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Reduced Visibility, Mountainous Terrain Cited in Gulfstream III CFIT at Aspen

Darkness increased and weather conditions deteriorated as the pilots continued a nonprecision instrument approach below minimums without adequate visual references at the Aspen (Colorado, U.S.) airport. A delayed departure, a nighttime landing curfew and pressure from the charter customer to land were factors cited in the controlled-flight-into-terrain (CFIT) accident.

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FSF Editorial Staff

About 1901 local time on March 29, 2001, a Gulfstream Aerospace Gulfstream III operated by Avjet Corp. struck terrain approximately 2,400 feet (732 meters) from the runway threshold during a nonprecision instrument approach in instrument meteorological conditions (IMC) at Aspen–Pitkin County (Colorado, U.S.) Airport. The two pilots, the flight attendant and the 15 passengers were killed. The airplane was destroyed.

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 operation of the airplane below the minimum descent altitude [MDA] without an appropriate visual reference for the runway."

NTSB said that factors contributing to the accident were:

- "The [U.S.] Federal Aviation Administration's (FAA) unclear wording of [a] March 27, 2001, notice to airmen [NOTAM] regarding the nighttime restriction for the VOR/DME-C [very-high-frequency omnidirectional radio/distance-measuring equipment] approach to the airport and the FAA's failure to communicate this restriction to the Aspen [air traffic control] tower [ATCT];
- "The inability of the flight crew to adequately see the mountainous terrain because of the darkness and the weather conditions; [and,]
- "The pressure on the captain to land from the charter customer and because of the airplane's delayed departure and the airport's nighttime landing restriction."

The captain, 44, held an airline transport pilot (ATP) certificate and had 9,900 flight hours, including 1,475 flight hours in type. He was hired by Avjet in October 2000.

The report said that in January 1999, the captain was involved in an incident.

"The captain was landing a Gulfstream 1159-series airplane at Chino, California, but the airplane departed the end of the runway and went 150 feet [46 meters] into the paved overrun area," the report said. "No action was taken [by FAA] against the captain."

The first officer, 38, held an ATP certificate and a Gulfstream III type rating, and had 5,500 flight hours, including 913 flight hours as a first officer in type. He was hired by Avjet in November 2000.

The report said that in May 1998, the first officer failed his first check ride for an ATP certificate because of inadequate performance of VOR approaches and circling approaches; he passed his second check ride for an ATP certificate in June 1998.

"On March 25, 1999, the first officer was performing a [Gulfstream III] simulator competency check ride, during which time it was determined that he needed additional training to gain proficiency in normal takeoff, takeoff with engine failure and nonprecision approaches," the report said.

The captain and the first officer had been flying together for five months and had conducted two flights to Aspen in daylight conditions.

"According to Avjet's director of operations, the company considered [Aspen] to be a special airport," the report said. "He explained that, for operations into special airports, the charter manager would discuss the flight crew's qualifications with upper managers and might not assign a captain to an airport with which he/she was not familiar."

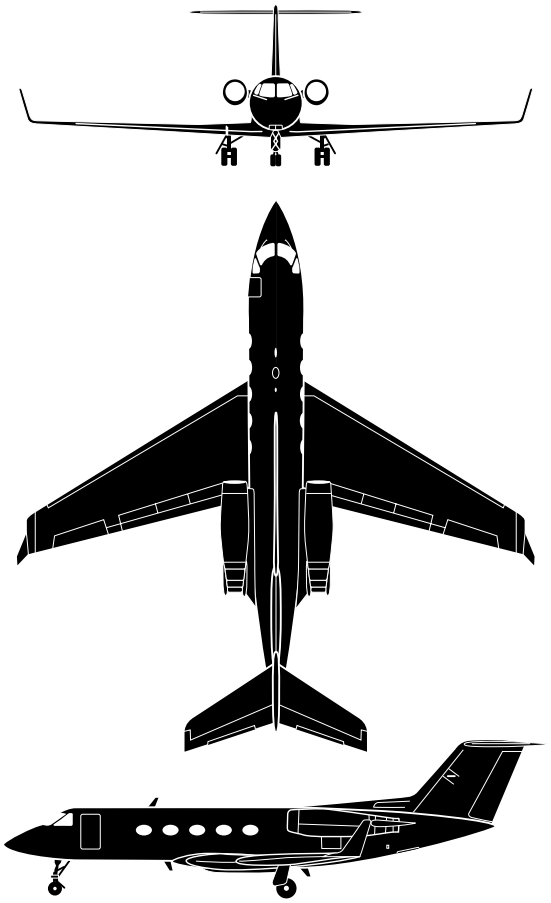
At the time of the accident, Avjet had 55 pilots and four check airmen in full-time employment. The company's U.S. Federal Aviation Regulations (FARs) Part 135 certificate [for on-demand operations] listed 18 aircraft, including 15 Gulfstream aircraft.

The accident aircraft was manufactured in 1980 and was exported from the United States to Ivory Coast. In 1988, the aircraft was substantially damaged when it struck a ditch while being landed on a closed runway in Africa. The aircraft was repaired by the manufacturer and returned to service in the United States in 1989.

At the time of the accident, the aircraft had accumulated 7,266 flight hours and 3,507 cycles (takeoffs and landings). The aircraft's registration number was N303GA.

The aircraft was equipped with a Collins FPA-80 flight profile advisory system, which calls out deviations from the selected altitude and radio altitude every 100 feet from 1,000 feet above ground level (AGL) to 100 feet AGL, and an AlliedSignal [now Honeywell] Mark VI ground-proximity warning system (GPWS), which calls out excessive descent rate, excessive closure rate with terrain, excessive bank angle, insufficient terrain clearance and radio altitude at 500 feet AGL and at 200 feet AGL.

The captain and the first officer reported for duty at the Avjet facility at Burbank–Glendale–Pasadena (California) Airport at 1300 Mountain Standard Time (Aspen local time, which is one hour later than local time in California). The captain used



Gulfstream III

The Grumman American (now Gulfstream Aerospace) Gulfstream III long-range executive transport first flew in 1979. Compared to its predecessor, the Gulfstream II, the aircraft has a longer fuselage, more fuel capacity and a redesigned wing, with extended-chord leading edges and winglets.

The aircraft accommodates two flight crewmembers and up to 19 passengers. Maximum fuel capacity is 28,300 pounds (12,837 kilograms). Maximum takeoff weight is 69,700 pounds (31,616 kilograms). Maximum landing weight is 58,500 pounds (28,536 kilograms).

Each of the two Rolls-Royce Spey 511-8 turbofan engines produces 11,400 pounds static thrust (50.7 kilonewtons). Maximum cruising speed is Mach 0.85. Long-range cruising speed is Mach 0.77. Maximum operating altitude is 45,000 feet. Range is 4,100 nautical miles (7,593 kilometers). Stall speed at maximum landing weight is 105 knots.♦

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

a personal computer to obtain weather information and discussed the Aspen weather conditions with an Avjet charter scheduler.

About one hour before reporting for duty, the first officer obtained a briefing from a specialist at the Hawthorne (California) Automated Flight Service Station (AFSS). The specialist discussed three AIRMETs (airman's meteorological information advisories) with the first officer. The AIRMETs advised of occasional mountain obscuration by clouds and precipitation, occasional moderate turbulence below 15,000 feet and occasional moderate rime icing or mixed icing in clouds and in precipitation above the freezing level.

A weather observation transmitted at 1141 by the automated surface observing system (ASOS) at Aspen indicated that the airport had seven statute miles (11 kilometers) visibility in light snow, a few clouds at 1,100 feet, scattered clouds at 1,600 feet and an overcast ceiling at 3,000 feet.

"The AFSS specialist informed the first officer that the visibility reported in this observation had recently increased from one mile [two kilometers] in heavier snow showers," the report said.

The forecast for Aspen until 1900 was for visibilities greater than six statute miles (10 kilometers), scattered clouds at 3,000 feet and a broken ceiling at 5,000 feet. The forecast said that temporary conditions would include three miles (five kilometers) visibility in light snow showers, a broken ceiling at 2,500 feet and an overcast at 5,000 feet.

The AFSS specialist also told the first officer that the Aspen VOR/DME-C approach circling minimums were no longer authorized at night.

The Aspen airport, also known as Sardy Field, is at an elevation of 7,815 feet and is surrounded by higher terrain (see Figure 1). The VOR/DME-C approach procedure includes only circling approach minimums; straight-in approach minimums are not included because a straight-in approach would require a descent gradient of 700 feet per nautical mile between the final approach fix (FAF) and the runway threshold crossing height (see Figure 2, page 4). Among FAA's requirements for straight-in approach procedures is a maximum descent gradient of 400 feet per nautical mile between the FAF and the threshold crossing height.

"When the [Aspen] VOR/DME-C approach was first established in December 1988, the procedure was not authorized at night," the report said. "The night restriction on the approach was removed in October 1994 because of complaints from user groups."

On March 21, 2001, an FAA flight-inspection crew conducted a flight check of a proposed GPS (global positioning system) approach to Runway 15.

Airborne View of Final Approach to Runway 15, Aspen–Pitkin County (Colorado, U.S.) Airport, March 29, 2001

Source: U.S. National Transportation Safety Board

Figure 1

"The flight inspection crew [recommended to FAA] that circling should not be allowed at night because areas of unlighted terrain conflicted with traffic patterns and circling descent maneuvers near the airport," the report said.

On March 27, 2001, FAA issued a NOTAM for the VOR/DME-C approach that stated "circling NA [not authorized] at night." The report said that "because of human error," a flight data communications specialist at the Denver (Colorado) Air Route Traffic Control Center did not send the NOTAM to the Aspen ATCT.

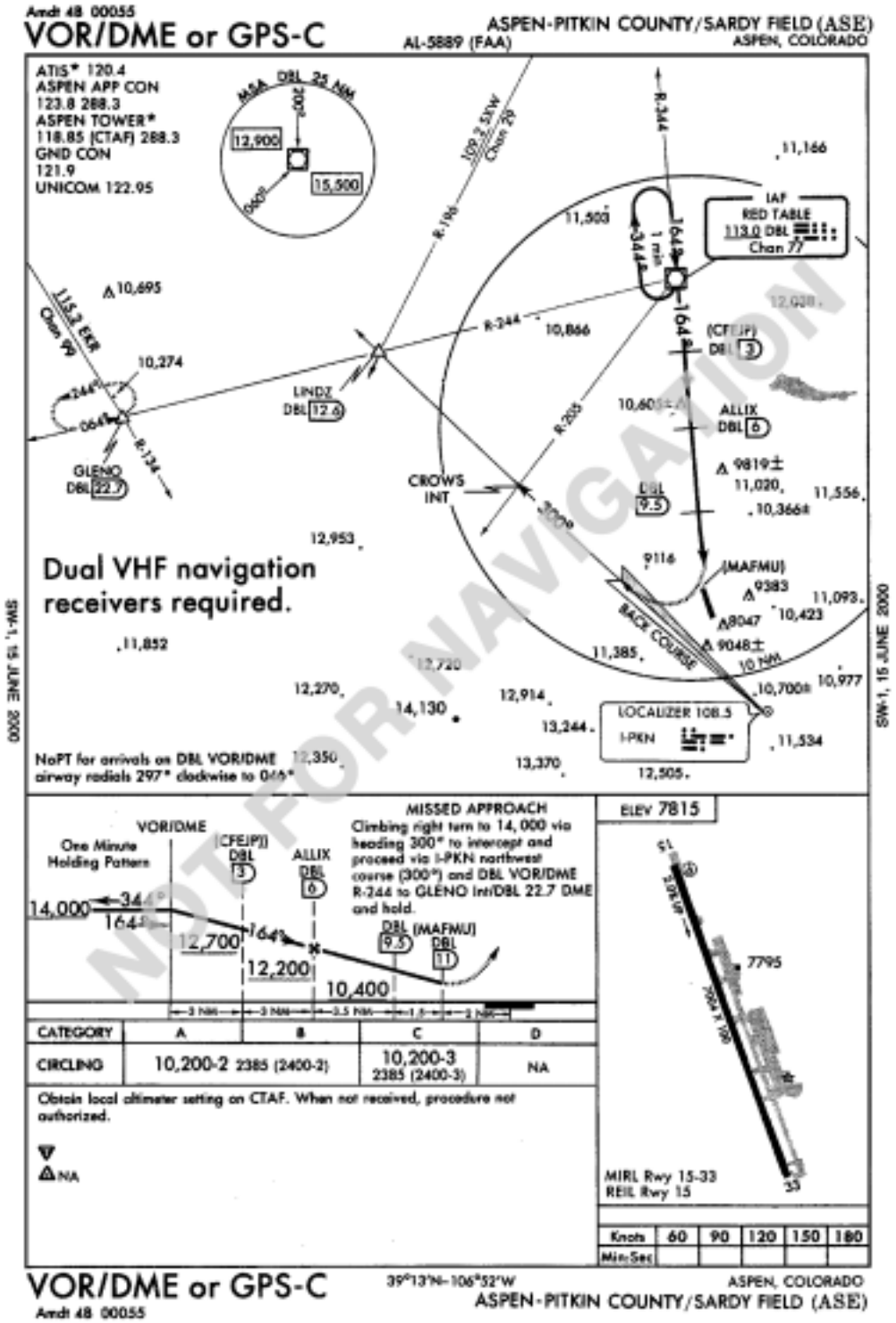
The report said that the NOTAM was vaguely worded.

"The NOTAM was intended to mean that the instrument approach procedure was no longer authorized at night, because only circling minimums were authorized for that procedure," the report said. "Thus, the NOTAM was vaguely worded because pilots could infer that [conducting] an approach without a circle-to-land maneuver to Runway 15 was still authorized."

On March 30, 2001, FAA revised the NOTAM to state "procedure NA at night."

The accident aircraft had been chartered by a client who was hosting a party in Aspen. The itinerary was for the crew to reposition the aircraft from Burbank to Los Angeles (California) International Airport, pick up the charter client and the other passengers, fly the passengers to Aspen and then reposition the aircraft to Burbank.

VOR/DME-C Approach Procedure, Aspen–Pitkin County (Colorado, U.S.) Airport, March 29, 2001



Source: U.S. Department of Transportation

Figure 2

The crew departed from Burbank at 1538 and landed the Gulfstream at Los Angeles at 1549. The scheduled departure time from Los Angeles was 1630, and estimated arrival time in Aspen was 1805 — 53 minutes before a nighttime landing curfew began at the Aspen airport for aircraft that do not meet FAA Stage 3 noise criteria. (The Gulfstream III does not meet FAA Stage 3 noise criteria; the aircraft is classified by FAA as a Stage 2 airplane.)

At 1630, an Avjet flight scheduler told the charter client's business assistant that the passengers were not at the airport and that the aircraft would have to depart from Los Angeles by 1655 to fly to Aspen; a later departure would mean that the crew would have to fly the passengers to Rifle, Colorado, the alternate airport included on the crew's instrument flight rules (IFR) flight plan. [The Rifle airport — Garfield County Regional — is approximately 54 nautical miles (100 kilometers) west-northwest of Aspen.]

(The report said that the 1655 time limit for departure from Los Angeles provided sufficient time for the crew to land at Aspen, deplane the passengers, refuel and depart from Aspen before the curfew began. A later departure would necessitate an overnight stay at Aspen, and the charges for the overnight stay would be billed to the charter client.)

"The business assistant stated that when he told his employer about the possibility that the flight might have to divert, his employer became 'irate,'" the report said. "He [said that] he was told to call Avjet and tell the company that the airplane was not going to be redirected. Specifically, he was told to say that his employer had flown into [Aspen] at night and was going to do it again. The business assistant stated that he called Avjet to express his employer's displeasure about the possibility of not landing in [Aspen]."

The report said that postaccident interviews with Avjet pilots indicated that "the company would have placed no pressure on the captain to land at [Aspen]."

The aircraft departed from Los Angeles at 1711 — 41 minutes later than scheduled. The estimated time of arrival at Aspen was 1846 — 12 minutes before the curfew began. The captain was the pilot flying.

The report said that the cockpit voice recorder (CVR) transcript indicates that the pilots were aware of the curfew.

At 1831, the captain said, "Well, there's the edge of night right here."

The first officer said, "What time is official sunset?"

"Six twenty-eight," the captain said. "So, we get thirty minutes after sunset. So, six fifty-eight … about … seven o'clock."

"Seven is good enough, yeah," the first officer said.

The crew conducted the "Descent" checklist while flying the aircraft from cruise altitude to Flight Level 210. When the first officer called for the approach briefing, the captain said, "We're probably going to make it a visual [approach]. If we don't get the airport … we'll go ahead and shoot that [instrument] approach. … We're not going to have a bunch of extra gas, so we only get to shoot it once, and then we're going to Rifle."

The report said that the captain's approach briefing did not include several items required by the *Avjet Operations Manual*, such as the instrument approach procedure and the missed approach procedure.

"Thus, the flight crew was not adequately prepared to perform [Aspen's] instrument [approach procedure] and missed approach procedure," the report said. "In addition, Avjet's manual indicates that the captain was to brief the airplane's configuration and approach speed, [FAF] altitude, [MDA], visual descent point, circling maneuver, runway information and abnormal conditions."

At 1839, the first officer listened to the Aspen automated terminal information service (ATIS) radio broadcast. The information was based on a weather observation at 1753 that included surface winds from 030 degrees at four knots, 10 statute miles (16 kilometers) visibility, scattered clouds at 2,000 feet AGL, broken ceilings at 5,500 feet AGL and at 9,000 feet AGL, temperature 2 degrees Celsius (36 degrees Fahrenheit) and dew point –3 degrees Celsius (27 degrees Fahrenheit).

The ATIS said that pilots could expect to conduct the VOR/DME-C approach and that landing operations were being conducted on Runway 15 and takeoffs were being conducted on Runway 33. (The runway is 7,006 feet [2,137 meters] long, 100 feet [31 meters] wide and has medium-intensity lights.)

The ATIS said that MSAW (minimum safe altitude warning) services were not available from air traffic control (ATC) because of the mountainous terrain.

The report said that Aspen does not have MSAW because of "the high number of false alarms that would be created by the high terrain surrounding [the airport]."

The first officer read back the wind conditions, visibility, cloud bases and temperatures to the captain.

At 1844, the crew heard the crew of a Canadair Challenger request clearance from Aspen Approach Control to conduct another instrument approach.

The first officer told the captain, "I hope he's doing practice approaches."

The captain then asked the approach controller whether the Challenger crew was conducting practice approaches or had

conducted a missed approach because they were unable to continue the approach to landing.

The controller said, "He actually went missed. … We saw him, though, at 10,400 [feet]. I [have] two other aircraft on approach in front of you." The controller then told the crew to fly a heading of 360 degrees for sequencing for the instrument approach.

The captain asked the first officer if he could see a highway that parallels the extended centerline of Runway 15.

"Where's that highway?" the captain said. "Can we get down in there?"

"I'm looking," the first officer said. "I'm looking. … No."

The controller told the crew to descend to Flight Level 190 after reducing airspeed to 210 knots. The first officer read back the instruction to the controller and then told the captain, "One niner zero."

The crew resumed their discussion of outside visual references.

"Can't really see up there, can [you]?" the captain said.

"Nope, not really," the first officer said. "I see a river, but I don't see [anything] else."

At 1846, the CVR recorded a comment by the flight attendant. "Are you scared?" she said.

"Well, [I am] hoping we make it," the captain said. "Somebody just missed."

"I don't want to hear that," the flight attendant said. "Why did you tell me? Why didn't you say no I'm not scared?"

"Well, I'm not scared," the captain said.

The first officer said, "I'm not scared. [We] just cannot make it."

"Yeah, we don't have enough gas to go hanging around," the captain said. "I mean, we're [going to] have [enough fuel for one approach] and then we [have to] go to Rifle."

The aircraft had 12,450 pounds (5,647 kilograms) of fuel when it departed from Los Angeles. The report said that this quantity was more fuel than is required to comply with FARs Part 135.223, which requires that an aircraft carry enough fuel during an IFR flight to complete the flight to the intended destination airport, fly from that airport to the alternate airport and fly thereafter for 45 minutes at normal cruising speed.

At 1847, the controller told all flight crews monitoring the radio frequency that a Cessna Citation crew had established visual contact with the airport when their aircraft was at 10,400 feet and were conducting a straight-in approach.

The first officer said, "Ah, that's good."

The captain told the controller, "Yeah, from where Golf Alpha is, I can almost see up the canyon … but I don't know the terrain well enough or I'd take the visual [i.e., conduct a visual approach]."

The first officer told the captain, "Could do a contact [approach], but … I don't know. Probably, we could not."

At 1848, the controller told the crew to descend to 17,000 feet.

The captain said, "There's the highway right there. … Can you see up there yet at all?" After the first officer said no, the captain said, "Can you see the highway directly down there?"

"No," the first officer said. "It's clouds over here. … I don't see it."

"But it's right there," the captain said. He then told the flight attendant again that if they missed the approach to Aspen, they would have to fly to Rifle because "it's too late in the evening to come around" for another approach to Aspen.

At 1851, the captain told the first officer, "See, it's right over there. Look. … Look, it's a hundred and forty-five degrees, so it's right back under those clouds."

The first officer said, "Cannot see it. I saw the lights over there, but must be something else."

The controller told the crew to turn the aircraft to a heading of 050 degrees. About one minute later, the controller told the crew to turn the aircraft to a heading of 140 degrees to intercept the final approach course and to maintain 16,000 feet.

The controller then told all flight crews monitoring the radio frequency that the "last aircraft [to conduct the instrument approach] went missed."

The first officer told the captain, "That's … not … good."

At 1853, the flight attendant asked the crew if a passenger could occupy the cockpit jump seat. About the same time, the controller told the crew to "maintain slowest practical speed for sequence." The CVR recorded no reply from the crew to the flight attendant's question.

At 1854, the flight attendant told the passenger to ensure that his seat belt was fastened. The report said that the presence of this passenger in the cockpit, especially if the passenger was the charter client, increased the pressure on the flight crew to land at Aspen.

At 1855, a Challenger crew told the controller that they were conducting a missed approach.

"The weather's gone down," the captain said. "They're not making it in."

The CVR recorded an unidentified male voice saying, "Oh, really."

At 1856, the controller told the crew that their aircraft was five nautical miles (nine kilometers) from the Red Table VOR (the initial approach fix) and to cross the VOR at or above 14,000 feet. The controller then cleared the crew to conduct the VOR/DME-C approach.

"Here we go," the captain said. "OK, descending to one four thousand."

"After [the] VOR, you are cleared to twelve thousand seven hundred [feet]," the first officer said.

The report said that the cloud tops were at about 16,000 feet and that "after descending through this altitude, the airplane was in and out of the clouds."

The controller said, "Attention all aircraft, [ATIS] information India is current. Remarks … visibility north two [statute miles (three kilometers)]."

ATIS information India said that visibility at the airport was 10 statute miles. The VOR/DME-C approach procedure required a minimum visibility of three statute miles (five kilometers) for Category C aircraft (i.e., aircraft with approach speeds greater than 121 knots but less than 141 knots). The report said that the Gulfstream III is a Category C aircraft.

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The approach controller told the crew to establish radio communication with the Aspen ATCT local controller.

At 1857, the local controller told the crew that they were following a Challenger that was two nautical miles from the runway, that the surface winds were from 240 degrees at five knots and that they were cleared to land on Runway 15.

The report said that pilots are not prohibited from conducting a straight-in landing after conducting an instrument approach for which only circling minimums are published. Paragraph 5-4-18d of the FAA *Aeronautical Information Manual* states the following:

> The fact that a straight-in minimum is not published does not preclude pilots from landing straight-in if they have the active runway in sight and have sufficient time to make a normal approach for landing. Under such conditions and when ATC has cleared them for landing on that runway, pilots are not expected to circle even though only circling minimums are published. If they desire to circle, they should advise ATC.

The report said that about the time the crew was cleared to land on Runway 15, the aircraft flew over the Red Table VOR at 14,000 feet and at 160 knots (see Figure 3, page 8).

The captain asked the first officer where they could begin the descent from 12,700 feet. The first officer said "three DME [three nautical miles from the Red Table VOR]."

At 1858, the aircraft flew over the three-DME step-down fix at 12,700 feet and 150 knots. About this time, the controller asked the Challenger crew if they had the airport in sight. The Challenger crew said that they did not have the airport in sight and were conducting a go-around.

The CVR then recorded an unidentified male voice asking, "Are we clear?"

"[No,] not yet," the captain said. "The guy in front of us didn't make it either."

"Oh, really," the unidentified male said.

The captain then asked the first officer for the minimum altitude after the three-DME step-down fix. The first officer said that they could maintain 12,200 feet until the six-DME step-down fix.

"Twelve two to six," the captain said.

The aircraft was at 12,100 feet at 1859 when it flew over the six-DME step-down fix, which is the FAF (ALLIX). Calibrated airspeed was approximately 125 knots; the crew had selected 123 knots as their landing reference speed (V_{REF}).

The captain said, "OK, next altitude is?" The first officer said 10,400 feet. The captain then told the first officer to extend the landing gear and the landing flaps.

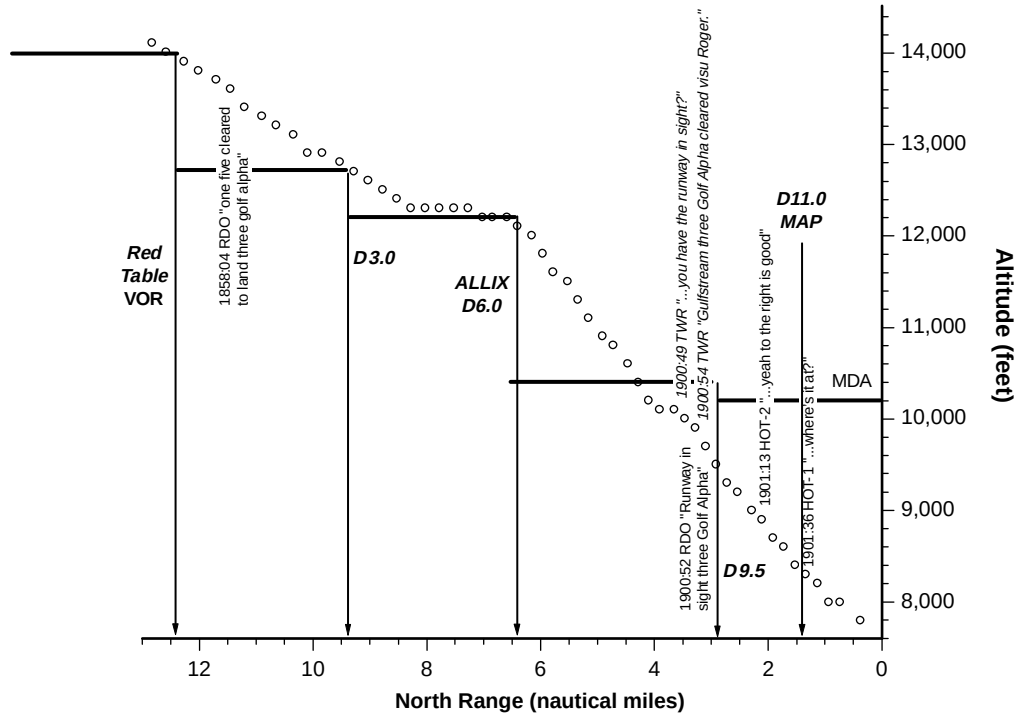
About this time, the unidentified male said "snow."

A few seconds later, the captain said, "OK, I'm breaking out." He then asked the controller if the runway lights were "all the way up."

The controller said, "Affirmative, they're on high."

At 1900:30, the first officer told the captain that they could descend to 10,200 feet, which was the MDA and was 2,385 feet above airport elevation.

Gulfstream III Flight Path, Aspen–Pitkin County (Colorado, U.S.) Airport, March 29, 2001



Times are coordinated universal time.

D = Distance in nautical miles from Red Table VOR HOT-1 = Statement by captain HOT-2 = Statement by first officer
MAP = Missed approach point MDA = Minimum descent altitude RDO = Radio transmission by Gulfstream III crew
TWR = Radio transmission by Aspen Tower local controller VOR = Very-high-frequency omnidirectional radio

Source: U.S. National Transportation Safety Board

Figure 3

"Ten thousand two hundred?" the captain said.

"Ten thousand two hundred, to eleven DME," the first officer said. The 11-DME fix is the missed approach point (MAP).

After flying over ALLIX at 12,100 feet, the crew flew the aircraft at 2,200 feet per minute to 10,100 feet — about 300 feet below the minimum specified altitude for the 9.5-DME step-down fix. The crew flew the aircraft in level flight for about 10 seconds and then began to descend again at 2,200 feet per minute.

"At that point, the airplane's heading increased about 15 degrees [from 168 degrees to 183 degrees] as the airplane turned slightly to the right," the report said. (The final approach course is 164 degrees.)

At 1900:43, the captain asked the first officer if he could see the runway. The first officer's reply was unintelligible. The captain asked him if he could see the highway. The first officer said "see highway." The report said that this statement could have meant that the first officer had the highway in sight or that he was repeating the captain's words while looking for the highway.

At 1900:49, the controller asked the crew if they had the runway in sight.

"In postaccident interviews, controllers at the ATCT indicated that when they observe an airplane's altitude about 200 feet lower than the published altitude (to account for altimeter [error] or transponder error), they ask the pilot whether the runway is in sight," the report said. "If the pilot does not report the runway in sight, the controller issues a low-altitude alert and may issue missed approach instructions."

The controller told investigators that she had observed the aircraft descend below 10,400 feet before reaching the 9.5-DME step-down fix.

Before responding to the controller, the first officer told the captain "affirmative."

"Yes, now, yeah, we do," the captain said.

The first officer then told the controller that they had the runway in sight.

At this time, the crew would have had to turn left to align the aircraft's flight path with the runway; however, radar data showed that the aircraft turned slightly right. The report said that the crew "probably did not have the runway in sight or had it in sight only briefly."

At 1900:56, the CVR recorded a sound similar to decreasing engine speed. The report said that the captain reduced engine speed to 55 percent N_2 and that the *Gulfstream III Flight Manual* says that the power setting should be maintained at 64 percent N_2 or higher on final approach to meet FAA go-around performance requirements.[1]

At 1901:00, the aircraft was flown over the 9.5-DME step-down fix at 9,500 feet — 900 feet below the minimum specified altitude and 700 feet below MDA. Airspeed was 125 knots.

At 1901:12, the first officer said, "To the right is good."

The report said, "It is not apparent what the first officer could see from the cockpit when he made his statement because the runway would have been to the left of the nose of the airplane."

The captain did not verbally acknowledge the first officer's statement and did not turn right.

At 1901:21, the CVR recorded a sound similar to the aircraft's configuration alarm; the sound continued for nine seconds.

The report said, "This warning indicated that the captain had deployed the spoilers [speed brakes] after the landing gear had been extended and the final landing flaps had been selected."

The flight manual says that speed brakes must not be extended with flaps at 39 degrees (landing configuration) or with landing gear extended.

The report said that the captain likely had reduced power to 55 percent N_2 and extended the speed brakes "to get below the snow showers and visually acquire the runway."

At 1901:28, the FPA called out "1,000 [feet]."

At 1901:31, the FPA called out "nine hundred."

At 1901:34, the FPA called out "eight hundred." At this time, the aircraft, which was on a heading of 185 degrees, began to turn right.

At 1901:36, the aircraft was flown at 8,300 feet over the MAP — 1,900 feet below MDA.

The captain said, "Where's it at?"

The report said that this statement indicates that the captain "had not identified or had lost visual contact with the runway. At this point, the captain should have abandoned the approach, especially because the airplane was close to the ground in mountainous terrain."

At 1901:38, the FPA called out "seven hundred."

At 1901:41, the FPA called out "six hundred."

At 1901:42, the first officer said, "To the right."

"To the right," the captain said. At this time, the aircraft was at 8,100 feet and was 1.2 nautical miles (2.2 kilometers) from the runway.

At 1901:45, the FPA and the GPWS called out "five hundred." At this time, the aircraft's heading was 200 degrees.

The first officer told the captain that indicated airspeed was "V-ref plus five."

Recorded ATC radar data indicate that the aircraft began a left turn about 1901:47. The GPWS then called out "sink rate" because the aircraft's rate of descent exceeded a predetermined threshold.

At this time, the aircraft stopped turning right and began turning left with an initial bank angle of about 10 degrees. The report said that this is the "first clear indication" that the captain might have seen the runway after the aircraft descended below MDA.

At 1901:48, the FPS called out "four hundred."

At 1901:49, the aircraft was descending at 900 feet per minute through 8,000 feet and was 0.9 nautical mile (1.7 kilometers) from the runway. The aircraft's left bank angle began to increase.

At 1901:51.8, the GPWS called out "sink rate."

The aircraft flew over a riverbed, and the terrain elevation decreased 140 feet. The FPA again called out "four hundred" at 1901:52.3.

At 1901:52.7, the first officer said "plus ten." At this time, the CVR began to record an "unidentified rumbling noise"; the noise continued until the end of the recording. The report said that the noise was similar to a post-accident recording of the sound of activation of the stick shaker (stall-warning) system in a similar Gulfstream III.

Between 1901:52 and 1901:57, the accident aircraft's airspeed varied between 120 knots and 127 knots. The left bank increased to 40 degrees.

"At 40 degrees of bank and the airplane's weight at the time of the accident [approximately 50,033 pounds (22,695 kilograms)], the stall speed was about 134 knots," the report said.

At 1901:53.5, the CVR recorded a sound similar to increased engine speed. A sound-spectrum analysis of the recording indicated that engine power was increased to maximum at this time.

As the airplane flew over rising terrain in the riverbed at 1901:53.7, the FPA called out "three hundred." About one second later, the FPA and the GPWS called out "two hundred."

At 1901:57.2, the GPWS called out "bank angle." The aircraft was banked more than 40 degrees left at this time.

At 1901:57.9, the CVR recorded the sound of a grunt; it was the last sound recorded by the CVR.

The local controller told investigators that about one minute after she asked the crew if they had the runway in sight, she observed the aircraft "come out of the snow, pointed at Shale [Bluffs]," which is northwest of the airport, and rapidly enter a steep left bank.

"The local controller said that the airplane appeared low and to the right of the centerline," the report said. "She indicated that the pilot apparently 'got the runway and turned toward it.' She noted that the airplane looked as if it were accelerating, with its lights pointed directly at the tower, and that the airplane was rolling rapidly to its left."

The report said that the captain might have made the steep left turn to line up with the runway, to line up with the highway or to avoid terrain.

About five seconds after the controller observed the aircraft emerge from the snow shower, she observed an explosion and activated an emergency siren to alert the airport's aircraft rescue and fire fighting unit.

The aircraft was banked 49 degrees left when it struck terrain 300 feet (92 meters) right of the extended runway centerline and 100 feet above runway threshold elevation.

"The impact subjected the airplane to severe accordion-type crushing, causing components to separate and structure to fracture," the report said.

Autopsies of the captain, the first officer and the flight attendant indicated that they died from "multiple blunt-force injuries." The Pitkin County coroner said that the cause of the deaths of the passengers was "massive blunt-force trauma."

Ten minutes after the accident occurred, the ASOS transmitted a special weather observation indicating that visibility at the airport had decreased to 1.75 statute miles (2.82 kilometers) in light snow.

About the time of the accident, the Rifle ASOS indicated that the sky was clear below 12,000 feet and that visibility was 10 statute miles.

On April 10, 2001, the FAA flight standards district office in Van Nuys, California, revised the operations specifications for Avjet and for 11 other turbojet-airplane operators in its jurisdiction to specify that a ceiling of at least 4,000 feet and visibility of at least five statute miles (eight kilometers) are required to conduct the VOR/DME-C approach at Aspen.

On the same day, Avjet issued a memorandum to its flight crews and flight schedulers prohibiting operations between sunset and sunrise at the Aspen airport and at three other airports located in mountainous terrain: Eagle, Colorado; Telluride, Colorado; and Hailey, Idaho.

The accident occurred 34 minutes after official sunset, which the report defined as when "the center of the sun is 0.8333 degrees below the horizon and its top edge is at the horizon." Official sunset was 1828. The report said, however, that the sun set below the mountainous terrain near Aspen about 25 minutes before official sunset.

"The shadow for the ridge immediately to the west of the accident site would have crossed the site 79 minutes earlier than official sunset," the report said. "All eyewitnesses to the accident reported that lighting conditions were very dark at the time of the crash. … Because of these low light conditions, the pilot of N303GA most likely would not have been able to see the unlighted terrain while maneuvering to land."

The report said that the Flight Safety Foundation *CFIT Checklist* includes limited lighting, a nonprecision approach and mountainous terrain as high-risk factors for controlled flight into terrain (CFIT).[2]

"Investigators determined that the combined effects of the surrounding terrain's high elevation and weather conditions created twilight [conditions] and nighttime conditions much earlier than would have occurred in non-mountainous terrain and in clear weather," the report said.

Based on this finding, NTSB on April 15, 2002, made the following recommendation (no. A-02-08) to FAA:

> Revise any restrictions and prohibitions that currently reference or address "night" or "nighttime" flight operations in mountainous terrain so that those restrictions and prohibitions account for the entire period of insufficient ambient light conditions, and ensure that it is clear to flight crews when such restrictions and prohibitions apply.

[In a letter dated June 24, 2002, FAA responded, in part, to NTSB recommendation A-02-08, as follows:

> To address this safety recommendation, the FAA will establish flight inspection policy for evaluating the effect of terrain on [instrument approach] minima or procedures limited to daylight only. The FAA will develop a subtractive factor to sunset and an additive factor to sunrise to account for loss of light prior to the predicted sunset and after the predicted sunrise.
>
> Potential methods of assessing these factors include on-site evaluation (on the ground and in flight), local experience gained from official sources (like air traffic control facilities and local and state police agencies) and computer modeling.
>
> The intent of this action is to provide guidance to pilots on procedure restriction and prohibitions by referencing times relative to legal sunset/sunrise, like the following chart note: "Procedure NA SS – :50 through SR + :50."]

Another recommendation to FAA was based on a finding from the accident investigation that the flight crew demonstrated inadequate crew resource management (CRM).

The report said, "The accident flight crew exercised poor CRM in the following ways:

- "The captain did not brief the instrument [approach procedure] and missed approach procedure or any other required information;
- "The flight crew did not make required instrument approach callouts;
- "The captain did not include the first officer in the aeronautical decision-making process; and,
- "The first officer did not question or challenge the captain or intervene when he placed the airplane in a potentially unsafe flying condition."

The report said that the *Avjet Training Manual* included CRM as a subject to be covered during initial training and recurrent training of Gulfstream pilots; nevertheless, the company was not required to establish an FAA-approved CRM training program for its pilots.

FAA requires approved CRM training for pilots of air carriers operating under FARs Part 121 and for pilots of commuter airlines operating under Part 135; FAA does not require approved CRM training for pilots of on-demand operations conducted under Part 135.

Based on this finding, NTSB on June 13, 2002, made the following recommendation (no. A-02-12) to FAA:

> Revise [FARs] Part 135 to require on-demand charter operators that conduct operations with aircraft requiring two or more pilots to establish [an FAA-approved CRM] training program for their flight crews in accordance with [FARs] Part 121.

[In a letter dated Aug. 8, 2002, FAA responded, in part, to NTSB recommendation A-02-12 as follows:

> There is no regulatory initiative underway at this time to revise [FARs] Part 135. However, when a regulatory initiative is considered, CRM training for [FARs] Part 135 on-demand charter operators with two or more pilots will be included.
>
> In the interim, the FAA will issue a notice to its inspectors who have oversight responsibility for [FARs] Part 135 on-demand operators to remind them of the circumstances of the accident. The notice will direct inspectors to point out pertinent information contained in [Advisory Circular] 120-51D [Crew Resource Management Training] to its operators and emphasize the importance of CRM training. The inspectors will be directed to relay this information at the next normal contact with their operators.]♦

[FSF editorial note: "This article, except where specifically noted, is based on U.S. National Transportation Safety Board (NTSB) Aircraft Accident Brief DCA01MA034 (42 pages with illustrations), NTSB Safety Recommendation A-02-08 (five pages), NTSB Safety Recommendation A-02-12 (six pages) and NTSB Factual Report DCA01MA034 (981 pages with appendixes and illustrations).]

Notes

1. N_2 is engine high-pressure rotor speed, which is typically displayed as a percentage of maximum revolutions per minute.
2. Controlled flight into terrain (CFIT) occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase, which begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.

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