FLIGHT SAFETY FOUNDATION

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Helicopter Strikes Terrain During Departure in Whiteout

The fatal accident in northern Canada led to the operator's increased use of full-motion flight-simulator training to replicate whiteout conditions.

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FSF Editorial Staff

Flight into weather conditions conducive to a whiteout was cited as a cause of an Oct. 30, 2004, accident involving a Bell 212 helicopter soon after takeoff from a radar facility helipad in northern Canada.[1,2]

The first officer was killed, and the captain and three passengers were injured in the accident; the helicopter was substantially damaged.

The Transportation Safety Board of Canada said, in its final report, that the causes and contributing factors of the accident were the following:

- "The helicopter departed into environmental conditions conducive to whiteout and loss of micro texture for attitude reference;[3]
- "The potential for entering whiteout conditions was masked by the visibility of objects in the vicinity of the departure point; [and,]
- "The crew did not maintain the priority of rate-of-climb during the rotation to forward flight, did not maintain an adequate instrument scan and were not able to overcome the whiteout conditions and establish a positive rate-of-climb."

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The captain held an airline transport pilot license for helicopters, endorsed for the Bell 212, with an instrument rating. He had 6,949 flight hours, including about 1,600 flight hours in Bell 212s, 30 flight hours in the previous 30 days and 21.8 instrument flight hours in the year preceding the accident. He was serving the first week of a four-week deployment to the Arctic. He was the pilot flying (PF) for the previous flight, which had concluded about 1400 local time the previous day; the captain had gone to bed around 2200.

The first officer held an airline transport pilot license for helicopters, endorsed for the Bell 212, with an instrument rating. He had more than 13,000 flight hours, including 42 flight hours in Bell 212s, 30 flight hours in the previous 30 days and 3.7 instrument flight hours in the year preceding the accident. He was serving the last week of a four-week deployment to the Arctic and was the pilot not flying (PNF) for the previous flight; he also had gone to bed about 2200.

The first officer's Bell 212 training was completed two months before the accident. Training included conducting vertical takeoffs at Villeneuve, Alberta, Canada, north of Edmonton, and night departures from the end of a runway "to simulate lack of visual references," the report said. He received no simulator training. The captain, who assisted in the first officer's training, also practiced takeoffs at Villeneuve and "did not consider the training ideal, because of lights in the area around the airport," the report said. The captain had received simulator training.

The accident helicopter was operated by Canadian Helicopters Limited, which operates helicopters from several bases in Canada, and was certified for air taxi operations — under both visual flight rules (VFR) and instrument flight rules (IFR). The helicopter was based in Cambridge Bay, Nunavut, and was used to transport personnel and maintenance equipment to and from North Warning System (NWS) radar sites, which provide aerospace surveillance of North America. The system includes 47 unstaffed radar sites and five logistics support sites, operated as part of the North American Aerospace Defense Command (NORAD) agreement with the United States.[4]

The day of the accident was the fourth day of the crew's deployment, with three passengers and their equipment, to Shepherd Bay, site of an NWS complex that includes a barracks with private crew sleeping accommodations. The flight crew arose about 0600 to prepare for a planned departure at 0800 for a flight to an NWS facility at Simpson Lake. They obtained weather information from Arctic Radio and filed a defense VFR flight plan; later, the flight was canceled because of weather, and the crew decided to fly the helicopter to another NWS facility at Gjoa Haven.

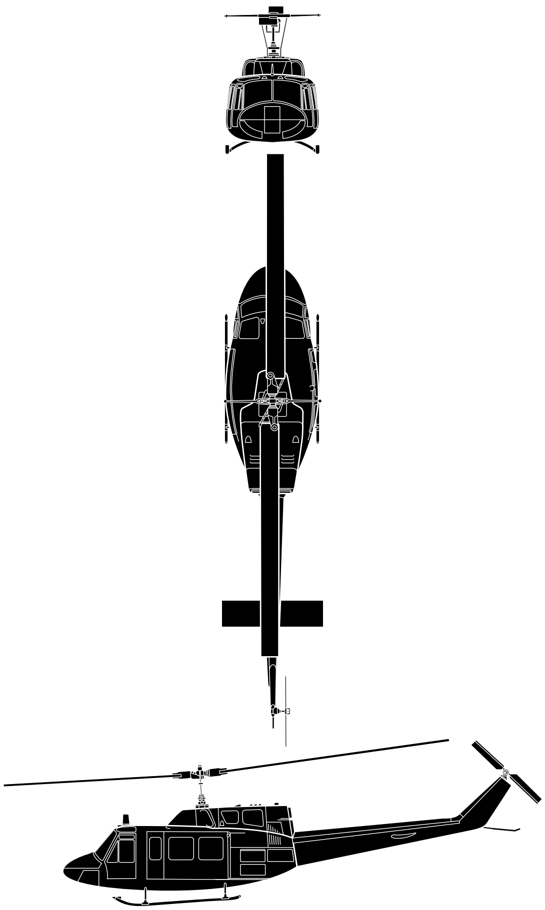
Communications problems delayed the departure until about 1100. The helicopter had been fueled, and at departure, the fuel tanks contained 2,400 pounds (1,089 kilograms) of fuel — an amount sufficient for a diversion to Cambridge Bay, if weather conditions required.

Weather at the time of departure included visibility of 1.0 statute mile (1.6 kilometers). Before departure, crewmembers could see the hangar, which was about 0.5 statute mile (0.8 kilometer) away; a video recording of the departure, obtained from the video security system at the helicopter pad, showed that the sky was obscured, with no discernible horizon.

Terrain surrounding the helicopter pad was snow-covered, with no visible vegetation or rocks, the report said. The NWS complex was located on a small ridge, and the helicopter pad was located at the edge of the ridge at 135 feet; the report described the terrain surrounding the ridgeline as "flat and featureless, except for the hangar."

The first officer flew the helicopter from the right seat, with the captain in the left seat and three passengers in the rear.

The report described the engine start as normal, with all systems functioning normally except the automatic direction finder, "which was not essential for the flight."



Bell 212 Twin Two-Twelve

The Bell model 212 is a twin-turboshaft utility helicopter first flown in 1968.

The Bell 212 is powered by a Pratt & Whitney Canada PT6T-3B Turbo Twin Pac, comprising two T6 turboshaft engines that together produce 1,342 kilowatts (1,800 shaft horsepower) and are flat-rated at 962 kilowatts (1,290 shaft horsepower) for takeoff and 842 kilowatts (1,130 shaft horsepower) for continuous operation.

The rotor system comprises a two-blade, all-metal, semi-rigid main rotor with interchangeable blades and a diameter of 14.69 meters (48.19 feet), and a two-blade, all-metal tail rotor.

The Bell 212 can accommodate one pilot and as many as 14 passengers; in cargo configuration, internal volume totals seven cubic meters (248 cubic feet).

Maximum takeoff weight is 5,080 kilograms (11,200 pounds).

Never-exceed speed and maximum cruising speed at sea level are 100 knots. Maximum rate of climb at sea level is 1,320 feet per minute. Service ceiling is 13,000 feet, and maximum altitude for takeoff and landing is 4,700 feet. Hovering ceiling in ground effect is 11,000 feet.

Maximum range at sea level with standard fuel and no fuel reserves is 227 nautical miles (420 kilometers).♦

Source: *Jane's All the World's Aircraft*

The crew set their altimeters to 29.63 inches of mercury (1,003.39 millibars); as a result, the altimeter used by the PF indicated 90 feet and the altimeter used by the PNF indicated 150 feet. The crew set radio altimeters to 200 feet above ground level, as directed by the company's standard operating procedures (SOPs).

"The PF gave a takeoff briefing indicating that he would take off vertically, bring the helicopter to the hover while turning about 90 degrees to the right, and that the climb performance would be limited," the report said.

The video recording showed the helicopter during engine start and the initial low hover, as the PNF monitored the instruments and made advisory calls, the report said.

"When the helicopter was established in the low hover, the transmission torque was called by the PNF at 85 percent to 86 percent, indicating that up to 15 percent additional torque was available for takeoff," the report said.

"The maximum power allowed by the aircraft flight manual (AFM) during takeoff is 15 percent torque above hover torque. While climbing to the low hover, the PF allowed the helicopter to drift rearward, still positioned over the pad. The PF then began to climb vertically, and the recirculating snow completely obscured the helicopter in the security[-system] video."

During this period, both pilots were able to see ground references and lights on the helicopter pad.

Within 15 seconds, the helicopter reached the maximum torque limit of 100 percent, and the vertical climb stopped.

"For the next 15 seconds, visual references in the vicinity of the pad were mentioned by both pilots, while the helicopter was hovered above the pad," the report said. "The PNF then indicated concern about movement of the helicopter rearward toward some of the site's structure and urged the PF to move forward in departure. Torque reached 105 percent as the helicopter started to move forward. Although still nearly obscured by recirculating snow, the helicopter's movement can be discerned in the security-system video."

The PF flew the helicopter about 20 feet above the ground from the rear of the pad to the intended departure end of the pad, where the helicopter disappeared from view. The PNF told the PF to lower the helicopter's nose and said that the torque was 110 percent.

"The PF did not respond and made no further calls or responses for the remaining 15 seconds of flight," the report said. "The collective [control] was nudged down by the PNF, who then called the torque at 100 percent. When the pad lights disappeared, the PNF was looking completely inside and believed that outside visual references had been lost in whiteout, even though the helicopter had moved out of the recirculating snow.

"About two seconds after calling the torque at 100 percent, the PNF called the helicopter climbing and the airspeed alive at 40 knots. The PNF then instructed the PF to keep climbing and, approximately five seconds later, called a warning about heading and that the helicopter was rolling left. Almost immediately, the helicopter struck the terrain."

Information from the helicopter's global positioning system (GPS) receiver indicated that the helicopter had flown forward at more than 30 knots for about 18 seconds.

The main wreckage was found about 350 meters (1,148 feet) from the helicopter pad, although some pieces were about 250 meters (820 feet) from the pad. The left skid was bent beneath the helicopter, and the right skid was torn off. Ground scars from the accident were obliterated by a blizzard before accident investigators were able to examine the area, but one of the survivors said that the ground scar from the left skid was "significantly longer" than the ground scar from the right skid. Both skids had broken through the ice on the surface of a pond, and the pop-out floats had deployed.

Examination of the wreckage revealed no pre-impact anomalies. The pilot's pressure altimeter, vertical speed indicator, radio altimeter, attitude indicator, airspeed indicator and horizontal situation indicator were tested and determined to be serviceable. Their indications at the time of impact could not be determined.

Investigators reviewed the helicopter's digital cockpit voice recorder, which contained cockpit conversations and ambient sounds from the previous day's flight and the accident flight. The helicopter was not equipped with a flight data recorder, and one was not required. The emergency locator transmitter was not activated by the impact; the report said that it was damaged when it was struck by the main-rotor blade.

Pilots May Fail to Recognize Whiteout

The report said that pilots often do not realize that they have encountered a whiteout, because it can occur in clear air. In some instances, pilots have flown their aircraft into snow-covered terrain and have been unaware that their aircraft were descending, "and confident that they could see the surface," the report said.

As a result, if a pilot encounters a whiteout — or a condition that he or she believes might be a whiteout — at low altitude, the correct action is to immediately initiate a climb. At higher altitude, the helicopter should be leveled and then turned toward an area of "sharp terrain features," the report said. Flight should be continued only if the pilot is prepared and qualified to safely fly the helicopter across the whiteout area using flight instruments, the report said.

The report cites the following SOPs for NWS flights involving takeoffs in whiteout or low-light conditions:

- "Takeoff checks complete;
- "Radio altimeter set to 200 feet;
- "Radio calls and PNF duties complete;
- "Lift off into low stabilized hover and check power;
- "Continue upward from low hover — through 30 feet PNF calls 'Rotate';
- "PF rotates nose-down approximately five degrees (priority is rate-of-climb). PNF calls 'Positive rate of climb';
- "As airspeed builds, PNF calls 'Airspeed live,' '40 knots', '58 knots';
- "As altitude increases, PNF calls [100-foot] increments to 500 feet;
- "PF adjusts attitude to climb at 70 knots at 80 percent torque;
- "No turns below 500 feet;
- "Only essential radio calls and no cockpit checks until 1,000 feet; [and,]
- "Through 1,000 [feet above ground level], both radio altimeters shall be set to 1,000 feet en route."

The Transport Canada *Instrument Procedures Manual* says that an instrument takeoff in a helicopter with a two-member crew is a "composite visual/instrument procedure" that requires one pilot to monitor flight instruments and the other pilot to observe outside visual references. Before transitioning to forward flight, there must be a positive rate of climb, as indicated on the vertical speed indicator and the altimeter.

The report cited several other topics discussed in the *Instrument Procedures Manual*, including the following:

- Because helicopters can climb, descend and change heading without a change in attitude, the instrument cross-check can become ineffective if a pilot looks too long at the attitude indicator;
- Most helicopters certificated for IFR flight are equipped with an instantaneous vertical speed indicator (IVSI), which — in comparison with a conventional vertical speed indicator (VSI) — has no apparent lag. The accident helicopter was not equipped with an IVSI; and,
- A reduction of power in a helicopter manufactured in North America causes the helicopter's nose to pitch down and the helicopter to yaw left.

The accident report said that an investigation by the U.S. Federal Aviation Administration (FAA) found that, for helicopter pilots flying in degraded visual environments, "the primary cue for stabilization in the low speed and hover flight regime is 'micro texture,' … rather than large objects."

The accident report said, "Snow-covered terrain, particularly when snow is blown up by rotor wash, is an environment lacking micro texture and one in which controllability problems can be expected. The [FAA] report concludes that the degraded handling characteristics can increase the workload in excess of 100 percent of the pilot's capacity, and this situation significantly increases the probability of serious error. The report found that increased stabilization has a substantial positive effect of reducing pilot workload in conditions of degraded visual cueing and recommended the use of attitude stabilization in such conditions. The report also suggested that an education program be undertaken to improve awareness of the danger of low speed and hover operations in areas of minimal visual cueing."

No Crew Discussion of Whiteout

The report said that environmental conditions at the departure site were deceptive because the hangar and other objects could be seen clearly. Before takeoff, the crew did not discuss the possibility of whiteout; nevertheless, they identified the loose snow as a risk and therefore planned a vertical takeoff, which should have reduced the risk of whiteout, the report said.

Although there were several advantages to the selected departure path, there also were disadvantages, which increased the whiteout risk for several reasons: "The wind, while light, was at 90 degrees to the takeoff heading; the hangar, which was one-half mile away, could not be seen on the takeoff heading and could not be used for attitude reference; and the terrain in the direction of flight was featureless, with no visible horizon," the report said.

The 15 percent torque margin available while the helicopter was in the low hover indicated that the helicopter had adequate performance for a safe takeoff and departure. Both the *Instrument Procedures Manual* and the operator's SOPs "stress that the priority is rate of climb before rotation," and the available power was used to move the helicopter to a high hover, from which the helicopter drifted backward, the report said.

"The crew spent some 15 seconds while drifting over the pad discussing visual references," the report said. "This expended the vertical momentum of the helicopter, and when rotation was made to transition to forward flight, the helicopter was in level flight. The rushed nature of the rotation is indicated not only by the sense of urgency of the PNF but also by the over-torque of 10 percent above the maximum allowable torque of 100 percent. Because the vertical takeoff was not executed in accordance with the SOPs, the time that the helicopter was in the recirculating snow was extended, and this occurred while in close proximity to the terrain as the helicopter moved into the whiteout conditions."

Although the PNF had said soon before the helicopter struck the ground that the helicopter was "climbing," the report said that a positive rate of climb probably had not been established. The PNF may have incorrectly identified the climb because the VSI may have lagged or may have "bounced misleadingly" in recirculating air; because the radio altimeter indicated an increase as the helicopter moved over downward-sloping terrain; and because on the pad, the PNF's altimeter had indicated 150 feet (instead of the actual elevation of 135 feet). In addition, the PNF told the PF to keep climbing; this instruction might have indicated uncertainty about the positive rate of climb, the report said.

The radio altimeter was set to 200 feet above ground level, which caused the decision-height light to remain illuminated throughout the departure, providing no indication of descent into terrain. The report said that an IVSI would have provided more timely information.

The cockpit voice recording indicated, by "the amount of coaching by the PNF and the lack of responses from the PF during the transition," that the PF was task-saturated and "likely unsure of his attitude references," the report said. When the PNF reduced power from 110 percent to 100 percent, the PF did not compensate quickly enough for the resulting downward pitch of the helicopter's nose and the left yaw. As a result, the helicopter struck terrain.

Both crewmembers were experienced pilots, but the PF's limited time in Bell 212s "likely contributed to his lack of proficiency in accomplishing a vertical takeoff and also increased his workload," the report said. "Neither pilot had significant recent instrument experience, and the training of both pilots in this type of departure had been conducted in an area with external visual cues. These factors may have accounted for the tendency for prolonged 'eye rest' on the attitude indicator and the slow instrument scan."

The report cited, in its findings as to risk, that training was conducted "in a setting that did not demonstrate the effects of lack of micro texture, and the crew did not anticipate whiteout, other than the effects of recirculating snow," and that training "did not develop the rapid instrument scan required to compensate for the [PF's] minimal experience on type and in Arctic conditions."

After the accident, as part of its safety management system, the operator conducted an internal investigation. As a result, the operator increased use of full-motion flight-simulator training to replicate departures in whiteout conditions and to monitor flight crew interaction. Future simulator training also will emphasize compliance with SOPs, the report said. In addition, the operator adopted a policy to require a minimum of 50 flight hours in type before pilots conduct departures in whiteout conditions and was evaluating use of low-profile reflective markers at NWS helipads to provide visual cues along departure paths and approach paths.♦

Notes

1. Transportation Safety Board of Canada. Aviation Investigation Report A04C0190, *Collision With Terrain: Canadian Helicopters Limited, Bell 212 C-GMOH, Shepherd Bay, Nunavut, 30 October 2004.*

2. Transport Canada describes whiteout as "an extremely hazardous visual flight condition … [that] occurs over an unbroken snow cover and beneath a uniformly overcast sky. Because the light is diffused, the sky and terrain blend imperceptibly into one another, obliterating the horizon. The horizon, shadows and clouds are not discernible, and sense of depth and orientation is lost; only very dark, nearby objects can be seen."

3. Micro texture is considered to be fine-grained detail.

4. Department of National Defence. *Backgrounder: North Warning System*. <www.forces.gc.ca>.

Further Reading From FSF Publications

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Mondor, Colleen. "Among U.S. States, Alaska Has Highest Incidence of Accidents in FARs Part 135 Operations." *Flight Safety Digest* Volume 20 (November–December 2001).

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