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# In-flight Separation of Propeller Blade Results in Uncontrolled Descent and Fatal Accident to Twin-turboprop Commuter Aircraft

***After receiving second-degree burns to her ankles and legs in the postaccident fire, the flight attendant continued to assist passengers by moving them away from the airplane and extinguished flames on at least one passenger who was on fire, the official U.S. report said.***

*FSF Editorial Staff*

The crew of the Atlantic Southeast Airlines Inc. (ASA) Embraer EMB-120RT (a 29-passenger twin-turboprop commuter aircraft) had departed the William B. Hartsfield Atlanta International Airport (ATL), Atlanta, Georgia, U.S., on an instrument flight rules (IFR) flight plan to Gulfport, Mississippi. As the aircraft was climbing through 18,100 feet (5,520 meters) mean sea level (MSL), a left-engine propeller blade separated. The flight crew declared an emergency and attempted to return to ATL.

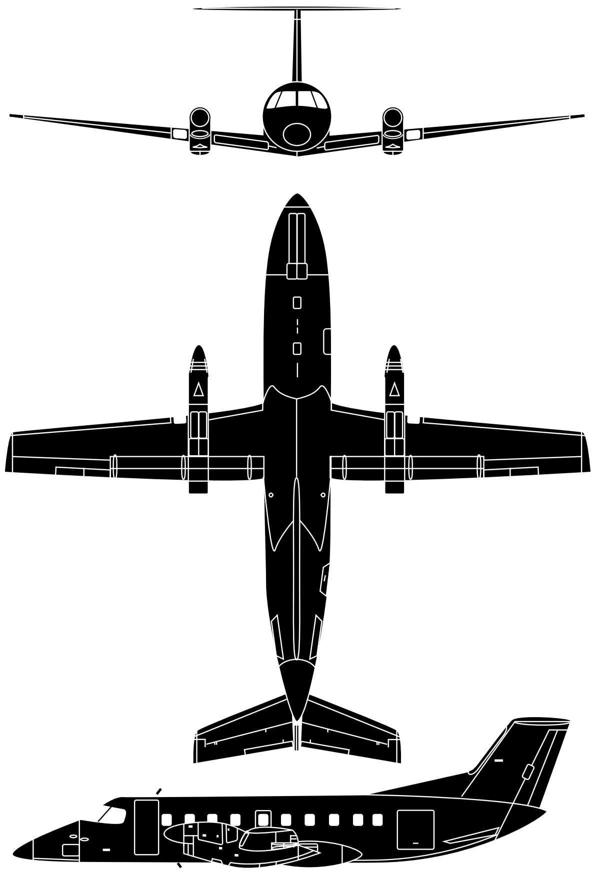
Unable to maintain altitude, the crew was vectored by air traffic control (ATC) toward the West Georgia Regional Airport (CTJ), Carrollton, Georgia (the closest airport to their position). The airplane continued descending until it passed through trees, impacted terrain and burned, approximately 6.4 kilometers (four miles) southwest of CTJ. The airplane was destroyed by the impact and postaccident fire. Its estimated value was US$5 million.

The captain, who was the pilot flying, and four passengers were killed. Three other passengers died of injuries in the following 30 days. The first officer, the flight attendant and 11 passengers were seriously injured, and the remaining eight passengers suffered minor injuries in the Aug. 21, 1995, accident. One of the passengers whose injuries were classified as "serious" died four months after the accident as a result of her injuries.

The accident occurred in daylight and in visual meteorological conditions (VMC).

The U.S. National Transportation Safety Board (NTSB) determined that "the probable cause of this accident was the in-flight fatigue fracture and separation of a propeller blade resulting in the distortion of the left-engine nacelle, causing excessive drag, loss of wing lift and reduced directional control of the airplane. The fracture was caused by a fatigue crack from multiple corrosion pits that were not discovered by Hamilton Standard [the propeller blade manufacturer] because of inadequate and ineffective corporate inspection and repair techniques, training, documentation and communications.

"Contributing to the accident was Hamilton Standard's and the [U.S.] Federal Aviation Administration's [FAA's] failure to require recurrent on-wing ultrasonic inspections for the affected propellers. Contributing to the severity of the accident was the overcast cloud ceiling at the accident site."



**Embraer EMB-120 Brasilia**

The Embraer EMB-120 Brasilia was first flown in 1983. The twin-turboprop aircraft can seat as many as 30 passengers and has a long-range cruising speed at 25,000 feet (7,620 meters) of 260 knots (482 kilometers per hour). It has a maximum takeoff weight of 11,500 kilograms (25,353 pounds), a range of 945 nautical miles (1,750 kilometers) at 25,000 feet with a maximum 30-passenger payload and a service ceiling of 29,800 feet (9,085 meters).

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

The accident occurred on the first day of a two-day trip for the flight crew. Their first flight of the day was from Macon, Georgia, to ATL. An ASA captain who rode in the jump seat during that flight "reported that the flight was uneventful and that the crew appeared to be rested and in a relaxed mood during the flight," the report said.

Operating under U.S. Federal Aviation Regulations (FARs) Part 135, the accident flight departed ATL at 1223 hours local time with 26 passengers and three crew members. At 1236, the first officer contacted the Atlanta FAA air route traffic control center (ARTCC) and reported climbing through 13,000 feet (3,965 meters). About eight minutes later, the flight was cleared to climb and maintain flight level (FL) 240 (24,000 feet [7,320 meters]), which the crew acknowledged.

The accident aircraft was equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR). At 1243:25, data from the recorders indicated that "while climbing through 18,100 feet at 160 knots indicated airspeed (KIAS) [298 kilometers per hour (kph)], several thuds could be heard from the cockpit, and the torque on the left engine decreased to zero," the report said. "The airplane then rolled to the left, pitched down and subsequently started to descend."

During interviews following the accident, survivors told investigators that "during the climb-out, they heard a loud sound and felt the airplane shudder," the report said. "They also indicated that two or three blades from the left propeller were wedged against the front of the wing. The flight attendant said that she looked out the left side of the aircraft and observed, 'a mangled piece of machinery where the propeller and the front part of the cowling [were located].' Other passengers observed the propeller displaced outboard from its original position on the engine."

FDR data indicated that numerous flight-control inputs were made to control the aircraft. Despite the crew's efforts to counteract the flight-path deviations, "the airplane attitude decreased to about nine degrees nose low, and the airplane began a descent that progressed to about 5,500 feet per minute (FPM) [1,677 meters per minute]," the report said.

The captain said to the first officer, "I can't hold this thing," which was followed shortly by, "help me hold it." The first officer called Atlanta ARTCC, declared an emergency and reported the engine failure. ATC cleared the flight direct to ATL.

At 1245:46, the first officer told the flight attendant that the aircraft had experienced an engine failure and that the aircraft was being diverted back to ATL. He also told the flight attendant to brief the passengers. There were no further communications with the flight attendant, the report said.

About 30 seconds later, the first officer reported to ATC, "we're going to need to keep descending. We need an airport quick and uh, roll the trucks and everything for us." The flight was then provided with heading information to CTJ.

The report said that the flight crew "applied various combinations of flight-control inputs and power on the right engine, partially stabilizing the airplane descent rate to between 1,000 [FPM] and 2,000 FPM [305 meters per minute and 610 meters per minute] and the airspeed to between 153 [KIAS] and 175 [KIAS] [283 kph and 325 kph]."

As the aircraft descended through 4,500 feet (1,372 meters), the Atlanta ARTCC lost contact with the flight's transponder. At about 1250, the crew was told to contact the Atlanta FAA terminal radar approach control (TRACON). The crew contacted Atlanta TRACON and "requested the localizer frequency and vectors for [CTJ]," the report said. "The controller issued the localizer frequency. The flight crew acknowledged and then requested vectors for a visual approach."

After verifying that the flight was in VMC, the controller told the crew to "fly heading zero four zero … airport's at your about 10 o'clock and [9.7 kilometers (six miles)]." The crew acknowledged the heading assignment, which was the last radio transmission from the accident flight.

The report said: "After 1251:30, [the] airspeed steadily decreased from 168 KIAS [317 kph] to about 120 KIAS [222 kph]. FDR and CVR information indicated that the landing gear and flaps remained retracted. CVR sounds indicated that the first ground impact occurred about 1252:45."

The aircraft initially contacted trees in a 20-degree descent angle, with an increasing left wing–down attitude of 15 degrees to 40 degrees, the report said. It traveled through trees for about 110 meters (360 feet), then through an open field for 149 meters (490 feet) before coming to rest on a heading of about 330 degrees.

The passengers later told investigators that the aircraft cabin started breaking up during the initial ground impact. "Passengers stated that overhead storage bins in the cabin dislodged during the initial ground impact and that passenger-seat structures separated and/or became deformed," the report said. "According to one passenger, as the fuselage slid on its left side, several large holes were created that allowed enough daylight to appear in the cabin [to provide] the flight attendant and passengers visual escape cues."

After the aircraft had come to a complete stop, passengers said there was about a one-minute period before a fire broke out. "The passengers described black smoke and flame consistent with what would be expected of a fuel-fed fire," the report said. "Passengers reported that the fire was immediately preceded by cracking sounds and sparks from wires and cables, and that the fire started in small patches and spread quickly, fully engulfing the area aft of the cockpit entrance door.

"Some passengers related that they found portions of their clothing saturated with fuel, and one passenger saw 'a couple of people on fire.' The flight attendant and several passengers said they had to run through flames to escape from the cabin wreckage."

The report noted: "None of the survivors reported escaping from the cabin through the main entrance door, the overwing emergency exits or the cabin emergency exit. They escaped through the holes in the fuselage, which were immediately behind the cockpit and aft of the wing. Passengers who were unable to escape from the wreckage succumbed to smoke inhalation."

The flight attendant, despite having received second-degree burns to her ankles and legs, "continued to assist passengers

## Cockpit Voice Recorder Transcript, Atlantic Southeast Airlines EMB-120RT, Aug. 21, 1995

| Time | Source | Content |
|---|---|---|
| **1243:25** | **CAM**: | [Sound of several thuds] |
| **1243:26** | **CAM-1:** | ****. |
| **1243:28** | **CAM:** | [Three chimes similar to master warning] Autopilot, engine control, oil [and continues to repeat.] |
| **1243:29** | **CAM-?:** | *. |
| **1243:32** | **CAM-2:** | Pack off. |
| **1243:34** | **CAM-1:** | *. |
| **1243:38** | **CAM-1:** | We got a left engine out. Left power lever. Flight idle. |
| **1243:45** | **CAM:** | [Shaking sound starts and continues for 33 seconds.] |
| **1243:46** | **CAM-1:** | Left condition lever. Left condition lever. |
| **1243:48** | **CAM-2:** | Yeah. |
| **1243:49** | **CAM-1:** | Feather. |
| **1243:51** | **HOT-B:** | [Series of rapid beeps for one second similar to engine fire warning] |
| **1243:54** | **CAM-1:** | Yeah we're feathered. Left condition lever, fuel shut-off. |
| **1243:59** | **CAM-1:** | I need some help here. |
| **1244:02** | **CAM:** | [Mechanical voice messages for engine control and oil cease. Chimes and autopilot warning continue.] |
| **1244:03** | **CAM-2:** | OK. |
| **1244:03** | **CAM-1:** | I need some help on this. |
| **1244:05** | **CAM-?:** | (You said it's) feathered? |
| **1244:06** | **CAM-1:** | Uh ... |
| **1244:07** | **CAM-2:** | It did feather. |
| **1244:07** | **CAM-1:** | It's feathered. |
| **1244:09** | **CAM-2:** | OK. |
| **1244:09** | **CAM:** | [Master warning chimes and voice warning continues.] |
| **1244:10** | **CAM-1:** | What the hell's going on with this thing. |
| **1244:13** | **CAM-2:** | I don't know ... got this detector inop. |
| **1244:16** | **CAM-1:** | OK ***. |
| **1244:18** | **CAM-?:** | OK, let's put our headsets on. |

| | | |
|---|---|---|
| **1244:20** | **CAM-1:** | I can't hold this thing. |
| **1244:23** | **CAM-1:** | Help me hold it. |
| **1244:24** | **HOT-2:** | OK. |
| **1244:26** | **CAM-1:** | All right comin' on headset. |
| **1244:26** | **RDO-2:** | Atlanta center. AC five twenty-nine, declaring an emergency. We've had an engine failure. We're out of fourteen two at this time. |
| **1244:31** | **CTR:** | AC five twenty-nine, roger, left turn direct Atlanta. |
| **1244:33** | **HOT-1:** | # damn. |
| **1244:34** | **RDO-2:** | Left turn direct Atlanta, AC five twenty nine. |
| **1244:36** | **HOT-?:** | [Sound of heavy breathing] |
| **1244:41** | **HOT-?:** | ** back **. |
| **1244:57** | **HOT-?:** | [Sound of squeal] |
| **1245:01** | **CAM:** | [Tone similar to master caution cancel button being activated. All warnings cease.] |
| **1245:03** | **HOT-1:** | All right turn your speaker off. Oh, we got it. Its ... |
| **1245:07** | **HOT-1:** | I pulled the power back. |
| **1245:10** | **CTR:** | AC five twenty-nine, say altitude descending to. |
| **1245:12** | **RDO-2:** | We're out of eleven six at this time. AC five twenty-nine. |
| **1245:17** | **HOT-1:** | All right, it's, it's getting more controllable here ... the engine ... let's watch our speed. |
| **1245:32** | **HOT-1:** | All right, we've trimmed completely here. |
| **1245:38** | **HOT-2:** | I'll tell Robin what's goin' on. |
| **1245:39** | **HOT-1:** | Yeah. |
| **1245:44** | **HOT-B:** | [Sound of two chimes similar to cabin call button being activated] |
| **1245:45** | **INT-3:** | Yes sir. |
| **1245:46** | **INT-2:** | OK, we had an engine failure Robin. We declared an emergency, we're diverting back into Atlanta. Go ahead and uh, brief the passengers. This will be an emergency landing back in. |
| **1245:55** | **INT-3:** | All right. Thank you. |
| **1245:56** | **HOT-1**: | Tell 'em we want ... |
| **1245:58** | **CTR:** | AC five twenty-nine, say altitude leaving. |
| **1246:01** | **RDO-2:** | AC five twenty-nine's out of ten point three at this time. |

after the accident by moving them away from the airplane," the report said. "She also extinguished flames on at least one passenger who was on fire."

As the passengers were evacuating the cabin, "the first officer attempted unsuccessfully to open the right-side cockpit window, which was damaged during the impact," the report said. The first officer then retrieved a small ax with a wooden handle from behind his crew seat and "attempted to chop a hole in the side window, but was only successful in chopping a hole approximately [10 centimeters (four inches)] in diameter ... ."

The first officer then handed the ax through the small hole to a passenger who tried to break the window, but was unsuccessful, the report said. The wooden handle separated from the ax head. A sheriff's deputy (the first of local emergency personnel to arrive at the scene) saw the passenger striking the cockpit window with the ax.

Minutes later, the local fire department arrived and firefighters were unable to break the window using full-size fire axes. Firefighters then applied water on the window.

The sheriff's deputy reported that "a continuous roaring sound emanated from an area behind the cockpit in which there was an intense fire," the report said. Firefighters were eventually able to control the fire behind the cockpit sufficiently to enter the cabin, break through the cockpit door and rescue the first officer. "The sheriff's deputy did not observe any signs of life from the captain during the rescue sequence."

The local medical examiner reported the cause of death for the captain as thermal burns and smoke inhalation. The medical examiner also reported "that blunt force trauma injuries to the [captain's] face and head were 'other significant conditions,'" the report said. "The first officer survived with burns over 80 percent of his body." The seven fatally injured passengers died as a result of thermal burns and smoke inhalation.

The report noted: "One passenger died four months after the accident as a result of her injuries. She sustained third-degree burns over 50 percent of her body, as well as inhalation injuries. In accordance with 49 CFR [U.S. Code of Federal Regulations] 830.2, which defines 'fatal injury' as any injury that results in death within 30 days of the accident, her injuries were classified as 'serious.'"

The report described the accident site: "The main wreckage area consisted of the cockpit, fuselage, right wing and engine, and the empennage. Portions of two of the right engine's propeller blades remained attached to the propeller hub and engine. The remaining two blades of the right-engine propeller assembly were located nearby. An area of the grass leading up to and surrounding the main wreckage was burned out to a radius of about [9.1 meters (30 feet)]. The airplane came to rest at the northwest end of [a 259-meter (850-foot)] wreckage trail … ."

When investigators examined the main wreckage, they found that “the aft portion of the fuselage had separated from the forward portion in two places, near the trailing edge of the wing and also just behind the cockpit,” the report said. “The forward fuselage section (including the cockpit) was upright. The aft portion of the fuselage was resting on the right side and was supported by the right horizontal stabilizer. The vertical stabilizer was intact and essentially undamaged. Most of the passenger cabin that was not resting on the ground was destroyed by fire.”

Although the right side of the forward fuselage had very little damage, “the left side of the forward fuselage below the cockpit window from the radome to just forward of the passenger/crew entry door was crushed in, aft and up to the left side of the nose landing-gear wheel well,” the report said.

The report described the fire damage: “Fire had destroyed the left side of the fuselage aft of the passenger/crew entry door. The fire damage extended to just forward of the cargo door and the entire right side of the fuselage from the leading edge of the wing to two seat rows forward of the cargo section. The upper portion of the right fuselage forward of the leading edge of the wing to the cockpit had also been destroyed by fire.”

Investigators examined the cockpit and found both the left and right sliding windows “restricted by airframe damage consistent with impact and deformation of the windows’ slide tracks,” the report said. “The first officer’s cockpit sliding window was found to have jammed in its track in the closed position.” Investigators were only able to open the windows with the use of pry bars.

On further examination of the cockpit, investigators found the flight crew oxygen walk-around cylinder and smoke masks stored, respectively, on the left and right sides of the cockpit, the report said. Neither unit appeared to have been used.

The report noted: “Protective breathing equipment (PBE) required in [FARs] Part 121 airplanes was not carried [on the accident flight] (nor was it required to be) because the airplane was operated under [FARs] Part 135.”

Examining the wreckage path, investigators found the left-engine propeller blade and reduction gear box (RGB) 49 meters (160 feet) past the tree line where the aircraft initially made contact. “The propeller hub and blade assembly contained three complete propeller blades with the inboard piece of a fourth propeller blade protruding about [0.3 meter (one foot)] from the hub,” the report said.

The NTSB used a computer program to calculate the trajectory of the missing propeller blade piece. Investigators “devised a search area and alerted the local residents and authorities about the missing piece,” the report said. “Three weeks after the accident, the outboard piece of the propeller blade was discovered by a farmer. It had been well hidden in some tall

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| **1246:03** | **CTR:** | AC five twenty-nine roger, can you level off or do you need to keep descending? |
| **1246:09** | **HOT-1:** | We ca ... We’re gonna need to keep con ... descending. We need a airport quick. |
| **1246:13** | **RDO-2:** | OK, we uh, we’re going to need to keep descending. We need an airport quick and uh, roll the trucks and everything for us. |
| **1246:20** | **CTR:** | AC five twenty-nine, West Georgia, the regional airport is at your ... ten o’clock position and about ten miles. |
| **1246:28** | **RDO-2:** | Understand ten o’clock and ten miles. AC five twenty-nine. |
| **1246:30** | **CTR:** | ’s correct. |
| **1246:36** | **HOT-1:** | (* give me) [whispered] |
| **1246:38** | **HOT-1:** | Let’s get out the uh ... engine failure checklist, please. |
| **1246:47** | **HOT-2:** | OK, I’ll do it manually here. |
| **1246:55** | **HOT-2:** | OK, engine failure in flight. |
| **1246:57** | **CTR:** | AC five twenty-nine, say heading. |
| **1246:59** | **RDO-2:** | Turnin’ to about uh, three ten right now. |
| **1247:01** | **HOT-2:** | Power level’s, flight idle. |
| **1247:03** | **CTR:** | AC five twenty-nine, roger. You need to be on about a zero three zero heading for West Georgia Regional, sir. |
| **1247:07** | **RDO-2:** | Roger, we’ll (“prob’ly,” or possibly, “try ta”) turn right. We’re having uh, difficulty controlling right now. |
| **1247:11** | **HOT-2:** | OK, condition lever’s, feather. |
| **1247:13** | **HOT-1:** | All right. |
| **1247:14** | **HOT-2:** | It did feather ... NP’s showing zero. |
| **1247:18** | **HOT-1:** | ’K. |
| **1247:19** | **HOT-2:** | OK. |
| **1247:20** | **CTR:** | AC five twenty-nine, when you can, it’s zero four zero. |
| **1247:22** | **RDO-2:** | Zero four zero, AC five twenty-nine. |
| **1247:25** | **HOT-2:** | ’K, electric, yeah OK it did feather. There’s no fire. |
| **1247:27** | **HOT-1:** | All right. |
| **1247:28** | **HOT-2:** | OK. |
| **1247:32** | **HOT-2:** | Main auxiliary generators of the failed engine off. |
| **1247:35** | **HOT-1:** | ’K. I got that. |
| **1247:40** | **HOT-2:** | ’K, APU ... if available, start. Want me to start it? |

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| **1247:45** | **HOT-1:** | We gotta, bring this down, bring those. Put the that off. Bring the ice off ... |
| **1247:54** | **HOT-B:** | [Sound of chime similar to master caution starts and repeats at six-second intervals until the end of the recording.] |
| **1247:56** | **HOT-?:** | *. |
| **1247:56** | **CTR:** | AC five twenty-nine uh, say your altitude now sir. |
| **1247:59** | **RDO-2:** | Out of seven thousand, AC five twenty-nine. |
| **1248:00** | **HOT-B:** | [Sound of three chimes followed by voice message] Trim fail. [Warning starts and continues.] |
| **1248:04** | **HOT-1:** | Good start. |
| **1248:04** | **CTR:** | AC five twenty-nine, I missed that, I'm sorry. |
| **1248:06** | **RDO-2:** | We're outta six point nine right now, AC five twenty-nine. |
| **1248:09** | **CTR:** | AC five twenty-nine roger, West Georgia Regional, heading zero seven zero. |
| **1248:13** | **RDO-2:** | Zero seven zero, AC five twenty-nine. |
| **1248:20** | **HOT-B:** | [Sound of single beep] |
| **1248:33** | **HOT-2:** | OK, it's up and running, Ed. |
| **1248:34** | **HOT-1:** | All right, go ahead. |
| **1248:35** | **CTR:** | AC five twenty-nine, West Georgia Regional is your closest airport. The other one's uh, Anniston and that's about thirty miles to your west, sir. |
| **1248:40** | **HOT-1:** | How long, how far West Georgia Reg ... What kind of a runway they got. |
| **1248:44** | **RDO-2:** | What kind of runway's West Georgia Regional got? |
| **1248:54** | **HOT-1:** | Go ahead and finish the checklist. |
| **1248:58** | **CTR:** | West Georgia Regional is uh, five say one six and three four and it's five thousand feet ... |
| **1249:01** | **HOT-2:** | OK, APU started. OK, prop sync, off. Prop sync's comin' off. |
| **1249:03** | **HOT-1:** | OK. |
| **1249:04** | **HOT-2:** | Fuel pumps failed engine. You want uh, max on this? |
| **1249:07** | **HOT-1:** | Go ahead, please. |
| **1249:08** | **HOT-2:** | OK. |
| **1249:09** | **CAM:** | [Sound similar to propeller increasing in RPM] |

grass within about [31 meters (100 yards)] of the primary search area." The property on which the propeller blade was found was about 56 kilometers (35 miles) west of the accident site.

The major portion of the left wing, with the nacelle and engine partially attached, was found along the wreckage path 38 meters (125 feet) in front of the cockpit, the report said. "The inboard portion of the left-wing leading edge, from the fuselage to the left-engine nacelle, was intact. The leading edge outboard of the left-engine nacelle was recovered from the debris field, but was broken into several pieces. There were no cuts or gouges in the leading edge."

The captain, 45, held an airline transport pilot (ATP) certificate and had logged 9,876 hours of flight time, of which 7,374 were in type. He had logged 2,186 hours of flight time as captain on the EMB-120. The captain held a valid first-class medical certificate and a flight instructor certificate with ratings for airplane, instrument and multi-engine. His last proficiency check was on March 3, 1995, and his most recent training, on Aug. 7, 1995, was line-oriented flight training (LOFT), the report said.

The first officer, 28, held a commercial pilot certificate with ratings for airplane, single-engine land, airplane multi-engine land and instrument airplane. He also held a flight instructor certificate with ratings for airplane, multi-engine and instrument, and held a valid first-class medical certificate. The first officer had 1,193 hours of flight time, of which 363 were in type. He received his ASA first officer training in April 1995, and completed his initial operating experience on May 4, 1995, the report said.

The flight attendant, 37, was employed by ASA on Feb. 8, 1993. She had no prior experience as a flight attendant. She completed her initial training, which included emergency procedures training, on Feb. 23, 1993. Her most recent recurrent training on the EMB-120 was on Jan. 26, 1995, the report said.

The report noted that the "activities of the crew in the days before the accident were routine and unremarkable. They appeared to have received normal rest."

The NTSB examined the crew's actions during the emergency. Because of the severely degraded aircraft performance following the loss of the propeller blade, "the flight crew's actions were reasonable and appropriate during their attempts to control and maneuver the airplane throughout the accident sequence and were not a factor in this accident," the report said.

The NTSB expressed concern "that the flight attendant neither received nor sought information about the time remaining to prepare the cabin or to brace for impact. The CVR transcript revealed that the flight crew informed her seven minutes before impact that they had experienced an engine failure, that they had declared an emergency for return to ATL and that they had advised her to brief the passengers. There were no further communications with the flight attendant."

The cockpit crew never told the flight attendant that they would not be able to return to ATL, and instead would need to make an off-airport landing. "The flight attendant stated that while preparing the cabin and passengers, she saw the tree tops from a cabin window," the report said. "She immediately returned to her jump seat and shouted her commands. A passenger commented that the flight attendant was barely in the brace position when the impact occurred."

The NTSB praised the manner in which the flight attendant handled the emergency. "According to passengers, immediately following the loss of the propeller blade, the flight attendant checked with each passenger individually to make sure that they all understood how to assume the brace position, and she yelled instructions to the passengers up until the time of impact," the report said.

The report concluded: "If the flight attendant had not had sufficient time to fasten her safety belt and shoulder harness, she might have received more serious or fatal injuries, and she might have been incapable of directing an evacuation."

To improve the communication between cockpit crews and cabin crews, the NTSB recommended that the FAA amend Advisory Circular (AC) 120-15B, *Crew Resource Management Training*, "to include guidance regarding the communication of time management information among flight and cabin crew members during an emergency," the report said.

The aircraft was climbing above overcast clouds when the propeller blade failed, the report said. The flight crew reported later that their aircraft was below the clouds after descending through 1,900 feet (579 meters) MSL.

"A weather observation taken at CTJ [by an automated weather observing system-3 (AWOS-3)], approximately [6.4 kilometers] from the crash site, reported an 800-foot [244-meter] overcast cloud ceiling just after the accident," the report said.

[The AWOS-3 reports cloud/ceiling data, visibility, altimeter setting, wind data, temperature, dew point and density altitude on a discrete very high frequency (VHF) radio frequency that can be received up to 25 nautical miles (40 kilometers) from the AWOS site and up to an altitude of 10,000 feet (3,050 meters) above ground level).]

A helicopter pilot, who arrived at the accident site about one hour after the accident, "estimated scattered clouds at about 1,500 feet [457 meters] and a broken ceiling at around 2,500 feet (762 meters)," the report said. "[The helicopter pilot] estimated the visibility at 3.5 miles (5.6 kilometers) in haze."

The report commented: "From the flight crew's requests to ATC for vectors to the airfield, it is apparent that the cloud ceiling affected the flight crew's ability to visually acquire a suitable landing site during the descent for a forced landing.

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| **1249:09** | **CTR:** | ... and it is asphalt sir. |
| **1249:11** | **HOT-2:** | Hydraulic pump, failed engine? As required. Put it to the on position? |
| **1249:15** | **HOT-1:** | Correct. |
| **1249:17** | **HOT-2:** | 'K. Engine bleed failed engine is closed and the pack is off. |
| **1249:19** | **HOT-1:** | 'K. |
| **1249:26** | **HOT-2:** | 'K, cross-bleed open. |
| **1249:29** | **HOT-1:** | 'K. |
| **1249:32** | **HOT-2:** | Electrical load, below four thousand amps. |
| **1249:38** | **HOT-1:** | It is. Put the ice ba ... (well you) don't need to do that just leave that alone. |
| **1249:45** | **HOT-1:** | All right, single-engine checklist please. |
| **1249:48** | **CTR:** | AC five twenty-nine, I've lost your transponder. Say altitude. |
| **1249:52** | **RDO-2:** | We're out of four point five at this time. |
| **1249:54** | **CTR:** | AC five twenty-nine, I've got you now and the airport's at your, say say your heading now sir. |
| **1249:59** | **RDO-2:** | Right now we're heading uh, zero eight zero. |
| **1250:01** | **CTR:** | Roger, you need about ten degrees left. Should be twelve o'clock and about eight miles. |
| **1250:05** | **RDO-2:** | Ten left, twelve 'n eight miles and uh, do we got a, ILS to this runway? |
| **1250:10** | **CTR:** | I'll tell you what. Let me put you on the approach. He works that airport and he will be able to give you more information. Contact Atlanta approach on one two one point zero, sir. |
| **1250:15** | **HOT-1:** | We can get in on a visual. |
| **1250:17** | **RDO-2:** | One more time on the freq ... |
| **1250:20** | **RDO-1:** | Say again on the frequency? |
| **1250:22** | **CTR:** | Atlanta approach one two one point zero. |
| **1250:24** | **RDO-2:** | Twenty one zero, see ya. |
| **1250:26** | **UNK-?:** | Good luck guys. |
| **1250:27** | **RDO-2:** | 'preciate it. |
| **1250:28** | **HOT-B:** | [Single beep similar to radio frequency change] |
| **1250:29** | **RDO-2:** | Atlanta approach, AC five twenty-nine's with you out of three point four. |

| | | |
|---|---|---|
| **1250:36** | **HOT-1:** | Engine's exploded. It's just hanging out there. |
| **1250:43** | **RDO-2:** | Atlanta approach, AC five twenty-nine. |
| **1250:45** | **ATLA:** | AC five twenty-nine, Atlanta approach. |
| **1250:48** | **RDO-2:** | Yes sir, we're with you declaring an emergency. |
| **1250:49** | **ATLA:** | AC five twenty-nine, roger. Expect localizer runway three four approach and uh, could you fly heading one eight zero uh no sorry, one six zero? |
| **1250:56** | **RDO-2:** | Yeah we can do that. Give me the loc freq ... |
| **1250:59** | **ATLA:** | Localizer frequency, runway three four localizer frequency is uh, one one one point seven. |
| **1251:05** | **HOT-1:** | We can get in on a visual. Just give us vectors. |
| **1251:07** | **RDO-2:** | One one one point seven. ... Just give us vectors. We'll go the visual. |
| **1251:17** | **HOT-1:** | Sing, single, single-engine checklist, please. |
| **1251:28** | **HOT-2:** | Where the # is it? |
| **1251:29** | **ATLA:** | AC five twenty-nine, say altitude leaving. |
| **1251:31** | **RDO-2:** | We're out of nineteen hundred at this time. |
| **1251:33** | **HOT-1:** | We're below the clouds. Tell 'm ... |
| **1251:35** | **ATLA:** | You're out of nineteen hundred now? |
| **1251:36** | **RDO-2:** | 'K we're uh, VFR at this time. Give us a vector to the airport. |
| **1251:39** | **ATLA:** | AC five twenty-nine. Turn left uh, fly heading zero four zero. Bear, the uh, airport's at your about ten o'clock and six miles sir. Radar contact lost at this time. |
| **1251:47** | **RDO-2:** | Zero four zero, AC five twenty-nine. |
| **1252:07** | **HOT-M:** | Five hundred. |
| **1252:10** | **HOT-M:** | Too low gear. [Starts and repeats.] |
| **1252:11** | **ATLA:** | AC five twenty-nine, if able, change to my frequency, one one eight point seven. The airport uh, in the vicinity of your ten o'clock at twelve o'clock and about four miles or so. |
| **1252:20** | **HOT-1:** | Help me, help me hold it, help me hold, help me hold it. |
| **1252:56** | **ATLA:** | AC five twenty-nine, change frequency, one one eight point seven if able. |

In the latter portion of the descent, after descending below the overcast cloud ceiling, the airplane's height above terrain would have limited the view of the flight crew to just the immediate area.

"The airplane impacted the ground in a left wing–down attitude, probably because the flight crew was attempting to complete a turn to properly align themselves for a forced landing. If the overcast cloud ceiling had been higher, the crew would have had more time to align the airplane and level the wings before the impact."

The report concluded "that the cloud ceiling precluded the flight crew from being able to see the ground and thus to make a more successful forced landing, a situation that contributed to the severity of the accident."

In reviewing the performance of both the Atlanta ARTCC and TRACON controllers in assisting the accident flight, the NTSB expressed concern "about the failure of ATC controllers to notify CFR [crash, fire and rescue] services once the controllers were aware of the emergency situation," the report said.

Two minutes after the first officer had declared an emergency, he told the controller the flight needed to "land quick" and to "roll the trucks and everything for us," the report said.

"The controller then advised the flight crew that CTJ was the closest airport and directed the aircraft to CTJ," the report said. "Although ATC was aware of the emergency situation and destination airport, ATC did not notify the fire and emergency services covering CTJ ... of the incoming aircraft."

By the time the Atlanta TRACON notified the appropriate sheriff's office about the emergency, the accident had occurred and had been reported to the sheriff's office by a private citizen.

The NTSB concluded that "if the Atlanta [ARTCC] had placed a call for emergency services as soon as the pilot requested, which was 10 minutes before the accident, personnel would have responded sooner, and the rescue efforts might have been more timely and effective."

The NTSB recommended that "the FAA should include an article in the *Air Traffic Bulletin* and provide a mandatory formal briefing to all air traffic controllers regarding the necessity and importance of notifying crash, fire and rescue personnel upon a pilot's request for emergency assistance. Ensure that [ARTCC] controllers are aware that such a request may require them to notify local emergency personnel."

Investigators reviewed the unsuccessful attempt by the first officer to open his cockpit sliding window. The crash ax provided to the flight crew "was apparently intended for use as a woodworking tool because it consisted of a blade and nail puller attached to a wooden handle," the report said.

The report commented: "Although regulations exist that require most passenger-carrying aircraft to be equipped with a crash ax, there is no FAA or other civil technical standard regarding the design and use of crash axes. This accident demonstrates the importance of adequate crash-ax design."

The report also noted: "The crash [axes] aboard military transport aircraft [conform] to a special design. Large commercial transport airplanes manufactured in the United States are equipped with crash axes of similar design."

The NTSB recommended that the FAA "evaluate the necessary functions of the aircraft crash ax, and provide a technical standard order or other specifications for a device that serves the functional requirements of such tools carried aboard aircraft."

The propeller blades on the accident aircraft were manufactured by Hamilton Standard. The propeller blades, designed for use on turboprop commuter airplanes, are made from composite materials (Figure 1, page 10). The core of each propeller blade is a solid, forged aluminum alloy spar, which is the main load-carrying member. "The airfoil shape of the blade is formed by glass fiber–filled epoxy and foam adhesively bonded to the spar," the report said. "A conical hole (taper bore) is bored in the center of the spar from the inboard end to propeller blade station 21, for weight reduction and balance-weight installation."

The taper bore on the propeller blade from the accident airplane was not shotpeened when the blade was originally manufactured, the report said. [In shotpeening, a surface is bombarded by air-propelled glass beads or shot to improve the surface's resistance to cracking.] Hamilton Standard had reviewed its production process and deemed shotpeening unnecessary. With FAA approval, Hamilton Standard discontinued this process.

The report noted: "According to information provided to the [NTSB] in February 1995, Hamilton Standard statistical data from field service experience indicate that propeller blades without shotpeened taper bores are susceptible to earlier corrosion and cracking."

When the left-engine propeller blade that separated on the accident airplane was examined, the NTSB concluded that its failure resulted from "a fatigue crack that originated from multiple corrosion pits in the taper bore surface of the blade spar [that] propagated toward the outside of the blade, around both sides of the taper bore [and] then reached critical size," the report said.

Investigators found that the accident propeller blade "exhibited a nearly continuous layer of oxide deposits on the initial [1.25 centimeter (0.49 inch)] of the crack depth." The oxide was attributed to a residue from before the accident propeller blade had been repaired by Hamilton Standard in June 1994. Because the repair would have eliminated any further oxide deposits, the report said, the oxide layer indicated the size of the crack at the time of the repair.

The propeller blade "contained corrosion damage (pitting) in the taper bore and the oxide layer in the origin area of the fatigue crack … ," the report said. This same condition was found on two previous failures of Hamilton Standard composite-type propeller blades in 1994. One of these failures

| | | |
|---|---|---|
| **1252:32** | **HOT-B:** | Too low gear. [Warning stops.] |
| **1252:32** | **HOT-B:** | [Series of rapid beeps similar to aural stall warning] |
| **1252:32** | **CAM:** | [Vibrating sound similar to aircraft stick shaker starts and continues for four seconds.] |
| **1252:36** | **CAM:** | [Vibrating sound similar to aircraft stick shaker starts again and continues to impact.] |
| **1252:37** | **HOT-2:** | Amy, I love you. |
| **1252:40** | **HOT-B:** | Landing gear. |
| **1252:41** | **CAM-?:** | [Sound of grunting] |
| **1252:45** | **CAM:** | [Sound of impact] |
| **1252:46** | **HOT-B:** | Landing gear. |
| **1252:46** | **CAM:** | [Sound of impact] |
| **1252:46** | | [End of recording] |

| | | |
|---|---|---|
| **HOT** | = | Crew member "hot" microphone voice or sound source |
| **HOT-M** | = | Aircraft mechanical voice heard on all channels |
| **RDO** | = | Radio transmission from accident aircraft |
| **CAM** | = | Cockpit-area microphone |
| **INT** | = | Transmission over aircraft interphone system |
| **CTR** | = | Radio transmission from Atlanta ARTCC |
| **ATLA** | = | Radio transmission from Atlanta approach control |
| **UNK** | = | Radio transmission received from unidentified aircraft |
| -B | = | Sounds heard through both pilots' "hot" microphone systems |
| -1 | = | Voice identified as captain |
| -2 | = | Voice identified as first officer |
| -3 | = | Voice identified as flight attendant |
| -? | = | Voice unidentified |
| * | = | Unintelligible word |
| # | = | Expletive |
| ( ) | = | Questionable insertion |
| [ ] | = | Editorial insertion |
| . . . | = | Pause |

Source: U.S. National Transportation Safety Board

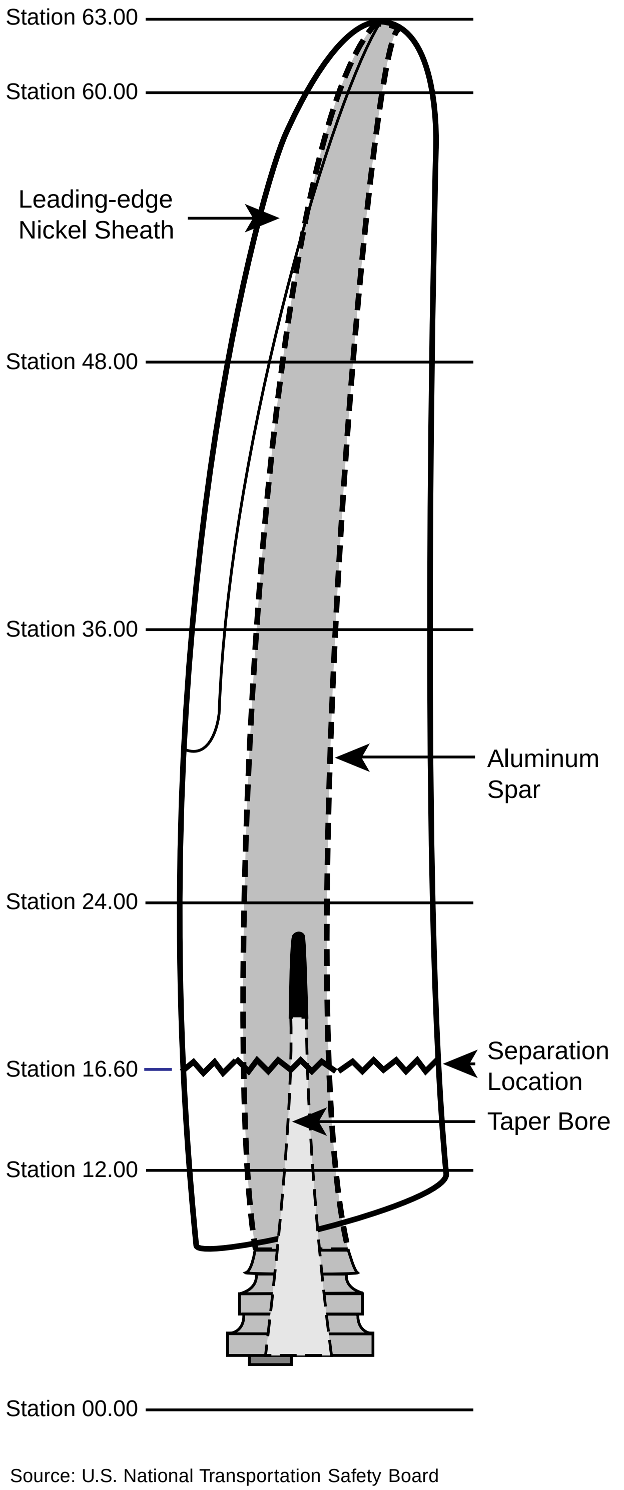


**Figure 1**

occurred in Brazil, on an EMB-120 with the same model propeller blade as the accident aircraft. The other failure occurred in Canada, on a similar model propeller blade.

Three weeks before the ASA accident, another EMB-120 experienced an in-flight loss of the same model propeller blade in Belgium, the report said. The propeller-blade failure did not result from taper-bore corrosion, but from a crack on the outer surface of the blade shank that occurred during the manufacturing process.

After the two propeller-blade failures in 1994, "Hamilton Standard identified inadequacies in the inspection process and generated improvements to address these inadequacies," the report said. " ... When these improvements in the inspection methods were made, Hamilton Standard either did not recognize or was not concerned that taper-bore flaws, such as the crack in the ASA blade, might have gone undetected during the previous inspection and repair process before the improvements were made because Hamilton Standard did not implement retroactive inspection of those blades that had been inspected previously and returned to service under inspection standards and processes that were no longer considered adequate."

The report concluded: "Hamilton Standard's failure to recommend, and the FAA's failure to require, repetitive ultrasonic inspections for all propellers (particularly those already inspected when there were recognized shortcomings in the inspection process) contributed to the accident because the crack in the accident blade would likely have been detected in a recurrent ultrasonic inspection."

The fractured propeller blade on the accident airplane had been overhauled by Hamilton Standard in April 1993. "Records indicated that only routine maintenance actions were necessary at the time of overhaul," the report said.

When the overhauled propeller blade was returned to ASA, the blade was installed on an airplane, which was not the accident airplane. In May 1994, "the blade received an on-wing ultrasonic inspection of the taper bore by a Hamilton Standard contract inspector in accordance with [an FAA airworthiness directive (AD)]," the report said. The propeller blade was rejected as a result of the inspection, and was shipped to Hamilton Standard for inspection and repair.

A technician at Hamilton Standard's repair facility inspected the propeller blade and reported that no visible faults were found in the blade, the report said. The taper bore of the propeller blade was then refinished. Following the refinishing, the propeller blade should have undergone a final ultrasonic inspection. The shop form accompanying the propeller blade did not indicate that the inspection had been performed. Nevertheless, the propeller blade was approved for return to service.

The report said that the technician who performed the refinishing work on the propeller blade "was not an FAA-certificated mechanic, [and the technician] stated that he was permitted to perform and sign off the work that he was qualified to perform. The technician, as an employee of the Hamilton Standard's … blade repair facility, which is an FAA-certificated repair station under [FARs] Part 145, is not required to be a certificated mechanic to work on the propeller blades."

The propeller blade was returned to ASA and was installed on the left propeller assembly of the accident airplane in September 1994, where it remained until the accident, the report said. At the time of the accident, the propeller blade had accumulated 2,398.5 hours and 2,425 cycles since the repair.

As a result of the ASA accident and the NTSB recommendations, the FAA issued two ADs. These ADs "required that all blades installed on EMB-120 aircraft that, like the accident blade, had been removed from service in accordance with [a previous AD] and [had] been reworked and returned to service be immediately removed from service, and it required ultrasonic reinspection of all other [similar model blades] (a total of approximately 15,000 blades) on a 1,250-cycle interval," the report said.

Investigators conducted a computer analysis to predict the number of stress cycles required for the crack in the accident propeller blade to progress from the initial flaw to its fracture. "Hamilton Standard indicated to the [NTSB] that for a corrosion pit to initiate a crack, especially for small pit sizes, such as in the ASA blade, a blade would have to have been subjected to a very high number of stress cycles of the most severe type that the blade would normally encounter in routine operations," the report said.

The report continued: "Since a ground-air-ground (GAG) cycle imparts severe stress to the blade only once per flight, Hamilton Standard engineers believed that 2P resonance (which occurs twice per revolution of the propeller) in adverse winds, perhaps during a maintenance ground run, contributed to the initiation of the crack from corrosion pitting and propagation of the crack while it was small."

The computer analysis determined that for the crack in the accident propeller blade to have progressed to failure, "an average of 50 maximum-level 2P stress cycles would have to be accumulated each flight," the report said. "This number of cycles could be accumulated in about 1.6 seconds of operation at the rpm [revolutions per minute] range associated with 2P resonance during ground operation in adverse winds (quartering tailwinds)."

The report concluded that "a combination of 2P resonance and GAG cycle stresses initiated the crack from the corrosion pits in the ASA blade and caused the crack to propagate to failure under normal operating conditions."

As a result of its investigation, the NTSB made the following recommendations to the FAA regarding Hamilton Standard, FAA-approved repair facilities and propellers:

- "Require Hamilton Standard to review and evaluate the adequacy of its tools, training and procedures for performing propeller-blend repairs, and ensure that those blend repairs are being performed properly;

- "Review the need to require inspection ('buy back') after the completion of work that is performed by uncertificated mechanics at [FARs] Part 145 repair stations to ensure the satisfactory completion of the assigned tasks;

- "Revise Advisory Circular 20-66 [*Vibration Evaluation of Aircraft Propellers*] to include the vibratory testing of composite propeller blades that have been previously operated for a substantial number of hours, and composite blades that have been altered to the limits set forth in FAA-approved repair manuals to determine the expected effects of age on propeller vibration and provide guidelines for rpm margin between a propeller blade's natural frequencies and the excitation frequencies associated with propeller operation;

- "Require that Hamilton Standard consider long-term, atmospheric-induced corrosion effects and amend the component maintenance manual (CMM) inspection procedure to reflect an appropriate interval that will detect any corrosion within the taper bore; [and,]

- "Require Hamilton Standard to review and, if necessary, revise its policies and procedures regarding 1) internal communication and documentation of engineering decisions, and 2) involvement of the designated engineering representative (DER) and FAA, and to ensure that there is proper communication, both internally and with the FAA, regarding all significant engineering decisions."♦

Editorial note: This article was adapted from *In-flight Loss of Propeller Blade, Forced Landing and Collision with Terrain, Embraer EMB-120RT, N256AS, Carrollton, Georgia, August 21, 1995*. U.S. National Transportation Safety Board, Report no. NTSB/AAR-96/06. The 113-page report contains photographs, figures and appendices.

## Further Reading From FSF Publications

"U.S. Accident Report: Failure of Propeller Control System Downs Aircraft." *Accident Prevention* Volume 50 (February 1993).

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