



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 12 1999

In reply refer to: A-99-35 and -36

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On January 13, 1998, about 0810 central standard time,¹ a Gates Learjet 25B, N627WS, impacted terrain approximately 2 nautical miles (nm) east of the runway 26 threshold at George Bush Intercontinental Airport (IAH), Houston, Texas, during an instrument landing system (ILS) approach. The airplane was operated by American Corporate Aviation, Inc., of Houston and was registered to First Star, Inc., of Wilmington, Delaware. The positioning flight, which was operating under 14 Code of Federal Regulations (CFR) Part 91, had departed from Houston's Hobby Airport about 0745 with a destination of IAH. The captain and first officer were the sole occupants aboard the flight. Instrument meteorological conditions prevailed for the flight, and an instrument flight rules flight plan had been filed. Both flight crewmembers were killed, and the airplane was destroyed by impact forces and fire. Five people were waiting at IAH to board the airplane for a 14 CFR Part 135 charter flight to Fargo, North Dakota.²

The captain was the flying pilot, and the first officer was the nonflying pilot. Shortly after takeoff, the flight was identified on radar and vectored for an ILS approach to runway 26 at IAH by Houston approach control. The controller provided the flight crew with the IAH automatic terminal information service (ATIS) weather conditions, which included a broken ceiling at 200 feet and surface visibility of 5 statute miles. Neither flight crewmember conducted a briefing as the approach was initiated.³ Cockpit voice recorder (CVR) information indicated that, about 0753:47, when the airplane was on the final approach course, the captain stated, "I got a compass

¹ All times are central standard time, based on a 24-hour clock.

² For more information, see Brief of Accident FTW98MA096 (enclosed).

³ According to Federal Aviation Administration (FAA) Order 8400.10, "Air Transportation Operations Inspectors Handbook," volume 4, chapter 2, an approach briefing is a verbal review of the approach procedure to be flown, including the field elevation, minimum safe altitude, type of approach, final approach course, minimum descent altitude or decision height, controlling minimums, and missed approach procedure.

flag.” Immediately after the captain’s comment, the airplane departed the localizer centerline to the left, establishing a track about 25° left of the final approach course. The airplane’s track continued to diverge from the localizer centerline until, about 1 minute later, the local controller said, “Lear ah, seven Whiskey Sierra uh, say heading.” The first officer stated, “uh, we need to go missed.... We’re going missed approach.” The flight was then assigned a heading and an altitude to fly and switched from local control back to approach control.

About 0756:30, a Houston approach controller asked the flight crew, “do you have a problem with the aircraft?” The first officer replied, “just the compass. We’re working on it.” The ensuing discussion between the two crewmembers, as recorded by the CVR, indicated that the captain’s course deviation indicator (CDI)⁴ was no longer providing a reliable indication of the airplane’s magnetic (or compass) heading. The discussion further indicated that the captain’s radio magnetic indicator (RMI),⁵ located directly to the left of the CDI on the captain’s instrument panel, was functioning properly.

According to the CVR, the CDI problem remained unresolved despite a few minutes of discussion between the captain and the first officer. During that time, both crewmembers attempted to locate and reset the circuit breaker associated with the CDI. About 0759:10, the captain said, “well let’s go back to Hobby, we can’t, we can’t do a trip like this,” but then said, “well now let’s think about this a second.” The first officer then asked the captain about the weather conditions in North Dakota. The captain replied that the weather was “severe clear” and said, “uh, let’s go on and try Intercontinental again.” The first officer requested another approach to IAH. However, the crewmembers did not discuss how to fly the approach with the unresolved CDI problem, and neither crewmember conducted an approach briefing.

Houston approach control began vectoring the flight for a second ILS approach to runway 26, and the controller transmitted the IAH ATIS weather conditions, which included a broken ceiling at 200 feet, an overcast layer at 600 feet, and a runway visual range of more than 6,000 feet. The flight was cleared to land about 0807:53, when the airplane was just outside of the outer marker. About 10 seconds later, the first officer said to the captain, “OK, you are cleared to land. Apparently, it the glideslope (isn’t) working. I can’t watch it....” After that time, the CVR recorded no further discussion by the flight crew about a glideslope indication problem.

Radar and CVR data indicated that the captain was having difficulty tracking the localizer course as the airplane proceeded past the outer marker. Approximately 0.6 nm inside the outer marker, the airplane traveled momentarily outside the left edge of the localizer course. At that point, the first officer said, “...quit turning, quit turning. We’re gonna go through it. Follow mine right here.” About 18 seconds later, the first officer said, “...OK, ease your wings back. To

⁴ A CDI is a primary cockpit instrument that displays magnetic heading and provides a pictorial presentation of aircraft displacement relative to VOR radials, localizers, and glideslope beams. It is also referred to as a horizontal situation indicator.

⁵ An RMI is a navigation instrument that displays magnetic heading and magnetic bearing to radio navigation aids.

the right, to the right, to the right....” The captain then stated, “all right. Can you fly it?” The first officer replied, “yeah, I think so.”

Although the first officer noted a problem with her glideslope indication earlier in the approach, the flight crew’s statements after the transfer of control indicated that both pilots were using the glideslope indication on the first officer’s instruments to determine the airplane’s position. About 0809:08, immediately after the first officer became the flying pilot, the captain asked, “where’s your glideslope?” The first officer replied, “right here,” and the captain then said, “look at it.” About 0809:21, the first officer stated, “...we are way above glideslope,” and the captain responded, “right. Ease it on down.” Radar data indicated that the airplane was between 200 to 300 feet below the glideslope at that point.

About 0809:30, the first officer asked, “all right, where’s the missed approach point...?” The captain answered, “two hundred feet.” The first officer’s query about the “missed approach point” for this ILS approach was apparently referring to the published decision height (DH)⁶ of 200 feet above field elevation or, as indicated on the captain’s and first officer’s altimeters, 296 feet above mean sea level (msl). About 0809:45, the first officer said, “OK. three hundred feet to missed. OK, I’m breaking out.” Radar data indicated, however, that the airplane was actually about 200 feet above DH at that time. The airplane continued to descend until it struck trees about 9 seconds later at approximately 180 feet msl (more than 100 feet below DH) and impacted the ground at approximately 100 feet msl.

The accident investigation disclosed that both flight crewmembers were properly certified according to the Federal Aviation Regulations. The captain held an airline transport pilot certificate and was type rated in the Learjet. According to the captain’s pilot logbook, he had accumulated 8,777 hours total flight time, including 2,512 hours in the Learjet and 623 hours of instrument time. Three months before the accident, the captain successfully completed a Learjet recurrent simulator training course that included 12 hours of ground school and 9 hours of flight simulator time.

The first officer held a commercial pilot certificate and a flight instructor certificate with single-engine land, multiengine land, and instrument airplane ratings. According to the first officer’s pilot logbook, she had accumulated 2,237 hours total flight time, including 350 hours in the Learjet and 343 hours of instrument time. Nine months before the accident, the first officer successfully completed a Learjet simulator training course that included 14 hours of ground school and 18 hours of flight simulator time.

At the time of the accident, neither the captain nor the first officer had full-time employment; they were working as contract pilots for various 14 CFR Part 135 on-demand air carriers. National Transportation Safety Board investigators found that, in the year preceding the accident, the captain had satisfactorily completed the training and checking requirements to act as pilot-in-command of a Learjet for at least three on-demand air carriers, one of which was

⁶ On an ILS approach, a DH defines the altitude at which a decision must be made either to continue the approach or execute a missed approach.

American Corporate Aviation. Safety Board investigators also found that, in the year preceding the accident, the first officer had satisfactorily completed the training and checking requirements to act as second-in-command of a Learjet for at least three on-demand air carriers, one of which was American Corporate Aviation.

Postaccident evaluation of the first officer's Collins VIR-30A navigation receiver⁷ revealed that the amplifier that controls the glideslope deviation output had failed. This failure resulted in the glideslope pointers on the first officer's CDI and horizon and director indicator (HDI)⁸ giving a false maximum fly-down indication regardless of the airplane's position relative to the glideslope. Examination of maintenance records indicated that the glideslope deficiency was discovered 2 months before the accident by another flight crew. An FAA repair station attempted to resolve the problem and misdiagnosed it as "sticking" pointers in the first officer's instruments. American Corporate Aviation was immediately advised of the problem, but a repair, which was required within 10 days,⁹ was not accomplished.

Because the investigation revealed no evidence of any problems with the captain's glideslope receiver, the captain's CDI and HDI glideslope pointers were likely giving a proper fly-up indication. However, the flight crewmembers failed to crosscheck their glideslope indications, which might have alerted them to the airplane's increasing deviation below the glideslope.

The ILS approach crew coordination procedure described in American Corporate Aviation's Training Manual included specific duties for the captain and the first officer. The captain's duties were to set the navigation radios to the proper frequencies and bearings and give the first officer the final approach briefing. The first officer's duties were to review the approach (after the captain gave the final approach briefing) and make the following callouts: glideslope intercept, 1,000 feet to go to DH, 500 feet to go to DH (and every 100 feet thereafter until reaching the DH), DH, and runway in sight. (The Safety Board notes that this procedure always assumes that the captain is the flying pilot.) The flight crew failed to follow the crew coordination procedure on both approaches. The Safety Board considers it likely that, if the procedure had been followed, the flight crew would have been aware throughout the approach of the airplane's position relative to the published DH and might have taken action to arrest the airplane's descent at DH until visual contact with the runway environment was established.

⁷ The airplane was equipped with two Collins VIR-30A navigation receivers, one each for the captain and first officer positions.

⁸ An HDI is a primary cockpit instrument that displays aircraft attitude, localizer, and glideslope beam information; speed command deviation; and computed pitch and roll steering commands. It is also referred to as an attitude director indicator.

⁹ American Corporate Aviation's Minimum Equipment List (MEL) applicable to N627WS indicated that the ILS navigation systems were Category C repair interval items, which require repair within 10 days. Title 14 CFR Section 135.179 prohibits taking off with inoperable instruments or equipment installed unless the aircraft is operated under all applicable conditions and limitations contained in the aircraft's MEL. Title 14 CFR Section 91.213 requires that an MEL issued for an aircraft operated under Part 135 shall be used for operations conducted with that aircraft under Part 91.

The Safety Board determined that the probable cause of this accident was the flight crew's continued descent of the airplane below the glideslope and through the published DH without visual contact with the runway environment. Also, the Board determined that, when the captain encountered difficulty tracking the localizer course, his improper decision to continue the approach by transferring control to the first officer instead of executing a missed approach contributed to the cause. In addition, the following were factors to the accident: (1) American Corporate Aviation's failure to provide an airworthy airplane to the flight crew following maintenance, resulting in a false glideslope indication to the first officer; (2) the flight crew's failure to follow company crew coordination procedures, which called for an approach briefing and altitude callouts; and (3) the lack of an FAA requirement for a ground proximity warning system (GPWS) on the airplane.¹⁰

Importance of Adherence to Standard Operating Procedures

The Safety Board has recognized the failure of flight crews to follow standard operating procedures as a significant causal factor in accidents. For example, in a 1994 study of 14 CFR Part 121 air carrier accidents involving flight crew errors, the Safety Board identified procedural errors, including the failure to make required callouts and conduct required briefings, in 29 of the 37 accidents (78 percent) reviewed.¹¹ In addition, as a result of its investigation of the accident involving USAir flight 1016, a DC-9-31 that crashed into terrain during a missed approach at Charlotte, North Carolina, on July 2, 1994, the Safety Board issued Safety Recommendation A-95-46, which asked the FAA to

Require that principal operations inspectors (POIs) ensure their respective air carrier(s) adhere to the company's operating procedures and emphasize rigorous compliance to checklist procedures.

On August 11, 1995, the FAA issued Flight Standards Information Bulletin (FSIB) 95-20, which directed POIs to reemphasize to their air carrier(s) the need for adherence to company operating procedures. Because this FSIB met the intent of Safety Recommendation A-95-46, it was classified "Closed—Acceptable Action." The action recommended in FSIB 95-20 appears to be appropriate for American Corporate Aviation. Further, the Safety Board believes that the FAA should issue an FSIB to POIs assigned to 14 CFR Part 135 on-demand air carriers, informing them of the circumstances of this accident and urging them to discuss the accident with their air carriers and encourage the use of the accident as a pilot training case study, to stress the importance of pilots' adherence to standard operating procedures.

¹⁰ A GPWS is designed to issue visual and aural warnings to the flight crew when proximity to terrain, closure rate, descent rate, bank angle, and glideslope deviation become excessive (based on internal ground proximity logic coupled with an airplane's configuration).

¹¹ See National Transportation Safety Board. 1994. *A Review of Flightcrew-Involved Major Accidents of U.S. Air Carriers, 1978 Through 1990*. Safety Study NTSB/SS-94-01. Washington, DC.

Ground Proximity Warning Systems

N627WS was not equipped with a GPWS and was not required to be so equipped.¹² According to data supplied by a U.S. manufacturer of GPWS equipment, the flight profile of the accident airplane indicated that, if the airplane had been equipped with a GPWS, a mode 5, Descent Below Glideslope, aural warning would have sounded approximately 40 seconds before initial impact at an altitude of 1,100 feet msl. Two additional aural mode 5 warnings would have sounded about 34 and 14 seconds before impact. Further, a mode 1, Excessive Sink Rate, aural warning would have sounded about 11 seconds before impact at an altitude of 600 feet msl. The aural mode 1 warning would have continued to the end of the flight. With the assumption that the glideslope input to the GPWS was functioning, the warnings would have provided adequate time to allow the flight crew to take appropriate action to avoid impact with the terrain.

The Safety Board has previously addressed the issue of a GPWS on turbojet-powered airplanes. On December 11, 1991, a Bruno's, Inc., Beechjet 400, operating under 14 CFR Part 91, impacted mountainous terrain approximately 3 minutes after takeoff from Richard B. Russell Airport near Rome, Georgia. The two flight crewmembers and all seven passengers were killed. The airplane was not equipped with a GPWS and was not required by the Federal Aviation Regulations to be so equipped. The Safety Board concluded that, if a GPWS had been installed on the airplane, a warning would have sounded about 12 seconds before impact and would have most likely provided sufficient time for the pilots to take action to avoid flying into terrain. As a result of the accident, the Board issued Safety Recommendation A-92-55, which asked the FAA to

Require all turbojet-powered airplanes that have six or more passenger seats to be equipped with a GPWS.

The FAA, however, did not agree with this recommendation. In an October 13, 1992, letter to the Safety Board, the FAA stated that, in making the determination not to require a GPWS on all turbojet-powered airplanes with six or more passenger seats, it considered, "among other factors, the operating environment most prevalent for turbojet-powered airplanes, the extent of radar service in the air traffic control system, and the employment of the minimum safe altitude warning system." On January 6, 1993, the Board classified Safety Recommendation A-92-55 "Closed—Unacceptable Action."

On June 18, 1994, a Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, operating under 14 CFR Part 129, crashed 0.8 nm south of the threshold of runway 1R at Dulles International Airport, Chantilly, Virginia, during an ILS approach in instrument meteorological conditions. The 2 flight crewmembers and all 10 passengers were killed. The airplane was not equipped with a GPWS and was not required by the Federal Aviation Regulations to be so

¹² Currently, a GPWS is required equipment for turbine-powered airplanes with 10 or more passenger seats operated under 14 CFR Part 135 and for all turbine-powered airplanes operated under 14 CFR Part 121. N627WS (which would have been operated under 14 CFR Part 135 for a charter flight from IAH to Fargo) was equipped with eight passenger seats.

equipped. The Safety Board concluded that, if a GPWS had been installed on the airplane, a mode 5 (Descent Below Glideslope) aural warning would have sounded about 64 seconds before initial impact and would have continued to the end of the flight. As a result of this accident, the Safety Board issued Safety Recommendation A-95-35, which asked the FAA to

Require within 2 years that all turbojet-powered airplanes equipped with six or more passenger seats have an operating GPWS.

Further, on December 20, 1995, American Airlines flight 965, a Boeing 757, was on a regularly scheduled 14 CFR Part 121 flight from Miami, Florida, to Cali, Colombia, when it struck trees and crashed into the side of a mountain near Buga, Colombia, in night visual meteorological conditions. Of the 8 crewmembers and 156 passengers aboard the airplane, all but 4 were killed. The airplane was equipped with a GPWS, as required. Approximately 12 seconds before impact, the GPWS began issuing aural warnings of "TERRAIN" and "PULL UP." However, the GPWS did not provide the warning in time for the flight crew to successfully avoid impacting the mountainous terrain.

The frequency of controlled flight into terrain (CFIT) accidents could be reduced by employing recent technological advances, such as enhanced GPWS, which allows the presentation of terrain information on flight management system-generated displays and weather radar displays by using a digital terrain elevation database and an airplane three-dimensional position. Also, enhanced GPWS provides a terrain warning that is independent of the airplane's glideslope receiver. Because the enhanced GPWS may considerably reduce the potential for CFIT accidents by providing pilots with an earlier warning of terrain than GPWS and a visual display of the threatening terrain, the Safety Board issued Safety Recommendation A-96-101, which asked the FAA to

Examine the effectiveness of the enhanced GPWS and, if found effective, require all transport-category aircraft to be equipped with an enhanced GPWS that provides pilots with an early warning of terrain.

In 1996, the FAA commissioned the Department of Transportation's (DOT) Volpe National Transportation Systems Center to conduct a study examining the effectiveness of GPWS and enhanced GPWS in preventing CFIT accidents in 14 CFR Part 91 operations. The center studied 44 CFIT accidents that occurred between 1985 and 1994 and involved airplanes operating under 14 CFR Part 91 with 6 to 10 passenger seats. Of the 44 airplanes, 11 were turbojets and 33 were turboprops, and none of the airplanes had GPWS installed. The center used computer modeling techniques to conclude that (1) GPWS could have prevented 33 of the 44 accidents (75 percent) and 96 fatalities and (2) enhanced GPWS could have prevented 42 of the 44 accidents (95 percent) and 126 fatalities.¹³

On August 26, 1998, the FAA issued a Notice of Proposed Rulemaking (NPRM) that proposed to prohibit the operation of any turbine-powered airplane with six or more passenger

¹³ "Investigation of Controlled Flight Into Terrain," DOT-TSC-FA6D1-96-01, March 1996.

seats unless that airplane was equipped with an FAA-approved terrain awareness and warning system (TAWS).¹⁴ The NPRM also proposed that airplanes manufactured 1 year after the effective date of the final rule be equipped with TAWS and that the equipment be installed on all other airplanes within 4 years of the final rule's effective date. In a December 24, 1998, letter to the FAA, the Safety Board indicated that the NPRM was responsive to the intent of Safety Recommendations A-95-35 and A-96-101. The Board stated that the NPRM, if promulgated, would have a positive effect on aviation safety by reducing the possibility for CFIT accidents.

The circumstances of this accident, the TAESA Learjet accident, and the Bruno's Beechjet accident clearly indicate the potential to reduce CFIT accidents by requiring the installation of a GPWS in turbojet-powered airplanes equipped with six or more passenger seats. The Cali accident indicates that enhanced GPWS would likely reduce the number of CFIT accidents even more. Further, the 1996 FAA/DOT study of 44 CFIT accidents provides compelling evidence that Safety Recommendation A-95-35 should be broadened to include turboprop-powered airplanes and require the installation of enhanced GPWS. As a result, the Safety Board classifies Safety Recommendation A-95-35 "Closed—Acceptable Action/Superseded." Until enhanced GPWS (or TAWS) is installed on all turbine-powered airplanes with six or more passenger seats, similar accidents might occur. Although the Safety Board's December 1998 letter to the FAA supported the NPRM on TAWS as proposed, the Safety Board now concludes that the 4-year installation time frame should be shortened for airplanes that currently lack any GPWS protection. Therefore, the Safety Board believes that the FAA should require, within 3 years, that all turbine-powered airplanes with six or more passenger seats that are not currently required to be equipped with a GPWS have an operating enhanced GPWS (or TAWS).

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue a Flight Standards Information Bulletin to principal operations inspectors assigned to 14 Code of Federal Regulations Part 135 on-demand air carriers, informing them of the circumstances of this accident and urging them to discuss the accident with their air carriers and encourage the use of the accident as a pilot training case study, to stress the importance of pilots' adherence to standard operating procedures. (A-99-35)

Require, within 3 years, that all turbine-powered airplanes with six or more passenger seats that are not currently required to be equipped with a ground proximity warning system (GPWS) have an operating enhanced GPWS (or terrain awareness and warning system). (A-99-36)

¹⁴ In the NPRM, the FAA uses the term "TAWS" when referring to enhanced GPWS because the FAA expects that a variety of systems may be developed to meet the improved standards proposed in the NPRM.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

Enclosure