FLIGHT SAFETY FOUNDATION
HELICOPTER SAFETY
Vol. 19 No. 3 *For Everyone Concerned with the Safety of Flight* May/June 1993

Typical Helicopter Accidents Profiled; Safety Still Rests with Pilots

Researchers compiled accident data from U.S. National Transportation Safety Board and military sources to create composite scenarios of helicopter accidents at heliports and airports. The report is designed as a training aid for pilots and provides heliport design suggestions.

Editorial Staff Report

"Although facility design is a contributing factor in only a small percentage of helicopter accidents, the cost of such accidents is potentially very high," a report prepared for the U.S. Federal Aviation Administration (FAA) said.

The report, which presented 16 composite accident scenarios to illustrate the types of facility design-related accidents that can occur, added: "A rotating tail rotor striking an object can result in a catastrophic event that may include fatal injuries."

The hypothetical accident scenarios were developed from accident and incident information compiled by the U.S. National Transportation Safety Board (NTSB) and the U.S. Army. The scenarios were created as training and learning aids for facility designers, managers, operators and pilots, the FAA report said.

The composite accident scenarios included obstacle strikes involving light and sign poles, wires, buildings and personnel. In addition, the scenarios focused on multiple aircraft collisions, refueling fires, engine failures and rotor-wash damage. The report also discussed factors that influenced pilot performance. The report suggested that the majority of helicopter accidents at heliports and airports involved obstacle strikes (Figure 1).

Following are selected and abridged examples from the 16 accident scenarios presented in the report:

Scenario: Obstacle Strike/Light Pole

The large, twin-turbine helicopter was being used to ferry corporate marketing personnel to several cities as part of an effort to promote a new product line. The pilot began his workday at 0630 hours. At 1610, he departed for the fifth and final stop of the day. The weather was typical for a late autumn day, with gray skies and a cold light rain.

After arriving at the airport, the pilot hover-taxied the helicopter to the fixed-base operator (FBO) to deplane the passengers. While at the FBO, a line person told the pilot where to park overnight and also said that he would assist the pilot in parking the aircraft.

A chain link fence surrounded the parking area, and two 40-foot-high light poles were equally spaced along one side of the fence. The gray metal light poles were adjacent to the parking area, approximately 15 inches (37.5 centimeters) beyond the fence.

A number of helicopters were parked in the area, leaving a limited amount of room for the helicopter. The line person signaled the pilot to taxi along the fence and then make a right turn into the parking space. As the helicopter proceeded along the fence, the line person positioned himself next to another helicopter that was parked adjacent to the intended parking space.

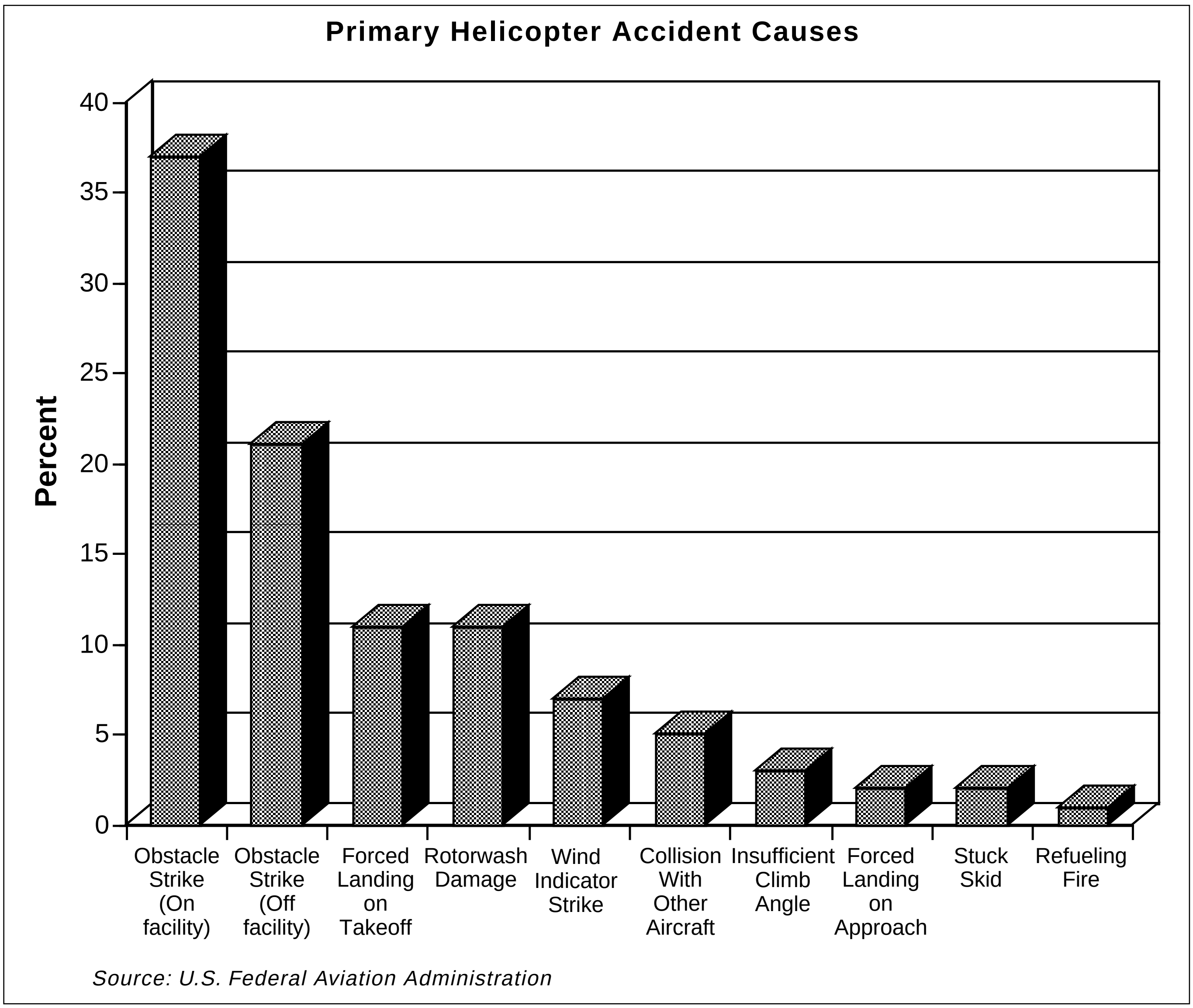

Figure 1

As the pilot prepared to turn the helicopter into the parking space, he watched for hand signals from the line person to let him know that the rotor blades would clear the parked aircraft. When the pilot was about to initiate a right turn into the parking space, the main rotor blades contacted one of the light poles. The pilot later stated that the gray poles blended with the sky and that he momentarily forgot about them.

The report concluded that:

- Heliport designers should consider marking obstacles near operational areas with reflective materials, floodlights or obstruction lights. Placing permanent obstacles in or near operating areas must be done with care and consideration;

- The maneuvering space in the parking area was too small for the helicopter and placed high demands on the pilot. Facility designers and operators should consider the type of demands their facility design and operations will place on pilots;

- The weather was a contributing factor. The gray metal light pole blended with the gray overcast skies;

- The pilot was suffering from fatigue after flying his fifth flight of a long workday; and,

- Personnel who assist pilots in ground operations should receive appropriate training.

Scenario: Obstacle Strike/Wires

The 5,500-hour emergency medical service (EMS) pilot was on standby when an emergency call was received requesting an automobile accident scene pickup. The pilot, a doctor and a nurse departed from the hospital at 0500 hours and headed toward the accident scene 60 miles (97 kilometers) to the south.

The pilot had been on vacation for two weeks, and this was his first EMS flight since returning from vacation. Upon arrival at the accident location, the pilot made an uneventful landing on a section of road that had been blocked by state police.

At the accident site, the doctor told the pilot that the patient desperately needed the immediate services of a trauma center. The patient was placed aboard the twin-turbine helicopter, and the pilot departed for a trauma center located 60 miles (97 kilometers) to the east.

Approximately 20 miles (32 kilometers) from their destination, the pilot alerted the center that they were inbound with a critically injured patient and estimated the flight time to the center to be 10 minutes.

As the helicopter approached the ground-based heliport, the pilot elected to save time and make a straight-in approach from the west rather than the normal approach from the east. At 0625 hours, the pilot slowed the aircraft for the final approach just as the sun was rising directly ahead above the eastern horizon.

At approximately 30 feet (9 meters) AGL and 300 feet (91 meters) from the helipad, the pilot saw power lines across the helicopter's flight path.

Even though sun glare resulted in a somewhat difficult approach, the pilot established a shallow final approach that would take the aircraft between the hospital and a new clinic building that was under construction.

At approximately 30 feet (9 meters) above ground level (AGL) and 300 feet (91 meters) from the helipad, the pilot saw power lines across the helicopter's flight path. He immediately pulled collective and aft cyclic but was too late. The helicopter struck the wires and it fell to the asphalt.

The power lines had been installed three days prior to the accident. The pilot stated after the accident that the wires could not be seen against the background, which included the asphalt parking lot and a stand of trees. In addition, the pilot stated that the early morning glare from the sun made it difficult to look straight ahead during the approach. Hospital officials had not notified local EMS pilots of the power lines because the normal approach to the helipad was from the east.

The report concluded that:

- Although the wires were located below the protected airspace surface, they remained hazardous to operations. They were difficult to see because they blended with the background. Just because the power lines were located below the approach/departure protected airspace surface did not preclude them from being a hazard to operations;

- The pilot allowed the severity of the patient's injuries and the patient's need for immediate attention to pressure him into making an approach that was not normally used at the heliport;

- Even though the wires were installed very close to the heliport, the pilot had not been notified that the wires were there. Whenever obstacles, especially wires, are installed near a heliport, hospital officials should always notify helicopter operators who use their facilities; and,

- It is strongly recommended that all helicopter operators who conduct missions to unimproved areas equip their aircraft with wire strike protection systems (WSPS). In addition, WSPS should be considered for helicopters that are used for low-level missions such as power line patrols.

Scenario: Main Rotor Blade Contact With Ground/Multiple Aircraft

The multi-engine, turbine helicopter departed from the local airport at 1500 hours in visual meteorological conditions to pick up six passengers at the downtown heliport.

Upon arrival at the heliport, the pilot was informed by a local radio operator (Unicom) that either space No. 3 or No. 4 was available to await the pickup scheduled for 1530. The pilot wheel-taxied to space No. 3, set the brakes, reduced engine power to ground idle and completed the after-landing checklist.

At about 1535, the line crew began to board the passengers in the helicopter. The pilot turned to ask the passengers their destination (he was yet to be informed) and noticed another twin-turbine helicopter preparing to land.

The Unicom operator informed the second helicopter that space No. 4 was available. The pilot of the second helicopter informed the crew of the first helicopter of his intention to park next to them. He hover-taxied to space No. 4. While hovering, the pilot saw the crew of the parked helicopter cringe and duck out of sight and the linemen crouch down on the ground. At about the same time, there were several loud noises and pieces of rotor blades from both aircraft flew in all directions. Both pilots immediately secured their aircrafts' engines.

While hovering, the pilot saw the crew of the parked helicopter cringe and duck out of sight and the linemen crouch down on the ground.

After the blade contact, the first helicopter was observed about five feet left of the parking space centerline, and the second helicopter was about one foot (30 centimeters) to the right of its designated parking centerline. Both helicopters incurred substantial damage. There were no injuries to the crew members, passengers or line personnel. There was no fire and no other damage as a result of the accident.

According to post-accident statements, the parking spaces were built with a minimum clearance of 10 feet (3 meters) between parking spaces. Although the Unicom operator stated that he was familiar with the maximum size helicopter specified in the parking plan (displayed on a sheet of paper at the Unicom position), he inadvertently directed the large helicopters to spaces that were too close to allow a reasonable safety margin.

The report concluded that:

- Helicopter parking areas should allow adequate clearance for adjacent parking of the largest helicopters;

- The fact that both helicopters parked off the parking space centerline contributed to the cause of the accident; and,

- FBOs should provide basic parking information to pilots, such as the parking space designator and what diameter rotor system can be accommodated in that space. This information should be adjacent to the parking space and painted so that it can be seen clearly in all light conditions.

Scenario: Obstacle Strike/Building

A light, skid-equipped, single-engine, piston helicopter was being operated on a proficiency flight. The 50-year-old pilot-in-command possessed an airline transport pilot (ATP) certificate with ratings in both single-engine and multi-engine airplanes and helicopters. In addition, he possessed a flight instructor's certificate for single- and multi-engine airplanes and helicopters. He had accumulated a total of 22,000 flight hours with more than 12,000 flight hours in helicopters.

At 1730 hours, the local weather was reported as visual meteorological conditions with 10 miles (16 kilometers) visibility and scattered clouds at 3,000 feet (909 meters). The wind was from 270 degrees at 15 knots with no gusts reported.

The helicopter crashed on takeoff from its base heliport when the rotor blades struck a hangar building. On liftoff, the pilot reported that his attention was diverted by the proximity of parked automobiles and the activity in the parking area. A sudden gust of wind blew the helicopter into the hangar. Flying debris struck a ground-support person standing nearby. He was taken to a local hospital in critical condition with head and leg injuries. The pilot exited from the helicopter uninjured, although the helicopter was substantially damaged.

The pilot stated that the helicopter was in its normal takeoff space with about five feet of clearance between the hangar and the rotor blades when liftoff was attempted.

The report concluded that:

- Unobstructed takeoff and landing areas are recommended for both private and public heliport facilities. The areas should provide at least one-third rotor diameter tip clearance, but not less than 20 feet (6 meters) horizontally from buildings, fences, fueling facilities, windsocks, earth berms or any other objects that could present a hazard to flight;

- The heliport/helicopter parking area should be designed so that parked helicopters will not interfere with the clear area used for takeoffs and landings;

- The potential for sudden changes in aircraft handling by windshifts must be anticipated, in heliport design and in operational situations. Operating close to buildings may also have the effect of disrupting the outflow pattern from rotor wash. This can produce a burble over the rotor blades that will increase pilot workload in the hover, thereby making operations near buildings more difficult;

- A decision to depart from a position more removed from the hangar might have prevented this accident; and,

- Normal safe operating procedures dictate that no personnel are allowed on the pad during liftoff and touchdown.

Scenario: Insufficient Takeoff Power

The aircraft was on a flight to pick up a geophysical crew at a contractor's base heliport that was located in mountainous terrain. The heliport elevation was approximately 7,000 feet (2,121 meters) mean sea level (MSL).

During the previous month, the 40-year-old commercial pilot had landed without incident at the site several times to deliver passengers or supplies. He described the circumstances surrounding his arrival as normal and uneventful. The pilot loaded his passengers and cargo just before noon.

The heliport was located in a saddle between two ridges. According to the pilot, weather at the site was excellent with scattered clouds at 5,000 feet (1,515 meters) and 30 miles (48 kilometers) visibility. The wind had been from 120 degrees at zero to eight knots since he had arrived at the heliport. The temperature was 60 degrees F (15 degrees C), and because the pilot had flown from the heliport before, he did not feel the need to compute the density altitude. However, this was the first time the aircraft was loaded to near-maximum gross weight.

As the helicopter was about to clear the tree, rotor rpm began decreasing and the pilot observed the tachometer needles passing through the "bottom of the green."

In preparation for takeoff, the pilot completed a normal engine run-up, and raised the helicopter slowly to a three-foot hover. After making a 120-degree hovering pedal turn to the right into the perceived wind, he again checked the gauges and began a takeoff. About 100 feet (30 meters) in front of the helicopter was an oak tree that was approximately 10 feet (3 meters) higher than the saddle at the takeoff point.

As the takeoff began, the helicopter did not climb. The pilot added power to the maximum takeoff manifold pressure and increased collective in an attempt to climb away from the oak tree. As the helicopter was about to clear the tree, rotor rpm began decreasing and the pilot observed the tachometer needles passing through the "bottom of the green." He could not return to the takeoff location, because rotor rpm was insufficient to control a 180-degree turn and the area was too narrow for any margin of error.

According to passengers and observers, the engine's response to the power demand was a gradual power fade until the engine stopped. Because of the steep slope surrounding the area, the pilot elected to land in the oak tree to prevent a downhill roll. He did not flare to prevent ballooning over the tree. There was no perceptible bounce, and the tree held the helicopter. The time from first branch strike to stop was about one second. The helicopter was demolished, but there were no serious injuries.

Assuming the pilot-observed outside air temperature and approximate heliport elevation of 7,000 feet (2,121 meters) were correct, accident investigators calculated that the density altitude was actually 9,010 feet (2,730 meters). The flight manual for the aircraft at the estimated aircraft weight and density altitude showed a hover-in-ground-effect (HIGE) ceiling of 13,000 feet (3,939 meters) and a hover-out-of-ground-effect (HOGE) ceiling of 7,500 feet (2,273 meters).

The report concluded that:

- Rejected takeoff accidents may occur at any altitude; however, the likelihood of such occurrences increases at high density altitudes. Civil accident reports contain examples of this type of accident at altitudes from 2,400 to 9,000 feet (727 to 2,727 meters). During heliport design and site selection, designers and operators should consider the primary-use helicopter expected, the missions for which it will be used (passengers, equipment, supplies, percent of maximum gross weight, etc.), and the helicopter's maximum performance capabilities. Additional clear space for rejected takeoffs is desirable whenever practical;
- Rejected takeoff accidents have resulted in helicopters settling into trees, ponds, street intersections, bushes, fences, light poles, fuel pumps, etc. If possible, objects, including parked helicopters or construction equipment, under the preferred approach/departure path of the heliport should be removed;
- Locating heliports in confined areas such as saddles, valleys, wooded areas or where surrounded by tall buildings or towers is not recommended; and,
- The pilot community must be convinced to calculate density altitude and to check the helicopter's capabilities and limitations before each flight.

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Scenario: Refueling Fire

The pilot landed his light, piston-powered helicopter at the small airport 10 minutes late for his passenger pickup at 0800 hours. He waited in the helicopter at the fuel pump until line service personnel arrived.

When the line personnel arrived, the pilot shut down the aircraft engine but left an electric cooling fan running. The line personnel were unusually busy, and the pilot volunteered to refuel his aircraft.

As the pilot began to refuel the helicopter, he engaged the hold-open feature on the fuel nozzle. When the tank was full, the automatic fuel shut-off failed and fuel began to overflow from the fuel tank onto the ground.

The pilot quickly removed the fuel nozzle from the tank and unlatched the hold-open feature, but the fuel was ignited and a fire began to burn the aircraft and the tarmac ramp. There was no fire extinguisher near the stationary fuel pump.

Two fire extinguishers were finally located and used on the fire, but the aircraft and ramp area continued to burn until the local fire department arrived. The helicopter was destroyed, but there were no injuries.

The report concluded that:

- Requirements for fuel-area firefighting equipment have been established by the U.S. National Fire Protection Association (NFPA). Guidance on the type and amount of firefighting equipment required to support heliport operations should be obtained from NFPA;
- The absence of easily accessible fire extinguishers at the refueling pump location contributed to the severity of damage to the helicopter; and,
- Ensuring proper refueling procedures is the responsibility of the facility operator. Fuel nozzles should not contain features that allow them to automatically dispense fuel. In addition, employees must understand that the nozzle should never be rigged to automatically dispense fuel, for example, by using a piece of wood to hold the release lever open.

Scenario: Obstacle Strike/Perimeter Light

The pilot met two of the company's vice presidents at the general aviation ramp. They then boarded the turbine-powered helicopter for the 45-minute flight to their corporate headquarters.

The visibility en route was unrestricted, which provided a pleasant trip for the two passengers. As the helicopter approached the corporate headquarters, the passengers were impressed by the site of the brand-new rooftop helipad. In just five years, the company had expanded sufficiently to afford installation of a rooftop helipad, and this was the first trip to the helipad for the pilot and passengers. The approach to the helipad was normal, and the landing was smooth.

After discharging the passengers, the aircraft was flown to a hover and then the pilot felt the aircraft shudder, followed by a severe vibration. The tail rotor separated from the aircraft, and the aircraft rotated to the right.

Power was reduced to stop the rotation, and the aircraft settled on the helipad. The aircraft bounced from side to side, rolled off the helipad and came to rest on its left side. The pilot exited from the helicopter and extinguished a small fire that had started near the engine exhaust.

After extinguishing the fire, the pilot discovered that the tail rotor had struck the glass cover of a perimeter light. The helicopter was substantially damaged, but the pilot was not injured. The pilot did not report any system malfunction prior to the impact and did not have any reason for landing near the side of the helipad rather than in the center.

The report concluded that:

- The (FAA) *Heliport Design Advisory Circular* recommends using flush-mounted lights whenever practical. If elevated lights are needed, for example in locations where heavy snow is anticipated, the advisory circular discusses safety considerations and also recommends using low-impact resistance lights;

- Several perimeter light strikes have involved operations to new heliports or first-time operations to unfamiliar locations; and,

- The pilot elected to land toward one side of the landing area rather than in the center. This choice reduced the amount of obstacle clearance, thereby reducing the margin of safety.

Scenario: Tail Rotor Strike/Passenger

A man and his wife arrived from France for three days of sightseeing in Boston. On the night of their arrival, they saw a coupon in a local newspaper that was good for a $5 discount on a helicopter sightseeing trip.

Neither had flown in a helicopter. They decided that this would be an excellent way to see the city and photograph it.

The following day the couple took a taxi to the airport for the sightseeing ride. After purchasing their tickets, the couple talked about the clear sky and that it looked like a great day for sightseeing. When the flight was announced, the couple, along with two other passengers, met a ticket agent at the gate.

The agent told them that they would be led out to the helicopter. He cautioned them about the potential danger of walking near the helicopter while the rotor blades were turning. The couple from France did not understand much of what the agent said because of their unfamiliarity with English.

The helicopter was kept operating during passenger boarding and unboarding. When the time came for the couple to board the helicopter, they were escorted by an agent, entered on the right side, and slid to the left side to make room for the other passengers.

While they were fastening their seat belts, the pilot told them that there would be a short delay while they waited for one more passenger. The French couple talked about the great pictures they would take on the flight.

Accident reports show that even passengers who have flown often on helicopters are still prone to tail rotor accidents.

The man suddenly remembered that he had left the extra roll of film in their hotel room. He told his wife that he had to get more film and that he would return quickly. He then exited the aircraft on the left side without informing the pilot and before his wife could stop him. As he skirted around the rear of the helicopter, he walked into the tail rotor.

The report concluded that:

- Accident reports show that even passengers who have flown often on helicopters are still prone to tail rotor accidents. When helicopter flights carrying passengers occur on a regular basis from a location, specific ground markings to guide passengers could enhance safety;

- A turning tail rotor may be difficult to see in some conditions. Studies have shown that certain paint schemes can make a turning tail rotor more visible. Operators and manufacturers should ensure that helicopter tail rotors are painted for maximum visibility when rotating;

- Although the passengers were briefed on the dangers of walking near the tail rotor, the French couple did not understand the briefing because of their unfamiliarity with English. Drawings of hazardous areas and emergency procedures could be very valuable to many passengers; and,

- Pilots should, whenever possible, position their aircraft in the direction from which the passengers will be boarded and unboarded. In this accident, had the helicopter been facing the terminal, the accident may not have occurred.

The FAA report urged that facility designers and operators “take the special needs of helicopters into account.”

In addition, the report urged pilots to recognize the importance of situational awareness and vigilance at heliports and the dangers of fatigue, stress, pilot distraction and complacency.

"Heliports should be designed with safety as the primary consideration, but the overall responsibility for safety still rests with the pilot," the report concluded. ♦

Editor's Note: The report on which this article was based, Composite Profiles of Helicopter Mishaps at Heliports and Airports, DOT/FAA/RD-91-1, *can be obtained from the U.S. National Technical Information Service, Springfield, Virginia 22161 U.S. Telephone (703) 487-4780.*

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