweizer 269C	substantial	1 minor
<p>The report said that the helicopter was being used to load holly trees onto a trailer truck when the helicopter's landing skid contacted the side of the trailer. The helicopter then struck the ground.</p>				
May 17, 1989	Ketchikan, Alaska	Bell 214B-1	substantial	2 serious
<p>The report said that the pilot misjudged clearance from trees while conducting a hover descent to pick up a load of logs. The tail rotor contacted a tree, and the helicopter struck the ground.</p>				
June 14, 1989	Baring, Washington	Oregon Helicopters UH-1L	substantial	1 serious, 1 minor
<p>The helicopter was lifting a log when the crew heard unusual noises and felt vibrations. They released the log and flew toward a landing site. The helicopter was in a high hover when it began spinning. The pilot conducted a hovering autorotation. The helicopter landed hard and rolled down a hill. The report said that the input spiral-bevel gear in the tail-rotor 42-degree gearbox had failed in fatigue because of pilot-induced overstress. The engine N<sub>2</sub> (high-pressure compressor shaft) torque indicator in the accident helicopter had a redline of 55 pounds; the U.S. Navy UH-1 operations manual and the FAA type certificate specify an N<sub>2</sub> torque limit of 50 pounds.</p>				
Sept. 15, 1989	Louisville, Georgia	Sikorsky H-34J	destroyed	none
<p>The pilot felt a jerking motion while hovering the helicopter at 200 feet. The motion occurred several times in a brief period. The pilot jettisoned the external line and conducted an emergency landing in a swampy area. The helicopter burned and was not recovered. The pilot believed that the main-rotor-drive free-wheeling unit had failed.</p>				
Nov. 15, 1989	Estacada, Oregon	Hughes 269C	destroyed	1 fatal
<p>The helicopter was being used to transport Christmas trees from a field to a drop zone for loading onto a truck. The report said that, during an approach to the drop zone, the pilot did not maintain sufficient altitude or clearance, and the external load struck an obstruction. The pilot lost control of the helicopter. The helicopter flew backwards about 200 feet (61 meters), struck the ground tail-first and rolled over. The report said that the pilot had only a manual means of releasing the external line from the helicopter's hook; the electrical release system had been rewired to provide power only to the loading hook. The pilot had accumulated five flight hours of dual instruction and eight flight hours as pilot-in-command in external-load operations; she did not have the required letter of competency for the accident operation.</p>				
March 9, 1990	Cross, South Carolina	Sikorsky HSS-1N	destroyed	1 fatal
<p>After about one hour aloft, the pilot flew the helicopter toward the refueling area. The engine failed about 200 feet over a wooded area. Witnesses said that the helicopter was in a nose-high attitude and that main-rotor-blade rotation speed was decreasing. One witness said that the helicopter turned about 180 degrees before striking trees. The pilot was removed from the helicopter before it burst into flames. Before the pilot died, he said that the fuel gauge was indicating between 100 pounds and 200 pounds (45 kilograms and 91 kilograms) before the engine failed.</p>				

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
April 20, 1990	Moncks Corner, South Carolina	Bell 205A-1	destroyed	1 fatal
<p>The pilot flew the helicopter back to the pickup area because the external load of logs was too heavy. He brought the helicopter to a hover at 200 feet AGL and released the load. The ground crew observed the helicopter pitch nose-up, roll left and descend to the ground. The report said that failure of a main-rotor pillow-block bolt caused the main rotor to separate from the mast. Maintenance procedures recommended by the manufacturer had not been followed, and the pillow-block bolts had become corroded.</p>				
May 21, 1990	Juneau, Alaska	Sikorsky S-58D	substantial	1 serious, 1 none
<p>The pilot lost tail-rotor control while conducting a high hover with an external load of logs. The helicopter spun right and descended to the ground. The report said that the tail-rotor drive-shaft assembly had fractured.</p>				
May 21, 1990	Kelso, Washington	Hughes 369D	minor	1 fatal, 1 none
<p>The helicopter was departing from the logging area with an external load of cedar blocks when the load struck tree branches and fell to the ground. One cedar block struck and killed a ground crewmember. The report said that the company operating manual required that ground personnel clear the area before an aircraft departs and that the pilot conduct a vertical takeoff to a height clear of obstructions.</p>				
July 16, 1990	Ovando, Montana	Sikorsky S-58BT	substantial	none
<p>The pilot was preparing to pick up an external load when the no. 1 engine lost power. Flames were seen exiting the exhaust system. The pilot attempted to fly the helicopter to a suitable landing area, but rotor speed decreased. The pilot then conducted an autorotative landing. The report said that the engine failure was caused by a compressor-blade failure.</p>				
Aug. 7, 1990	Cougar, Washington	Aerospatiale SA-315B	substantial	1 serious
<p>The helicopter was hovering over trees at approximately 200 feet and picking up a load of logs when the engine lost power. The helicopter descended vertically and struck terrain. The report said that particles of sealant material were inside the engine-speed governor assembly.</p>				
Nov. 8, 1990	Trout Lake, Washington	Aerospatiale SA-315B	substantial	1 minor
<p>As the pilot released a load of logs, the helicopter drifted sideways and the external line became entangled with trees. The pilot released the external line but was unable to maintain control of the helicopter, which struck the trees and terrain. The pilot said that no mechanical failures or malfunctions preceded the accident.</p>				
Nov. 26, 1990	Mulino, Oregon	Hughes 369D	substantial	none
<p>A pick-up device on the external line became entangled with an unidentified object, and the external line contacted the main-rotor system. The pilot said that he attempted to conduct an autorotative landing, but rotor speed decreased, and the main-rotor blades struck and severed the tail boom.</p>				
May 21, 1991	Dog Fish Bay, Alaska	Bell UH-1B	destroyed	1 fatal
<p>The helicopter struck terrain while departing with a log on a 150-foot (46-meter) external line. The report said that the helicopter was loaded 1,660 pounds (753 kilograms) over maximum gross weight.</p>				
June 27, 1991	Index, Washington	Sikorsky S-64E	substantial	3 serious, 2 minor
<p>After landing to refuel, the pilot exited the helicopter, and the copilot remained in the helicopter to complete load reports. The engine continued to operate at full rpm, and the helicopter controls were unattended. The crew chief, who had become airsick, attempted to exit the helicopter and inadvertently moved the collective control. The helicopter lifted off and turned left. The tail rotor struck a trailer parked near the refueling site. The helicopter pitched nose-down, rolled over and struck the ground.</p>				
Feb. 23, 1992	Hobart Bay, Alaska	Bell 214B-1	destroyed	6 fatal, 5 serious
<p>At the pilot's request, a 30-foot (nine-meter) cable had been attached to the helicopter to dissipate static electricity. The pilot had picked up passengers and was flying the helicopter to the base camp when the flight encountered turbulence. The cable became entangled in the tail rotor, and the tail-rotor 90-degree gearbox separated. The pilot attempted an autorotative landing, and the helicopter struck tall trees.</p>				
March 6, 1992	Hobart Bay, Alaska	Bell 214B-1	substantial	2 serious
<p>The helicopter was hovering at approximately 200 feet AGL while a log was attached to the external line. The pilots heard a "loud bang," and the engine lost power. The pilots conducted an autorotative landing on steep, uneven terrain. The report said that the centrifugal impeller had failed because of fatigue from insufficient cooling.</p>				
July 28, 1992	Hayfork, California	Bell UH-1B	substantial	1 minor
<p>The pilot released a load of logs and was flying the helicopter back to the pickup area when he heard a "loud bang" that was followed by a left yaw and rapid loss of rotor speed. The pilot began an autorotative descent, and the helicopter struck trees. The report said that an O-ring had been installed improperly during maintenance conducted three days before the accident; the main-rotor drive shaft had lost lubrication, overheated and failed.</p>				
Nov. 10, 1992	Elf Point Camp, Alaska	Bell 206B-3	substantial	none
<p>The external line was dragged on the ground as the pilot conducted an approach to a landing site. The line became entangled with a stump, and the helicopter struck the ground.</p>				

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Nov. 27, 1992	Scotts Mills, Oregon	Hughes 369HS	substantial	none
<p>The pilot was receiving instruction on techniques for conducting operations with external loads of Christmas trees. The instructor was experienced in such operations. During an approach with a load of small logs, the pilot landed the helicopter hard, and the main-rotor blades struck the tail boom.</p>				
Feb. 19, 1993	Ketchikan, Alaska	Bell 214B-1	destroyed	2 fatal
<p>Witnesses said that the helicopter entered uncontrolled flight while hovering at 200 feet AGL with a load of logs on a 150-foot (46-meter) external line. The external load became entangled in tree stumps, and the helicopter struck the ground. The lower piston rod in the right dual-hydraulic-servo actuator had failed from fatigue. The report said that the helicopter was overloaded by 2,000 pounds (907 kilograms) and that the operator's records showed regular overloading of its helicopters.</p>				
May 2, 1993	Copper Harbor, Alaska	Bell 204B	substantial	1 fatal, 1 minor
<p>The helicopter logging operation required a steep descent from the pickup site at 1,200 feet to the drop site at 70 feet. The report said that the operation required the pilot to fly the helicopter "straight down in autorotation" and that the pilot had expressed reservations about being able to conduct the operation. The pilot conducted one descent and while flying the helicopter in a hover over the drop site, the tail rotor and the tail-rotor 90-degree gearbox separated. The report said that the helicopter had been operated with loads exceeding the external-line hook gross-weight limit. The report also cited inadequate quality control and material defects of the tail-rotor gearbox as factors that contributed to the accident.</p>				
May 8, 1993	Thorne Bay, Alaska	Bell 214B-1	substantial	2 minor
<p>The pilot said that as he maneuvered the helicopter to lift a log, he heard a loud noise that was followed by a loss of engine power. An autorotative landing was conducted on rough, downhill terrain. The report said that foreign-object damage to the engine had occurred because nuts had been improperly installed in the compressor case by maintenance personnel.</p>				
May 12, 1993	Anatone, Washington	Kaman HH-43F	destroyed	1 fatal
<p>The converted military helicopter was being used to lift an external load of logs when the main-rotor pylons separated. The pilot lost control of the helicopter, which descended to the ground. The report said that the transmission-rotor input-gear shaft had fractured because of fatigue that resulted from "improper certification/approval of the helicopter modification by the FAA." The FAA type certificate for the HH-43F includes an 1,100-shaft-horsepower (820-kilowatt) engine and an external-load limit of 2,300 pounds (1,043 kilograms). The FAA had approved the installation of a 1,400-shaft-horsepower (1,044-kilowatt) engine and operation with an external-load limit of 4,000 pounds (1,814 kilograms).</p>				
Oct. 18, 1993	Beckwourth, California	Aerospatiale SA-315	substantial	1 serious
<p>After lifting two logs, the pilot heard a loud "thunk" that was followed by an uncontrolled turn to the right. The pilot could not lower the collective control and, thus, was not able to maintain adequate rotor speed. The report said that an internal hydraulic leak in the collective servo had caused a hydraulic lock.</p>				
Nov. 9, 1993	Toledo, Washington	Bell 47G3B1	substantial	none
<p>While lifting an external load of Christmas trees, the pilot heard a "clunk" that was followed by a loss of power. The helicopter struck a tree during the autorotative landing. The report said that the transmission shear bolts had sheared. The pilot said that the bolts sheared because of power impulses from repeated engine-compressor stalls.</p>				
Nov. 12, 1993	North Bend, Washington	Hawkins & Powers UH-1B	substantial	1 minor
<p>The pilot heard loud "grinding" sounds and "banging" sounds emanating from the rear of the helicopter before he lost directional control. The pilot released the external load of logs and the external line, and executed a powered autorotation into trees. The report said that the 42-degree intermediate gearbox pinion gear had several fatigue cracks.</p>				
Nov. 26, 1993	Sublimity, Oregon	Hiller UH-12D	substantial	none
<p>The helicopter was transporting trees from a field to a truck when it collided with unmarked electrical-transmission wires. The pilot had examined the field before flight but did not see the wires.</p>				
Dec. 29, 1993	Mobile, Alabama	Kaman HH-43B/F	substantial	none
<p>After lifting a load of logs, the pilot experienced control problems with the helicopter. He released the load and the external line, and began an emergency descent toward a remote, temporary log heliport. The pilot lost control of the helicopter when he attempted to slow its descent rate. The report said that company maintenance personnel had failed to install a cotter pin that secured the retaining nut on the right-main rotor hub.</p>				
Feb. 23, 1994	Seaside, Oregon	Soloy H-23D	substantial	1 minor
<p>The helicopter was in a hover when the pilot released a sling load of wood and increased power. The helicopter began to descend, and the pilot was unable to arrest the descent. The helicopter struck terrain and rolled over. The report said that the helicopter settled with power because of the pilot's improper use of the flight controls.</p>				



## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
April 1, 1994	Rimrock, Washington	Hughes 369D	substantial	1 minor
The helicopter was in a hover at 125 feet AGL and zero forward airspeed when the engine failed. The pilot conducted an autorotation, and the helicopter landed hard and rolled over. The pilot said that the fuel supply had been exhausted. The report said that the height and velocity of the helicopter when the engine failed were not sufficient for a safe autorotative landing.				
May 27, 1994	Libby, Montana	Bell 204B	substantial	1 serious
The helicopter was being used to lift a log when the 42-degree gearbox input-pinion gear failed. The pilot released the log and began an emergency descent toward mountainous terrain. The report said that the pilot was attempting to initiate a landing flare when the helicopter stuck the terrain.				
July 17, 1994	Pilot Rock, Oregon	Bell UH-1B	substantial	1 serious
The pilot said that the helicopter began rotating left and that the anti-torque pedals would not move. The report said that no evidence of a mechanical deficiency was found during the postaccident inspection.				
Oct. 30, 1994	Willits, California	Kaman HH-43F	substantial	1 serious
The pilot had completed logging operations and was returning to the landing site when the engine flamed out. The pilot conducted an autorotative landing on the side of a hill. The helicopter then rolled down the hill and struck a tree. The report said that the engine flamed out because of fuel exhaustion.				
Oct. 31, 1994	Willits, California	Bell UH-1E	substantial	1 minor
The helicopter was departing from a drop site when the tail-rotor assembly struck a tree and separated. The pilot conducted an autorotative landing.				
Nov. 19, 1994	Yamhill, Oregon	Fairchild-Hiller FH-1100	substantial	1 serious
The helicopter was being maneuvered to pick up a load of Christmas trees when the external-load hook became entangled with a bundle of trees. The hook then became disentangled and rebounded into the main-rotor blades. The helicopter descended out of control.				
Feb. 13, 1995	Marblemount, Washington	Sikorsky S-58JT	substantial	1 serious
The main-rotor drive shaft failed while the pilot was conducting logging operations. The report said that the helicopter's height and velocity were not sufficient for a successful autorotation. The main-rotor drive shaft had accumulated 952 service hours after installation during a gearbox overhaul. Recommended gearbox overhaul time and main-rotor drive shaft retirement time are 2,500 service hours.				
April 22, 1995	Walla Walla, Washington	Bell UH-1B	substantial	1 serious
The pilot said that just after the load cleared the ground, the helicopter shuddered, emitted a loud "scraping" noise and lost rotor speed. The pilot released the load and maneuvered the helicopter for an emergency landing. During the maneuver, the helicopter collided with trees. The report said that the freewheeling one-way clutch assembly had failed.				
June 1, 1995	Umpqua, Oregon	Garlick TH-1L	destroyed	1 fatal
Witnesses saw the tail rotor strike a tree when the helicopter lifted a 3,000-pound (1,361-kilogram) log using a 150-foot (46-meter) external line. The pilot lost directional control, and the helicopter struck a rock bluff and came to a stop in an inverted attitude.				
Aug. 26, 1995	Emigrant Gap, California	Sikorsky CH-54A	substantial	none
While flying upslope with an external load of logs, the pilot heard an explosion. The helicopter pitched nose-up and rolled right. The pilot began to conduct a forced landing, and the copilot attempted to release the load. The report said that neither crewmember verified load release. The cargo hook struck the ground, opened and released the logs. The main-rotor blades struck several trees before the helicopter touched down and rolled onto its left side. The report said that compressor stalls had occurred in the right engine.				
Sept. 18, 1995	Grace, Idaho	Bell UH-1L	substantial	1 serious
When the helicopter's military-variant engine lost power, the pilot released the external load of logs and conducted an autorotative landing. The engine's centrifugal impeller had separated because of fatigue cracking in one of the drain holes. The report said that an FAA airworthiness directive (AD) required inspection of the centrifugal impellers in civilian variants of the engine but not in military variants of the engine.				
Nov. 9, 1995	Crystal, Michigan	Hughes 369D	substantial	none
The helicopter was at approximately 50 feet AGL, lifting a load of trees, when the engine lost power. A witness observed "black smoke around the ship" as the helicopter descended. The helicopter's right skid collapsed during the autorotative landing. The report said that the helicopter's fuel-sump screen contained water and that the refueling truck's pump filter had been installed at an incorrect angle, allowing water to enter the helicopter's fuel system.				
Nov. 29, 1995	Scotts Mills, Oregon	Hughes 369D	substantial	1 minor
While the helicopter was being maneuvered to pick up a load of Christmas trees, the external line and hook contacted the ground. The hook bounced up, struck a main-rotor blade and ricocheted into the tail boom. The tail boom separated, and the pilot lost control of the helicopter.				

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Dec. 20, 1995	Feather Falls, California	Hughes 369D	destroyed	1 fatal
<p>The pilot was maneuvering the helicopter near a logging site when the sling load struck trees and terrain near a ridge. Witnesses saw the helicopter shake and oscillate before it spun to the ground with the external line still attached.</p>				
April 4, 1996	Rainier, Washington	Bell UH-1H	substantial	none
<p>While preparing to pick up a load of logs, the pilot heard several changes in engine noise and two "loud bangs." The engine then lost power, and the pilot conducted an autorotative landing. The report said the ex-military engine's forward bearing had disintegrated. The engine had accumulated 4,202 service hours, including 199 service hours in civilian operations. Nonmandatory Service Bulletin No. 0056 recommended procedures for replacing the forward bearing with an improved forward bearing.</p>				
July 13, 1996	Ketchikan, Alaska	Sikorsky CH-54A	destroyed	1 fatal, 1 serious
<p>The military-surplus helicopter was being used to lift a load estimated to weigh 18,000 pounds (8,165 kilograms) when ground personnel heard a "popping" sound and saw the tail rotor begin to slow and the helicopter begin to spin. The helicopter descended onto sloping terrain in an area of cut logs. The tail-rotor drive shaft had failed at the no. 5 bearing position. The report said that possible factors in the drive-shaft failure were inadequate handling/labeling of the relubricated bearing by intermediate suppliers, and/or insufficient shelf life/service limits for military-surplus parts.</p>				
Aug. 12, 1996	Coeur d'Alene, Idaho	Garlick UH-1H	substantial	1 serious
<p>During external-load logging operations, the helicopter's vertical stabilizer and tail rotor separated from the tail boom. The helicopter then descended out of control. The report said that a fatigue fracture had occurred in the left side of the forward vertical-stabilizer spar.</p>				
Nov. 5, 1996	Leavenworth, Washington	Garlick TH-1L	destroyed	1 fatal
<p>The pilot was maneuvering the helicopter from a hover to lift a log when the vertical stabilizer separated. The helicopter descended out of control and struck wooded, sloped terrain. Postaccident examination of the vertical stabilizer disclosed fatigue fractures emanating from a rivet hole in the left spar cap. The report said that the operator had exceeded the design stress limits of the helicopter.</p>				
Nov. 16, 1996	Forks, Washington	Hughes 369D	substantial	1 serious
<p>The engine lost power, and the helicopter struck trees during the emergency landing. The report said that fuel contamination disrupted the flow of fuel through the engine fuel nozzles. Contaminants were found in fuel samples from the storage tank and the helicopter fuel filter.</p>				
Nov. 18, 1996	Ballston, Oregon	Bell 206B-3	substantial	1 serious
<p>Witnesses said that the helicopter lifted a load of Christmas trees, began a left turn and then spun to the ground. The report said that there was no evidence of airframe or engine malfunction.</p>				
May 22, 1997	Lolo, Montana	Garlick UH-1H	substantial	none
<p>The pilot said that the fuel gauge showed 150 pounds (68 kilograms) of fuel remaining, and he decided to transport a large stump to a slash pile before landing the helicopter at the service area, which was about 40 feet (12 meters) from the stump. The pilot was flying the helicopter in a hover about 150 feet above the stump when the engine lost power because of fuel exhaustion. The pilot conducted a tight spiraling descent, and the helicopter touched down hard in the landing area.</p>				
June 3, 1997	Addy, Washington	Garlick UH-1H	substantial	none
<p>The pilot said that he heard a "high-speed shredding" sound and felt a vibration during cruise flight. He released the external line and began a descent. He then heard another loud noise, and rotor speed began to decrease. The helicopter struck four small trees and pitched over, and the main-rotor blades severed the tail boom. The report said that fatigue cracks were found in the drive shaft.</p>				
Aug. 27, 1997	Skykomish, Washington	Southern Aero UH-1B	destroyed	1 fatal
<p>The helicopter struck the ground after the main-rotor system separated in flight. The report said that a fatigue fracture had occurred in the main-rotor mast. The "thin-walled" mast tube had accumulated 4,007 hours in service. An FAA airworthiness directive in 1997 established a 6,000-hour life limit on thin-walled mast tubes in civilian versions of the helicopter. The U.S. Army in 1984 ordered thin-walled mast tubes removed from UH-1H helicopters.</p>				
Nov. 8, 1997	Forest Grove, Oregon	Bell 206B	substantial	none
<p>The pilot was conducting an approach over a ridge to a pickup area in a basin. He said that as the helicopter decelerated, he heard a "loud bang." The helicopter turned left, rolled right and struck trees and terrain. Witnesses said that the external line had swung forward and up in front of the helicopter, and the main-rotor blades had separated from the helicopter. Cable marks were found on one main-rotor blade and on one tail-rotor blade.</p>				
May 19, 1998	Hope, Idaho	Garlick UH-1H	substantial	none
<p>The pilot said that he was maneuvering to pick up a load of logs when he heard a "weird squealing noise [from the engine], followed by a constant series of compressor stalls." Ground crewmembers said that smoke and flames were emitted from the tail pipe. The pilot turned the helicopter toward a clearing and released the external line. The engine then lost power, and the helicopter was landed hard in the clearing.</p>				

## Appendix

### Helicopter Accidents During U.S. Helicopter Logging Operations, 1983–1999

Date	Location	Helicopter Type	Helicopter Damage	Injuries
June 18, 1998	Coeur d'Alene, Idaho	Garlick UH-1H	substantial	none
<p>The pilot was conducting an approach to drop a load of logs when he heard a "loud metallic bang" from the rear of the helicopter. The engine then lost power. The pilot released the load and the external line, and landed the helicopter on a disused logging road. The helicopter rocked backward on touchdown and then rolled onto its left side. The report said that the output-reduction gearbox had been damaged by fatigue on the outside of the no. 1 planet-gear shaft.</p>				
July 9, 1998	Raymond, Washington	Hughes 369D	minor	1 fatal, 1 none
<p>The helicopter was being used to lift a load of cedar-shake blocks when one of the two external-line splices failed, releasing the load. A ground crewmember was struck and killed by debris. The report said that an examination of the other external-line splice showed that the splice did not meet accepted industry standards.</p>				
July 24, 1998	Libby, Montana	Garlick UH-1H	substantial	1 serious
<p>The helicopter was departing from the pickup area with a load of large tree roots when the roots contacted the ground. The composite-material external line snapped and rebounded into the tail rotor. The pilot attempted to land in a clearing, but the helicopter struck trees before reaching the clearing.</p>				
Aug. 10, 1998	Oso, Washington	McDonnell Douglas 369D	substantial	1 minor
<p>The pilot was flying the helicopter at about 250 feet AGL when he heard a "bang" and saw the tail-rotor gearbox go forward past the left side of the helicopter. The helicopter then pitched over and began to turn right rapidly. The pilot conducted an autorotative landing. The report said that the tail-rotor gearbox, tail-rotor output shaft, fork assembly, tail-boom fitting and flex coupling showed signs of overload failure. The tail-rotor blades were not recovered.</p>				
Sept. 19, 1998	Price, Utah	Bell UH-1L	substantial	1 minor
<p>The pilot was hovering the helicopter over a pickup site with a left-quartering crosswind when the helicopter began to turn right. The pilot applied full pressure on the left anti-torque pedal, but the right turn continued. The pilot conducted an autorotative descent. The landing skids struck a beaver dam, the helicopter bounced into the air and pitched over, and the main-rotor blades struck the ground.</p>				
Oct. 5, 1998	Big Sky, Montana	Aerospatiale SA-315B	substantial	1 minor
<p>A ground crewmember inadvertently attached the helicopter's external line to a log that was still rooted to the ground. When the pilot attempted to lift the log, the helicopter stopped abruptly and pitched backwards. The pilot attempted to release the external line, but the release device (hook) jammed because a clevis (a U-shaped yoke) of improper size had been attached to the hook. The helicopter then struck the ground.</p>				
Dec. 14, 1998	Darrington, Washington	Garlick UH-1H	substantial	1 serious
<p>The pilot flew the helicopter in a hover while ground crewmembers attached a load of logs to the 150-foot (46-meter) external line. The pilot then was maneuvering the helicopter to remove slack from the external line when he heard a "loud bang." The vertical fin had separated, and the helicopter spun right and descended into the terrain. The report said that all five layers of the left side of the vertical fin had fatigue cracks.</p>				
March 2, 1999	Shelton, Washington	Sikorsky S-64E	none	1 fatal, 2 none
<p>The helicopter was being used to position a log for delivery at a collection area when one of the two choker lines around the log failed to separate immediately when the long-line release mechanism was operated. One end of the log was lifted back into the air, then fell and struck and killed a ground crewmember who had entered the collection area before both choker lines separated from the long line.</p>				
June 8, 1999	South Bend, Washington	Hughes 369D	substantial	1 minor
<p>The pilot heard a "loud bang" after releasing an external load and increasing power to depart from the log-collection area. The helicopter began to spin left and descend rapidly. The pilot applied full collective control, and the helicopter landed hard. The report said that a three-inch section of the engine compressor impeller disc had separated from the impeller because of fatigue cracks that propagated from corrosion pits.</p>				
Sept. 21, 1999	Usk, Washington	Garlick UH-1H	substantial	none
<p>The pilot released an external load of logs after losing tail-rotor control. The helicopter then struck terrain. The report said that the tail-rotor 90-degree gearbox mounting studs apparently had sheared.</p>				
Dec. 3, 1999	Salem, Oregon	Hughes 369E	substantial	1 minor
<p>The pilot was flying the helicopter to the pick-up area at 30 feet to 50 feet AGL when he heard a "bang" and released the external line. The pilot then lost tail-rotor control, and the helicopter began to spin right. The main-rotor blades struck and severed the tail boom during the forced landing. The report said that there was evidence that the tail-rotor blades had struck the external line.</p>				

Source: Patrick R. Veillette, Ph.D., from reports by the U.S. National Transportation Safety Board

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