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Unstabilized Approach, Icing Conditions Lead To Commuter Tragedy

When the crew of the Jetstream commuter decided to salvage a missed approach in hazardous weather conditions, they set an error chain in motion that left them few recovery options. An investigation revealed that poor vectoring by air traffic control and tail plane icing contributed to the fatal crash.

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Editorial Staff Report

The commuter, a British Aerospace BAe-31 Jetstream, was on final approach to the Tri-Cities Airport in Pasco, Washington, U.S., when it pitched down and crashed 400 feet short of the runway.

The crash killed the two pilots and four passengers and occurred while the twin-engine, turboprop Jetstream was executing an instrument landing system (ILS) approach to runway 21R at 2230 local time. Visual meteorological conditions prevailed beneath the cloud bases, which were about 1,000 feet above ground level (AGL) at the time of the crash, according to a recent U.S. National Transportation Safety Board (NTSB) report on the 1989 accident.

The NTSB report concluded that the probable cause of the accident was the "flight crew's decision to continue an unstabilized ILS approach that led to a stall, most likely of the horizontal stabilizer, and loss of control at low altitude."

The report added: "Contributing to the accident was the air traffic controller's improper vectors that positioned the airplane inside the outer marker while it was still well above the glideslope. Contributing to the stall and loss of control was the accumulation of airframe ice that degraded the aerodynamic performance of the airplane."

The aircraft was not equipped with a cockpit voice recorder (CVR). [Turbine-powered commercial aircraft with 10 or more passenger seats are now required to have CVRs installed.]

According to the NTSB report, recorded air traffic control (ATC) radar indicated that the flight did not intercept the final approach course until it was 1.5 miles inside the outer marker, at an altitude about 1,000 feet above the glideslope.

"Further examination of the radar data and weather information indicated that the airplane was in the clouds in icing conditions for almost 9 and 1/2 minutes. As the approach was initiated, the flight crew called the Seattle Air Route Traffic Control Center for a missed approach because of 'a couple of flags on our instruments,' but then elected to continue the approach," the NTSB report said.

A few seconds later, the Jetstream's crew reported that they were on short final for runway 21R. Pasco tower responded that it was closing and advised that there was no traffic. The Jetstream's first officer acknowledged the tower with "okay, thank you." It was the aircraft's last radio transmission.

The flight, known as Sundance 415, was a scheduled commuter from Seattle to Pasco, with an intermediate stop in Yakima, Washington.

While at Yakima, the NTSB report said, the commuter company's station agent observed the flight's first officer and another company first officer [who was a passenger on the flight] "knocking ice off the wing leading edge surfaces." The agent also saw ice sliding off the aircraft, the report said.

During the stop in Yakima, the flight crew was asked six times by the station agent if they wanted the aircraft de-iced, especially the tail, which could not be reached by the crew.

"The pilot responded that there would be no problem," the report said. "[The agent] stated later that she does not normally insist on de-icing but, in this case, the equipment was ready and she wanted to be helpful. Sundance 415 was the only flight of six flights that had landed on Dec. 26 [at Yakima] that was not de-iced."

As Sundance 415 taxied to the runway, the flight crew was also informed by the tower that there had been "numerous reports of light to moderate icing between the tops and bases and that's between eighteen and 4,000 feet." The first officer replied: "Thanks ... we did experience a little of that coming in ourselves."

[The NTSB report said that while the amount of ice on the aircraft when it landed at Yakima was not a factor in the ensuing accident, "it was poor judgment on the part of the captain to take off without assurance that both wings and empennage were properly de-iced." The report noted that subsequent ice buidup may have contributed to the accident.]

The Pasco tower controller said he observed the aircraft at a "higher than normal" altitude descending with its wings level. The NTSB report said the controller also noted that the rate of descent appeared to be faster than normal. "He saw the airplane descend short of the runway and crash."

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The captain, 38, held an airline transport certificate with a type rating for the Jetstream. At the time of the accident he had a total of 6,600 hours of flight time, of which 670 were in the Jetstream.

According to the NTSB report, the captain had failed his initial type-rating check and proficiency check for unsatisfactory performance during an ILS approach and the missed approach part of a nondirectional beacon (NDB) approach. His retraining was accomplished in a single flight.

The U.S. Federal Aviation Administration (FAA)-designated examiner advised the check airman, who was assigned to fly with the captain during his initial operating experience (IOE) period, that he was "a little uncomfortable with this one," the NTSB said. The chief pilot advised the IOE check airman: "If he flunked he must be doing something wrong, let's find out now."

However, by the end of 20-hour IOE, the check airman concluded that the captain was "deliberate, as opposed to slow" and was "fully competent in all aspects." A first officer who flew with the captain described him as "conscientious, prudent and conservative with excellent crew coordination abilities."

The first officer, 25, held an airline transport pilot certificate and had logged a total of 2,792 flight hours at the time of the accident, with 213 hours in the Jetstream.

A company captain described the first officer as "possessing good flying skills, but lacking experience in 'bigger' aircraft."

The BAe Jetstream 31 aircraft was manufactured in 1987. It was configured for two pilot seats and 19 passenger seats. The airplane had accumulated 4,972 hours and 7,168 cycles at the time of the accident. It was equipped with two Garrett turboprop engines.

Weather at the time of the accident was reported as 1,000 feet overcast; visibility seven miles; temperature 32 degrees F; dewpoint 30 degrees F and calm. The area had been under the influence of a strong temperature inversion.

The captain of another Jetstream commuter flight that landed at Pasco about 30 minutes before the accident said the flight encountered rapid ice buildup for 15-20 seconds with airspeed loss and increased rate of descent after entering the clouds just outside the outer marker. "He stated that he had not seen such a high rate of ice accretion at so low an altitude. He estimated that his airplane accumulated approximately 1/4-inch of ice, which he described as 'not enough to use the boots,'" the NTSB report said.

In the case of Sundance 415, the NTSB concluded that the aircraft had accumulated from between 1/2-inch to 1-inch of mixed rime and clear ice during the flight to Pasco. "Such a layer of ice, both because of its depth and shape, would be detrimental to the airflow over the wing and empennage airfoil surfaces, affecting the stall characteristics of the airplane," the report said.

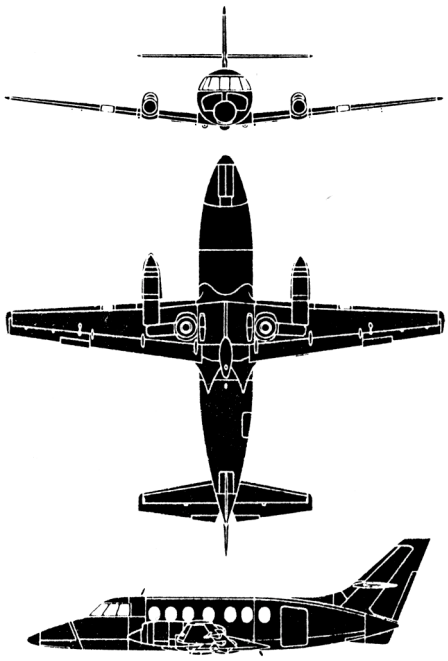
The wreckage was located about 400 feet northeast of the approach end of runway 21R. First ground contact was about 600 feet from the runway. "Measurements of the debris path, wreckage crush angles and ground damage patterns showed that the airplane was at an angle of about 50 to 60 degrees nose down at impact," the NTSB said.

A review of the recorded radar data indicated that the flight was normal until Sundance 415 was cleared for the approach to Pasco.

"The outer marker for the ILS approach is located 5.9 nautical miles from the threshold of runway 21R, with a standard crossing altitude of 2,400 feet mean sea level (MSL). The accident airplane was not aligned with the ILS localizer for runway 21R until it was approximately 1.5 nautical miles inside the outer marker, at 2,900 feet MSL. The final portion of the radar data shows Sundance 415 maintaining a descending flight path 1,000 feet above the standard 3-degree ILS glideslope. Altitude information was lost 2.5 nautical miles from the runway, at 2,400 feet MSL (about 2,000 feet above ground level). An average glidepath of about 7 degrees would have been required for Sundance 415 to reach the runway threshold from its last recorded position," the NTSB report said.

The report said that while the Seattle Center vector to intercept the localizer met FAA air traffic control (ATC) criteria for maximum intercept angle, the position of the airplane at that time would not have allowed the aircraft to intercept the localizer two miles outside the approach gate, as required by ATC guidelines.

"The improper vector can be attributed to the fact that the Seattle Center controller was operating his radar scope on an expanded range of 150 miles," the report said.



Development of current Jetstream twin-turboprop versions was launched by British Aerospace in 1978. Full production commenced in 1982.

The Jetstream 31 has a maximum range of 680 nautical miles (1,260 kilometers, 783 miles) with 18 passengers, baggage and full instrument flight rules (IFR) reserves. It has a maximum cruising speed of 263 knots at 15,000 feet and an economy cruising speed of 230 knots at 25,000 feet.

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

The NTSB report said it was not uncommon for center controllers to operate radar scopes on an extended range to provide coverage for combined sectors. But it said that under such conditions "it is difficult for controllers to issue accurate vectors to a final approach fix because of the [poor] resolution of position data."

Controllers in such situations frequently set up an adjacent radar scope for a smaller range to verify vector accuracy or, if time permits, alternate the range back and forth on their scopes.

"In this accident, the Seattle Center radar controller did not choose either option but set the radar scope range to

150 miles. In addition, the map chosen by the radar controller did not depict the ILS runway 21R approach gate. Consequently ... the controller was unable to determine the point from which Sundance 415 could properly intercept the localizer," the NTSB said.

Following the Pasco accident [and another radar range setting-related accident that occurred in California in 1990], the NTSB recommended that air route traffic control centers end the practice of providing vectors to final approach courses when using radar scopes set to extended ranges and when using video maps that do not depict approach gates.

In response, the FAA directed controllers not to use range settings of more than 125 nautical miles for vectors to a final approach course. It also required that all maps depict the approach gate for all airports where controllers are required to vector aircraft to the final approach course.

The NTSB report, while citing the controller's actions, emphasized that the flight crew should have known that their approach was becoming increasingly hazardous.

"Although the Seattle Center controller provided the flight crew with an improper localizer intercept, the flight crew should have been aware that they would not intercept the localizer until they were well inside the outer marker, and with considerable excess altitude, and they should have requested additional vectoring back to a position and altitude from which they would have made a proper intercept," the report said.

When the flight crew acknowledged their position to Seattle Center as four miles north of the airport, the aircraft was still at an altitude of 2,500 feet (2,000 feet AGL), a situation "that would have presented a full-scale fly-down deflection on the glideslope indicator in the cockpit." (Figure 1, page 5)

The report added: "The rushed nature of the descent and the out-of-tolerance condition of these events suggest that the flight crew should have discontinued the approach at several points and attempted a second one. The controller placed the flight crew in a position that made a stabilized approach more difficult to accomplish. However, after the flight crew saw 'flags' on their instruments, the decision to initiate a go-around was imperative."

The NTSB said that the flight crew should have realized that a "glideslope full-needle deflection combined with the appearance of a warning flag ... suggested an obvious hazard of an unreliable glideslope signal during an abnormally steep approach."

The report noted that initiating a missed approach, however briefly, would have increased the instrument deviation above the glideslope and would have made a stabilized approach even more difficult.

Investigation revealed that an average glidepath of about seven degrees was required for the aircraft to reach the runway threshold from its last radar-targeted position. This angle is more than twice the glidepath angle used for a normal ILS approach. Investigators also found that the flight crew could lose ILS glideslope guidance (with warning flags) after initiating a steep descent from a position well above the glideslope.

Tests indicated that a descent rate of between 2,000 and 3,000 feet per minute would have been required to reach the runway successfully.

"The warning flags were attributed to the relative position of the ILS antenna and the radar antenna on the airplane's fuselage. When in a steep descent, the body attitude of the airplane was such that the ILS antenna was in the shadow of the radar antenna so that the signal from the ILS transmitter would not be received. The flight crew's radio transmissions indicating intermittent flags on the instruments are thus consistent with a conclusion that the flight crew initiated a steep descent with the airplane in a nose-down attitude."

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While the NTSB did not rule out the possibility that Sundance 415 experienced a severe wing stall caused by ice contamination, it concluded that the "steep impact angle ... is more indicative of tail plane (horizontal stabilizer) stall than wing stall."

The report said it was reasonable to assume that the captain would have maintained a speed margin to compensate for wing icing "without realizing the significant hazard of stabilizer icing."

Flight tests conducted by British Aerospace and the FAA following a similar Jetstream accident in West Virginia "confirmed the susceptibility of the BAe-3100 airplane to a longitudinal problem when flaps were extended to 50 degrees with ice accumulated on the horizontal stabilizer," the report said. Post-crash investigation of the Sundance 415 accident determined a flap setting of 50 degrees. In the 1991 West Virginia accident, the pilot reported that the pitch-over occurred when he selected 50 degrees of flaps while in

icing conditions (with inoperative de-icing boots).

"One of the most insidious hazards of ice contamination is that the aerodynamic stall can occur at an airspeed that the pilot perceives as safe and at a corresponding angle of attack that is below that at which the stall protection devices activate. In this case, the pilot would not receive a warning of an impending stall," the NTSB report said.

The report said the investigation determined that, because of the amount of ice on the aircraft found during its stop in Yakima, there was a possibility that the de-icing system was faulty.

"If the flight crew was relying on the illumination of the wing de-ice light on the instrument panel ... as an indication that the boots were operating properly, they could have been misled. The investigation disclosed that the light illuminates with only 10 pounds per square inch (psi) pressure, but 15 psi is required to inflate the boots properly. Thus ... there could have been sufficient air pressure to give the appearance of normal operation based on the light, without actually inflating the boots sufficiently to remove ice."

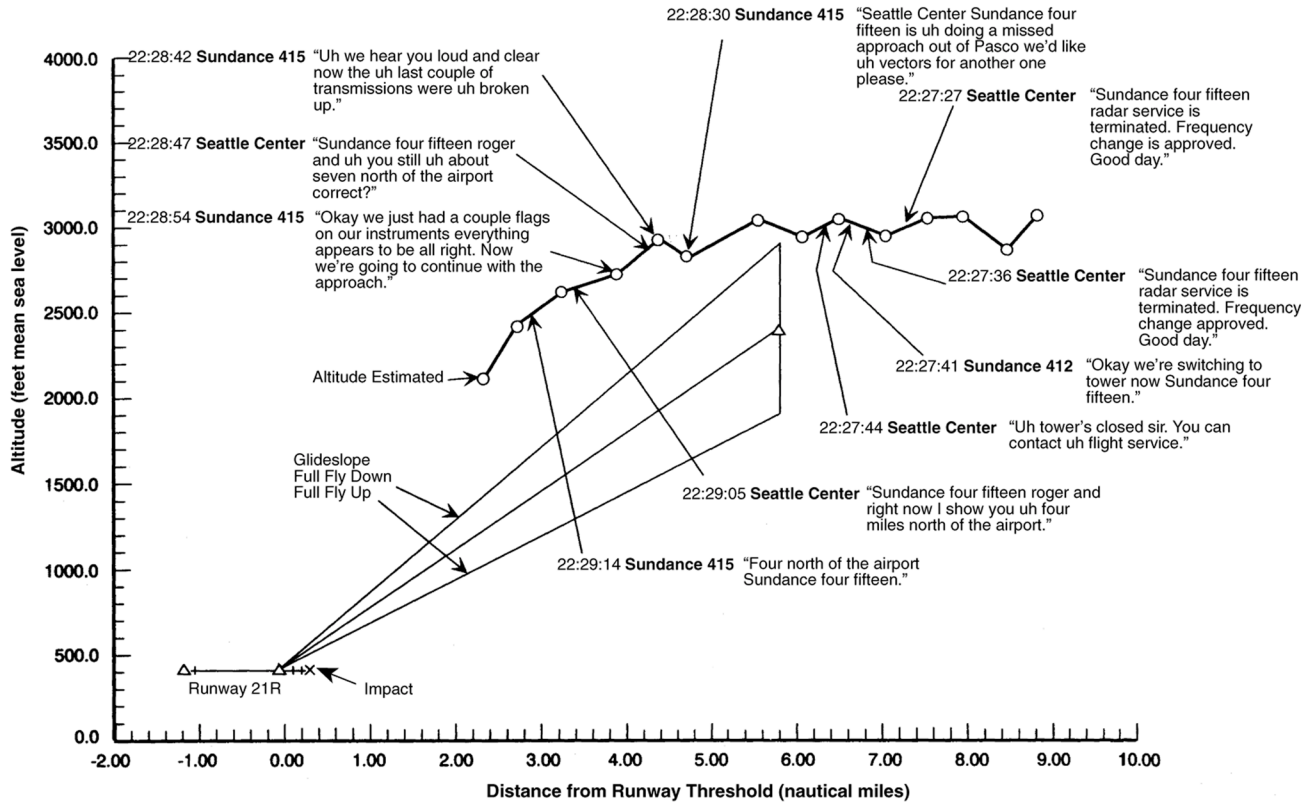
The NTSB report also concluded:

- The de-ice distribution valve may have been unable to direct sufficient air to the wing's leading edge de-ice boots because of corrosion in the control valve; and,

- FAA regulations and British Aerospace Jetstream icing certification flight tests did not account for possible tail stall when the airplane had accumulated ice and was configured for approach with 20 degrees flaps, which were then lowered to 50 degrees.

  [The report noted, however, that subsequent actions taken by British Aerospace and airworthiness actions initiated by the FAA and the British Civil Aviation Authority "should prevent tail stall and pitch down with a reasonable ice accumulation." The action involved limiting 50-degree flap speed to 130 knots. The NTSB concluded that more abrupt pitch-overs would occur with less recovery capability if the flaps were extended to 50 degrees at an airspeed greater than 150 knots.]

Profile View of Sundance 415 Radar Data



Source: U.S. National Transportation Safety Board

Figure 1

The NTSB said that it could not be determined precisely why the flight crew decided to continue the approach. The report speculated the decision may have resulted from their knowledge that good visibility existed below the 1,000-foot overcast ceiling. The flight crew was also familiar with the airport and the runway 21R ILS approach. But the decision to continue, the report said, was the fatal turn in the error chain.

"Although the vectoring and instrumentation problems complicated the approach, these problems did not directly cause the accident. The problems should have prompted the flight crew to abandon the initial approach, rather than continue. The [NTSB] believes that the flight crew's decision to continue the unstabilized approach set the stage for the subsequent loss of control and crash." ♦

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