Windshield Weakness

BY LINDA WERFELMAN

The S-76 crashed, killing eight people, after a hawk shattered the windshield and curtailed fuel flow to both engines.

The 2009 accident resulted in a slew of safety recommendations from the NTSB.

A Sikorsky S-76C++ that crashed into a Louisiana marsh after an en route bird strike was equipped with lightweight acrylic windshields — installed in place of the original bird-strike-resistant laminated glass, the U.S. National Transportation Safety Board (NTSB) said in its final report on the Jan. 4, 2009, accident.

The crash killed both pilots and six of the seven passengers, who had been on their way from Amelia, Louisiana, U.S., to an oil platform in the Gulf of Mexico when the helicopter struck a red-tailed hawk and plunged into the marsh at 1409 local time, about seven minutes after departure. The remaining passenger was critically injured, the report said.

The NTSB said that maintenance records showed that about two years before the accident, the operator, PHI, had replaced the original windshields with cast acrylic windshields.[1]

The NTSB, in its final report on the accident, said that the probable causes were "the sudden loss of power to both engines that resulted from impact with a bird … , which fractured the windshield and interfered with engine fuel controls, and the subsequent disorientation of the flight crewmembers, which left them unable to recover from the loss of power."

Contributing causes included the absence of U.S. Federal Aviation Administration (FAA) regulations or guidance — at the time the helicopter was certificated — to require bird-strike-resistant windshields.

In addition — noting that the impact had initiated a chain of events that jarred the T-handles that held engine fire extinguishers in place and pushed the engine control power levers (ECLs) aft, reducing fuel flow to the engines — the NTSB cited the "lack of protections that would prevent the T-handles from inadvertently dislodging out of their detents" and the "lack of a master warning light and audible system to alert the flight crew of a low-rotor-speed condition."

The T-handles were located about 4 in (10 cm) aft of the windshields. The NTSB said that the handles are "normally in the full-forward position during flight and are held in place by a spring-loaded pin that rests in a detent; aft pulling force is required to move the handles out of their detents."

In the event of an in-flight engine fire, the pilots are told to move the T-handle for the affected engine full aft, "so that a mechanical cam on the T-handle pushes the trigger on the ECL out of the wedge-shaped stop, allowing it to physically move aft with the T-handle," the NTSB said. "Fuel to the affected engine is then reduced."

The accident flight took off from PHI's Lake Palourde Base Heliport in Amelia at 1402 local time, carrying workers from two oil companies to the South Timbalier oil platform in the Gulf of Mexico. At 1409, the helicopter crashed in a marsh 12 nm (22 km) southeast of the heliport. There had been no distress calls or emergency transmissions to the PHI Communications Center or to air traffic control.

The U.S. Air Force received the helicopter's emergency locator transmitter (ELT) distress signal and began a search at 1414. The helicopter was found soon afterward, partially submerged in the marsh.

The report said that data and audio recordings from the cockpit voice recorder (CVR) and flight data recorder (FDR) showed that the helicopter had been in cruise flight at 850 ft and 135 kt "when a loud bang occurred. Immediately following the bang, sounds were recorded consistent with rushing wind, engine power reductions on both engines and main rotor rpm decay."

The captain of the accident flight had 15,373 flight hours, including 14,673 hours in rotorcraft and 5,423 hours in S-76s. The copilot had 5,524 flight hours, including 1,290 hours in helicopters and 962 hours in S-76s. Both men held airline transport pilot certificates for helicopters, commercial certificates for airplanes, instrument ratings for both helicopters and airplanes, and first class medical certificates, and both had flown more than 200 hours in helicopters during the 90 days before the accident. The copilot also held a flight instructor certificate for single/multi-engine airplanes and helicopters.

Both had completed all required training, along with initial and recurrent emergency training in ground school and in an S-76C++ simulator.

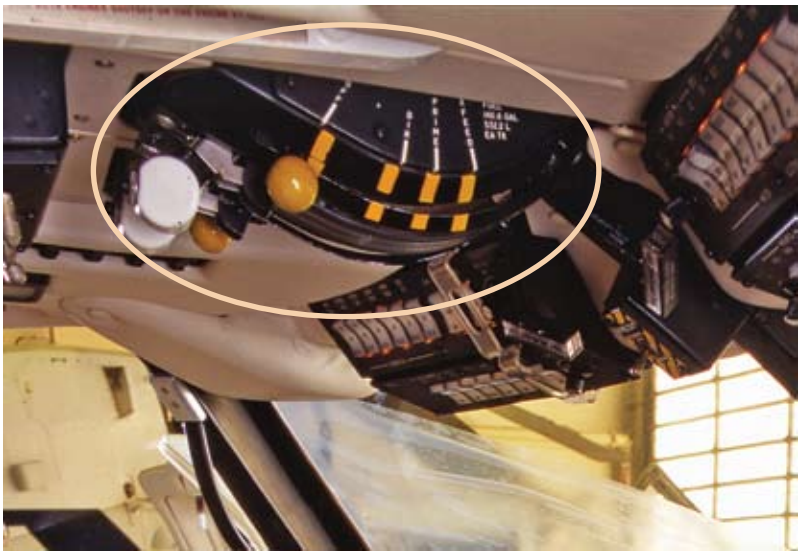
Two-Year-Old Helicopter

The twin-engine helicopter was two years old at the time of the accident and had a glass cockpit, a combination CVR and FDR, an enhanced ground proximity warning system, a solid-state quick access recorder, a vibration recorder, and Turbomeca Arriel 2S2 turboshaft engines with digital engine control units — all of which were evaluated by accident investigators.

The helicopter was manufactured with laminated glass windshields, which PHI removed in 2007 and replaced with lighter-weight cast acrylic windshields. The replacement was approved by the FAA under a supplemental type certificate issued in 1997 to the windshield manufacturer, Aeronautical Accessories Incorporated (AAI).[2] In 2008, PHI again replaced the windshields because of cracks at the mounting holes.

Weather conditions at Amelia at 1430 included scattered clouds at 1,500 ft and 3,500 ft and broken clouds at 10,000 ft, visibility of 10 mi (16 km), wind from 160 degrees at 6 kt, and a temperature of 24 degrees C (75 degrees F).

The impact of a bird strike caused a chain reaction that forced the engine control power levers — shown at the top of the photo — aft and reduced fuel flow.



© Chris Sorensen Photography

'A Bang … and a Loud Air Noise'

Examinations of the wreckage revealed no pre-crash problems that might have caused the accident. A review of the non-volatile memory from the digital engine electronic control units revealed no anomalies. The CVR recorded "the sound of a bang and a loud air noise," followed by an increase in background noise and "the sound of decreasing rotor and engine rpm," the report said, adding that the recording stopped 17 seconds later.

Although there was no evidence of a bird strike during initial visual examinations of the helicopter, subsequent tests revealed the microscopic remains of a bird. The remains were found on the pilot side of the windshield; subsequent tests revealed additional bird remains on the right windshield and the engine air filters, and parts of feathers under a windshield seal and in the right engine inlet air filter, the report said.

The bird subsequently was identified as a female red-tailed hawk — a bird with an average weight of 2.4 lb (1.1 kg).

Windshield Replacement

When the S-76 was certificated in 1978, the FAA had no specific requirements concerning bird strikes. In 1996, U.S. Federal Aviation Regulations (FARs) Part 29.631 took effect, requiring transport category helicopters to be capable of a safe landing after an impact with a 2.2-lb (1.0-kg) bird. However, because the requirement took effect after the S-76 was first certificated, any approved replacement windshield did not have to meet subsequent bird-strike requirements, the report said.[2]

U.S. National Transportation Safety Board

The report cited a 2006 FAA study that found helicopters — and helicopter windshields — are more likely than airplanes to be damaged by bird strikes and that helicopter bird strikes are more likely to result in injuries.[3]

Nevertheless, the FARs impose stricter requirements for transport category airplanes, which must be capable of withstanding "without penetration, the impact of a 4.0-lb [1.8 kg] bird" and be designed in a way that minimizes the risks of flying windshield fragments. In contrast, the FARs require that windshields on normal category helicopters, including those used for emergency medical services (EMS) and sightseeing flights, "must be made of material that will not break into dangerous fragments." The term "dangerous fragments" is not defined, and the regulations do not include guidance on how manufacturers should demonstrate compliance with the requirements, the NTSB report said.

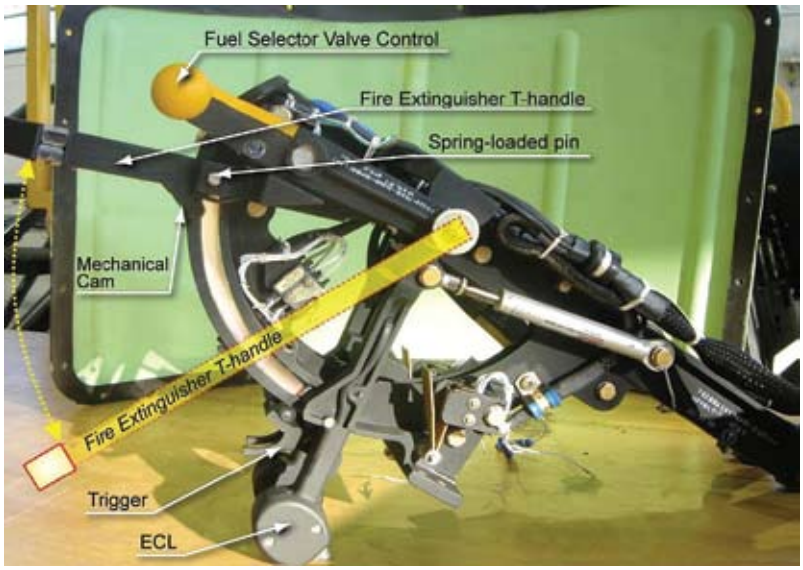
Because Sikorsky intended to market S-76s to North Sea oil operators, it installed laminated glass windshields to meet British Civil Aviation Requirements (BCARs), which "required the windshield to resist penetration of a 2-lb bird at 160 kt," the report said.

"Thus, in 1978, the Sikorsky-installed windshields had already exceeded the FAA's requirements that would have been imposed on a new aircraft at the time of the S-76C certification in 1991," the report said.

PHI had what the report characterized as "delamination issues" with the original windshields and, in the mid-1980s, began replacing the glass-laminated windshields on most of its S-76s with cast acrylic windshields manufactured by AAI. At the time of the accident, all of PHI's 46 S-76s had cast acrylic windshields; by September 2009, cast acrylic windshields were still in place in 14 of PHI's older S-76s.

AAI had performed no bird-impact tests on the S-76 windshields, the report said.

The report cited two bird-strike incidents that were similar to the 2009 accident. The first occurred in West Palm Beach, Florida, U.S., on Nov. 13, 1999, in an S-76C+ with a laminated-glass windshield. In that incident, the bird did not penetrate the windshield, although the impact cracked the windshield's outer ply and forced the T-handles supporting the fire extinguisher out of their detents. The four people in the helicopter for that EMS flight were not injured.



The fire extinguisher T-handle and ECL on an S-76C++

The second incident occurred April 19, 2006, in a PHI S-76A++ with a cast acrylic windshield identical to the windshield in the accident helicopter, the report said, noting that a bird came through the windshield and "pushed the right throttle to idle." The pilot landed the helicopter safety, although "the trapped remains of the bird prevented the right throttle from being re-engaged." The two pilots — the only people in the helicopter — were not injured.

The report said that after the 2009 accident, on May 19, Sikorsky issued Safety Advisory SSA-S76-09-002 expressing concern about the reduced safety of acrylic windshields and notifying S-76 operators that the S-76 laminated-glass windshield "demonstrated more tolerance to penetrating damage resulting from in-flight impacts such as bird strikes."

In a Nov. 23, 2010, letter accompanying a series of safety recommendations to FAA Administrator Randy Babbitt, the NTSB cited two U.S. Army reports that concluded that cast acrylic windshields are "incapable of defeating a bird

strike" and that cast acrylic would have to be three times thicker than a windshield of stretch acrylic[4] or polycarbonate to provide the level of protection afforded by those windshields.

"The 2009 PHI bird strike accident, the 2006 PHI bird-strike incident, Sikorsky's field experience and U.S. Army reports indicate that cast acrylic windshields are inadequate to prevent bird penetration," the NTSB said. "The superiority of laminated glass was demonstrated in the 1999 … bird-strike incident.

"The NTSB concludes that cast acrylic windshields such as those installed in the accident helicopter offer less protection from bird impacts compared to the original laminated glass windshields supplied by Sikorsky. The NTSB also concludes that, because Sikorsky developed the laminated glass windshields for the S-76 as a result of testing to satisfy a foreign bird-strike requirement, other helicopter manufacturers might also equip their helicopters with windshields with demonstrated bird-strike resistance."

Among the NTSB's 12 safety recommendations was a call to the FAA to prevent operators from replacing bird-strike-resistant windshields with windshields that are not resistant to bird strikes.

The NTSB also expressed concern that helicopters certificated before 1996 might have windshields that provide insufficient protection against bird strikes. The agency recommended that the FAA "evaluate the feasibility of retrofitting helicopters manufactured before 1996 with windshields that meet the current bird-strike requirements." Another recommendation asked the FAA to extend the evaluation to the feasibility of requiring the installation of windshields that meet current requirements in new helicopters that were built under old certification requirements.

In addition, the NTSB said that the FAA should revise FARs Part 27 "to specify a bird weight and velocity of impact that the helicopter must withstand and still be able to land safely and that the windshield must withstand without penetration." Revisions also should be incorporated into Part 29 to ensure that bird-strike standards for transport category helicopters are "consistent with the latest military and civilian bird-strike database information and trends in bird populations," the NTSB said.

Other recommendations called on the FAA to "require that Sikorsky redesign the S-76C++ model helicopter fire extinguisher T-handles and/or engine control quadrant to ensure that the T-handles do not inadvertently dislodge out of their detents due to any external force on the canopy or windshields that could cause unintended movement of the engine power control levers."

Other helicopter models with similar engine control quadrant designs also should be modified to ensure that an impact on the canopy or windshields does not result in the unintended movement of the levers, the NTSB said.

The NTSB also recommended that the FAA require helicopter manufacturers to develop guidance to aid pilots in "devising precautionary helicopter operational strategies for minimizing the severity of helicopter damage sustained during a bird strike … when operating in areas of known bird activity."

This article was based on NTSB accident report no. CEN09MA117, accompanying public docket material and NTSB Safety Recommendations A-10-136 through A-10-147.

Notes

1. Cast acrylic windshields are made by allowing acrylic resin to harden in a mold.
2. In 1998, the FAA issued parts manufacturer approval to AAI for the manufacture of the windshields.
3. Dolbeer, R.A.; Wright, S.E.; Cleary, E.C. "Bird Strikes to Civil Helicopters in the United States, 1990–2005," Appendix A, p. 45–50 in Cleary, E.C.; Dolbeer, R.A.; Wright, S.E. *Wildlife Strikes to Civil Aircraft in the United States, 1990– 2005*. U.S. Department of Transportation, FAA Office of Airport Safety and Standards, Serial Report No. 12, Washington. Available online at <http://wildlife-mitigation.tc.faa.gov>.
4. Stretch acrylic windshields are made by heating sheets of cast acrylic and stretching them.