



Abrupt Maneuver and Mast Bumping Cited in Loss-of-control Accident

Witnesses said that the Fairchild Hiller FH-1100 helicopter was being flown at low altitude when the main rotor separated and a rotor blade struck the cabin.

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FSF Editorial Staff

At 1415 local time on April 26, 1998, a Fairchild Hiller FH-1100 (serial number 180, registration number N1345Q) broke apart in flight, descended uncontrolled and struck the ground during an aerial-photography flight in Stevensville, Maryland, U.S. The pilot and the passenger were killed. The helicopter was destroyed by the in-flight breakup, impact and postaccident fire.

The U.S. National Transportation Safety Board (NTSB) said, in its final report, that the probable cause of the accident was “the pilot’s abrupt, low-g maneuver, which resulted in mast bumping and separation of the main-rotor system.”

The purpose of the flight was to photograph real estate near the northern shore of Kent Island, in Chesapeake Bay. The flight was conducted under the general operating and flight rules of U.S. Federal Aviation Regulations (FARs) Part 91.

The pilot, 54, held an airline transport pilot certificate and a flight instructor certificate; both certificates included ratings for helicopters and airplanes. He had 5,903 flight hours, including 247 flight hours in helicopters. The report said that the pilot’s principal profession was “business”; the owner of the accident helicopter told investigators that the pilot was a licensed real-estate broker.



The pilot had 15 flight hours in type — all logged in the accident helicopter. The pilot’s first flight in the helicopter was a test flight March 16, 1998, following installation of radios. He then flew the helicopter to the owner’s home base.

“Prior to that date, the pilot had not flown a helicopter since November 8, 1994,” the report said. “The pilot logged his first flight in N1345Q as a test flight that was one hour in duration. Later the same day, he flew a cross-country flight that was 1.5 hours in duration. The pilot received a proficiency evaluation in the helicopter from the owner/operator the

following day.”

The owner of the accident helicopter held a commercial pilot certificate with ratings for helicopters and single-engine airplanes, a flight instructor certificate with a rating for helicopters and an airframe-and-powerplant mechanic certificate.

The passenger had received 1.5 hours of flight instruction in the helicopter, including 0.5 hour of flight instruction administered by the accident pilot, during the week preceding the accident. He held a private pilot certificate with an instrument rating and had 763 flight hours. The report said that the passenger’s principal profession was “doctor/dentist.”

The helicopter departed from Easton, Maryland, about 1300. The flight was conducted in visual meteorological conditions that included a 12,000-foot broken ceiling, 10 statute miles (16 kilometers) visibility and light surface winds. The outside air temperature was 63 degrees Fahrenheit (17 degrees Celsius).



Fairchild Hiller FH-1100

Hiller Aircraft Co. began designing a light observation helicopter designated the OH-5A in 1961. The OH-5A competed for a U.S. military contract that was won by the Hughes OH-6A. In 1964, Hiller was acquired by Fairchild Stratos Corp. The company, renamed Fairchild Hiller, developed a civilian utility version of the OH-5A designated the FH-1100 and began production of the helicopter in 1966. Production ended in 1974, after 246 of the helicopters were built.

The FH-1100 accommodates a pilot and four passengers. The three rear seats fold to increase cargo area. The Allison 250-C18 turboshaft engine is rated at 317 shaft horsepower (237 kilowatts) for takeoff and 270 shaft horsepower (201 kilowatts) for continuous operation. The main rotor and tail rotor each have two blades of all-metal construction. A bladder fuel tank in the bottom of the center fuselage has a capacity of 69 gallons (261 liters).

Maximum takeoff weight is 2,750 pounds (1,247 kilograms). Maximum rate of climb at sea level is 1,600 feet per minute. Maximum cruising speed at 5,000 feet is 110 knots. Range with maximum payload at sea level is 302 nautical miles (559 kilometers). Service ceiling is 14,200 feet. Hovering ceiling in ground effect is 13,400 feet. Hovering ceiling out of ground effect is 8,400 feet. ♦

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

Witnesses observed the helicopter being maneuvered abruptly about 200 feet above ground level before it broke up in flight.

A witness observed the helicopter being flown toward her house. "I heard a big pop and then a huge boom while it was still in the air," she said. "I saw things flying off of both sides the whole time. Then it fell straight down. I could hear the aircraft. It sounded a little different, but the engine had no hesitation. When I heard the pop, something flew off the top. Then I heard the bang, and more things flew off. When the boom came, it just went down."

Another witness was planting a tree in the front yard of his home, about 300 feet (92 meters) from the accident site, when he observed the helicopter "flying erratically and performing abrupt maneuvers." He said that the helicopter was being flown from house to house and hovering near each house for three minutes to five minutes.

"I observed the [heli]copter turn toward my house," he said. "While trying to negotiate this turn, the copter pitched back and forth 25 degrees, then yawed 25 degrees from side to side. This was clearly not normal, and control appeared to be almost lost."

The witness observed the helicopter fly slowly overhead and then begin to hover over a pond.

"From what seemed to be a steady hover, the tail of the copter swayed from side to side in a 15-degree arc, then the entire copter reared up 45 degrees with a high-pitched engine noise, and the main-rotor blades disengaged, striking the side of the cabin and causing it to collapse inward, then come apart," the witness said. "I observed the copilot and pilot thrown out either side of the cabin, heads toward the ground."

"The rotor then hit the tail section, and I observed the windshield and rotor fly ... toward me and land in the pond. ... The rest of the copter fell straight down, with the occupants falling in tandem. ... There was no explosion or engine noise or fire as it fell."

The main-rotor hub and blade assembly, and the upper portion of the main-rotor mast were located about 190 feet (58 meters) from the main wreckage. Paint and metal from the rotor mast were found on the rotor-hub static stops.

"The mast fracture was aligned with the bottom of the hub at the static stops, and the mast exhibited overload fractures with no evidence of fatigue," the report said.

Hiller Aviation [which acquired the rights to the FH-1100 and the UH-12 from Fairchild Industries in 1973] issued Service Letter 10-10 to FH-1100 owners in August 1983. The service letter provided the following information:

Abrupt pull-ups and push-overs can be catastrophic.

A recent fatal accident was caused by a pilot putting the helicopter into a low-g (weightless) flight condition. While he attempted to maneuver the helicopter with full cyclic inputs during the low-g condition, the rotor flapping at the teeter hinge exceeded design limits, causing extreme “mast bumping,” fracturing the main-rotor shaft. [The FH-1100 has a semirigid rotor system: The two rotor blades are rigidly mounted to the main-rotor hub; a teetering hinge allows the hub to tilt and the blades to teeter (i.e., move up and down) with respect to the main-rotor shaft.]

Caution: In forward flight, when a pull-up (aft cyclic) is followed by a push-over (forward cyclic), a weightless (low-g) condition will occur. If the aircraft starts to roll during this condition, gently apply aft cyclic to reduce the weightless feeling *before* using lateral cyclic to stop the roll.

For cyclic control, light helicopters depend primarily on tilting the main-rotor thrust to produce control moments about the aircraft center of gravity (CG), so the helicopter will roll or pitch in the desired direction. In forward flight, when a pull-up is followed by a push-over, the angle-of-attack and thrust of the rotor [are] reduced, causing a low-g or weightless flight condition. During the low-g condition, the lateral cyclic has little, if any, effect on fuselage attitude because the rotor thrust has been reduced. Also, there is no main-rotor thrust component to the left to counteract the tail-rotor thrust to the right; and, since the tail rotor is above the CG, the tail-rotor thrust will cause the helicopter to roll rapidly to the right. If the pilot attempts to stop the right roll by applying full left cyclic before regaining main-rotor thrust, the rotor can exceed its flapping limits and cause structural failure of the rotor shaft.

The best way to prevent mast bumping is to avoid abrupt cyclic pull-ups or push-overs during forward flight. Always use gentle and sensitive cyclic-control inputs and, if you do have a feeling of weightlessness during a maneuver or gusty condition, gently bring the cyclic aft to regain main-rotor thrust *before* lateral cyclic is applied. Remember [that] out-of-limit CG conditions can aggravate mast bumping.

The report said that NTSB records showed that the accident helicopter had been destroyed and deregistered (i.e., removed from the U.S. civil aircraft registry) after an accident in 1988.

[In its report on the Sept. 11, 1988 accident (report no. LAX88FA332), NTSB said that the helicopter struck terrain

in Picacho, Arizona, when the pilot flying lost control during takeoff. One occupant received serious injuries; one occupant received minor injuries; and one occupant was not injured. “Neither the flying pilot nor the owner/PIC (pilot-in-command) ... held a rotorcraft-helicopter rating,” the report said. “The PIC had previously flown helicopters, including the accident helicopter. The aircraft did not have dual controls. The owner/PIC and the pilot, who was also an FAA designated medical examiner, initially reported to authorities that the passenger fell out of a pickup truck. Later, the owner/PIC reported to (NTSB) that he was preflighting the helicopter with the engine running when it rolled over. The postaccident investigation revealed that the helicopter struck the ground under high power in a left, nose-down attitude and ... that the pilot flying was the pilot with no previous helicopter experience.” NTSB said that the probable cause of the accident was that the “owner/PIC used poor judgment in allowing an unqualified pilot to fly the helicopter when it was not equipped with dual controls.”]

The report on the 1998 accident indicates that the helicopter was sold to an individual and reregistered in 1993.

A flight-test engineer for Hiller Aircraft Corp. [which provides spare parts for Hiller UH-12 series helicopters] told investigators that he performed a prepurchase inspection of the helicopter in February 1996. He said that the company wanted to purchase an FH-1100 as a ground-test vehicle. (The report did not specify the location of the prepurchase inspection.)

“I went down and looked it over,” he said. “It looked to me like it had been piecemealed together. You could tell [that the helicopter]

was pieced together by all the different colors. ... There were discrepancies in the logbook. Some of the components came off other aircraft, and I had to wonder what happened to those other aircraft to make those components available, because we stopped manufacturing parts for this aircraft in 1972.”

The Hiller engineer told investigators that the company did not purchase the helicopter because it was unsuitable for use as a ground-test vehicle.

The owner of the helicopter at the time of the April 1998 accident purchased the helicopter in November 1997. He told investigators that the previous owner performed “extensive component overhauls in May 1997” before delivering the helicopter “via Mexico, via Texas,” where an annual inspection and a review of the type certificate were performed.

The report said that an FAA airworthiness inspector examined the helicopter’s records after the accident and submitted to

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investigators “an itemized list of discrepancies that spanned three pages.” Among the discrepancies were the following:

- “No permanent records existed for FH-1100 serial number 180, N1345Q, or the time-limited components installed on the airframe as required by [FARs] Part 91.417;
- “A mechanic with no inspection authority signed off the most recent annual inspection [on May 13, 1997];
- “Weight-and-balance forms were altered originals from FH-1100 serial number 220;
- “[An FAA] designated airworthiness representative with no rating for helicopters issued the airworthiness certificate on November 19, 1997, at 7,118 aircraft hours; [and,]
- “Four months later [March 17, 1998], the helicopter owner/operator recorded complete disassembly of the aircraft to components parts, overhauls of components to zero time and reassembly of the helicopter with no

corresponding paperwork. The owner/operator recorded the work was completed at 7,076 aircraft hours, a reduction of 42 hours of total airframe time since he purchased the helicopter.” (The NTSB report on the September 1998 accident said that the helicopter had accumulated 7,601 airframe hours.)

The records indicated that an Allison 250-C18B engine was removed from another FH-1100, serial no. 069, and installed in the accident helicopter in May 1997.

“However, no maintenance records or history existed for this engine,” the report said. “The engine and engine component total times and time since overhaul could not be determined.

“Research revealed that [the engine] was installed in a Bell 206 that was destroyed in an accident in January 1983. No records of maintenance, overhaul or component purchases for the engine since that time were found.”♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board accident report no. IAD98FA049, which comprises 67 pages and contains illustrations and photographs.]

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