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External Loads, Powerplant Problems And Obstacles Challenge Pilots During Aerial Fire Fighting Operations

U.S. accident reports from 1974–1998 show that diversion of attention was a major factor in accidents during external-load operations, which accounted for more than half of the accidents. Powerplant malfunctions and powerplant failures were involved in more than a third of the accidents. More than a quarter of the accidents occurred when helicopters struck obstacles, such as trees and wires, during fire fighting missions.

Patrick R. Veillette, Ph.D.

Helicopter operations in support of fire fighting activities in the United States typically are conducted in remote areas where rugged terrain and adverse flight conditions present unique risks for the aviators. Table 1 (page 2) shows that since 1955, there have been 24 fatal helicopter accidents, in which 45 crewmembers were killed, during aerial fire fighting operations.[1]

Table 2, page 2 shows the accident rates for helicopters during U.S. aerial fire fighting operations in five-year periods from 1961 to 1995. The aerial fire fighting accident rates are high, compared with accident rates in other helicopter operations. For example, rotorcraft were involved in 18.60 accidents per 100,000 hours flown in aerial fire fighting in 1981–1985.[2] U.S. National Transportation Safety Board (NTSB) data show that, in all civilian flight operations during the same period, turbine-powered rotorcraft were involved in 8.01 accidents per 100,000 hours.

This report examines rotary-wing aerial fire fighting operations but recognizes that fixed-wing aircraft also play a major role in aerial fire fighting.[3]

To identify accident causes and potential methods of improving U.S. helicopter aerial fire fighting safety, the author conducted a study that included the following:

- Analysis of official reports on 97 helicopter accidents that occurred in direct support of U.S. aerial fire fighting operations from January 1974 through December 1998 (see Appendix, page 9), with follow-up interviews of accident investigators and some witnesses, and inspections of some accident sites;
- Examination of training documents and training courses;
- Examination of operating specifications and manuals;

Table 1
Aircraft Accidents During U.S. Aerial Fire Fighting Operations, 1955–1997

Aircraft	Accidents	Fatalities
Helicopters	24	45
Airplanes	124	202
Total	**148**	**247**

Source: Patrick. R. Veillette, from Bushey, Chuck. "Wildland Fire/Aircraft Firefighter Fatalities in the United States Compared with Ground Based Firefighter Fatalities." In *Proceedings of the First Canada/U.S. Wildland Fire Safety Summit, Rossland, British Columbia, Canada, 29 Sep.–Oct. 1997*. Fairfield, Washington, U.S.: International Association of Wildland Fire, 1997.

- Examination of aircraft; and,
- Inspections of some fire bases.

The study produced the following major findings:

- Forty-two of the 97 accidents occurred while helicopters were being maneuvered for reconnaissance, to release water or chemical retardant on fires, to deliver external loads or to deliver firefighters to the fire area. Human error was involved in 18 of the accidents;
- Sixteen accidents occurred during the en route phase of flight. Human error was involved in nine of the accidents;
- Sixteen accidents occurred during landing approaches. Human error was involved in 12 of the accidents; and,
- Human error was the leading accident cause. Factors contributing to human error were deficiencies in pilot judgment, loss of situational awareness and noncompliance with standard operating procedures (SOPs).

Formal documentation of SOPs improved with the publication in May 1994 of the *Interagency Helicopter Operations Guide* (IHOG). Published by the National Interagency Fire Center, the IHOG establishes procedures for operating helicopters for the U.S. Department of Agriculture and the U.S. Department of the Interior. The IHOG also sets standards for crewmember experience and training. The second edition of IHOG was published in January 1998.

The aircraft used in aerial fire fighting operations frequently are operated as "public aircraft" (commonly called public-use aircraft), which are exempt from some U.S. Federal Aviation Regulations (FARs).[4,5] Many regulations governing pilot certification, pilot training, aircraft operations and aircraft maintenance apply to "civil aircraft," which by definition do not include public-use aircraft.

Before April 1995, many accidents and incidents involving public-use aircraft were investigated only by the agencies that operated the aircraft. U.S. regulations adopted in April 1995 require that NTSB be notified of, and investigate, all public-use aircraft accidents and incidents.

Reports on some accidents investigated only by the respective operating agencies were not available for analysis; thus, the exact number of helicopter aerial fire fighting accidents in 1974–1998 is unknown.

Analysis of the 97 reports available for this period shows that eight accidents involved fatalities and that 25 accidents involved serious injuries. Eleven people were killed, 56 people were seriously injured, and 31 people received minor injuries.

Figure 1 shows that 41 nonfatal accidents and one fatal accident occurred as helicopters were being maneuvered for reconnaissance, to drop water or chemical retardant on fires or to deliver cargo and/or firefighters to fire areas. Figure 2 shows that 17 of the maneuvering accidents were caused by

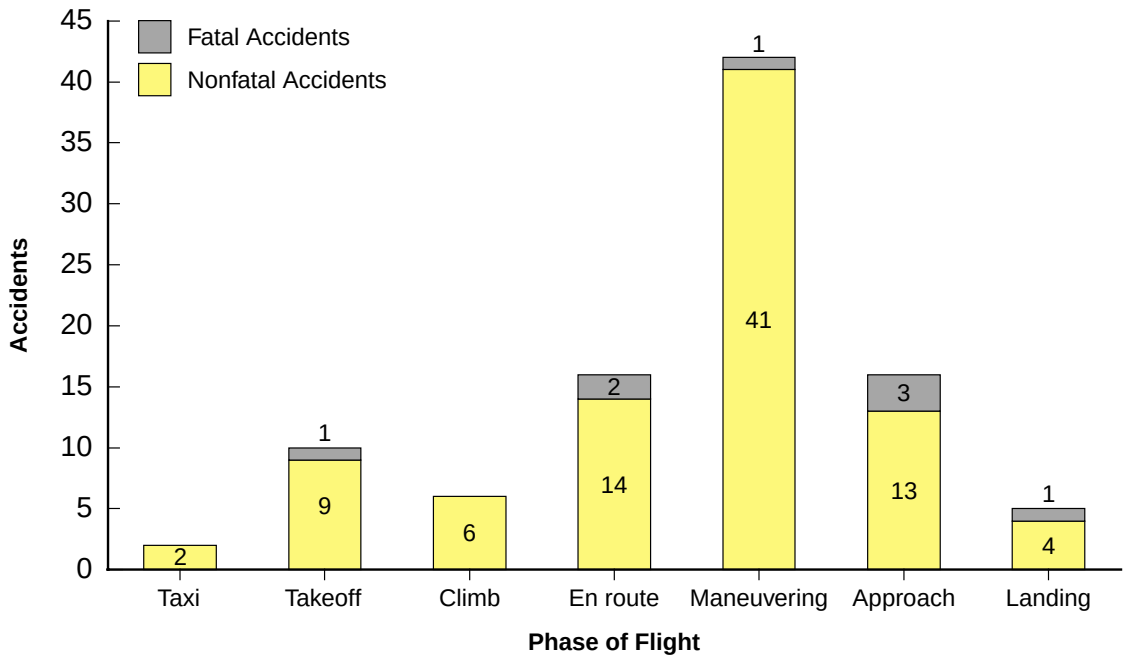
Table 2
U.S. Aerial Fire Fighting Helicopter Accidents, 1961–1995

Years	Hours Flown	Total Accidents	Fatal Accidents	Total Accident Rate*	Fatal Accident Rate*
1961–1965	71,000	29	NA	40.84	NA
1966–1970	102,000	46	NA	45.10	NA
1971–1975	126,000	33	NA	26.19	NA
1976–1980	103,000	32	1	31.07	0.97
1981–1985	86,000	16	2	18.60	2.33
1986–1990	108,854	18	1	16.54	0.92
1991–1995	135,262	14	3	10.35	2.22

* per 100,000 hours flown
NA = Not available

Source: Patrick R. Veillette, from U.S. Department of Agriculture, *Aviation Accident and Incident Trend Study, Letter to the Director, Fire and Aviation Management*. A special report prepared at the request of the U.S. Forest Service. March 1996.

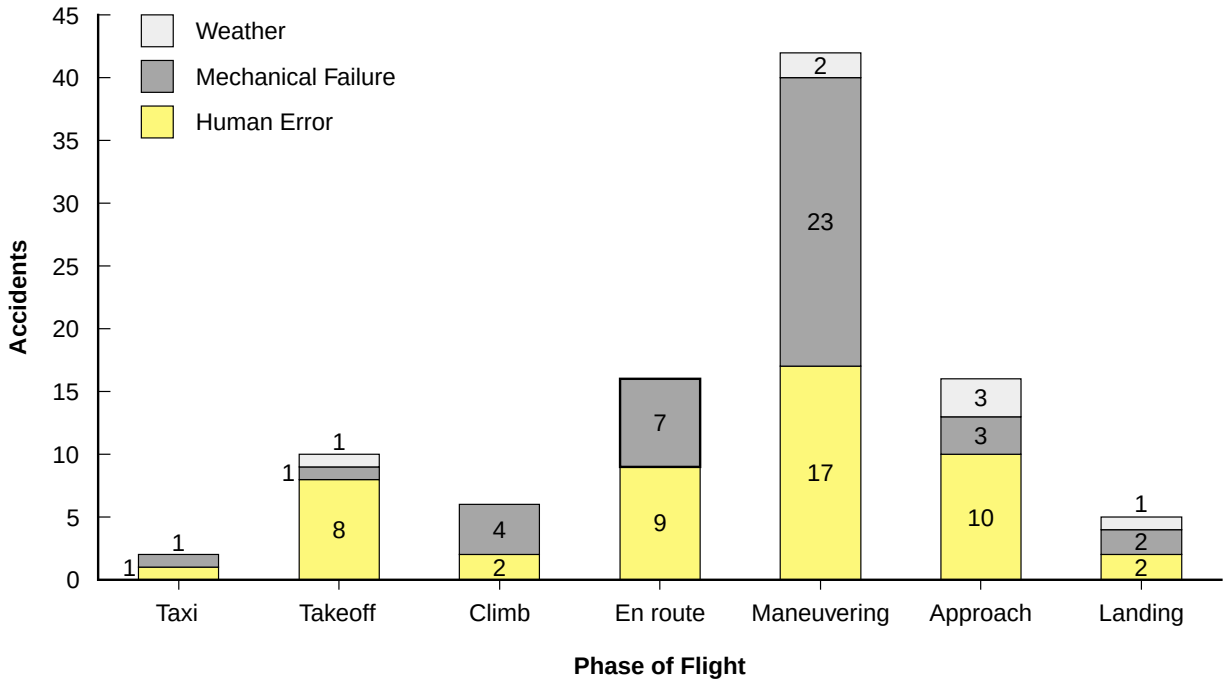
Phase of Flight for 97 U.S. Aerial Fire Fighting Helicopter Accidents, 1974–1998



Source: Patrick R. Veillette

Figure 1

Involvement of Weather, Mechanical Failure and Human Error by Phase of Flight In 97 U.S. Aerial Fire Fighting Helicopter Accidents, 1974–1998



Source: Patrick R. Veillette

Figure 2

human error, 23 accidents were caused by mechanical failure, and two accidents were caused by adverse weather conditions.

Maneuvering typically is conducted for extended periods at low altitudes in steep, mountainous terrain where maneuvering room is limited. Helicopters often are flown in smoke, gusty winds and in close proximity to other aircraft. High density altitude often reduces hovering capability. Maneuvering at low altitudes and slow airspeeds reduces the probability of a successful autorotative landing if a powerplant fails.

Fourteen nonfatal accidents and two fatal accidents occurred during the en route phase of flight — that is, while helicopters were being flown to a fire area or returning to a helibase. Nine en route phase accidents were caused by human error, and seven accidents were caused by mechanical failure.

Thirteen nonfatal accidents and three fatal accidents occurred during the approach phase of flight. Ten approach-phase accidents involved human error, three accidents were caused by mechanical failure, and three accidents were caused by adverse weather conditions (downdrafts in each case).

Nine nonfatal accidents and one fatal accident occurred during takeoff. Eight takeoff accidents involved human error, one accident involved mechanical failure, and one accident involved adverse weather conditions. Most accidents occurred when helicopters struck obstacles while taking off in confined areas. Misrouted external-load cables were factors in four takeoff accidents.

Six nonfatal accidents occurred during the climb phase of flight. Two climb accidents involved human error, and four accidents involved mechanical failure (engine failures).

Four nonfatal accidents and one fatal accident occurred during landing. Two landing accidents involved human error, two accidents involved mechanical failure, and one accident was caused by adverse weather conditions.

External loads were involved in 55 accidents. Pilot workload is high during external-load operations. Twenty-four external-load accidents involved diversion of the pilots' attention from aircraft control. Sixteen external-load accidents were caused by powerplant failures; nine of these accidents occurred when helicopters were being flown at low altitudes or low airspeeds (or both).

All external loads are attached to helicopters with cargo hooks, which must be approved by the U.S. Federal Aviation Administration (FAA). The cargo hooks must be designed to enable the pilot to jettison the external load, either manually or electrically. External loads had important safety implications because of the high density altitude and limited maneuvering room that are common in aerial fire fighting operations. Helicopters carry water buckets with maximum-load ratings that range from approximately 1,000 pounds to 18,000 pounds (454 kilograms to 8,165 kilograms).

Pilots attempted to jettison external loads in 18 of the 55 external-load accidents. Malfunctions of the external-load line, water bucket or snorkel (a tube-like device used to fill water tanks inside or attached to helicopters) occurred in seven accidents.

Nineteen external-load accidents occurred when helicopters or helicopter external loads struck obstacles (typically, trees and wires) while the helicopters were being maneuvered. When maneuvering a helicopter to drop water on a fire, the pilot concentrates attention on the external load, the engine instruments, aircraft stability and the departure path; the pilot's ability to scan all around the helicopter for obstacles sometimes is diminished.

Eight external-load accidents occurred when helicopters settled under power.[6]

Four external-load accidents were caused by misrouted cables. All the accident aircraft became uncontrollable when their centers of gravity moved beyond limits.

Thirty-four accidents were caused by powerplant failures. Thirty-one accident aircraft were not within range of a suitable area for a safe autorotative landing; 25 of these accidents involved low main-rotor speed and high sink rates. Rugged terrain was a factor in 32 powerplant-failure accidents.

Twenty-seven accidents occurred when helicopters struck obstacles during normal operations (i.e., not during emergency landings). Nineteen helicopters struck trees; eight of these accidents involved collisions with trees that were behind the aircraft. Eight tree strikes occurred when the pilots were performing vertical-reference work, which typically involves leaning outside the cockpit and looking down. Six helicopters struck unmarked wires.

The pilots' attention was diverted in 25 obstacle-strike accidents. Crews misjudged obstacle clearance in 10 of the accidents. Twenty-one helicopters were being operated in confined areas when they struck obstacles.

Sixteen accidents were caused by loss of tail-rotor effectiveness (LTE). Nine LTE accidents were caused by mechanical failures; four of the accidents involved external loads that either became entangled with the tail-rotor system or struck the tail-rotor system. Four LTE accidents were caused by adverse winds. Three LTE accidents occurred at high density altitudes.

Gusty winds and low-level turbulence were factors in 33 maneuvering accidents and 12 approach-and-landing accidents. All of these accidents involved errors in judgment about the effects of gusty winds and turbulence on aircraft performance.

Fifteen accidents were caused by downdrafts. Only three of the accident pilots had received weather forecasts warning of the possibility of downdrafts.

Twenty-four accidents occurred during takeoffs or landings on sloped terrain. Four slope-operation accidents involved dynamic rollovers.[7]

Fifty-eight accidents occurred in density altitudes above 7,000 feet. High density altitude specifically was cited as a contributing factor in 13 accident reports. Helicopters were being hovered out of ground effect in seven of the high-density-altitude accidents.

High density altitude reduces available engine power, often in situations involving a heavy external load or a heavy payload that increases the engine power required for the mission.

Seven accidents involved miscalculated loads and/or incorrect performance calculations. Crewmembers of three accident helicopters computed hover-in-ground-effect performance, but failed to recognize that hover-out-of-ground-effect (HOGE) conditions would exist at the helispot (a temporary landing area) and did not calculate HOGE performance.

Figure 3 shows that 82 accidents occurred in the months of June, July, August and September. This is the period in which the greatest fire activity occurs in the western United States. The tempo of aerial fire fighting operations increases significantly during this time, thus increasing the risk of fatigue-related accidents and incidents.

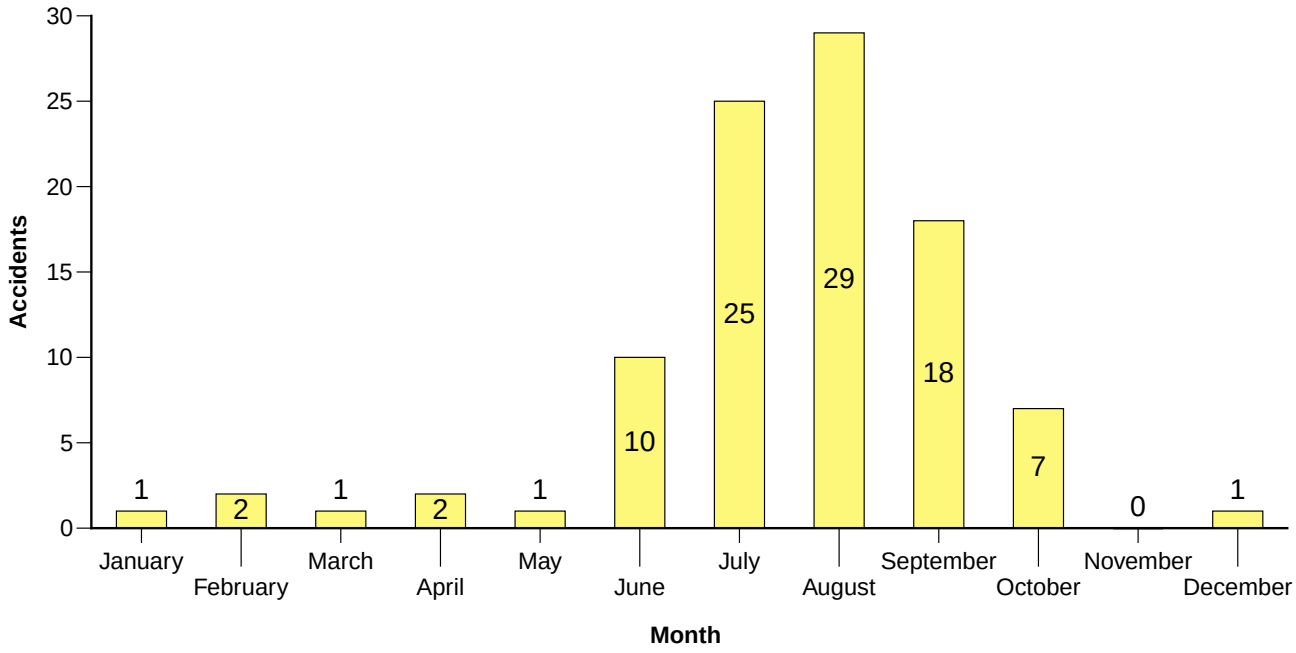
Most aerial firefighters are paid a base salary plus compensation for flight time and for overtime (duty time and flight time beyond limits specified in their contracts). Many of these aviators and crewmembers work on a seasonal basis and welcome the opportunity for overtime compensation.

Nevertheless, the U.S. Forest Service (USFS) and some other aerial fire fighting agencies have adopted FARs Part 135 duty-time restrictions and flight-time restrictions. The duty-time limit for aerial firefighters is 14 hours; during that time, they may fly a maximum of eight hours. A two-day rest period is required in any 14-day period. The USFS has guidelines for further restriction of duty time and flight time during periods of heightened fire activity.

A survey of aerial firefighters showed that short-term fatigue, long-term fatigue and heat-related stress sometimes are experienced during periods of intense fire fighting operations.

Eleven accident reports said that crewmember fatigue was a possible factor. The actual incidence of fatigue-related errors is likely much higher. Studies have shown that fatigue typically

Distribution by Month of 97 U.S. Aerial Fire Fighting Helicopter Accidents, 1974–1998



Source: Patrick R. Veillette

Figure 3

is under-reported in accident reports and incident reports. An analysis of U.S. Aviation Safety Reporting System reports, for example, showed that fatigue specifically was cited in only 3.8 percent of the sample reports, although evidence of fatigue appeared in 21.2 percent of the sample reports.[8]

All the fatigue-related accidents occurred during the hours of 1500–1900, that is, during the late afternoon and early evening. The reports did not say how many flights the crews had conducted during the morning or early afternoon on the days the accidents occurred. Because most aerial fire fighting operations are conducted during daylight and involve multiple flights, the possibility exists that the risk of fatigue was increased. (Accident reports did not provide such details.)

No accidents occurred during the first few days after pilots returned from the two-day rest periods required by the USFS and other government agencies. All 11 fatigue-related accidents occurred more than seven days after pilots returned to duty after two-day rest periods.

Fifteen accidents involved postaccident fires. Thirteen postaccident-fire accidents occurred in off-airport locations, where prompt response by aircraft rescue and fire fighting services was not possible.

Eleven postaccident fires began after the aircraft came to rest. Two postaccident fires began more than one minute after the aircraft came to rest. One postaccident fire began during the impact sequence. One postaccident fire was ignited by a wildfire.

Four reports on accidents involving postaccident fires said that the engine was the most likely ignition source. A hot aircraft surface ignited three postaccident fires. The ignition source was not determined in eight postaccident fires. Fuel tanks were ruptured in two accidents, drenching the aircraft occupants with aviation fuel.

Several accident reports said that postaccident fires were made worse by improperly labeled and improperly secured cargo that either ignited, added combustible material to the fire or impeded occupant evacuation from the helicopters.

The IHOG requires personal-protection equipment (PPE) to be worn by firefighters. PPE typically includes fire-resistant Nomex flight suits or fire fighting clothing, Nomex gloves or leather gloves, and ankle-length leather boots. PPE generally was effective in protecting the accident crewmembers.

Flight helmets (commonly the military SPH-4 helmet) are worn by most helicopter pilots and crewmembers (see "Helicopter Crews Conduct Numerous Fire Fighting Activities").[9] Hard hats are required to be worn by all ground firefighters while working in the fire area and while riding in a helicopter.

Helicopter Crews Conduct Numerous Fire Fighting Activities

Helicopters are used for a variety of aerial fire fighting missions in the United States. Transportation of personnel is a common mission; firefighters can travel to fires in remote and rugged areas more expeditiously in helicopters than in ground vehicles or by foot.

Helicopters transport "hot-shot" teams (elite 20-person fire fighting crews) and helitak (helicopter-attack) crews. Helitak crewmembers are qualified to fight fires, manage helispots (temporary landing areas), marshal flight activities and ground activities at landing sites, and perform other duties.

When transporting firefighters, helicopter pilots often must find a suitable landing site near the fire. Some firefighters, called heli-rappellers, are trained to rappel (descend by rope) from helicopters onto terrain that is not suitable for landing. Two heli-rappellers exit simultaneously from opposite sides of the helicopter; this procedure is designed to ensure that the helicopter's center of gravity remains within limits during the operation.

Helicopters often are used to light backfires ahead of spreading wildfires to starve the wildfires of fuel. Helicopters also are used in controlled-burning operations, in which fires are deliberately set to control the spread of a wildfire. Backfires and controlled burns also are lighted by ground personnel.

The ignition devices carried by helicopters include small (1.25-inch [3.2-centimeter]) polystyrene balls containing potassium permanganate. The balls are injected with ethylene glycol before they are dropped from the helicopter by a dispensing unit; the chemical reaction causes the balls to ignite after they are on the ground.

Helicopters also carry helitorches, which dispense and ignite gelled gasoline or gelled diesel fuel. Helitorches are suspended from cargo hooks and can be jettisoned in an emergency.

Helicopters are used for fire patrol and reconnaissance, and are equipped with infrared-detection systems to detect hot spots in wildfires.

Helicopters are used extensively to drop water — or a mixture of foam and water — on wildfires. A number of different tankage systems and delivery systems are used. A bucket suspended on a long line is a common delivery system. Some buckets are adjustable so that they cannot carry a load that will exceed the helicopter's performance capability. The buckets are filled at dip sites, such as lakes and rivers, or from tanks assembled and filled near suitable landing sites. Some helicopters carry water in internal tanks that are refilled through a snorkel (a tube-like device) while the helicopter hovers over a dip site.

Helicopters also are used to deliver external loads of cargo and supplies to ground-based firefighters, and for command and control of fire fighting operations conducted by the crews of other helicopters.

During a command-and-control flight, a helicopter coordinator aboard the aircraft develops overall fire fighting strategy in conjunction with air-tactical-group supervisors, inspects fire zones for hazards, assigns specific tasks to helicopter crews, and coordinates with the crews of other aircraft for the safe operation of both fixed-wing aircraft and rotary-wing aircraft.

Federal agencies that utilize helicopters for aerial fire fighting include the U.S. Department of Agriculture's Forest Service and the following agencies of the U.S. Department of the Interior: Bureau of Indian Affairs; Bureau of Land Management; Fish and Wildlife Service; and National Park Service.

These agencies utilize contractors for most helicopter operations. The contractors generally operate on either an exclusive-use basis or a call-when-needed (CWN) basis.

Exclusive-use helicopters are available only for aerial fire fighting operations. The contractors' helicopters and pilots are inspected by the contracting agency before the fire season begins. The pilots and other helicopter crewmembers typically work with a government helicopter manager during the fire season.

Crewmembers are expected to comply with the standard operating procedures set forth in the *Interagency Helicopter Operations Guide*. The crewmembers and the helicopter manager usually have the opportunity early in the fire season, when activity is low, to become acquainted with each other and to discuss crew-coordination issues.

CWN helicopters and pilots are used when increased fire fighting activity requires more resources. CWN crewmembers often begin working with a government helicopter manager when the crewmembers arrive in the fire area.

Nonpilot crewmembers have critical roles in safety. They perform important tasks, such as weighing, manifesting and loading cargo; hooking up external loads; and marshaling ground activities and flight operations at landing sites.

Many state agencies utilize helicopters for aerial fire fighting. Many agencies use contractors, but some agencies operate their own helicopters. During periods of intense fire activity, many states activate their National Guard helicopter units.

Numerous county governments and city governments also operate helicopters for aerial fire fighting.♦

— Patrick R. Veillette

Damage to helmets and hard hats worn by 15 occupants in nine helicopter accidents showed that the helmets and hard hats absorbed significant impact forces. Five accident pilots said that their flight helmets saved their lives. In five accidents, a total of three flight helmets and nine hard hats were knocked off the victims' heads.

All helicopters are required to have FAA-approved double-strap shoulder harnesses with automatic-locking inertia reels for each front-seat occupant. Lap belts are required for all aft-seat occupants. If shoulder harnesses are installed on aft seats, the occupants are required to wear them.

Crewmembers who conduct special activities — such as rappelling, aerial ignition and infrared sensing — are required to wear approved harnesses. The harnesses must have a quick-release system and should be attached to a helicopter hardpoint (a structure designed to accommodate the external load).

Emergency medical response is most effective when treatment is administered to trauma patients within "the golden hour" — that is, within the first hour of injury. The remote and rugged areas in which most aerial fire fighting operations are conducted, however, impedes quick response.

Twenty-six accidents required search-and-rescue (SAR) efforts. Nineteen searches were conducted in aircraft, five searches were conducted in ground vehicles or by foot (or both), and two searches were conducted in boats.

Sixteen accidents requiring SAR immediately were reported to dispatch centers and coordination centers; most of the accidents occurred near significant fire activity and were observed by other firefighters. Seven accidents were reported within 15 minutes by dispatchers who did not receive position reports from the pilots (the IHOG requires that helicopter pilots make position reports every 15 minutes during mission flights). Three accident helicopters were reported missing more than one hour after the accidents occurred.

Eight accident helicopters were located immediately by firefighters. Seven helicopters were found between one minute and 15 minutes after the accidents occurred. Six helicopters were found between 15 minutes and 30 minutes after the accidents occurred. Five helicopters were found more than one hour after the accidents occurred.

In 20 accidents, debris from helicopters caused minor injuries to ground personnel. Helicopters have several components

that rotate at high speeds and can travel significant distances if they separate from the aircraft. Crewmembers who work near operating helicopters are required to wear protective equipment, such as goggles, hearing protection, helmets, long-sleeve shirts, trousers and boots.

Eleven accident aircraft descended into water in lakes or rivers. All the water-accident reports said that crewmembers had difficulty escaping from the helicopters. Some crewmembers were hindered during egress because of injuries, disorientation, in-rushing water, confusion or rotor wash from other helicopters flying overhead.

The IHOG requires that personal flotation devices (PFDs) be worn by crewmembers during all operations beyond autorotation distance from shore. Nevertheless, helicopter crewmembers rarely wear PFDs.

Few aerial fire fighting crewmembers receive training in water egress from downed aircraft. In eight water accidents, occupants had to escape from submerged helicopters. Research has shown that the average person, when immersed in cold water, can hold his or her breath for 17.2 seconds, plus or minus 3.7 seconds.[10] Studies of water accidents involving military helicopters and civilian helicopters, however, show that successful underwater escape requires 40 seconds to 60 seconds.[11]

None of the water-accident helicopters was equipped with a helicopter emergency flotation system (HEFS), which is designed to keep the helicopter level and the cabin above the water line. Despite the advantages of a HEFS in a water accident, when deployed the system has obstructed cockpit hatches.[12]

U.S. helicopter aerial fire fighting safety might be improved by better human-error management, crew training and experience, management of risk in low-altitude operations, aircraft maintenance and ergonomic design for external-load operations.♦

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5. FAA. AC 20–132, *Public Aircraft*, Dec. 21, 1988.

6. FAA AC 61-13B, *Basic Helicopter Handbook*, describes settling with power as follows: "This condition of flight is sometimes described as settling in your own [main-rotor] downwash. It involves high vertical rates of descent, and the addition of more power produces an even greater rate of descent."

7. FAA AC 90-87, *Helicopter Dynamic Rollover*, describes dynamic rollover as follows: "During normal or slope takeoffs and [slope] landings with some degree of bank angle or side drift with one skid/wheel on the ground, the bank angle or side drift can place the helicopter in contact with the ground. … If a roll rate is permitted to develop, a critical bank angle (the angle between the helicopter and the horizon) may be reached where roll cannot be corrected, even with full lateral cyclic, and the helicopter will roll over onto its side."

8. Lyman, E.G.; Orlady, H.W. *Fatigue and Associated Performance Decrements in Air Transport Operations*. U.S. National Aeronautics and Space Administration (NASA) Contract Report NAS-210060. A special report prepared at the request of NASA. 1980.

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About the Author

Patrick R. Veillette, a professional pilot with more than 11,000 flight hours, flies de Havilland DHC-6 Twin Otter and Shorts

SD-3 Sherpa airplanes in aerial fire fighting operations. 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 several research projects on cockpit automation and human error in high-risk environments. Veillette has an air transport pilot certificate and is a former U.S. Federal Aviation Administration designated pilot examiner.

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Appendix

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998

Date	Location	Helicopter Type	Helicopter Damage	Injuries
July 10, 1974	Wasatch National Forest, Utah	Sikorsky S-55T	substantial	5 serious
The tail-rotor drive shaft was severed during cruise flight in gusty wind conditions, at a high gross weight and at a high density altitude. The helicopter rotated 2.5 turns to the left, descended through a 46,000-volt power line and landed hard.				
Aug. 8, 1975	Challis National Forest, Idaho	Bell 206B	substantial	none
The helicopter rolled onto its right side during takeoff. The report said that the pilot failed to recognize the severity of the takeoff bank angle soon enough to prevent the dynamic rollover (caused by a roll rate that developed while one skid was still in contact with the ground).				
July 18, 1976	Modoc National Forest, California	Bell 205A	substantial	3 serious; 4 minor
Rotor speed decreased for unknown reasons while the helicopter was being flown approximately 100 feet above a ridge line. The helicopter struck trees during the autorotative landing.				
Aug. 17, 1976	Snoqualmie National Forest, Washington	Hughes 500C	substantial	none
The helicopter was on the ground, with the rotors turning, when a passenger attempted to throw an object to a fellow employee. The object was drawn into the main-rotor system. A rotor blade was damaged and had to be replaced.				
Aug. 22, 1976	Willamette National Forest, Oregon	Bell 206B	destroyed	2 serious
When the pilot reduced airspeed to about 26 knots (48 kilometers per hour) on final approach, the helicopter began rotating right. Full deflection of the anti-torque pedals had no effect. The helicopter completed about 20 full rotations before striking the ground.				
July 24, 1977	Angeles National Forest, California	Bell 205; Bell 212	destroyed	1 fatal; 1 serious; 2 minor
The helicopters were approaching a helibase after dropping water on a fire at night. Both pilots were using night-vision goggles. Radio frequencies were saturated, and the pilots had difficulty communicating with the helibase manager. The helicopters collided while being maneuvered to land.				
Aug. 27, 1977	Black Hills National Forest, South Dakota	Hughes 500C	substantial	3 serious
The crew was searching for a reported fire when the engine lost power because of a hot-section failure. The helicopter struck trees during the autorotative landing.				
Oct. 14, 1977	Gifford, Washington	Aerospatiale SA-316	substantial	none
The engine failed because of fuel contamination. The pilot attempted an autorotative landing on the shore of a reservoir, but the helicopter struck a floating log boom and sank in five feet (1.5 meters) of water.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
June 22, 1978	Toiyabe National Forest, Nevada	Bell 206B	substantial	none
The pilot began a precautionary landing because of excessive turbine-outlet temperature. The engine flamed out at about 150 feet. The main-rotor blades severed the tail boom during the hard landing.				
June 2, 1979	Plumas National Forest, California	Aerospatiale SA-315B	substantial	2 minor
The helicopter was flown too low on final approach to a drop site. The tips of the main-rotor blades struck a treetop, and the helicopter spun to the ground.				
July 13, 1979	Ashley National Forest, Utah	Bell 212	substantial	none
The water-tank doors failed to open when the helicopter arrived at the drop site. The pilot made a steep right turn downhill, to avoid a ridge ahead, and the helicopter settled. The rotors struck tall trees, but the helicopter continued flying.				
Aug. 7, 1979	Salmon National Forest, Idaho	Aerospatiale AS-319B	substantial	none
The pilot did not perform an adequate preflight inspection after the helicopter was refueled and took off with the grounding cable still attached. The cable was drawn into the main-rotor system and struck the main rotor, tail rotor and horizontal stabilizer.				
Sept. 22, 1979	Helena National Forest, Montana	Bell 206L-1	substantial	5 serious
The helicopter was being flown 150 feet (46 meters) above trees when the engine failed because of a loose nut on the high-pressure fuel line. The helicopter struck trees, rolled and struck the ground on its right side.				
Sept. 3, 1980	San Bernardino National Forest, California	Bell 206B	substantial	1 minor
A load manifest was not prepared before the passengers and cargo were loaded. The helicopter was 356 pounds (162 kilograms) over the maximum certified weight for hover out of ground effect. The helicopter struck trees at 40 feet on takeoff and descended to the ground.				
June 26, 1981	Galiuro Mountains, Arizona	Bell 206B-3	substantial	none
A strong downdraft was encountered during an approach to a drop site on a ridge. The pilot attempted to turn away from the ridge, but the helicopter struck the ground.				
July 3, 1981	Gifford, Washington	Bell 206L-1	substantial	4 serious
While climbing through 5,000 feet, the pilot heard an explosion and saw the engine-failure warning light. A high sink rate developed during the emergency descent, and the helicopter landed hard.				
June 17, 1983	Gila National Forest, New Mexico	Aerospatiale SA-315B	substantial	none
The helicopter was being maneuvered for landing when a gusting left crosswind was encountered at approximately 20 feet. The main rotor was damaged when it struck a tree, but the pilot was able to land the helicopter.				
July 26, 1983	Fort Howes, Montana	Hughes 500C	substantial	none
The pilot made a precautionary landing on a concrete helipad because of an approaching thunderstorm. The two forward main-rotor blades were tied to the helicopter, but the helicopter was not tied to the helipad. The helicopter was substantially damaged when it was blown off the helipad by strong winds.				
July 29, 1983	Summerville, South Carolina	Hughes 269C	substantial	none
The helicopter was being flown 20 feet (six meters) over timberland when the engine lost power. The helicopter rolled over during the forced landing. Postaccident examination of the piston engine revealed lead fouling of all eight spark plugs.				
Oct. 20, 1983	McAdams, Mississippi	Bell 206B	substantial	none
The pilot said that, because of terrain and obstacles, his attention was diverted during an aerial-ignition flight in support of a controlled-burning operation. After completing the burn operation, he saw that about three gallons (11 liters) of fuel remained. The engine flamed out about a quarter mile (a half kilometer) from the landing area, and a hard landing occurred.				
Oct. 28, 1983	Lolo National Forest, Montana	Bell 206B	substantial	none
A ground signalman was in a poor location to monitor tail-rotor clearance and was not able to give accurate directions to the pilot as he lifted off in a confined area. The tail rotor struck a pine tree. The external load was not jettisoned.				
Feb. 15, 1984	Waldo, Florida	Hiller UH-12E	substantial	2 serious
During a flight in support of a controlled-burning operation, a fire erupted in a supply of incendiary devices stored in front of the seats. The pilot lost control of the helicopter during an attempted landing on a road.				
May 13, 1984	Palmer, Alaska	Bell 206B	substantial	none
While returning to the staging area after delivering supplies to firefighters, the helicopter struck unmarked power lines 85 feet (26 meters) above a valley. Although the pilot had flown numerous trips to and from the staging area the previous day, he was not aware of the power lines.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Aug. 1, 1984	Cleveland National Forest, California	Bell 206B	substantial	none
After the helicopter completed a water drop, the water bucket began to move back and forth. The pilot reduced airspeed; at the same time, the helicopter encountered a downdraft. The water bucket then struck the tail boom. The water bucket had been attached with the upper support ring removed from the bucket.				
Aug. 22, 1984	Nez Perce National Forest, Idaho	Bell 206B-3	substantial	1 fatal
A cable was misrouted around a helitorch barrel and became fouled when the barrel was lifted. Visual communication and verbal communication between the pilot and a ground crewmember were inadequate. The ground crewmember was attempting to clear the cable when the helicopter rolled right and yawed right. The ground crewmember then attempted to move away from the helicopter, but obstacles prevented his escape. He was struck and killed by the tail rotor.				
July 16, 1985	Payette National Forest, Idaho	Bell 206B-3	substantial	none
After picking up water, the helicopter struck unmarked wires and descended into the Salmon River. The pilot did not jettison the water bucket. The wires were depicted on hazard maps.				
Aug. 4, 1985	Los Padres National Forest, California	Aerospatiale SA-316B-1	substantial	1 serious
The pilot failed to maintain adequate separation from obstructions during a water drop. The main rotor disintegrated upon contact with an oak tree, and the helicopter descended to the ground. The bucket was not jettisoned.				
Aug. 9, 1985	Winthrop, Washington	Aerospatiale SA-316B	destroyed	1 fatal
The helicopter was flown at an excessive airspeed while towing a 100-foot (31-meter) cable with a cargo hook. The cable became entangled in the tail-rotor system and the main-rotor system.				
Aug. 18, 1985	Boise National Forest, Idaho	Bell 206B-3	substantial	none
The pilot and a crewmember misjudged clearance at a landing site. The main-rotor blades struck a tree during the landing.				
Sept. 3, 1985	Boise National Forest, Idaho	Bell 205	substantial	2 serious
The pilot attempted a downwind landing in a helicopter that was too heavy to land at the cargo-delivery site. The helicopter struck trees and came to rest inverted.				
Oct. 10, 1985	Mount Hood National Forest, Oregon	Hiller (Soloy) UH-12E	substantial	1 minor
The helicopter's fuel system was contaminated with water. The engine failed on takeoff. The helicopter struck the ground in a level attitude, with a helitorch still attached. The main-rotor blades struck the tail boom and several small trees.				
Jan. 8, 1986	Brewton, Alabama	Hughes 269A	substantial	1 minor
The helicopter was being flown at a low altitude in support of a controlled-burning operation when the engine lost power because of fuel exhaustion.				
Feb. 4, 1986	Council, North Carolina	Hughes 269B	substantial	1 serious
During a controlled-burning operation, the engine failed because of a connecting-rod fracture. The helicopter struck trees during the autorotative landing.				
Aug. 4, 1986	Watson, Oklahoma	Bell 206B	substantial	1 serious
The pilot experienced problems with a fire-dispensing apparatus slung beneath the helicopter. He landed the helicopter and released the apparatus. On takeoff, a cable from the apparatus caught on the right skid. The pilot lost control of the helicopter during a climbing right turn. The helicopter struck trees and terrain.				
Dec. 3, 1986	Glendora, California	Bell 206B	substantial	4 minor
During a controlled-burning operation, the pilot completed a fire-lighting pass along the side of a ridge and began to climb. The helicopter struck telephone wires and tumbled down a steep embankment. The helitorch was not released until ground impact was imminent.				
July 15, 1987	El Dorado National Forest, California	Bell 206L-1	substantial	5 minor
The helicopter was 430 pounds (195 kilograms) heavier than the hover-out-of-ground-effect weight limit. During a shallow approach, the pilot had insufficient anti-torque control, and the helicopter began to turn right. The pilot added power to go around, but the main-rotor blades struck a tree.				
July 22, 1987	Shasta, California	Bell 206B-3	substantial	none
The pilot was conducting a hovering approach with a full bucket load when the helicopter struck power lines, substantially damaging the main-rotor blades. The pilot jettisoned the bucket and landed the helicopter.				
Sept. 8, 1987	Six Rivers National Forest, California	Hughes 500D	substantial	none
The pilot was unable to release water from a bucket because of an electrical malfunction. The helicopter then encountered a downdraft, and the main-rotor blades struck trees. The pilot released the bucket and flew the helicopter back to base.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Sept. 23, 1987	Shasta, California	Bell 212	substantial	none
The main-rotor blades struck trees during a water-drop operation. The pilot continued flying the helicopter until a vibration began and increased. The pilot then conducted a precautionary landing. Inspection revealed delamination of the main-rotor blades.				
Oct. 6, 1987	Nez Perce National Forest, Idaho	Bell 206B-3	substantial	none
The helicopter was on short-final approach to Selway Lodge Airstrip when the main-rotor blades struck a thin, unmarked wire.				
March 3, 1988	Olympic National Forest, Washington	Bell 206B-3	substantial	none
The pilot was flying lower than normal during a controlled-burning operation when the helitorch struck a tree at about 20 feet. The pilot immediately jettisoned the helitorch.				
July 22, 1988	Bridger, Wyoming	Bell 206B-3	none	1 serious
A crewmember was trying to unload shovels jammed in the cargo compartment when the helicopter began to lift off. The pilot, whose vision was obstructed by a rain-spotted windshield, believed that he had received a takeoff signal, but the marshaller had signaled him to hold. The crewmember jumped to the ground as the pilot executed a right turn.				
Aug. 8, 1988	Deschutes National Forest, Oregon	Bell 212	substantial	1 serious
The pilot lost tail-rotor control when an empty bucket slung under the helicopter struck the tail-rotor drive shaft. The helicopter struck trees during the autorotative landing. The external load was not jettisoned.				
Aug. 17, 1988	Bridger, Wyoming	Bell 212	none	none
The pilot heard a loud rushing noise before rotor speed decreased and the engine-failure light and the engine-fire light for the no. 2 engine illuminated. The pilot shut down the engine and landed the helicopter at an airport.				
Aug. 25, 1988	Helena National Forest, Montana	Bell 205A	substantial	none
The pilot conducted an autorotative landing after the engine compressor failed in flight.				
Sept. 9, 1988	Entiat, Washington	Bell 204B	destroyed	2 fatal
The helicopter struck terrain for unknown reasons while flying a water bucket to a fire. There was evidence that the main-rotor mast fractured and the helicopter broke up while being flown in strong gusty wind conditions and mountain-wave conditions. Evidence indicated that the copilot, who was making his first flight in type and his first flight for the company, was the pilot flying.				
Sept. 14, 1988	Challis National Forest, Idaho	Bell 212	minor	none
The pilot conducted an autorotative landing after the transmission failed during a water-bucket operation.				
Sept. 20, 1988	Shoshone National Forest, Colorado	Bell 206B	substantial	none
Contrary to the manufacturer's instructions, the water bucket was installed with the data-plate instructions facing the wrong direction. The bucket was attached 180 degrees out of phase with the actuator. Strands of wire draped over the heel of the left skid and caused the helicopter to roll left on takeoff and come to rest inverted in 10 feet (three meters) of water.				
June 25, 1989	Ellensburg, Washington	Bell UH-1B	substantial	1 minor
The pilot was setting an empty water bucket on the ground when the engine lost power for undetermined reasons. The helicopter descended and rotated out of control. The pilot jettisoned the bucket while attempting to regain control. The helicopter struck the bucket and rolled onto its left side.				
July 8, 1989	Susanville, California	Sikorsky S-58T	substantial	1 minor
The helicopter entered an uncommanded left yaw in swirling winds during an approach to a water drop. The pilot dumped the water, jettisoned the bucket and began a descent. The pilot was unable to arrest the descent during the flare, and the helicopter landed hard.				
Aug. 3, 1989	Payette National Forest, Idaho	Bell 206B-3	substantial	none
The pilot's vision was obstructed by smoke and by the setting sun as he maneuvered the helicopter within confined spaces during an observation flight. The helicopter began to spin and then hit trees.				
Aug. 9, 1989	Boise National Forest, Idaho	MDD MD-500D	substantial	none
During an infrared-reconnaissance mission, the engine failed because of a corrosion-induced failure of the pneumatic-control tube. The helicopter struck a treetop during the autorotative landing.				
Aug. 14, 1989	Payette National Forest, Idaho	Bell 205A-1	substantial	none
The pilot pulled the water bucket from a lake and was transitioning from a hover to forward flight when several engine-compressor stalls occurred. The engine then flamed out. The skids were damaged during the autorotative landing.				
Aug. 18, 1989	Wenatchee National Forest, Washington	Bell 206L-3	substantial	1 serious
The pilot became disoriented during landing, and the helicopter rolled over.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Oct. 22, 1989	Ogilvie, Minnesota	Hughes 369HS	substantial	none
The pilot was dropping a sling load when the engine failed for undetermined reasons. The helicopter rolled over during an autorotative landing in a swampy area.				
June 21, 1990	Klamath National Forest, California	Bell 206L-3	substantial	4 serious
The engine failed for undetermined reasons during initial climb. Rotor speed decreased when the pilot turned the helicopter toward a suitable landing site. The skids and airframe were damaged during a hard autorotative landing.				
June 28, 1990	Los Padres National Forest, California	Sikorsky S-62A	substantial	1 minor
The helicopter was being flown in dense smoke during a water-drop operation when the engine lost power for undetermined reasons.				
July 1, 1990	Coronado National Forest, New Mexico	Sikorsky S-58ET	substantial	none
The pilot aborted a landing when the helicopter encountered a gust at about five feet. The tail rotor struck a tree, and the helicopter spun to the ground. The helicopter was within the hover-in-ground-effect weight limits but was not within the hover-out-of-ground-effect limits for landing at the helispot (temporary landing area).				
Aug. 13, 1990	Bieber, California	Bell UH-1B	substantial	1 serious
The pilot was slowing the helicopter for a water drop on rising terrain when the helicopter yawed right and began to settle. The pilot was not able to release the water before the helicopter struck the ground.				
Sept. 14, 1990	White River National Forest, Colorado	Aerospatiale SA-315B	substantial	none
During an approach to an unimproved landing area, the pilot was distracted by a passenger's question. The main-rotor blades were damaged when they struck a tree.				
Sept. 17, 1990	Stanislaus National Forest, California	Bell 204B	substantial	none
The helicopter began to spin to the right when the pilot conducted a vertical climb after filling the water bucket from a small pond surrounded by trees. The pilot released the bucket and conducted an autorotative landing. The tail boom was damaged when it struck a fence post.				
July 13, 1991	Payette National Forest, Idaho	Bell 206L-3	substantial	none
The helicopter encountered a strong downdraft on short-final approach to pick up firefighters. The helicopter landed hard, and the main-rotor blades struck the tail boom.				
July 24, 1991	Provencal, Louisiana	Bell 47D-1	substantial	none
The pilot was maneuvering the helicopter for a controlled-burning operation when the engine failed because of fuel exhaustion. Fuel had drained from the fuel-cell-sump-drain valve because of failure or premature deterioration of the valve.				
July 26, 1991	Stanislaus National Forest, California	Bell 206L-1	destroyed	1 fatal
During a landing approach out of ground effect, the helicopter descended into the vortices created by its main-rotor blades and lost main-rotor lift. The helicopter descended, struck trees and impacted nose down.				
Sept. 4, 1991	Sierra National Forest, Colorado	Bell 212	substantial	1 minor
The helicopter encountered a strong downdraft while dropping water on a fire. The pilot applied full power and jettisoned the external load, but the helicopter descended and struck the ground.				
Oct. 18, 1991	Panhandle National Forest, Idaho	Bell AH-1G	substantial	2 serious
The pilot was filling the water bucket from a lake when a main-transmission-component failure caused loss of tail-rotor effectiveness. The pilot said that he released the water but was not certain whether the bucket was released before the helicopter descended into the lake.				
April 9, 1992	Manteo, California	Kaman HH-43F	substantial	none
Strong gusts caused the pilot to reject four landings on an aluminum mat on sloping terrain with a water bucket suspended from the helicopter. During the fifth landing attempt, a main-rotor blade struck one of the helicopter's vertical stabilizers.				
July 29, 1992	Wallowa, Oregon	Bell 206L-3	substantial	1 serious
The pilot was hovering the helicopter over a pond to refill the water bucket when a cracked engine-pneumatic-control line caused a partial loss of power. The external load was not jettisoned. The μhelicopter descended into the pond, and the pilot swam to shore.				
Aug. 3, 1992	Challis National Forest, Idaho	Bell 205A-1	substantial	7 serious
Fatigue cracking that originated from a manufacturing defect in the second-stage power turbine caused the engine to lose power during an approach. Rotor speed decreased, and the helicopter descended rapidly to the ground.				
Aug. 12, 1992	Los Padres National Forest, California	Bell 204B	substantial	1 minor
When the engine lost power because of cracks in the power turbine section, the pilot was unable to release the external load because he was sitting in the left seat of the helicopter to observe the long-line operation; the remote external-load release switch cannot be reached from the left seat.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
Aug. 27, 1992	North Platte, Nebraska	Sikorsky S-58T	substantial	none
The engine-combining-gearbox drive shaft failed during liftoff, causing loss of power and loss of directional control. The right-main gear collapsed, and the main-rotor blades struck the ground. The gearbox drive shaft had been marked incorrectly, and maintenance had not been performed in compliance with an airworthiness directive.				
June 30, 1993	Agoura Hills, California	Bell 206L-3	destroyed	1 minor
The helicopter was on the ground with the rotors turning at flight idle when incendiary devices inadvertently were dispensed from an improperly wired aerial-ignition device. The helicopter was destroyed by fire.				
July 27, 1993	Tonto National Forest, Arizona	Bell 206B-3	substantial	1 serious
The pilot was filling a bucket with water when the tail-rotor blades struck the lake surface and the tail boom separated.				
June 10, 1994	Lincoln National Forest, New Mexico	Bell 204B	substantial	none
The pilot was filling a bucket with water from a portable tank when the engine lost power because a fuel-control-actuator rod had been installed improperly. The tail boom struck the tank.				
July 1, 1994	Coronado National Forest, New Mexico	Bell 206B-3	destroyed	1 serious
The pilot was hovering the helicopter to position a sling load on a ridgetop when a strong gust was encountered. The helicopter began to turn and descend. The sling load, suspended from a 50-foot (15-meter) line, jammed in a rock outcropping. The helicopter then struck the slope and burned.				
July 8, 1994	Lincoln National Forest, New Mexico	Sikorsky S-64	substantial	none
A snorkel (a tube-like device) was being used to fill the helicopter's tank with water from a pond. Mud ingested by the snorkel caused the helicopter to begin a vertical bouncing motion that increased in intensity. The tail rotor was damaged when it struck the water.				
July 12, 1994	Gila National Forest, New Mexico	Bell 206L-3	destroyed	3 fatal; 1 serious
The pilot made a downwind approach to offload firefighters on a pinnacle at 9,520 feet. He then lost control of the helicopter while attempting to hover out of ground effect. The helicopter struck trees and rolled down a steep slope.				
July 29, 1994	Superior, Montana	Bell 212	substantial	none
The pilot was maneuvering to fill a bucket with water from a river when the helicopter struck wires at about 100 feet. The pilot flew the helicopter to an airport, released the external load and hovered while mechanics inspected the helicopter for damage.				
Aug. 1, 1994	Leander, Louisiana	Hughes 269A	substantial	none
The helicopter was being flown at 100 feet during a controlled-burning flight when the engine lost power because of failure of the connecting-rod bolts in the no. 1 cylinder. The helicopter touched down hard during the autorotative landing.				
Aug. 17, 1994	Klamath National Forest, California	Bell 206B-3	substantial	1 minor
The helicopter was on approach to a helispot when a piece of the cabin headliner, held in place by Velcro strips, detached and struck the tail rotor. Loss of anti-torque control and severe vibration necessitated an immediate landing.				
Aug 21, 1994	Nez Perce National Forest, Idaho	Bell 212	minor	none
The pilot was maneuvering the helicopter for a water drop when one engine failed because of internal damage. The pilot released the external load and landed the helicopter.				
Sept. 1, 1994	Libby, Montana	Sikorsky S-64F	substantial	2 minor
The water-tank-quantity indicator was malfunctioning, and the crew was not certain whether lake water was being loaded into the tank through a snorkel. The crew stopped the water transfer and began flying away from the lake. Control response was sluggish and rate of climb was slow, and the crew was not able to dump water or jettison the tank. Rotor speed decreased, and the helicopter descended into the lake.				
Sept. 1, 1994	Kootenai National Forest, Montana	Bell 206L-3	substantial	none
During short-final approach, the tail-rotor drive shaft was severed by a disconnected antenna-lead coupling that could not be seen during a normal preflight inspection. The pilot conducted emergency procedures and landed the helicopter.				
Sept. 6, 1994	Clearwater National Forest, Idaho	Bell 206B-3	substantial	none
The pilot lost positional awareness while concentrating on a water drop, and the rotor blades struck trees. The pilot dumped the water and returned to the helispot without further incident.				
Sept. 23, 1994	Payette National Forest, Idaho	Boeing Vertol CH-47D	destroyed	1 fatal; 4 serious
The helicopter was touching down when the tail rose slightly in the air with the front landing gear on the ground. The tail then rose rapidly, and the helicopter flipped over onto its back. A front-rotor blade struck the fuselage and killed the flight engineer.				

Helicopter Accidents During U.S. Aerial Fire Fighting Operations, 1974–1998 *(continued)*

Date	Location	Helicopter Type	Helicopter Damage	Injuries
July 30, 1995	Wenatchee National Forest, Washington	Bell 206L-3	substantial	none
The pilot had to fly toward the setting sun to conduct an approach into the wind and over the lowest obstacles. The main-rotor blades struck a tree. After landing, the pilot inspected the main-rotor blades and decided to resume the mission. During a flat, fast departure, the pilot misjudged clearance, and the helicopter struck a tree.				
June 18, 1996	Pagosa Springs, Colorado	Bell 212	substantial	1 minor
While being flown upslope and downwind — and at near-maximum gross weight for hover out of ground effect — the helicopter began to settle. The pilot unsuccessfully attempted to jettison the water load and reverse course. The helicopter settled into trees in the fire area.				
Aug. 19, 1996	Umatilla National Forest, Oregon	Bell UH-1H	substantial	none
The helicopter was approaching the fire zone when either the flight-control system or the hydraulic system malfunctioned for undetermined reasons and rotor speed decreased. The pilot dropped the water but did not jettison the bucket. The helicopter landed hard, collapsing the skids, and rolled over.				
Sept. 4, 1996	Sheridan, Wyoming	Bell 206L-3	substantial	1 minor
The pilot lost tail-rotor control while maneuvering the helicopter for a water drop in high winds and turbulence. The helicopter began to spin. The pilot attempted to recover by entering an autorotation, but the helicopter struck terrain before he could regain control.				
Sept. 13, 1996	St. Regis, Montana	Bell 206B-3	substantial	none
The pilot said that the water bucket malfunctioned, and he was unable to drop the water on a fire. He then attempted to place the bucket on a railroad grade, so that he could tip the bucket over and empty the water. The main-rotor blades struck wires, and the pilot landed the helicopter on the railroad grade.				
April 16, 1997	Calderwood, Tennessee	Bell 204B	destroyed	none
The helicopter was being flown over a river to fill the bucket when the engine lost power because of a transmission-coupling failure. During the autorotative landing on the river bank, the helicopter struck trees, rolled inverted and descended to the ground.				
July 6, 1997	San Bernardino National Forest	Bell 206L-1	destroyed	1 fatal
The pilot was about to drop water on a fire when the engine failed for undetermined reasons. The helicopter was in autorotative flight when it struck a slope.				
Aug. 15, 1997	Lake Tahoe, California	Bell UH-1H	substantial	1 serious
The pilot lifted off the lake, transitioned to forward flight and then realized that the helicopter would not clear trees ahead. He attempted to turn, and the helicopter struck the water and sank.				
July 24, 1998	Reklaw, Texas	Bell 206L-3	substantial	none
The pilot was lifting a bucket from the water when the helicopter rolled left and struck the water. Evidence indicated that the bucket cable had become draped across the left skid.				
Aug. 8, 1998	Juntura, Oregon	Bell 212	substantial	none
The pilot was filling a bucket with water from a cattle tank when the helicopter began to settle. The pilot believed that the helicopter was settling in the vortices created by its main-rotor blades, and he initiated a descent. When he attempted to stop the descent, the low-rotor-speed warning sounded. The pilot then made an autorotative landing in the cattle tank, and the main-rotor blades struck a tree branch.				
Aug. 27, 1998	Porterville, California	Aerospatiale SA-316B	substantial	none
The helicopter was being flown down the side of a ridge when the water bucket, suspended on a 100-foot (31-meter) line, became entangled with trees. The line snapped and wrapped around the tail rotor. The tail-rotor blades and gearbox separated, and the helicopter spun to the ground and rolled down the slope.				
Sept. 12, 1998	Hinkley, Minnesota	Bell 206B-3	substantial	none
The pilot refilled the bucket with water from a lake and began to climb. As the helicopter entered translational lift, the engine failed for undetermined reasons, and rotor speed decreased. The pilot dumped the water from the bucket and flew the helicopter to shore. He was looking for a suitable place to land when the tail rotor struck a steel fence post, and the tail-rotor drive shaft failed. The helicopter began to spin, and the pilot made an autorotative landing.				

MDD = McDonnell Douglas

Source: Patrick R. Veillette, from reports by the U.S. Bureau of Land Management, U.S. Forest Service and U.S. National Transportation Safety Board

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