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Inadequate Fuel Supply Leads To Jetstream Engine Flameouts

The crew of the chartered Jetstream 31 conducted a missed approach because of weather conditions and was attempting another approach when a loss of power occurred in both turboprop engines. The report said that fuel exhaustion and fuel starvation were among the causes of the approach-and-landing accident.

FSF Editorial Staff

At 1128 local time May 21, 2000, a British Aerospace Jetstream 31 operated on a charter flight by East Coast Aviation Services struck terrain about 11 nautical miles (20 kilometers) south of Wilkes-Barre/Scranton (Pennsylvania, U.S.) Airport (AVP) during an instrument landing system (ILS) approach in instrument meteorological conditions (IMC). The airplane was destroyed by the impact and a subsequent fire. The two pilots and 17 passengers were killed.

The U.S. National Transportation Safety Board (NTSB) said, in its final report, that the probable cause of the accident was "the flight crew's failure to ensure an adequate fuel supply for the flight, which led to the stoppage of the right engine due to fuel exhaustion and the intermittent stoppage of the left engine due to fuel starvation.

"Contributing to the accident were the flight crew's failure to monitor the airplane's fuel state and the flight crew's failure to maintain directional control after the initial engine stoppage."

At the time of the accident, East Coast Aviation Services, doing business as Executive Airlines, employed 10 pilots and operated seven airplanes, all based at Republic Airport (FRG) in Farmingdale, New York.

The accident airplane was scheduled to be used for a flight chartered by Caesar's Palace Casino in Atlantic City, New Jersey. The airplane originally was scheduled to depart at 0900 from FRG for a flight to Atlantic City Airport (ACY) and to remain at ACY until 1900 for the return flight to FRG. On the day of the accident, the schedule was changed to include a flight between ACY and AVP.

The captain, 34, held an airline transport pilot certificate and had 8,500 flight hours, including about 1,874 flight hours as a Jetstream captain. He was employed by Atlantic Coast Airlines in December 1992 as a full-time pilot. He was hired by Executive Airlines in April 1998 as a part-time pilot.

"According to the captain's wife, the captain had flown previously with the accident first officer and considered him to be a good pilot," the report said.

The first officer, 38, held a commercial pilot certificate and had 1,282 flight hours, including 742 flight hours as a Jetstream first officer. He was hired by Executive Airlines in November 1998.

"According to the first officer's fiancée, the first officer had received a job offer on the Friday before the accident to fly with a regional airline," the report said. "She stated that the first officer was excited about the new position and that the captain had helped the first officer prepare for job interviews."

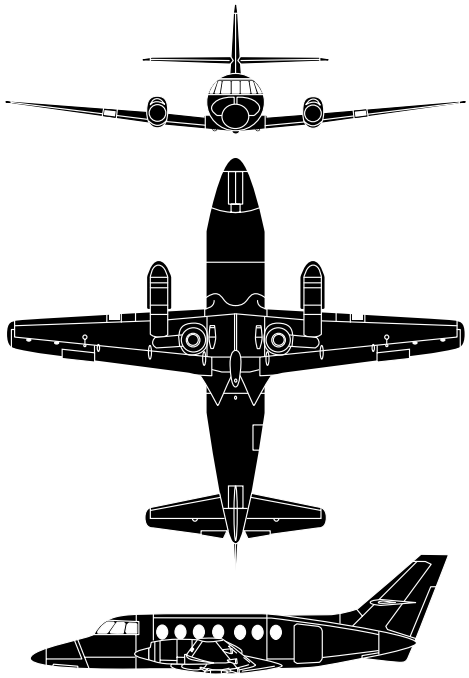
The U.S. Federal Aviation Administration (FAA) had no record of accidents, incidents or enforcement actions for either pilot.

"Their duty time, flight time, rest time and off-duty-activity patterns did not indicate any preexisting medical, behavioral

or physiological factors that might have affected their performance on the day of the accident," the report said.

The accident airplane was manufactured in 1988 and was configured with 19 passenger seats. Executive Airlines purchased the airplane in 1996 and changed its registration number to N16EJ.

At the time of the accident, the airplane had accumulated about 13,972 flight hours and about 18,503 cycles (i.e., takeoffs and landings). The left engine had accumulated 14,028 operating hours since new and 469 operating hours since its last overhaul. The right engine had accumulated 5,940 operating hours since new and 57 operating hours since its last overhaul.



British Aerospace Jetstream 31

Production of the twin-turboprop Jetstream 31 began in 1982. Several versions of the airplane were built for commuter operations and for executive transport. The airplane accommodates two flight crewmembers and up to 19 passengers.

Each of the Garrett (now Honeywell) TPE331-10UGR engines produces 701 kilowatts (940 shaft horsepower) and drives a full-feathering, four-blade Dowty Rotol propeller. Total fuel capacity is 1,718 liters (454 gallons).

Maximum standard takeoff weight is 6,950 kilograms (15,322 pounds). Maximum landing weight is 6,600 kilograms (14,550 pounds).

Maximum cruise speed at 15,000 feet is 264 knots. Economy-cruise speed at 25,000 feet (the maximum operating altitude) is 230 knots. Stall speed in landing configuration is 86 knots.

Maximum rate of climb at sea level is 2,080 feet per minute. Maximum single-engine rate of climb at sea level is 390 feet per minute. Single-engine service ceiling is 12,000 feet.♦

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

The airplane was equipped with a cockpit voice recorder (CVR). After the accident, NTSB found no information on the CVR about the accident flight or any other flight. The CVR had been overhauled by a repair station and had been installed in the airplane in February 2000.

"The accident airplane's maintenance log indicated that the CVR was operationally checked [after installation] and that no defects were noted," the report said.

No subsequent indications of CVR discrepancies or maintenance were found in the airplane's flight logs and maintenance logs. The CVR was bench-tested after the accident and functioned normally. The investigation did not determine why the CVR did not function during the accident flight.

The airplane was not equipped with, and was not required to be equipped with, a flight data recorder.

The captain checked in for duty at FRG at 0800. The first officer arrived 15 minutes later.

"While the pilots were conducting preflight inspections, they received a telephone call from Executive Airlines' owner and chief executive officer (CEO) advising them that they had been assigned an additional flight from ACY to AVP with a return flight to ACY later in the day, instead of the scheduled break in ACY," the report said. "Fuel records indicated that 90 gallons [341 liters] of fuel were added to the accident airplane's tanks before departure to ACY."

The report said that the weight-and-balance form completed by the flight crew and statements by the company's owner indicated that the crew had planned to add 180 gallons (682 liters) of fuel to the airplane.

"If the flight crew intended to load 180 gallons (about 1,200 pounds [544 kilograms]), it was common industry and company practice to ask for 90 gallons on each side [i.e., in each fuel tank]," the report said. "However, based on the evidence, it appears that a lack of clear communication between the pilots and the fueler resulted in only 90 gallons (about 600 pounds [272 kilograms]) of fuel being added, a total amount confirmed by the fuel-order receipt.

"Further, it is likely that the flight crew did not confirm the amount of fuel loaded before departure because flight crews do not see the fuel receipts after fueling and because the pilots were not outside the airplane, monitoring the fuel loading."

The report said that the airplane departed from FRG with less fuel than the pilots believed they had on board. Fuel capacity

of the Jetstream 31 is 454 gallons (1,718 liters). Investigators calculated that the airplane had about 240 gallons (908 liters) of fuel aboard when it departed from FRG at 0921 with 12 passengers aboard. When the airplane was landed at ACY at 0949, about 168 gallons (636 liters) of fuel remained in the tanks. No fuel was added at ACY.

The flight crew obtained information on weather conditions at AVP and filed an instrument flight rules (IFR) flight plan.

The report said that widespread cloudiness and scattered light rain showers prevailed in the northeastern United States. Overcast ceilings below 1,500 feet and cloud tops varying between 5,000 feet and 9,000 feet prevailed over New Jersey and eastern Pennsylvania.

At the time of the accident, a special weather observation for ACY included broken ceilings at 500 feet above ground level (AGL) and at 900 feet AGL, an overcast at 1,500 feet AGL and 2.5 statute miles (4.0 kilometers) visibility with mist. Surface wind was from 260 degrees at three knots.

The airplane departed from ACY about 1030 for the flight to AVP. Passengers who had deplaned at ACY told investigators that the captain had been the pilot flying on the flight from FRG to ACY.

"According to company practices, pilots alternate pilot-flying duties each flight leg," the report said. "Representatives of Executive Airlines who were familiar with both pilots reviewed the ATC [air traffic control] recordings from AVP approach and tower facilities and identified the captain as the pilot speaking with ATC in all radio transmissions. Based on company policy, it is likely that the first officer was the pilot flying on the flight to AVP."

The airplane was not flown above 5,000 feet and was in IMC during the flight to AVP. ATC radio-communication transcripts indicated that the crew established radio communication with Wilkes-Barre Approach Control at 1057 and received vectors for the ILS approach to Runway 4.

At 1102, the approach controller told the crew that the airplane was five nautical miles (nine kilometers) from the Crystal Lake nondirectional beacon (NDB) — an initial approach fix about 8.4 nautical miles (15.6 kilometers) from the runway threshold — and cleared the crew to conduct the ILS approach to Runway 4.

The approach controller told the crew to maintain 4,000 feet until they established the airplane on the localizer. The controller also told the crew that the pilots of another airplane, a Raytheon Beechjet, had obtained visual contact with the airport after flying the ILS approach to the decision altitude — 1,263 feet, which corresponds with a decision height of 300 feet above the runway touchdown zone elevation.

At 1104, the approach controller told the crew to establish radio communication with Wilkes-Barre Tower.

"The airplane then descended to about 2,200 feet, flew level at 2,200 feet for about 20 seconds and began to climb again about 2.2 nautical miles [4.1 kilometers] from the runway threshold," the report said. "At 1107:26, the captain reported executing the missed approach but provided no explanation to air traffic controllers."

The report did not discuss why the crew did not descend the airplane to the decision altitude during the ILS approach. Investigators did not determine why the crew conducted a missed approach.

"Because the flight crew's cockpit conversation was not recorded [by the CVR] and because the flight crew did not report the reason for the missed approach to controllers, [NTSB] could not conclusively determine why the missed approach was initiated," the report said. "However, ATC tapes indicated no sense of urgency from the flight crew. [NTSB] concludes that the flight crew was not aware of a potential low fuel state or mechanical anomalies when the missed approach was executed."

The tower controller asked the crew to state their intentions. The captain said, "We'd like to get re-vectored around for the ILS four."

The controller told the crew to fly the runway heading, climb to 4,000 feet and establish radio communication with Wilkes-Barre Approach Control.

"The pilots re-established contact with the approach controllers at 1108:04, as they climbed through 3,500 feet to 4,000 feet and requested [clearance to conduct] another ILS approach to Runway 4," the report said.

The approach controller issued vectors to the crew and told them that traffic, a Beech Bonanza, was at their 3 o'clock position at 5,000 feet and two nautical miles (four kilometers) from their airplane.

The captain told the controller that they were looking for the traffic but were in IMC.

At 1114, the controller told the crew to reduce speed and that they were following a Cessna 172 on the approach. At the time, the Cessna was crossing the Crystal Lake NDB.

The captain said, "OK, we're slowing."

At 1120, the controller cleared the crew to conduct the ILS approach to Runway 4 and told them to maintain 4,000 feet until the airplane was established on the localizer.

The report said that a performance study based on recorded ATC radar data indicated that airspeed was reduced from 180

knots as the crew conducted a right turn to intercept the localizer course to about 128 knots when the airplane was established on the localizer course and was descending at 300 feet per minute. At 1123:20, the airplane's flight path began to deviate to the right of the localizer course.

At 1123:49, the captain said, "For one six echo juliet, we'd like to declare an emergency." When the controller asked the nature of the problem, the captain said "engine failure."

At this time, the airplane was at 3,800 feet, about 12 nautical miles (22 kilometers) south of the airport and turning right through a heading of about 070 degrees. Airspeed was about 125 knots.

The airplane's deviation to the right of the localizer course likely resulted from asymmetric thrust (i.e., thrust produced only by the left engine after the right engine failed, causing the airplane to turn right).

"Experiencing engine failure in IMC could cause pilots to fixate on instruments, such as the attitude indicator and airspeed indicator, and to allow the heading to wander," the report said.

The controller told the crew that the airplane appeared to be south of the localizer course and asked if they wanted a vector to establish the airplane on the localizer. The captain said yes, and the controller told the crew to turn left to a heading of 010 degrees. The captain acknowledged the instruction.

About 20 seconds later, the controller asked the crew to verify that they were conducting a left turn to a heading of 010 degrees. The captain said, "We're trying, six echo juliet." The controller then asked if a right turn would be better. The captain said "stand by."

At this time, the airplane was on a heading of 100 degrees.

About 30 seconds after the captain told the controller to stand by, the controller told the crew that the minimum vectoring altitude (MVA) in the area was 3,300 feet.[1]

Five seconds later, at 1125:12, the captain said, "Stand by for six echo juliet. … We lost both engines. We lost both engines."

ATC radar data indicated that the airplane was descending through 3,000 feet at about 1,500 feet per minute. Airspeed was 130 knots.

"The airplane then turned to the left, to a 90-degree heading, and radar contact was temporarily lost," the report said. "Airspeed increased to 140 knots as the airplane descended through 2,100 feet."

The controller asked the crew how many passengers were aboard the airplane. The captain said, "Nineteen people altogether."

The controller said, "Nineteen people aboard. There's a couple of highways down below you. The sky condition is five hundred broken, nine hundred broken, one thousand five hundred broken."

At 1126:15, the captain told the controller to stand by and then said, "How's the altitude look for where we're at?"

The controller said that he was not receiving an altitude readout for the airplane. The controller said that the visibility was 2.5 statute miles (4.0 kilometers) and issued the altimeter setting.

At 1126:43, the captain said, "Just give us a vector back to the airport, please."

The controller told the crew to turn left to a heading of 340 degrees. The controller said that he had lost radar contact with the airplane and told them to verify their altitude. The captain said that the airplane was "level at two thousand."

At 1126:54, the controller again told the crew that the MVA was 3,300 feet and said that a heading of 330 degrees would bring the airplane back to the localizer. The controller said, "Do you have any engines?"

The captain said that they had restarted the left engine. At this time, the airplane was on a heading of about 285 degrees.

At 1127:23, the controller told the crew that he had radar contact with the airplane, which appeared to be at 2,000 feet, and that there was a ridgeline between the airplane and the airport.

The captain said, "That's us. We're at two thousand feet over the trees."

At 1127:37, the controller told the crew to fly a heading of 360 degrees and said that there were tall antennas about two nautical miles west of the airplane.

"The final series of radar returns showed the airplane at 2,000 feet and an airspeed of 103 knots," the report said. "The data indicated that the airplane continued to turn right at the same altitude and airspeed."

At 1127:46, the pilot said, "We're losing both engines."

The controller told the crew that a major highway was directly below the airplane and said, "Let me know if you can get your engines back. … Do you have any ground contact?"

The captain made no further radio transmissions. ATC began emergency-notification procedures. At about 1236, the crew of a Pennsylvania State Police helicopter found the wreckage of the airplane. Emergency personnel arrived at the accident site about 1306.

"The airplane wreckage was found on the top of a mountain [at an elevation of 1,755 feet]," the report said. "The airplane impacted

the ground at a 60-degree nose-low attitude and in a 135-degree left bank. … Fire damage was confined to the immediate impact area, with little fire damage to surrounding trees and foliage."

The report said that the accident was not survivable because of high impact forces. Autopsies indicated that the occupants died of blunt-force trauma.

Investigators interviewed several witnesses. One witness, who was in the area where the captain had reported engine failure, said that he heard engine noise that was "very loud, irregular running, with a real rough grinding noise … the sound pitched up and down in cycles."

Another witness, who was near the accident site, said, "The aircraft was making a very loud sound, as if overspeeding and slowing down at different times. A short time later, the engines stopped."

Investigators found no maintenance problems or signs of preexisting mechanical problems.

"There was no indication of preexisting maintenance discrepancies that could have contributed to the accident," the report said. "There were no pre-impact failures of any flight control system component. There were no pre-impact failures of any fuel system component to either engine and no evidence of pre-impact engine damage. There was no evidence of an in-flight fire."

Teardown inspections of the engines indicated that the left engine was developing power on impact and that the right engine was not developing power on impact.

Investigators' calculations based on high-speed cruise power settings indicated that the airplane had about 41 gallons (155 liters) of usable fuel remaining — sufficient for 15 minutes of flight at high-speed cruise power settings — when the accident occurred. The report said that this fuel quantity was "well below the reserve required by the IFR flight plan filed by the flight crew."

Calculations based on long-range cruise power settings indicated that the airplane had about 172 gallons (651 liters) of usable fuel remaining when the accident occurred. The report did not state how long the airplane could have been flown at long-range cruise power settings with this amount of fuel.

"The director of operations of Executive Airlines, who was also an instructor and a check captain on the Jetstream 31, stated that [company] pilots normally used … high-speed cruise power during the cruise portion of the flight," the report said. "However, Executive Airlines' owner and CEO stated that his pilots used long-range cruise power during cruise flight."

The report said that investigators considered the power-settings information provided by the company's director of operations to be more credible than the information provided by the company's owner and CEO because the director of operations had "direct interaction with line pilots as their supervisor and as a Jetstream 31 check captain and instructor."

The Jetstream 31 has a fuel tank in each wing. Each tank comprises five interconnected cells with a total usable fuel capacity of 227 gallons (859 liters).

"Each wing tank contains an independent low-fuel-level system that illuminates a small, low-fuel-quantity annunciator light in the cockpit if the fuel level falls below about 200 pounds [about 30 gallons (114 liters)]," the report said. "The low-fuel-quantity annunciator lights are located on the left center panel between the fuel-quantity gauges.

"According to the *Jetstream 31 Operating Manual*, the low-fuel-quantity annunciator lights were not designed to be warning lights. The manual states that they are a means to confirm low fuel quantity."

The fuel system includes a combination fuel-flow indicator and fuel-used indicator for each engine. The fuel-used indicator automatically resets to zero when electrical power is shut off.

Examination of the wreckage showed that the valve for the left fuel tank was selected to the left engine; the valve for the right fuel tank was selected to the right engine; the fuel-crossfeed valve was closed.

The report said that fuel was not distributed evenly when the airplane departed from FRG; the right tank contained less fuel than the left tank.

"Given the larger amount of fuel loaded in the left fuel tank, the right-engine stoppage could be explained by fuel exhaustion," the report said.

Malfunction of the left engine likely resulted from fuel starvation caused by unporting of fuel in the left tank. Unporting occurs when fuel flows away from the fuel pump, which is located in the inboard section of the fuel tank, during airplane maneuvering.

"Conditions would have been conducive to unporting if, for example, the airplane was in a left bank and in a nose-right sideslip following the loss of the right engine, which is consistent with flying straight while attempting to turn to the left, as indicated by the pilot statement 'we're trying' when the controller queried if the airplane was in a left turn," the report said. "Assuming some usable fuel was in the left tank, it is probable that the flight crew's maneuvering after the right-engine stoppage may have intermittently unported it, causing the sequential stoppage and restarting of the left engine."

The report said that the sequential stoppage and restarting of the left engine may have precipitated the crew's loss of control of the airplane. Examination of the wreckage indicated that the landing gear was extended and the flaps were extended 20 degrees.

During post-accident tests in a Jetstream 31 flight simulator, failure of the right engine was induced during an ILS approach at 140 knots.

"A moderate amount of force on the rudder with rudder trim was sufficient to correct the resulting deviation," the report said. "Any delay in flight-control input led to heading deviations of 10 degrees to 25 degrees to the right of the ILS course. When deviations occurred, the airplane was easily controllable back to the ILS course.

"When the scenario was conducted with an airspeed of 110 knots, considerably more rudder and rudder-trim inputs were required to correct the deviations, keep the airplane on course and turn back to the ILS. However, the airplane remained controllable."

Another test in the flight simulator included failure of the right engine and intermittent failure and restarting (by the engine's auto-ignition system) of the left engine during an ILS approach.

"In this scenario, the workload on the flying pilot was not considerably increased when the dual engine failure was induced," the report said. "However, pilot workload increased considerably (the airplane was difficult to control and required constant flight control and trim inputs) when the left engine was intermittently lost and restored."

The two pilots who conducted the flight-simulator tests were told by instructors, before the flights began, that the low-fuel-quantity annunciator lights would be activated during the flights.

"Neither pilot observed the lights when they first appeared, and both pilots continued to fly without observing the lights," the report said.♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board (NTSB) Aircraft Accident Brief NTSB/AAB-02/05 (34 pages with illustration) and NTSB Factual Report DCA00MA052 (725 pages with appendixes and illustrations).]

Note

1. The U.S. Federal Aviation Administration *Aeronautical Information Manual* defines *minimum vectoring altitude* as "the lowest MSL [mean sea level] altitude at which an IFR [instrument flight rules] aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures and missed approaches. The altitude meets IFR obstacle-clearance criteria. It may be lower than the published MEA [minimum en route altitude] along an airway or J-route [jet-route] segment. It may be utilized for radar vectoring only upon the controller's determination that an adequate radar return is being received from the aircraft being controlled. Charts depicting minimum vectoring altitudes are normally available only to the controller and not to pilots."

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