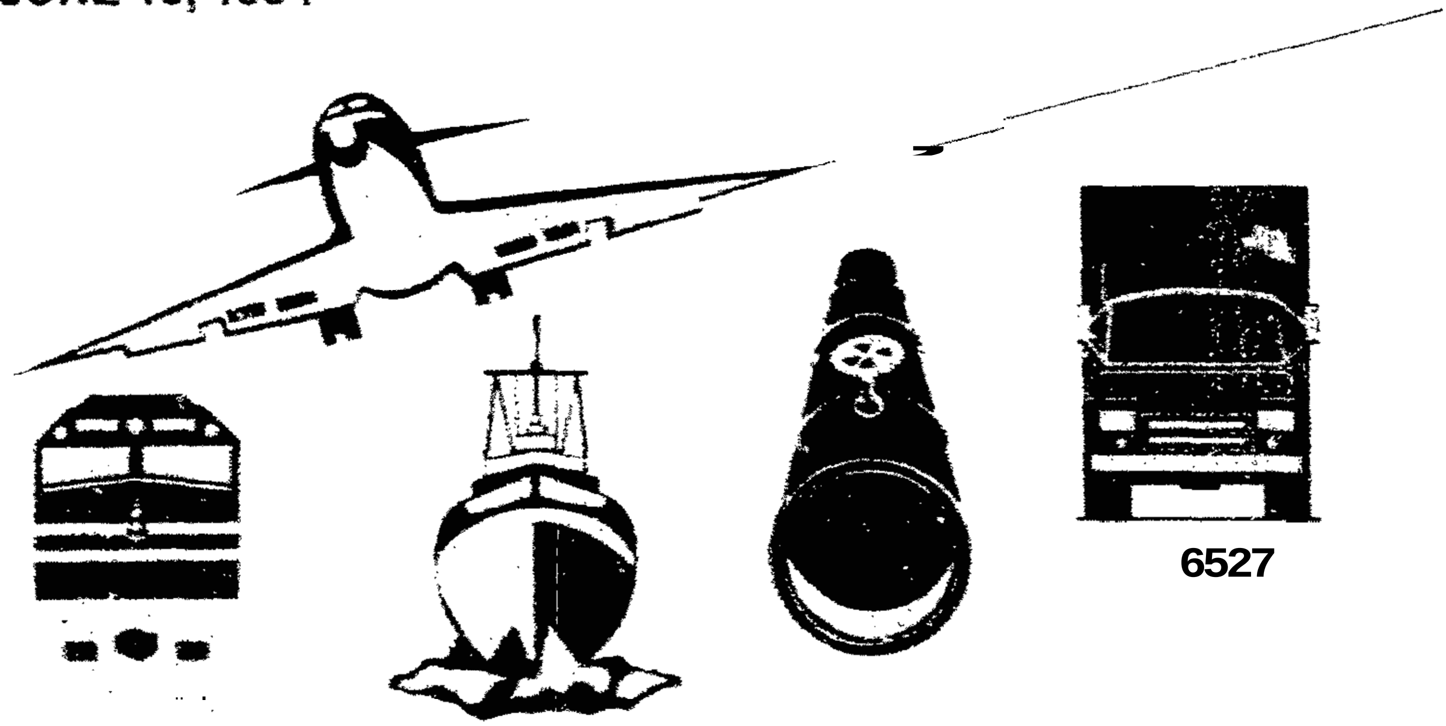
PB95-910402
NTSB/AAR-95/02

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

CONTROLLED COLLISION WITH TERRAIN
TRANSPORTES AEREOS EJECUTIVOS, S.A. (TAESA)
LEARJET 25D, XA-BBA
DULLES INTERNATIONAL AIRPORT
CHANTILLY, VIRGINIA
JUNE 18, 1994



6527

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CONTROLLED COLLISION WITH TERRAIN
TRANSPORTES AEREOS EJECUTIVOS, S.A. (TAESA)
LEARJET 250, XA-BBA
DULLES INTERNATIONAL AIRPORT
CHANTILLY, VIRGINIA
JUNE 18, 1994

Adopted: March 7, 1995
Notation 6527

Abstract: This report explains the accident involving the TAESA Learjet 25D that crashed near the threshold of runway 1R at Dulles International Airport, Chantilly, Virginia, on June 18, 1994. Safety issues in the report focused on weather at the airport, flightcrew training, qualifications, and performance, flightcrew fatigue, operations specifications, passenger seating, and the ground proximity warning system. Safety recommendations concerning some of these issues were made to the Federal Aviation Administration.

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EXECUTIVE SUMMARY

On June 18, 1994, about 0625, a Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA, crashed 0.8 nautical miles south of the threshold of runway 1R at Dulles International Airport, Chantilly, Virginia, during an instrument landing system approach in instrument meteorological conditions. All 10 passengers and both crewmembers aboard were killed. The airplane was destroyed by impact, and there was no fire.

The National Transportation Safety Board determines that the probable causes of the accident were the poor decisionmaking, poor airmanship, and relative inexperience of the captain in initiating and continuing an unstabilized instrument approach that led to a descent below the authorized altitude without visual contact with the runway environment. Contributing to the cause of the accident was the lack of a ground proximity warning system on the airplane.

Safety issues discussed in the report include weather at Dulles International Airport, flightcrew training, qualifications and performance, flightcrew fatigue, TAESA's operations specifications, passenger seating, and the ground proximity warning system. Safety recommendations concerning some of these issues were made to the Federal Aviation Administration. Also, as a result of the investigation of this accident, on November 21, 1994, the Safety Board issued safety recommendations to the Federal Aviation Administration concerning the minimum safe altitude warning system and the low level windshear alert system.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

CONTROLLED COLLISION WITH TERRAIN TRANSPORTES AEREOS EJECUTIVOS, S. A. (TAESA) LEARJET 25D, XA-BBA DULLES INTERNATIONAL AIRPORT CHANTILLY, VIRGINIA JUNE 18, 1994

1. FACTUAL INFORMATION

1.1 History of Flight

On June 18, 1994, about 0625,[1] a Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA, crashed 0.8 nautical miles (nmi) south of the threshold of runway 1R at Dulles International Airport (IAD), Chantilly, Virginia, during an instrument landing system (ILS) approach in instrument meteorological conditions. All 10 passengers and both crewmembers aboard were killed. The airplane was destroyed by impact, and there was no fire.

The flight originated in Mexico City, Mexico (MEX), as a commercial charter to IAD, with a planned refueling stop at Lakefront Airport (NEW), New Orleans, Louisiana. The passengers were planning to attend the World Cup soccer game between Mexico and Norway, scheduled to be played in Washington, D.C.

The flight was operating under Title 14 Code of Federal Regulations (CFR), Part 129, which regulates the operation of foreign air carriers within the United States. Part 129 requires that operations specifications be issued for the carrier. TAESA's operations specifications indicate that this type of flight operates in the United States in accordance with applicable parts of Title 14 CFR Part 91. (See section 1.17.7 for additional details).

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[1]All times herein are eastern daylight time (edt), in accordance with the 24-hour clock. Mexico City local time is 2 hours earlier than edt.

According to company information, the crew reported for duty on June 17, 1994, at 2200, and taxied from the ramp at 2300. The flight departed at 2315, and landed uneventfully at NEW at 0125 June 18, 1994. The weather on arrival at NEW was 1,600 feet scattered, 25,000 feet thin broken, and visibility was 10 miles. There was a delay in clearing U.S. Customs because the Customs agent was waiting to meet the airplane at New Orleans International Airport (Moisant Field). The agent arrived at NEW around 0230, and the flight cleared U.S. Customs about 0300.

The airplane then taxied to a fixed-base operator for servicing. The first officer assisted the ramp agent by refueling the right wing of the airplane. The captain called the TAESA flight following department and stated that he was in contact with the flight service station (FSS) regarding weather. He advised the company not to send any weather data (see section 1.7, Meteorological Information, for the weather forecast and existing weather conditions). No maintenance was requested or performed. The airplane departed the ramp at 0344, and was airborne at 0347. Both the customs agent and the refueler described the crew as alert and helpful. The destination was IAD, and the filed alternate was Baltimore-Washington International Airport (BWI).

The crew operated at flight level (FL) 410 en route to IAD, and contacted the Washington Air Route Traffic Control Center (ARTCC) about 0525. The controller issued holding instructions to the flight because of a Mooney airplane inbound from Leesburg, Virginia, that had declared an emergency. Approximately 0548, the first officer[2] reported entering the holding pattern, and within 4 1/2 minutes, the center controller cleared the crew direct to ARMEL[3] at 11,000 feet. The flight was switched to Dulles Approach Control at 0554, and the radar controller advised, "...altimeter three zero one two expect the ILS runway one right approach." During the next several minutes, the flight was given additional descent clearance to 6,000 feet, and a vector for sequencing. Also, at this time, the IAD automated terminal information service (ATIS) was changed, in part, as follows:

[2]Company personnel identified the voice on all transmissions from the flight as the first officer.

[3]ARMEL is the very high frequency omnidirectional range/tactical air navigation (VORTAC) located at IAD.

0553:23...information Charlie (0534 special) weather indefinite ceiling seven hundred sky obscured visibility one half fog temperature seven zero dew point seven zero wind calm....

0558:45...information Delta (0550 record) weather indefinite ceiling six hundred sky obscured visibility one half fog temperature seven one dew point seven one wind one four zero at four....

At 0601, the radar controller transmitted, "United one zero two and uh remaining aircraft on frequency the new Dulles weather is uh...sky...indefinite ceiling six hundred sky obscured visibility one half fog temperature seven one dewpoint seven one wind calm altimeter three zero one two...." After UAL 102 acknowledged the weather, he further advised, "...runway one right RVR [runway visual range] touchdown one thousand two hundred midpoint one thousand six hundred and rollout is more than six thousand." UAL 102 inquired if Category II[4] approaches were in operation. While this was being researched, the radar controller confirmed that XA-BBA had also received the weather. He then confirmed that, "...cat three [Category III] operation is now in effect for runway one right."

XA-BBA received further descent clearance and vectors, and was cleared for the approach before switching to the tower frequency at 0608. At 0612, the local controller advised, "United one eighty six heavy Dulles tower runway one right cleared to land wind calm the uh RVR touchdown six hundred midpoint eight hundred and rollout three thousand." Several seconds later, he asked, "Lear Bravo Bravo Alpha are you uh on the missed approach sir?" XA-BBA confirmed that they were, and they were switched from the local control frequency back to approach control. The radar controller inquired about their intentions, and the first officer replied, "(Unintelligible) vectors for another attem attempt for ILS." They were given appropriate vectors, and seconds later, UAL 186 also reported a missed approach on the same frequency.

At 0614, the radar controller advised, "American seventy four heavy thee (sic) runway one right touchdown RVR six hundred mid point one thousand

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[4]Category II and III operations refer to the straight-in ILS approaches to reduced minima under special rules of certification for the crews, runways, and equipment. Advisory Circular 97-1A Runway Visual Range (RVR) states in paragraph 6a that touchdown zone RVR is controlling for minima in both Category I and II approaches. For Category III approaches, when touchdown and midfield RVR's are available, both RVR's are controlling and the rollout RVR is advisory.

rollout three thousand contact tower...." He then asked, "Lear Bravo Bravo Alpha verify heading of one six zero." They responded, "Ah---one seven zero Bravo Bravo Alpha." The controller was busy coordinating other traffic (an overflight and a departure) and then inquired, "United one eighty six heavy...say your next request." The crew advised that they were checking weather and might divert to Pittsburgh. The radar controller asked the local controller in the tower if he could see the end of runway 19, and he responded "Just barely." Seconds later AA 74 reported clearing the runway.

About 0618, the radar controller asked UAL 186, "...would you like to try ILS runway one nine left approach the uh touchdown on that portion of the runway is three thousand the tower does advise they barely can see the approach end of the runway." UAL 186 responded, "Yeah thee (sic) uh north end of the field was uh looked pretty fine I mean we could see it as we...made the missed and it's definitely better but uh and we're getting a little close on uh our fuel here to divert we'll get right back to you in a minute." He subsequently handled a departure, and cleared UAL 186 to Martinsburg, West Virginia. At 0619:40, he cleared XA-BBA to descend to 2,000 feet and to turn to a heading of 260°. At 0620:46, he transmitted, "Lear Bravo Bravo Alpha seven miles from TILLE [outer marker] turn right heading three five zero maintain at or above two thousand until established on the localizer cleared ILS runway one right approach." The radar controller confirmed that XA-BBA was established on the ILS, and advised, at 0623, "Lear Bravo Bravo Alpha roger runway one right touchdown six hundred midpoint six hundred rollout four thousand wind calm contact tower...."

On initial contact for the second approach attempt, the local controller advised, "Lear X-ray Alpha Bravo Bravo Alpha Dulles tower runway one right cleared to land wind calm RVR six hundred rollout four thousand." XA-BBA acknowledged the transmission. At 0625, an unintelligible transmission, believed to be from the crew of XA-BBA, was recorded on the local control frequency.

About 0625, a motorist who was driving on State Route 28, which is generally parallel to the approach path to runway 1R, observed an airplane through the fog. He reported that the engines were mounted on the tail, the landing gear was down, and that the color of the airplane was blue and either gray or white. The windows of his automobile were down, but he did not hear any noise from the airplane. The airplane's attitude was nose low, and the airplane appeared to be flying at a lower altitude than other airplanes he had seen flying toward the runway. He described the driving conditions as clear until he was north of U.S. Route 50.

The fog restricted visibility from 200 to 300 yards. After the airplane had passed him, he reported that the fog became thicker, and that he almost entered the intersection before he saw the traffic signal at Gate 4. (See appendix C). The visibility improved as he passed the airport fuel farm (about the midpoint of the runway). He remarked that it was easier to see vertically than horizontally in the fog.

The captain of UAL 186 stated that they had been holding in the IAD area for 20 to 25 minutes because another airplane had experienced a problem. They were in the clear at 3,000 feet, and the ground fog was patchy. It thickened like low stratus clouds near the airport. As they descended on the approach, there was no clearly defined top to the cloud layer, but the surrounding tops varied between 1,500 and 1,000 feet. UAL 186 entered the fog layer at 500 feet and descended to 100 feet, and the crew saw nothing. During climbout on the missed approach, they saw lights and buildings at the north end of the airport.

The TAESA Learjet crashed in daylight hours, at 38" 54' 38.01' north latitude, and 77° 26' 0.03" west longitude, approximately 0.8 nmi south of the threshold of runway 1R. Initially it struck trees at approximately 1,100 feet on a bearing of 205° magnetic from the initial ground contact The bases of the trees were at 318 feet mean sea level (msl) and were broken from 41 feet to 51 feet above ?he ground. The elevation at the crash site was 320 feet msl. Official sunrise at IAD was 0544.

1.2 Injuries to Persons

Injuries	Flightcrew	Cabincrew	Passengers	Other	Total
Fatal	2	0	10	0	12
serious	0	0	0	0	0
Minor	0	0	0	0	0
None	0	0	0	0	0
Total	2	0	10	0	12

1.3 Damage to Aircraft

The airplane was destroyed by impact with the trees and ground. The airplane was insured for $1,500,000 dollars.

1.4 Other Damage

The impact area was within the confines of the airport property. At breakpoint, the tree trunks at the initial impact ranged from 3 to 6 inches in diameter; and the breakpoints of the trees at the crash site ranged from 3 to 10 inches in diameter. There was no property damage other than to the trees.

1.5 Personnel Information

1.5.1 Pilot in Command

The captain, age 27, was hired by TAESA on October 16, 1992. He held a Mexican pilot certificate, No. T.P.I. 130-MEX-3878, with ratings for Captain in Learjets 20s and 30s. The pilot certificate was revalidated on May 4, 1994. His most recent first-class medical certificate was issued on January 24, 1994, with no limitations. According to company records, he had accumulated 1,706 total flying hours, of which 1,314 hours were in the Learjet. He had approximately 87 hours as a pilot-in-command (PIC) in the Learjet.

The captain received upgrade training with another TAESA candidate for captain at Flight Safety International (FSI), Tucson, Arizona, from April 4 through 7, 1994. FSI conducted Learjet training under contract for TAESA. The upgrade training included 14 hours of ground school and 12 hours of flight simulator (6 hours of PIC for each applicant) as described in the FSI syllabus. The simulator instructor for the captain during his upgrade training described him as focused, with reasonably good motivation, and a quick learner. As a pilot, he had smooth airplane control and was polished as a first officer. He was a pleasant person, very consewative and correct. He was not a joker, and he was rather serious. He was fairly gracious in his response to criticism. He seemed like he might have been relieved when the training was over; it was a humbling experience. Captain upgrade candidates normally have 4,000-5,000 flight hours. With candidates from Latin countries it is not unusual to have 2,300 hours, but this captain was at the low end of experience.

The instructor's notes on the four simulator rides were as follows:

April 4, 1994 - Instrument scan defective and flight director usage poor. Briefed on correct scan techniques and (flight director operations). Crew coord. poor.

April 5, 1994 - (Flight director) usage improving. Instrument scan improving. Crew coord. marginal.

April 6, 1994 - V_1 cut outside limits. Veered 45° off heading and insufficient pitch for V_2 climb. Pilot received many pacing hints from first officer and m the presence of these hints, (cross-country) flight went quite well.

Aprii 7, 1994 - Pilot needs more CRM training to be competent as P.I.C. Below FSI (standards) for P.I.C. Additional training offered and declined.

The instructor stated that the captain had problems prioritizing the workload and directing the first officer. He did fairly well under basic control, but with an engine out, there was enough distraction for him to lose control. He left the pavement on every rejected takeoff on April 7. Although he flew non-precision approaches well, and the 2-engine ILS on day 2 was n o d , his instrument approaches definitely did not meet ATP standards.

The instructor reported that the captain was offered additional training (two periods without additional charge or approval from TAESA). Although he was interested in the extra Wining, he believed that the company needed him back to fly the line. He completed the training below the PIC level.

Following completion of the upgrade training at FSI, the Mexican Director General of Civil Aviation (DGAC) required the captain to perform as PIC in the airplane for 10 hours with an instructor pilot. Upon completing this flight time, he was given a written test and a flight check. After successfully completing both the written test and the flight check, he was issued a temporary license with the type rating on April 14, 1994. The captain's permanent license was issued on May 4, 1994.

The TAESA Executive Director of Operations stated that he had requested confidential reports of evaluations that were made for both pilots during their training at FSI, but that the only documentation received was the Pilot Record of Training,[5] which was hand delivered by the accident captain. The Director of Operations again requested written confidential evaluations, including instructor notes. FSI advised that the simulator instructor notes were €or internal use, but that they did provide a confidential written evaluation of each pilot. The letter transmitting the evaluations was dated April 18, 1994. The evaluations of the accident captain commented, in part, as follows:

> During (his) simulator training, he demonstrated satisfactory flying skills when flying the aircraft under normal conditions. He requires emphasis in crew management and decision making skills during his training to upgrade to Captain. (He) needs to improve his airmanship and command skills, especially when operating under the stress of abnormal and emergency situations.
>
> (His) most notable strength is his ability to smoothly fly the aircraft under normal operations. He displayed excellent qualities when acting in the capacity of First Officer. (He) can be considered for upgrade to Pilot-in-Command. During upgrade training, situational awareness under high workload conditions should be emphasized. He should fly with a strong training Captain or F i t Officer during his upgrade.

The confidential evaluation of the other TAESA applicant, who was the accident captain's partner in the upgrade trainiig, stated, in part:

> During (his) simulator training, he demonstrated satisfactory pilot skills when flying the aircraft under normal conditions. He requires additional training in crew resource management and decision making skills prior to considering him as an applicant for upgrade. (He) needs to improve his airmanship and command skills especially when operating under the stress of abnormal and emergency situations.

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[5]This form identifies the applicant, course, and dates of attendance. It also contains the subject matter covered, simulator hours flown, and the ground school test score. There is a space provided for specific certifications, such as PIC Check-12 months, 24 months: and Biennial Flight Review, Instrument Competency Check. The captain's *form* recorded a ground school test score of 96, and the appropriate hours of simulator time, but none of the certifications were filled in.

> As a final comment, (his) most notable strength is his ability to smoothly fly the aircraft under normal operations. Under high workload in emergency conditions, (he) tends to fixate on one item, thus he does not maintain situational awareness. Because of this, we do not think he is ready to upgrade to Pilot-in-Command. He needs to demonstrate the ability to maintain aircraft control and awareness of the flight conditions before his upgrade.

These evaluations of both applicants and the simulator instructor comments on the accident captain were provided by FSI to the Safety Board following the accident.

1.5.2 First Officer

The first officer, age 25, was hired by TAESA February 9, 1994. He held a Mexican commercial pilot certificate No. 10016, with a rating for copilot in Learjet 20's. It was revalidated on October 12, 1993. His most recent first-class medical certificate was issued on October 5, 1993, with the limitation that he use corrective lenses. Company records indicate that at the time of the accident, he had accumulated 852 total flying hours, of which 426 hours were in the Learjet.

The first officer received his initial Learjet training at FSI in Wichita, Kansas, from September 9 through 19, 1991. He received recurrent training at the same facility from May 18 through 21, 1992, and TAESA Learjet training in Mexico City in February 1994. Instructor comments on his May 1992 training forms included:

> 5/18 Good flight. Good crew coordination....
>
> 5/19 Good flight. Needs to improve checklist pacing...crashed because both pilots were busy with checklist and not watching....
>
> 5/20 Very good flight.
>
> 5/21 Good flight. Good (aircraft) control. Well-qualified for SIC.

1.5.3 Flightcrew Activities and Flight/Duty Times

The captain flew a 1-hour trip to San Luis Potosi late on the afternoon of June 14, 1994, and returned to MEX at 0210 on June 15, 1994. He was assigned to the accident trip late on the evening of June 16, 1994. According to his wife, the captain went to sleep about 0030 and awoke at about 0900 on the morning of June 17, 1994. He was observed by various company employees later that day, and his wife reported that he took a nap between 1400 and 1700 on that date. No one observed anything abnormal.

The first officer was off duty on June 14 and 15, but he flew an out and back trip, consisting of 45 minutes each way, on the afternoon of June 16. He was also assigned to the accident trip late on the evening of June 16. He was observed by company personnel on the afternoon of June 17, and he was in good spirits.

The U.S. Customs agent reported that the crew was alert and free from indications of impairment at NEW. The lineman who serviced the airplane at NEW stated that the crew appeared to be getting along well with each other and the passengers.

1.6 Airplane Information

1.6.1 General

XA-BBA, a Learjet 25D, Serial Number (S/N) 223, was manufactured on March 17, 1977, under type certificate A10CE, which was issued in May 1976. It was configured to carry eight passengers and two pilots. At the time of initial delivery, Dee Howard Company Supplemental Type Certificate (STC) SA1670SW thrust reversers were installed. In 1984, a subsequent owner installed the Dee Howard Company STC SA944NW extended range conversion, which included installation of an angle of attack system, a flap preselect system, and a flap/pitch compensator. The airplane was acquired by TAESA on April 15, 1991, with 4,978.5 hours and 4,635 cycles on the airframe. TAESA requested that the registration number be changed to XA-BBA on May 23, 1991. Prior to departure from MEX, the airplane had accumulated 6,118 hours and 5,663 cycles.

The airplane was equipped with two General Electric Model CJ610-6 engines installed as follows:

Position	Serial Number	Total Time	Cycles
1	240MC-007A	6,553.39 hours	5,123
2	240MC-122A	6,760.27 hours	5,480

This airplane was not equipped with a Ground Proximity Warning System (GPWS). The GPWS is designed to issue visual and aural warnings to a flightcrew when proximity to terrain, closure rate, rate of descent, bank angle, and glideslope deviation become excessive.

1.6.2 Airplane Weight and Balance

The airplane weight and balance were calculated for both takeoff at NEW and landing at IAD. The calculation performed by the pilots at NEW did not include the standard crew weight of 340 pounds. Using the corrected data, the airplane was below the allowable ramp weight of 16,800 pounds, and the center of gravity (CG), 381.02 inches (24.85 percent MAC) was also within the allowable limits. However, using a nominal fuel taxi burn of 100 pounds,the aircraft would have exceeded the allowable takeoff weight of 16,300 pounds by 345 pounds.

The calculations for landing at IAD, predicated on a fuel burn of 4,641 pounds (leaving 1,953 pounds, all in the wing tanks) indicate that the landing weight would have been 12,104 pounds. The CG would have been 16.79 percent MAC. Both values are within the limits of 13,700 pounds and a CG range of 8 percent to 27.5 percent.

1.6.3 Maintenance Records Review

TAESA reported that the last major inspection of XA-BBA was the 1200-hour inspection accomplished on April 20, 1994. The last overnight and transit inspections were accomplished on June 16 and June 17, respectively. The current aircraft maintenance logbook, which covered the period from June 5 to the accident, was examined at the crash site and disposed of due to contamination. It contained an entry on June 17 that the right airspeed indicator was 5 knots lower than the left airspeed indicator at slow speed. This item was deferred. The previous maintenance logbook, covering the period from May 3 through June 5, was also examined. The right angle of attack indicator was a deferred item. There were also recurring writeups on the right defogger blower and the weather radar/radome. The records that were available for review indicated that there were no writeups on either of these components after June 5 and 13, respectively.

According to records provided by Learjet, the installed altimeters were P/N 28007-017, S/N 123 on the left side, and P/N 23932-013, S/N 994 on the right side. These were the same altimeters recovered from the wreckage. The TAESA records for the calibration of the altimeters indicate that the left altimeter was P/N 518-16007-163, S/N 457.

1.7 Meteorological Information

The 0500 and 0800 surface analysis charts of the National Weather Service (NWS) depicted a large ridge of high pressure over the northeastern United States. Widespread fog conditions were indicated in the Virginia and Maryland areas. The weather observations at IAD are made by Weather Consultants, Inc., a private firm contracted by the NWS to provide surface observations. They do not issue weather advisories, weather warnings, or forecasts. The pertinent surface observations were as follows:

> 0253--Record--partial obscuration, 600 feet scattered, visibility 2 miles, fog, temperature 68°F, dew point 68°F, wind calm, altimeter setting 30.12 inches of Hg.

> 0550--Record--indefinite ceiling, sky obscured, vertical visibility 600 feet, visibility 1/2 mile, fog, temperature 71°F, dew point 71°F, winds 140° at 4 knots, altimeter setting 30.12 inches of Hg.

> 0635--Local--indefinite ceiling sky obscured, vertical visibility 500 feet, visibility 1/2 mile, fog, temperature 71°F, dew point 71°F, winds calm, altimeter setting 30.14 inches of Hg, Remarks--aircraft mishap.

The official terminal forecasts for both IAD and BWI [Baltimore-Washington International Airport] (the filed alternate) are prepared by the NWS Forecast Office, Sterling, Virginia. The scheduled forecast for IAD issued at 2000 on June 17, and valid after 0300, called for:

> Partial obscuration, ceiling 1,200 feet overcast, visibility 3 miles haze, occasional partial obscuration, visibility 1 1/2 miles fog.

The subsequent scheduled forecast issued at 0400 called for:

> Ceiling 800 feet broken, visibility 1 1/2 miles fog, occasionally ceiling 300 obscured, visibility 1/4 mile fog. 0600 - Ceiling 400 feet overcast, visibility 1 mile fog, occasional ceiling 100 feet obscured, visibility 1/4 mile fog.

The scheduled BWI terminal forecast issued at 2000 on June 17, and pertinent for the indicated times on June 18, was:

> 0300--Partial obscuration, ceiling 1,200 feet overcast, visibility 3 miles fog haze, occasional partial obscuration, ceiling 800 feet overcast, visibility 1 1/2 miles fog.
>
> Amendment 1, issued at 0415--Ceiling 0 feet obscured, visibility 0 mile fog, occasional ceiling 300 obscured, visibility 3/4 mile fog.

1.8 Aids to Navigation

Runway 1R is served by an ILS that is capable of Category III operations. UAL 102 completed a Category III approach at 0610:22, when they reported clearing the runway. AA 74 completed a Category III approach at 0617, and reported clearing the runway. These approaches occurred before and after the first approach by XA-BBA. The ILS was flight checked by the Federal Aviation Administration (FAA), and components were ground checked within hours of the accident. All components were operating within prescribed tolerances. In addition, FAA technicians conducted checks of the airport surveillance radar (ASR)-9, beacon interrogator system, low level windshear alert system (LLWAS), all components of the runway visual range (RVR) system, and the approach lighting system. There were no problems with the operating components/lights of any systems. The postaccident survey of equipment revealed that the approach light system monitor was malfunctioning. The FAA reported that the "ALS Mode Loop 1 Monitor" did not alarm during testing, until one bulb more than the criteria was removed, in both the "caution" and "failure" modes. The "ALS Mode Loop 3 Monitor" alarmed two bulbs earlier than the criteria, in both the "caution" and "failure" modes. This anomaly was in the monitoring phase only, and the problems were corrected.

See section 1.17, Additional Information, for details on minimum safe altitude warning (MSAW).

1.9 Communications

There were no reported communications difficulties or outages at IAD at the time of the accident. The IAD tower recording of communications contained two unintelligible transmissions at 0625:14 and 0625:20, respectively. These were attributed to XA-BBA.

1.10 Aerodrome Information

IAD is located 20 miles west of Washington, D.C., in Chantilly, Virginia. There are three primary runways: 12/30, 1L/19R, and 1R/19L. Runway 1R is the preferred instrument runway. It is 11,500 feet long and 150 feet wide, and has a grooved concrete surface. The runway touchdown zone elevation is 313 feet MSL. It is served by high intensity runway lights, centerline lights, a high intensity approach lighting system with sequenced flashing lights, a Category II configuration, and touchdown zone lighting. (See additional runway information in appendix B).

1.11 Flight Recorders

The airplane did not have either a flight data recorder (FDR) or a cockpit voice recorder (CVR) installed. 14 CFR Part 91.609 (c) requires an FDR on all U. S.-registered, multiengine, turbine-powered aircraft, having 10 passenger seats or more, that were manufactured after October 11, 1991. Because it had only eight passenger seats, XA-BBA would not have required an FDR by U. S. regulations.

The International Standards and Recommended Practices issued by the International Civil Aviation Organization (ICAO), Annex 6, Part I, Chapter 6.3.5.1, requires a 5-parameter FDR for all turbine-powered aircraft with a maximum certificated takeoff weight of 5,700 kilograms (12,566 pounds) or more, with airworthiness certificates issued before January 1, 1987. TAESA was technically required to comply with ICAO Annex 6 standards, which, in this case, are more stringent than the U. S. rules. However, no FDR was installed.

Effective October 11, 1991, 14 CFR 91.609 (e) required a CVR on all U. S.-registered, multiengine, turbine-powered aircraft, having 6 passenger seats or more, that are type certificated for two pilots. The ICAO provisions of Annex 6, Part I, Chapter 6.3.7.2, recommend a CVR for all turbine-powered aircraft, with a maximum certificated takeoff weight of 5,700 kilograms (12,566 pounds) or more, whose prototype was certificated after September 30, 1969.

1.12 Wreckage and Impact Information

1.12.1 Crash Site Details

The initial impact was with relatively tall trees, approximately 1 nmi south of the runway 1R threshold. There were six primary trees, ranging from 3 to 6 inches in diameter and 41 to 51 feet tall at the breaks, located within an approximate 30-foot cluster. A green lens was found about 78 feet from a center reference tree on a magnetic bearing of 25°. The aft cone of the right tip tank was located 102 feet from the same reference tree on a magnetic bearing of 008°. A red lens was found 150 feet from the tree on a magnetic bearing of 358°. The aft cone of the left tip tank was found 234 feet from the tree on a magnetic bearing of 358°. There were several additional indications of minor tree strikes between the initial impact point and the main crash site, including freshly cut wood and paint chips on the ground. However, there were no structural components located between the initial contacts and the crash site.

The ground impact site was approximately 1,100 feet on a magnetic bearing of 25° from the initial tree strike, 0.8 nmi south of the runway 1R threshold. The initial tree strike area was approximately 729 feet east, and the main crash site was approximately 911 feet east of the extended runway centerline.

Examination of the scene around the main wreckage revealed several broken trees and ground scars. One of the ground scars contained the center post and portions of both windshield halves imbedded to a depth of approximately 1 foot. This ground scar was located 36 feet on a magnetic bearing of 60° from a cluster of freshly broken trees, The flightpath angle from the trees to the windshield was approximately 35°. The airplane came to rest upright approximately 44 feet north northeast of the windshield scar. The fuselage separated from the wing section and was resting on top of it, aligned on a heading of about 170°. The right wing tip was generally under the tail section of the fuselage, which Came to rest in a tail-high attitude against several small trees.

1.12.2 Major Structural Components

The nose section of the fuselage (in front of the forward pressure bulkhead) was destroyed, although individual components were identified. The cockpit and passenger compartment (from the forward pressure bulkhead to the baggage compartment) was severely damaged and mangled. The fuselage aft of the baggage compartment sustained only minor damage.

The wing leading edge was crushed/dented predominantly in an aft and up direction. A distinct chordwise indentation (approximately 1 foot deep in the leading edge) was noted on the right wing, about 1 foot outboard of the fuselage attach point. Another indentation was on the left wing, about 4 feet inboard of the wing tip attach point. It was approximately 4 inches deep measured chordwise.

The right wing tip tank section at the wing tip was still attached. The left wing tip tank separated. The left wing tip was severely damaged and deformed upward. The wing and wing tip fuel tanks ruptured, but the fuselage tank was intact. No fuel was found in the fuel tanks, but fuel drained from the fuel lines, located below the wing tanks, and from fuel pump cavities and the engines when the aft fuselage was moved. A strong smell of fuel was present at the crash site.

No preimpact flight control anomalies were found. Examination of the ends of control cables revealed either tension failures or cuts made by the rescue personnel. Pulleys were found with bent and broken sidewalls. Complete control continuity could not be established forward of the wing because of the fuselage destruction.

The right aileron was jammed upward, and the outboard section sustained upward crushing damage. The left aileron was split chordwise about midpanel, and the inboard aileron portion, as well as the trim tab, was damaged in a forward and up direction.

The horizontal stabilizer was trimmed to approximately 6° 15' leading edge down. The rudder trim tab was about 1/2 inch right of center (about 6° of 15° available). The elevator and rudder were supporting the tail of the airplane against tree trunks. The elevator was beyond the upper travel limits, but the travel limit stop bolt was undamaged.

The cockpit spoiler control switch was found in the "extend" position, in a deformed portion of the control panel. Both spoiler actuators and the left spoiler were found retracted. The right spoiler had sheared rivets at the actuator attachment bracket, and was bent upward beyond the upper travel limit.

The left and right landing flaps were extended 39° and 40°, respectively, based on measurements of the actuators. The flap handle was found in the full down (40°) position. The flap indicator needle was about half way between the 10° and the 40° position. The right flap sustained upward crushing. The left flap separated from the actuator, but the outboard flap track was still intact. The landing gear were down and locked.

Both engines remained mounted in their normal positions on the rear fuselage. The inlets of both engines contained remnants of tree branches and leaves. The tips and leading edges of first stage compressor blades in both engines were bent and curled. Coarsely chopped vegetation, similar to sawdust, was packed in the compressor bleed air exit ports of both engines and in the borescope ports in the combustion cases. Both thrust reversers were stowed. There were no ruptures or penetrations of the cases of either engine, and there were no oil or metal fragments in the exhaust ducts.

1.12.3 Cockpit Documentation

The attitude (flight director) indicator was found in the left instrument panel, and the glass face was broken. The horizon display was inverted at an indication of 50° nose down, and the roll display showed the right wing about 34° below the horizon. All flags were stowed, except the glideslope and radar flags, which were about 1/2 exposed in an area of impact. The command bars were skewed across the top of the display. The localizer display was about 1/3 to 1/2 the distance between the center and the full left deflection. The glideslope needle was masked and above the scale. The radar altimeter displayed about 110 feet.

The first officer's attitude indicator was missing the display face, but the horizon ball indicated an inverted, 40° nose-down attitude. The roll display was found with the right wing 50° to 60° below the horizon.

The standby attitude indicator had the mounting plate and attached display face broken, but the instrument was still loosely attached to the instrument panel. The instrument can was crushed in the upper left quarter, and the display drum would move freely over about a 10° range in both pitch and roll. The attitude displayed was inverted but was generally neutral in pitch and bank.

Two airspeed indicators were found separated from the instrument panel. The needles of both instruments were free to move after the face glass was removed. The reference bug of S/N 062 was set at 117 knots, and S/N 111 was set at 120 knots.

Two altimeters were found. S/N 994 was set at 1,023 mbar [millibars], and the mercury window showed 30.21 inches. The display needle indicated 295 feet, and the digital display wheels were between 0 and 9. S/N 123 was set at 1020.7 mbar, and the mercury window was set at 30.14 inches. The display needle was missing, but the digital altitude was about 350 feet.

A crushed radar altimeter display was found. There was an orange flag in view in the left center of the instrument face, and the display needle was trapped about 200 feet. The radar altitude display on the flight director indicated 110 feet.

Both angle of attack gauges were recovered without the glass display faces, and one was also missing the needle and face card. Both gauges displayed off flags. The gauge with the needle indicated about .97, the top of the red scale.

Two angle of attack indexer displays, each containing three light bulbs, were attached to the top of the glareshield. The upper bulb from the left unit, which illuminates a red arrow pointing down, had a filament that was stretched from the top of the support post to the glass and then to the base connection. The upper bulb from the right unit had short filament sections attached to each base connection, in which there was stretching and discoloration, but there was no stretching and discoloration at the filament breaks. The remainder of the filament, which adhered to the base inside the bulb, exhibited massive stretching of each coil.

1.13 Medical and Pathological Information

The Office of the Chief Medical Examiner, located in Fairfax, Virginia, conducted post-mortem examinations of all occupants, and reported that all of them died of "multiple severe injuries." In addition, autopsies of the flight crewmembers were conducted, and no evidence of physical impairment was found. Toxicological tests were also performed, and there was no evidence of alcohol or other drugs of abuse in either crewmember. Another laboratory also found negative results in its independent toxicological tests.

No toxicological samples were taken from the controllers.

The 10 passengers aboard XA-BBA included two adult males, two adult females, two female children, and four male children. The ages of the passengers ranged from 40 to 5 years. No infants or handicapped persons were aboard the airplane.

1.14 Fire

There was no evidence of fire.

1.15 Survival Aspects

The accident was nonsurvivable. The cabin of XA-BBA was configured with eight passenger seats and eight passenger safety belts. The configuration was four forward-facing swivel seats, one side-facing single passenger seat (which was a lavatory) with a single safety belt, and a forward-facing bench seat with three safety belts.

Part 91.107, Use of Safety Belts, Shoulder Harnesses, and Child Restraint Systems, prescribes the requirements for U. S.-registered civil aircraft. Part 91.107 states, in part:

> (a)(2) No pilot may cause to be moved on the surface, take off, or land a U. S.-registered civil aircraft...unless the pilot in command of that aircraft ensures that each person on board has been notified to fasten his or her safety belt....
>
> (a)(3) Except as provided in this paragraph, each person on board a U. S. registered civil aircraft...must occupy an approved seat or berth with a safety belt...properly secured about him or her during movement on the surface, takeoff, and landing....Notwithstanding the preceding requirements of this paragraph, a person may:
>
> (i) Be held by an adult who is occupying a seat or berth if that person has not reached his or her second birthday;

The International Standards and Recommended Practices, issued by ICAO, Annex 6.2.2 (c), prescribes that an airplane shall be equipped with

1) a seat or berth for each person over an age to be determined by the State of the Operator.

2) a seat belt for each seat and restraining belts for each berth...

TAESA was required to meet this standard while operating in the United States. However, the flight did not meet this requirement because there were 10 passengers and only 8 seats.

The initial notification of a missing airplane was ntade by the controller-in-charge to the IAD Fire Department and Airport Police via the crash phone network at 0626. The fire department dispatched 8 pieces of equipment from fire stations 1 and 2, with a total complement of 17 firefighters and supervisors. The airport police dispatched three patrol officers to the area about 1/2 mile south of the runway 1R threshold. All personnel met at the access road adjacent to State Route 28, near Gate 4, and began a search of the area for the missing airplane. The ground search was hampered by the dense fog and wooded area. The airplane was located at 0725 by members of the fire department, who examined the crash site and made the initial assessment that there were no survivors.

During the initial response, 20 fire and police personnel participated in the search for the missing airplane. Subsequently, additional airport police, fire and fescue units from the Sterling Park Volunteer Fire Department, and personnel from the Fairfax County Police Crime Scene Unit responded to the accident site to provide assistance in removing the victims and identifying the remains. By 1945, all 12 victims were moved and transported to the state medical examiner's office. Overall, approximately 51 fire and police personnel assisted during the search and on-scene investigation.

1.16 Tests and Research

Sone

1.17 Additional Information

1.17.1 Organizational and Management Information

In April 1988, TAESA began its business as an air taxi operator in Mexico. It continued operating air charters and expanded its fleet from a single Jetstar 731 to more than 90 aircraft at the time of the accident, as follows:

Helicopters	8
Corporate Jets (i.e. Gulfstreams, Jetstars, Falcons, and Learjets)	55
Airline Fleet (B-767, B-757, B-737, and B-727)	35

At the time of the accident the corporate fleet included 10 Learjets in addition to XA-BBA. The company also established a Fixed Base Operations facility at MEX and was building a new facility at Toluca Airport (about 20 miles west of MEX). TAESA provided charter service to 61 cities in North and South America, Europe and Japan. Its scheduled airline operations served 27 major domestic markets. Within the United States, its scheduled service included cities, such as New York, Detroit, Laredo, and Oakland. At the time of the accident, it also operated five B-727 combinations configured for cargo out of a Monterey, Mexico, hub. The company provided maintenance through a "C" check, and had an avionics repair shop.

The TAESA Executive Director of Operations stated that flight training was provided in the United States by FSI and Simuflite. He said that the relationship with FSI, which trained the accident crew, had been very positive. According to the Director, this was the third pair of pilots to be sent to FSI, and the first crew that FSI had expressed hesitation about upgrading.

1.17.2 TAESA Approach Procedures

An English interpretation of the pertinent parts of TAESA's General Operations Manual revealed the following references to landing minimums:

> Page 3.5.12 A descent will not be attempted if the ceiling and visibility are below the approved minimums.

> Page 3.5.15 Establishes the CAT I instrument landing system (ILS) minimums as 200 feet and 1/2 mile visibility (2,400). 1,800 RVR may be used if mway centerline lights and touchdown lights are operative in conjunction with the approach lighting system

> Page 3.5.16 The last weather report must be at or above minimums in order to initiate an approach.

> Page 3.5.17 Upon reaching the DH [decision height] altitude, it is strictly prohibited *to* level the airplane in order to obtain visual contact and land the airplane. If upon reaching the DH, *there* is no visual contact, missed approach procedures shall be immediately initiated

The company operations specifications, approved by the FAA, provides a table of IFR [instrument flight rules] landing minimums for precision approaches. Given the lighting configuration for runway 1R at IAD, the minimums for that approach were 200 feet above the terrain, and an RVR value of 1,800 feet. This corresponds to the same minimums published on the approach chart used by the crew.

TAESA's operations specifications also provided in Part C, page 6, that:

> *An* instrument approach procedure may be executed when the U. *S.* National Weather Service report indicates that the visibility is less than *the* approved minimum for landing, if the airport is served by ILS and PAR [precision approach radar][6] in operative condition and both are used by the pilot. Thereafter a landing may be made, if weather conditions equal to or better than the prescribed minima are found to exist by the pilot-in-command upon reaching the authorized MDA [minimum descent altitude] or DH [decision height].

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[6]PAR is designed to be used as a landing aid, rather than an aid for sequencing and spacing aircraft. PAR equipment may be used as a primary landing aid, or it may be used to monitor other types of approaches. It is designed to display range, azimuth and elevation information. Two antennas are used in the PAR array, one scanning a vertical plane, and the other scanning horizontally. Since the range is limited to 10 miles, azimuth to 20 degrees, and elevation to 7 degrees, only the final approach area is covered. Each scope is divided into two parts. The upper half presents altitude and distance information, and the lower half presents azimuth and distance.

This paragraph is somewhat outdated since very few airports have PAR approaches available. IAD does not have PAR approaches available.

The operations specifications state that TAESA shall comply with the applicable provisions of Part 91. Part 91.175 specifies that:

> ...when an instrument letdown to a civil airport is necessary, each *person operating an aircraft...shall use a standard instrument* procedure prescribed for the airport in Part 97 of this chapter.
> 14 CFR 97.3 (x) states:
>
> Visibility minimums means the minimum visibility specified for approach or landing...expressed in statute miles, or in feet where RVR is reported.

1.17.3 Recorded Radar Study

The Safety Board examined recorded radar data from the IAD automated radar terminal system (ARTS IIIA) for the period between 0530 and 0630 on June 18, 1994. Appendix C depicts the ground track and profiles of the two approaches by XA-BBA. The data indicated that the airplane intercepted the localizer initially at 0606:10. it reached a maximum altitude of 3,100 feet 5 nmi from the runway, and maintained a northerly track during the descent until 2 nmi from the nmway. At this point, it deviated to the northeast while continuing to descend to 600 feet, maintaining the heading and altitude until about 1/2 mile from the threshold. Then the heading changed back to the north, and the altitude remained at 600 feet until the airplane was 1 nmi north of She departure end of the runway. At this point, the airplane began a climb, and maintained a northerly heading for 4.7 nmi, when it made a 180-degree turn. The airplane tracked southbound until approximately 12 nmi south of runway 1R, when it again reversed course.

During the second approach, the airplane was positioned concurrently an both the centerline of the glideslope and localizer for one radar return (the antenna rotates approximately every 5 seconds). It descended to 400 feet 1 nmi south of the threshold for two radar returns before climbing to 600 feet in 9.1 seconds. At this point radar contact was lost 1.11 nmi south of the threshold at 0625:03.52. This point was 0.16 nmi south of the initial impact with terrain

Four other airplanes made approaches to runway 1R, previous to the approach of XA-BBA, as follows:

a)	N6679/Mooney M-20C	landed approximately 0549
b)	UA 102/B-757	landed (CAT III) at 0610
c)	XA-BBA/Learjet	missed approach about 0612
d)	UA 186/DC-10	missed approach (CAT II) about 0614
e)	AA 74/B-767	landed (CAT III) about 0618
f)	XA-BBA/Learjet	accident approach about 0625

There were no primary radar targets found in the vicinity of XA-BBA, and there were no minimum safe altitude warning (MSAW)[7] alerts during the period cf the approaches. A plot of the MSAW site variable parameters and the XA-BBA radar track indicated that XA-BBA had one return below the alarm altitude of the runway 1R capture box in both tracking and beacon data (see figure 1). However, the FAA states in their MSAW system functional specifications, two "current position" hits, or three "'predictedposition" hits must be received on radar before an alert will activate the aural and visual warnings.

Inspection of the MSAW site variable parameter that defined the runway threshold indicated a discrepancy between the MSAW-defmed runway location and the actual threshold location. The prescribed magnetic variation of 10 degrees west was applied to the MSAW-defined threshold coordinates which created a position offset of 700 feet to the northeast from the actual runway 1R threshold. However, when a 7-degrees west variation was applied, a match between the MSAW-defined threshold and the actual runway threshold was established. Furthermore, inspection of the other site variables revealed that a localizer-only minimum descent altitude (MDA) was used to establish the base of the runway capture box (680 feet).

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[7]The MSAW system is a computer function that assists air traffic controllers in detecting aircraft that are within, or are approaching, unsafe proximity to terrain or obstacles. The function generates an alert when participating aircraft are, or are predicted to be, below a predetermined altitude. All instrument flight rules aircraft, and those aircraft operating under visual flight rules with an operating altitude encoding transponder that request MSAW following, automatically participate in the MSAW program. The controller will evaluate any observed alerts, and issue a safety alert when appropriate.

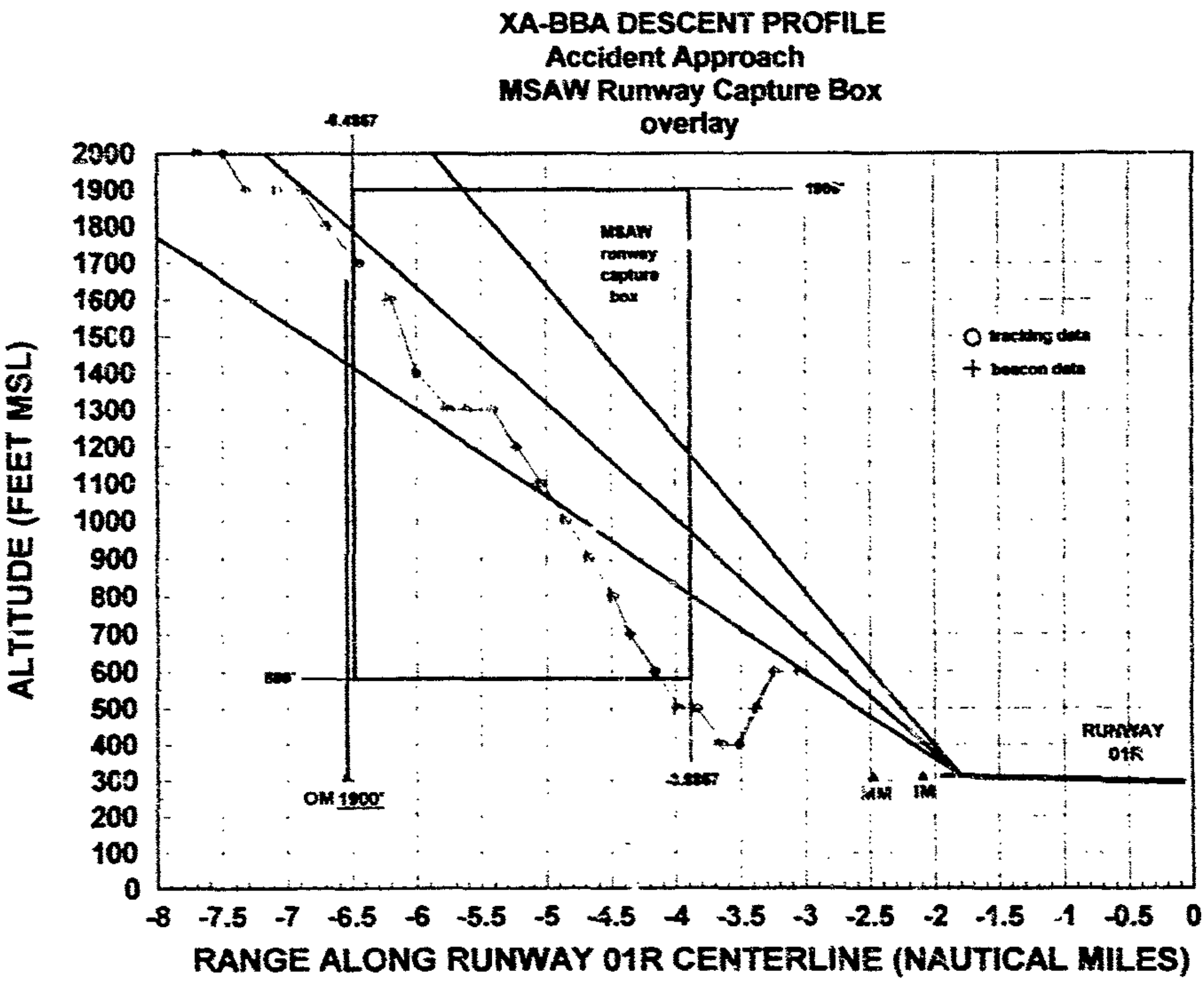

Figure 1.--Airplane descent profile.

NAS-MD-633, Standards For Defining and Adapting Values for MSAW Site Variable Parameters, prescribes the use of another nonprecision approach MDA, if one exists, but also gives general provisions for the adaptation of a localizer-only MDA. A nondirectional beacon (NDB) approach exists on runway 1R with an MDA of 760 feet. An August 4, 1994, letter from the IAD tower Air Traffic Manager acknowledged that the site variable parameter defining the runway 1R threshold did have an offset. It also justified the replacement of the NDB MDA with a localizer-only MDA that resulted in the decrease of 80 feet in the floor of the capture box (in order to avert "multiple nuisance alarms" caused by a variety of propeller aircraft that frequently use runway 1R). The memorandum based this justification on paragraph 1 of section 3.0 of NAS-MD-633.

On November 21, 1994, the Safety Board issued Safety Recommendations A-94-186 and A-94-187 to the FAA concerning the MSAW system at IAD and all radar environments using the system respectively. See appendix D for correspondence concerning these safety recommendations.

1.17.4 Airplane Performance Study

Recorded radar data, air traffic control transmissions, and data collected from the on-scene phase of the investigation were used to reconstruct the motion history of XA-BBA during the ILS approaches to runway 01R at IAD. The data were presented in composite plots of the ILS geometry to determine the relative proximity of XA-BBA's flightpath. The data were also used to determine vertical speeds, ground speeds, and flightpath angles. See appendix C for highlights of the sequence of events prior to XA-BBA's controlled flight into terrain.

Radar data indicated that the flightcrew of XA-BBA attempted two approaches to runway 01R on the day of the accident. They initially intercepted the runway 1R localizer at IAD 13 miles from the runway, and 9 miles from the outer marker (TILLE). The airplane reached a maximum altitude of 3,100 feet, and was above the full fly-down limit of the projected glideslope beam. The airplane then descended for 1 minute and 41 seconds and reached descent rates of 2,600 feet per minute (fpm). At an altitude of 1,300 feet, 2.5 miles from the runway threshold, the flightpath intersected the full fly-down limit of the projected glideslope beam. The airplane continued to descend until altitude values stabilized at 600 feet approximately 0.8 nmi from the runway threshold. This position was also coincident with the intersection of the centerline of the projected glideslope beam. During this approach, the airplane maintained a track within the localizer limits until

0.25 mile from the runway, whereupon it passed through the full fly-left limit of the projected localizer beam. The airplane maintained an altitude of 600 feet msl as it continued on a heading parallel to runway 1R.

During the second approach, XA-BBA was level at 2,100 feet msl when it intersected the full fly-up limit of the projected glideslope beam at 0622:32. Approximately 18 seconds later, the radar controller asked the flightcrew of XA-BBA to verify their relative position to the ILS. Four seconds later, at an altitude of 2,100 feet, approximately midway between the fly-up limit and the centerline of the projected glideslope beam, the flightcrew responded with an affirmation that they were established on the ILS. At 0623:04, approximately 1.4 nmi from the outer marker, XA-BBA began to descend from 2,100 feet. At 0623:27, XA-BBA was positioned on the centerlines of both the glideslope and localizer beams. At approximately 0623:34, XA-BBA was at the outer marker at an altitude between 1,700 and 1,800 feet. The airplane then descended at an average rate of 1,300 fpm to an altitude of 400 feet (about a -4° fight path angle), while maintaining a track within the localizer geometry limits. However, XA-BBA dropped below the full fly-up limits of the projected glideslope beam at 0624:17, at an altitude of 1,000 feet, 2.7 nmi from the runway. While still below the full fly-up limit, the airplane leveled off at 400 feet. At a distance of 1.7 miles south of the runway 1R threshold, the airplane climbed to an altitude of 600 feet in 9.1 seconds. Radar contact was lost at 0625:03.52, 1.1 nmi south of the runway 1R threshold. During the climb from 400 to 600 feet, XA-BBA attained a flightpath angle of approximately +7.4° and reached the full fly-up limit of the projected glideslope beam at the final radar return. However, the penultimate radar return indicated that XA-BBA had deviated to the full fly-left limit of the projected localizer beam. The last radar return was outside the full fly-left limits.

Radar data for the last 5 minutes of flight were used to calculate average ground speeds. Ground speed data were generated by calculating a 3, 5, and 7-point averages for distance and time values derived from the radar data. Ground speeds were converted to true airspeeds assuming zero wind. The data indicated that as XA-BBA began descending from an altitude of 2,100 feet at 0623:04, ground speed values increased slightly then decreased until the end of the radar data. A flightpath angle of -12.8° was calculated between the final radar return and the initial impact point. An elapsed time of 4.5 seconds following the last radar data point was assumed to position XA-BBA at the impact point. This was based on composite plots of X-range vs. time, Y-range vs. time, and the accident site. A time difference of 4.5 seconds was the best fit for an approximation of time between the last radar return and initial impact. This assumption yielded a ground speed of 134 knots at the time of initial impact.

The following data were gathered from various sources and used in the airplane performance study:

Airplane:

a)	Landing Weight:	12,104 pounds
b)	CG:	374.21" or 16.79% MAC
c)	Landing Gear:	Down
d)	Flaps:	20° or 40°
e)	Vstall (Vso) =	20° flaps, 101 KCAS
f)	Vstall (Vso) =	40° flaps, 94 KCAS
g)	Vref (1.3Vso) =	20° flaps, 131 KCAS
h)	Vref (1.3Vso)=	40° flaps, 122 KCAS
i)	Altimeter setting, (cpt):	30.14" Hg
j)	Altimeter setting (f/o):	30.21" Hg
k)	Wing Span:	35.58 feet
l)	Distance between nose cone and tip tank:	25.12 feet

Weather:

a) Wind: National Weather Service, Sterling, Virginia, 0711 wind observation from the surface to 1,047 feet was calm.
b) Temperature: 71° F
c) Dew point: 71° F
d) Barometric pressure: 30.12" Hg (reported by ATC) 30.14" Hg (0635 postaccident weather observation)
e) Conditions: indefinite ceiling, 500 feet sky obscured visibility 1/2-mile fog (reported by ATC)

Geography:

a) Runway heading: 10.2° magnetic, 0.20° true
b) Magnetic variation: 10° west
c) Runway 1R threshold elevation: 312 feet
d) Airport elevation: 313 feet

e) Initial impact elevation: 318 feet
f) Tallest tree elevation at initial impact: 60 feet
g) Accident site elevation: 320 feet
h) Tallest tree elevation at accident site: 30 feet

1.17.5 Ground Proximity Warning System

XA-BBA was not quipped with a Ground Proximity Warning System (GPWS),[8] and none was required under 14 CFR Part 91. However, as a result of a Beechjet 400 accident on December 11, 1991 near Rome, Georgia, the Safety Board issued Safety Recommendation A-92-055 to the FAA

> Require all turbojet-powered airplanes that have six or more passenger seats to be equipped with a ground proximity warning system.

The FAA issued a response dated October 13, 1992, in part, as follows:

> The FAA does not agree with this safety recommendation. All turbine-powered airplanes with 10 or more passenger seats operated under 14 CFR Part 135 were required to be equipped with an operating ground proximity warning system (GPWS) by April 1994. This rule which was adopted in April 1992, came after extensive study of the controlled flight into terrain issue and included the influence of air traffic programs, cockpit instrumentation, and flight operations procedures on the issue. In making the determination *not to* include all turbojet-powered airplanes with *six* or more seats. the FAA 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. The FAA will work with corporate flight departments on cockpit management and altitude awareness issues and will publicize the facts of this accident in appropriate trade journals and magazines.

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[8] A GPWS system is designed to issue visual and aural warnings to the flightcrew when proximity to terrain, closure rate, rate of descent, bank angle, and glideslope deviation become excessive, based on internal ground proximity logic, coupled to an airplane's configuration.

On January 6, 1993, the Safety Board issued a follow-up letter, in part, as follows:

> The Safety Board is disappointed that the FAA does not agree with this recommendation and does not plan to require the GPWS. The Board continues to believe that the recent accidents underscore the. need to equip turbojet-powered airplanes carrying six or more passengers and operating under the provisions of 14 CFR Part 91 or 135 with the GPWS. Therefore, the Board classifies Safety Recommendation A-92-055 "Closed--Unacceptable Action."

The ICAO Standards, Annex 6, Part I (Commercial Air Transport), recommends a GPWS fer Carbine-powered aircraft having a certificated takeoff weight of 15,000 kilograms (33,069 pounds) or more, or 30 passenger seats.

On February 17,1995, the Air Navigation Commission issued a working paper to the ICAO Council recommending the adoption of Amendment 16 to Annex 6, Part II (General Aviation) which states, in part: "Ail turbine engine aeroplanes of a maximum certificated take-off mass in excess of 5,700 kilograms (12,566 pounds] or authorized to carry more than nine passengers shall be quipped with a ground proximity warning system...." The effective date will be 1 January, four years after adoption.

1.17.6 Low Level Windshear Alert System

A Phase II LLWAS is installed at IAD to detect hazardous low level windshear. There are no ICAO standards for LLWAS installation, but the U. S. standard installation incorporates a system of six sensors. A computer continuously compares the wind measured by five sensors installed around the periphery of the airport with the wind measured by a sixth sensor at the center field location. When the difference between the center field sensor and any of the peripheral sensors exceeds a given value, windshear is probable, and an alarm is activated in the tower. The center field sensor at IAD is located west of runway 1R and east of the approach end of runway 3@. The latitude, longitude, and pole height of each sensor are contained in a Geometric Configuration File (GCF) for each airport. The GCF is issued to run the enhanced LLWAS windshear/microburst detection software.

During the field phase of the investigation, the IAD LLWAS data were requested. A memorandum received from the FAA, dated August 2, 1994, stated that the IAD LLWAS data included the GCF for Tampa International Airport, Florida. The memorandum further stated that it seemed likely that IAD was using an incorrect LLWAS GCF at the time of the accident.

According to the FAA, the GCF for each LLWAS airport contains specific and unique parameters that are vital for the correct operation of the enhanced LLWAS software. In order to run the LLWAS windshear/microburst detection software, the FAA has stated that it is necessary to input an appropriate GCF that is distinct and unique to the airport of concern. Following the accident, the GCF was corrected at IAD.

On November 21, 1994, the Safety Board issued Safety Recommendation A-94-188 concerning the LLWAS, See appendix D for further information on this recommendation.

1.17.7 FAA Surveillance

The Part 129 Operating Certificate for TAESA is held at the Dallas/Ft. Worth Flight Standards District Office. The assigned Principal Operations Inspector also has responsibility for 17 additional Part 129 carriers. He had been assigned to TAESA for 2 1/2 years, and stated that the company had added the large airplanes in 1991. He had a good working relationship with TAESA, and said that the company was responsive to FAA communications. Surveillance was accomplished by ramp checks at Laredo, where the company has scheduled service, as well as geographic support from other offices where TAESA makes charter stops. A review of the FAA's Program Tracking and Reporting Subsystem (PTRS) indicated no remarkable entries regarding TAESA operations.

TAESA operates in the United States under the provisions of 14 CFR Part 129.11 (a) which requires that it conduct "...operations within the United States in accordance with operations specifications issued by the Administrator...and in accordance with the Standards and Recommended Practices contained in Part I (International Commercial Air Transport) of Annex 6 (Operation of Aircraft)..." of ICAO. The operations specifications issued to TAESA require that its flights comply with the applicable provisions of 14 CFR Part 91 when it is operating within the United States. The principal operations inspector stated that this refers to Subpart H. However, according to senior FAA Flight Standards staff, all parts of Part 91 apply, except where specific language makes an exception.

Under the Convention on International Civil Aviation administered by ICAO, the State of Registry is responsible for oversight of its operators that are engaged in international flight operations. In order to ensure consistent and standardized procedures among international operators, States are required to comply with the applicable provisions of the ICAO Annexes. Both Mexico and the United States are signatories to the Convention. Therefore, Mexico is responsible for the direct oversight of TAESA to ensure that the regulations of Mexico and ICAO standards are met.

The FAA does not conduct routine, in-depth surveillance of Part 129 operators: rather, it relies on the States of registry to conduct surveillance. Of course, FAA inspectors would take appropriate actions should a deviation from regulations or other standards be noted, In such cases, the FAA would interact with the respective regulatory authority from the State and request that corrective actions be taken.

Historically, it has generally been assumed that most ICAO member States have attempted to adhere to the standards and recommended practices of the Convention on International Civil Aviation and its related Annexes. However, findings during previous investigations and previous safety recommendations by the Safety Board prompted the FAA to establish a more aggressive program to assess the capability of foreign authorities to ensure adherence to the standards. The increased FAA activity was also generated by several safety related issues, including accidents, the increasing numbers of operators flying into the United States, and the number of U. S. citizens flying on foreign carriers overseas. As a result, FAA inspectors have currently visited 44 countries, and where deficiencies were found, they have made resommendations directly to that civil aviation authority (CAA). If a carrier does not receive an acceptable level of oversight from its CAA, it is not permitted to operate in the United. States. Some carriers have been banned based on this program.

On September 8,1994, the FAA announced a modification to its policy regarding the assessment and oversight of foreign civil aviation authorities. The change made its general assessment findings of respective CAAs available to the public through the Department of State's Consular Information System and the FAA's Hotline.

1.17.8 FAA Runway Selection

Runway selection criteria is outlined in the Air Traffic Control Handbook 7110.65, Chapter 3 Airport Traffic Control, Section 5 Runway Selection, which states, in part:

> **3-60 SELECTION**
>
> a. Except where a "runway use" program is in effect, use the runway most nearly aligned with the wind when 5 knots or more or the "calm wind" runway when less than 5 knots (set tetrahedrons accordingly) unless use of another runway:
>
> **3-60a Note 1.**-If a pilot prefers to use a runway different from that specified, he/she is expected to advise ATC.

IAD does not have a "runway use" program, but the internal policy is to use runway 1R, based on service to the user, when wind is not a factor.

The IAD Tower Standard Operating Procedures Handbook, IAD 7110.65B, Section 3, Coordination Procedures, states, in part:

> **2-21 CHANGE IN DIRECTION OF OPERATION**
>
> The AM [Area Manager] shall be the final authority in the decision to change the direction of operation. The decision will be based on input from the Cab Supervisor (CS), TRACON Supervisor (TS), and Traffic Management Coordinator (TMC). Once a change is initiated, the AM will consult with the CS and TS prior to allowing a resumption of approaches/departures.

The radar controller, who had just come on duty shortly before XA-BBA arrived in the area, stated that his inquiry about whether UAL 186 wanted to "try" runway 19 was an initial step in the process to determine if a change in the landing runway would be prudent. He indicated that, based on the response from UAL 186, there did not seem to be a distinct advantage in changing to a south operation. Runway 1R was the only approach that had Category III landing minima, there was fog in the area, wind was not a factor, and other arrival traffic that was part of an arrival "push" was aligned southwest of the airport for approaches to runway 1R.

In this accident, the Area Supervisor on duty would have assumed the responsibilities of the Area Manager. As a result, the final decision to change to a runway 19L operation would have been made by the Area Supervisor.

1.17.9 Operational Use of the D-BRITE Radar

As the IAD Tower Standard Operating Procedures Handbook, IAD 7110.65B, pertains to the use of the D-BRITE radar display, controllers are advised, in part, to use the display in the following manner:

> Ensure separation of aircraft under their control, establish radar identification, provide aircraft with radar vectors, or advisories, and provide pilots with radar fixes.

In this accident, the D-BRITE radar was set to an overhead plan view of the final approach course for the ILS mway 1R approach. There is no specific view of the glidepath. The ARTS data block would have provided the local controller with the aircraft identification, the assigned runway, aircraft type, ground speed, and altitude. During the course of periodically scanning the radar, his primary concerns would have 'een the airplane's distance from the airport and separation from other aircraft

The altitude readout is shown in hundreds of feet. To determine an aircraft's rate of descent, a controller would have to continually monitor both the altitude readout and the aircraft's progress toward the mway,

2. ANALYSIS

2.1 General

The airplane was certificated and maintained in accordance with applicable FAA and Mexican regulations. It was properly configured for the landing, and there was no evidence of a preimpact anomaly in the portions of the flight controls that were not destroyed. The instruments appeared to have been operating, and the engines were running at the time of impact.

Although the airplane exceeded the maximum allowable takeoff weight at NEW by approximately 345 pounds, this did not affect the operation of the flight during the landing attempts at IAD.

2.2 Flightcrew Qualifications

The crew of XA-BBA was qualified for the operation, based on training provided by FSI, and the recurrent training and checking of TAESA. However, there was a communications problem between FSI and TAESA regarding the training results of the captain. TAESA requested confidential evaluations of their applicants, including instructor notes. FSI advised that the instructor notes were for internal use only. Following the accident, FSI did make the instructor notes available to the Safety Board, and a comparison of the two documents reveals a basis for misunderstanding. The evaluation stated that the captain, "...demonstrated satisfactory flying skills...under normal conditions." However, the evaluation specified that, "He requires emphasis in crew management and decisionmaking skills during his training to upgrade to captain. (He) needs to improve his airmanship and command skills, especially when operating under the stress of abnormal and emergency situations." The evaluation reiterated the captain's ability to fly the airplane smoothly under normal circumstances, and indicated that he, "...can be considered for upgrade to Pilot-in-Command. During upgrade training, situational awareness under high workload conditions should be emphasized. He should fly with a strong training Captain or First Officer during his upgrade."

The evaluations by FSI presented the candidate to its customer in the best possible light. The language was permissive in nature, suggesting that TAESA could consider the captain for upgrade. Recognizing that English is a second language for TAESA, it is understandable that it would interpret this evaluation as approval of the applicant, and continue his "training." This is especially true when the evaluation is contrasted to that of the accident captain's partner. That evaluation, although clearly based on the same "form letter" addressing specific areas indicating the degree of qualification, stated, "...we do not think he is ready to upgrade to Pilot-in-Command."

The instructor notes on the accident captain presented a clear picture of below average performance, which may have been improving during each simulator period, but, in the final analysis, was unsatisfactory. The instructor evaluation of the last period was:

> Pilot needs more CRM training to be competent as PIC Below FSI Stds for PIC. Add'l training offered and declined.

Had FSI made the instructor notes available to TAESA, the comments, in combination, *might* have enabled TAESA to understand the intent of FSI, and might have led *to* a delay *in* his upgrade. By contrast, *the* first officer received favorable comments on his performance throughout his training.

Apart from the respective flying skills of these crewmembers, their relative inexperience in both total flying time and in the Learjet is considered to be critical in this accident. Although approximately *75* percent *of* the captain's 1,706 total flying hours were accumulated in the Learjet, only 87 hours were as pilot-in-command. Similarly, the first officer had accumulated 50 percent of his total flying in the Learjet, but he had only 852 total flying hours. While these qualifications meet the basic requirements *of* the regulations in the United States and Mexico, the circumstances of this operation were far from "basic." For example, in scheduled U.S. air carrier service (14 CFR 121.652[a]) and in commuter and charter operations (14 CFR 135.225[d]) in turbine-powered airplanes, the captain is held to "high minimums" of 100 feet *and* 1/2 mile (or the RVR equivalent) above the authorized minimum until he has accrued 100 hours in type as pilot-in-command. In no event may the landing minimums be less than 300 feet and 1 mile. Both of these regulations indicate a recognized need for more pilot experience to meet the greater demands of such approaches. This approach was exactly the type of high workload and stressful operation that would exceed the captain's normal capabilities. Instead of an experienced training captain to assist him during the approach, he was paired with a relatively inexperienced first officer. Based on the radar data, it is evident that whatever assistance the first officer gave the captain with altitude, airspeed, or glideslope/localizer deviations, it was *not* effective. If the captain received any prompts, he either ignored them or failed to respond to them in an appropriate manner.

2.3 The First Approach

The first approach began with the airplane established within the parameters of the localizer and the glideslope approximately 14 nmi from the runway threshold. However, based on the radar plot, the approach was never stabilized. The captain generally bracketed the localizer from the full right limit to the full left limit. He eventually traveled outside the localizer limits from the point at which he leveled off, at 600 feet msl and 1/2 nmi from the threshold, until he was well north of the runway.

The vertical control of the airplane was even more erratic than the localizer control. Although the captain generally bracketed between the lower limit and the center of the glideslope until he was about 2.5 nmi from the outer marker, he began a slight climb when the airplane was approximately on the glideslope centerline. The airplane traveled so high--well above the full fly-down limit--that the rate of descent exceeded 2,000 fpm to reach the glideslope centerline again. At this point, the airplane was approximately 2 nmi from the threshold, but at the full fly right limit of the localizer. From this point through the level-off (about 1/2 nautical mile from the threshold) the captain maintained reasonable vertical control, but he allowed the airplane to travel well off to the right of the runway.

The radar track of the airplane suggests that the captain was actually attempting to establish visual contact with the runway during this time, to assess the conditions. He leveled off at 600 feet msl and maintained that altitude until he was about a mile north of the runway. This was not in accordance with company procedures. He did not exhibit any attempt at a missed approach until the controller inquired about his intentions.

2.4 The Second Approach

The second approach was initially more stable than the first approach. The localizer bracketing was not as erratic, and the glideslope centerline was intercepted just outside the outer marker. XA-BBA passed through the outer marker between 1,700 and 1,800 feet msl. This is lower than the prescribed 1,849 feet msl crossing altitude. Between 1,300 and 500 feet msl, the airplane descended at an average rate of 1,300 fpm for 42 seconds. The average flightpath angle for this period was calculated at -4°, and the glideslope angle was -3°. The excessive descent rate began to slow as they descended through 600 feet msl, but did not stop until 400 feet msl. Since the resolution of the radar data is limited to 100-foot increments, the airplane could actually have been as high as 449 feet msl or as low as 350 feet msl. At this time, the airplane was flying over a business park on the north side of U.S. Route 50. The highest obstacle in the area was an array of power lines, with a minimum elevation of 380 feet msl. Although there was no evidence that the airplane hit the power lines, the maximum clearance between them and XA-BBA was 69 feet. It was at this time that the airplane began climbing at a flightpath angle of +[illegible]°. The climb, which lasted for 9.1 seconds (approximately 1,300 fpm), stopped at 600 feet msl. Five seconds later, the airplane began descending at an approximate -12.8° flightpath angle (approximately -3,000 fpm).

The possibility of turbulence causing the erratic flightpath was rejected because of the stable weather and the stability of the other approaches flown by airplanes at the time. Wake turbulence from AA 74 was rejected because of the 9-minute separation between the two aircraft. Similarly, the possibility of a stall causing the excessive descent rate was rejected because the calculated ground speed from the last radar return and the initial impact point was approximately 134 knots. The stall speed, depending on the flap configuration, could have been as high as 103 knots (true airspeed). Although the evidence from the angle of attack gauges and the angle of attack indexer displays indicated that the airplane was beyond the stall angle of attack prior to final impact, the foregoing radar data indicates that the airplane reached a stall angle between the initial tree contact and the final impact.

2.4.1 ATC Personnel Statement

A review of the statement of the controller in charge concerning the accident indicated that he was "informed by the Local Controller that the "LR25" had not landed and was potentially in an unsafe profile descent for runway one right." While the statement was cause for concern, it was discounted for several reasons. The data provided by the D-BRITE display would not have provided adequate information from which the determination of an unsafe profile descent could be made unless the local controller had continuously monitored the altitude readout of XA-BBA. Although the local controller indicated that he periodically scanned the radar during the approach of XA-BBA, he would not continually monitor the data block for airplane position and altitude.

Following an interview with the controller-in-charge, investigators concluded that after being advised to activate the crash telephone, he did not know specifically what was said by the local controller. Finally, in the aftermath of the accident, the local controller's awareness of an unsafe profile descent was not consistent with his saying to the radar controller, "I'm not sure what happened here."

2.5 The Captain's Decisionmaking

TAESA personnel, familiar with the voices of the crewmembers, stated that the first officer was making the radio transmissions, which is consistent with the captain flying the airplane. This was proper in light of the weather, which was deteriorating as they approached the IAD area.

Apart from the low visibility on runway 1R, the captain's decisionmaking in the terminal area might also have been affected by the unscheduled holding at an unfamiliar fix (due to the earlier emergency), any fatigue from the all night operation, the customs delay at NEW, concern that BWI weather might be the same, and the probable logistical problems associated with a diversion to BWI. These are possible factors in his decisionmaking process that might have created a strong incentive to complete the charter to IAD. In this context, it is not surprising that he made a second attempt to land.

Between the time XA-BBA established radio contact with IAD approach control (0554:24) and the start of the first approach (0607:14) the ATIS broadcast weather deteriorated from, "...indefinite ceiling 700 sky obscured, visibility 1/2 [mile in] fog..." to "...indefinite ceiling 600 sky obscured, visibility 1/2 [mile in] fog...." Additional weather information issued by the radar controller, while XA-BBA was on the frequency, included the latter observation and the RVR values of 1,200, 1,600, and 6,000+, which were given to UAL 102 just prior to the start of its approach. UAL 102 inquired if Category II approaches were in progress. While the controller was checking, he obtained acknowledgment for the weather from the other flights, including XA-BBA. The confirmation of Category III operations was broadcast at 0604:41. XA-BBA received clearance for the approach at approximately 0607, and switched to the local control frequency at 0608. The crew of XA-BBA should have been well aware of the significant deterioration in the IAD weather and that they were actually below company authorized minimums.

Prior to XA-BBA switching to local control, UAL 102 reported that it was established on the runway 1R ILS, Category III. After XA-BBA was cleared to land, UAL 102 reported "...on the ground now taxiing off at uh echo three." The local controller then cleared UAL 186 to land, and announced that the RVR was 600, 800, and 3,000 (0612:11). Several seconds after this transmission, he inquired whether XA-BBA was making a missed approach, because their data block was still at 600 feet. The first officer confirmed that they were, and they were switched back to approach control. It appears that the captain of XA-BBA was maintaining 600 feet, while flying offset from the localizer, in an effort to establish visual contact with the runway. TAESA company procedures require that the captain should have applied power, climbed, and followed the published go around procedure. U. S. requirements provide that the pilots follow the published missed approach procedure. The pilots did not comply with either of these provisions.

During the next several minutes, while XA-BBA was flying southbound at 3,000 feet for a second approach, UAL 186 also returned to the frequency, AA 74 was given the current RVR values (600, 1,000, 3,000) and switched to the tower frequency, and the controllers discussed an overflight, a departure, and the outside visibility from the tower. At approximately 0618, the radar controller offered the runway 19C approach to UAL 136, with the comment that the tower could "barely see" the approach end of the runway. UAL 186 agreed that the north end of the runway was "pretty fine...it's definitely better," but they opted to divert to Pittsburgh instead. At approximately 0620, after issuing initial departure instructions to UAL 186, the radar controller turned XA-BBA to a base leg without repeating the suggestion of a runway 19L approach. As he indicated, there were good reasons to continue the runway 1R approaches, and XA-BBA was already downwind, to the southeast, ready for turn to base. In addition, there was no way of knowing if the fog condition would shift to the north. In any case, the primary responsibility for initiating a change in the active runway rested with the pilot, and the Safety Board concurs with the established procedures for changing the runway.

The radar controller confirmed that XA-BBA was established on the localizer (for the second approach), and then advised, at 0623, that the RVR values were 600, 600, and 4,000. The flight contacted the local controller who advised, "Lear X-ray Alpha Bravo Bravo Alpha Dulles tower runway one right cleared to land wind calm RVR six hundred rollout four thousand." Based on these very specific runway 1R visibility reports, and his own previous observations, the captain should have held for improvements in the weather, requested the runway 19L ILS approach, or diverted to his alternate. The RVR values were well below his authorized minimums and definitely beyond his experience level and qualifications.

It is not known why the captain did not request a reciprocal ILS approach, or what the controller would have done. However, since it was an option offered to UAL 186, it is assumed that a request from XA-BBA for the runway 19L ILS approach would have been approved with some delay for operational changes. In light of the existing weather, the Safety Board believes that the captain of XA-BBA should have exercised the option to request the runway 19L ILS approach.

2.6 MSAW Considerations

The airplane crashed outside the MSAW monitor area. However, between the altitudes of 1,700 and 500 feet msl on the second approach, XA-BBA was within the confines of the runway capture box of the MSAW system. The purpose of this area is to monitor the airplane's proximity to terrain while taking into account a descent profile associated with an approach €or landing. Given the site variable parameters established by IAD, the logic of the ''SAW system as explained by the FAA, and plots made by the Safety Board, an MSAW warning would have been issued if two radar returns had been detected below the 500-foot floor of the runway 1R capture box. However, only one target was received, and consequently there was no alarm. The inspection of a 24-hour automation input printout (TTY) and the statement of the IAD automation specialist revealed that the MSAW system had not been inhibited prior to the accident.

Further examination of the site variables at IAD indicated that the alarm altitude set for the runway 1R capture box was 80 feet lower than the prescribed altitude (NDB [nondirectional beacon] decision height minus 100 feet) sei forth in the MSAW site variable specifications. The position of the runway capture box was also offset to the northeast by 700 feet due to an improper interpretation of the radar system's operational magnetic variation. The FAA acknowledged the discrepancy in the interpretation of the magnetic variation but stated that discrepancy in the alarm altitude was related to many false alarms that had been issued at the prescribed alarm altitude by slower and lower flying aircraft on approach to runway 1R. However, the FAA stated that no documentation of false alarm incidents or any memoranda from within the organization outlining the reduction of the alarm altitude by 80 feet (ILS decision height minus 100 feet) existed.

Although discrepancies were found in two site variables, the Safety Board believes that this was not consequential to the accident. The offset in the location of the runway capture box actually brought it closer to the runway making it more "sensitive," and causing it to alarm at a higher altitude. However, since the crew of XA-BBA initiated a climb after reaching 400 feet msl, an MSAW alarm would have only confirmed the flightcrew's suspicions that they were close to the terrain. Also, when XA-BBA had reached 400 feet msl, the airplane would have been outside the runway capture box and exempt from any MSAW processing, This condition would have been sustained as the crew of XA-BBA reinitiated a descent to the initial impact point.

2.7 Ground Proximity Warning System

XA-BBA was not equipped with a GPWS. Analysis of XA-BBA's flightpath indicated that had a GPWS been installed on the aircraft, an aural mode 5, Descent Below Glideslope, warning would have been issued approximately 64 seconds prior to initial impact at an altitude of 1,200 feet msl and would have continued to the end of the flight- A Mode 1, Excessive Sink Rate, warning would have been issued at 700 feet msl. A Mode 1, a Mode 5, or both warnings would have been active in the last 64 seconds. The Safety Board believes that had there been a GPWS installed on XA-BBA, there would have been constant warnings and cues to the crew of their proximity to terrain. The warnings would have provided adequate time to allow the flightcrew to take the appropriate evasive actions to avoid impact with the terrain.

In view of the circumstances of this accident, and the ongoing ICAO review of its standards regarding GPWS, the Safety Board continues to believe that turbojet-powered airplanes carrying six or more passengers should be equipped with an operating GPWS. (See section 4, .Recommendations). Had a GPWS system been installed on XA-BBA, the warnings might have prevented the accident.

2.8 Flight Recorder Considerations

XA-BBA was not governed by the provisions of 14 CFR 91.609(c) and (e), FDR and CVR respectively, because it was a Part 129 operator. However, it was required to conform to ICAO Standards and Recommended Practices, Annex 6. Since no differences with the provisions of Chapter 6.3.5.1, dealing with the FDR, were filed by Mexico, XA-BBA was required to have a 5-parameter FDR installed. Annex 6 Chapter 6.3.7.2 recommends that a CVR be installed. If XA-BBA had been a U.S. registered aircraft, the CVR would have been required, but the FDR would not have been required. The absence of a CVR denied the Safety Board access to comments and sounds in the cockpit which probably would have provided insight into the crew's actions and decisionmaking.

Although there was no FDR installed, radar coverage at IAD was exceptional, and the flightpath of the airplane was accurately documented in this case. However, in many other cases the lack of an FDR would seriously diminish the Safety Board's ability to establish the flight dynamics and performance history of the airplane prior to the accident, thus, seriously jeopardizing the outcome of the investigation. This shortcoming also reflects poorly on the management oversight by TAESA for this flight.

2.9 Management and Government Oversight

TAESA was operating under the provisions of 14 CFR 129, which regulates the operation of foreign air carriers within the United States, and requires that they be issued operations specifications. A review of TAESA's operations specifications revealed that some of the pages were dated 1975. About 5 years ago, the FAA implemented an automated Operations Specifications Subsystem to provide standards and control of paragraphs, symbology, and procedures for amending standard paragraphs, but it did not include standardized material for Part 129 operators.

TAESA's operations specifications did not address which visibility value, prevailing visibility or RVR took precedence in establishing a minimum for landing. Part C, page 2, of the operations specifications (the effective date of the page was June 1, 1977) contained the table that specified TAESA's IFR landing minima for straight-in approaches. In this case, with the approach light configuration at IAD, the minimum DH was 200 feet HAT [height above touchdown (or threshold)]; no value for the prevailing visibility was prescribed. An RVR value of 1,800 feet was authorized. The prevailing visibility of 1/2 mile or 2,400 feet RVR was also approved for lesser approach light configurations. Although the FAA has established that RVR values, when reported, take precedence over prevailing visibility, this information was not contained in the TAESA operations specifications or in its operating manual. However, the captain should have complied with the minimums on his approach chart, and the applicable provisions of Parts 91 and 97.

The absence of the definitive statement that RVR, when available, is controlling represents an oversight by the FAA in the approval of operations specifications. Based on the comments of the POI, it appears that other Part 129 operators may also be operating with inappropriate or outdated operations specifications. The FAA should confirm that foreign operators in the U.S. are operating with current operations specifications, including the provision that RVR is controlling in establishing minimums (*See* section 4, Recommendations).

The fact that this flight did not meet the specifications of ICAO Annex 6, as specified in Part 129.11 {a), reflects poorly on the oversight of this operator by TAESA management. In view of the FAA's role in overseeing Part 129 operators, the Safety Board believes that the FAA should formally bring the circumstances of this accident and the deviations from approved procedures and regulations to the attention of the Mexican authorities.

2.10 Crew Fatigue

Human factors research has demonstrated that fatigue can be assessed by examining three factors: cumulative sleep loss, continuous hours of wakefulness, and circadian disruption. These factors were examined in the present accident for evidence related to fatigue.

Scientific literature has established that people require a certain number of hours of sleep each day to be fully alert, usually between 6 to 10 hours, and that a loss of as little as two hours sleep from an individual's typical daily requirement can degrade alertness and performance. In the case of both pilots, the Safety Board was unable to establish the pilots' typical sleep needs or possible cumulative sleep loss.

The length of time that an individual has been awake has been associated with errors in judgment and performance. At the time of the accident, the captain was awake about 11 1/2 houri, a length of time that has been associated with cockpit errors, and especially tactical decision errors, in aviation accidents.[9] The Safety Board was unable to determine the amount of time that the first officer had been wake.

Circadian disruption refers to a disruption in the cycles of sleeping and wakefulness that individuals display on a daily basis. Flying all night when the individual normally sleeps at night is an example of a circadian disruption. In the

[9]A review of flightcrew-involved, major accidents of U.S. Air Carriers. 1978 through 1990, NTSB/SS-94/01

present accident, the crew began duty at 2200, which ended at 0625 the next **morning,** thereby disrupting the normal sleep/wake cycle that the accident **crew** displayed in the days before the accident.

Another form of circadian disruption **occurs** when **an** individual **remains** awake during a time period that the body is physiologically primed to **be** asleep. The time that the accident occurred, shortly after 0400 in Mexico City time, *represents a period of typically* **low** *physiological alertness as regulated by brain* activity (the period of greatest sleepiness typically occurs between **3** to 5 a.m. every day). Based on these circadian considerations, the pilots would have Peen exposed to reduced alertness **during** the time that critical decisions ·d *to* be **made** concerning landing.

The **evidence** suggests that, **after flying ail night,** the crew **could** have been experiencing the effects of fatigue due to both the length of hours they had been awake and circadian disruption. Such fatigue would have added to the problems caused by the relatively low experience levels of **both** crewmembers, further degrading decision making and other aspects of performance. However, **because** of the limitations in the information available, the Safety Board could not conclude that fatigue was involved in the accident. Nor could the Safety Board rule it out as a factor.

2.11 Passenger Seating

Although this was **a** nonsurvivable accident, the Safety Board is concerned that the number of passengers exceeded the designed seating capacity of the airplane. Since there were only eight seats and eight safety belts available for passengers, two people on board were not seated and safety belted in accordance with Annex **6** to **ICAO.** The impact forces and cabin breakup prevented establishing exact occupant seating locations, but regardless of the seating, the occupants still would have been at increased risk under lower crash forces because of the inadequate seating and restraint capability.

Recognizing that this was a revenue flight, **TAESA** management should have **been** aware that they were operating the flight in violation of applicable regulations. Finally, the captain acted irresponsibly in allowing passengers on **his** aircraft without adequate restraint capability.

3. CONCLUSIONS

3.8 Findings

1. The airplane and flightcrew were properly certificated.

2. There were no mechanical problems with the airplane or the engines.

3. The mway 1R RVR at IAD was below published landing minimums for all but Category III approaches.

4. There probably was ineffective communications between the carrier and the contract training facility regarding the pilots' skills.

5. The captain was not authorized to attempt the approach and was relatively inexperienced for an approach under these conditions.

6. The captain failed to adhere to acceptable standards of airmanship during two unstabilized approaches.

7. After the unsuccessful ILS approach to runway 1R, the captain should have held for improvements in the weather, requested the runway 19L ILS, or proceeded to his alternate.

8. The MSAW equipment at IAD was improperly adjusted; however, this discrepancy did not contribute to the cause of the accident.

9. All components of the mway 1R ILS were operating within prescribed tolerances at the time of the accident.

10. Air Traffic Control services provided to XA-BBA were in accordance with procedures outlined in FAA Order 71 10.65 Air Traffic Control.

11. An operating GPWS aboard the airplane would have provided continuous warning to the crew for the last 64 seconds of flight and might have prevented the accident.

12. The airplane was not equipped with a flight data recorder, as required under Annex 6 of the International Civil Aviation Organization provisions for international flights.

13. The crew may have been experiencing the effects of fatigue following an all-night flight,

14. The impact was not survivable.

15. There were only eight cabin seats and safety belts installed, which meant that at least two passengers were not properly restrained. This is not in compliance with Annex 6 of the International Civil Aviation Organization Standards for international flights.

16. Oversight of the operation of the accident airplane and the accident flight by TAESA and the Mexican government was inadequate.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of the accident were the poor decisionmaking, poor airmanship, and relative inexperience of the captain in initiating and continuing an unstabilized instrument approach that led to a descent below the authorized altitude without visual contact with the runway environment. Contributing to the cause of the accident was the lack of a GPWS on the airplane.

4. RECOMMENDATIONS

As a result of the investigation of this and other accidents, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

Require within 2 years that all turbojet-powered airplanes equipped with six or more passenger seats have an operating ground proximity warning system installed. (Class II, Priority Action) (A-95-35)

Require that all operations Specifications of Part 129 operators be reviewed to ensure that they are current, and contain specific language that establishes RVR, when reported, as controlling for purposes of establishing visibility minimum. (Class II, Priority Action) (A-95-36)

Formally notify the Mexican Director General Civil Aviation of the circumstances of the accident, with particular emphasis on the lack of adherence to pertinent regulations and requirements of the United States, Mexico, and ICAO. (Class II, Priority Action) (A-95-37)

In addition, on November 21, 1994, the Safety Board issued the following recommendations to the Federal Aviation Administration (See appendix D):

A-94-186

Review the calculations establishing the runway threshold coordinates for all runways at IAD with respect to the air surveillance radar to verify proper alignment of the MSAW capture boxes.

A-94-1.87

Conduct a complete national review of all radar environments using MSAW systems. This review should address all user-defined site variables for she MSAW programs that control general terrain warnings, as well as runway capture boxes, to ensure compliance with prescribed procedures.

A-94-188

Ensure that all airports equipped with the Phase II (enhanced) LLWAS are using geometric configuration files appropriate to those facilities.

The FAA responded favorably to all three recommendations on January 24, 1995. Pending issuance of the specific documents and appropriate corrective action, these recommendations have been classified "Open--Acceptable Action."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

James E. Hall
Chairman

Robert T. Francis II
Vice Chairman

John Hammerschmidt
Member

March 7,1995

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 0645 on June 18, 1994. The full go-team was dispatched, and the following investigative groups were formed Operations/Human Performance, Air Traffic Control, Weather, Survival Factors, Airplane Performance, Structures, Systems, Powerplants, and Maintenance Records.

In accordance with the provisions of ICAO's International Standards and Practices, Aircraft Accident and Incident Investigation, Annex 13, the Director General of Civil Aviation, Mexico (the state of registration and the operator) was notified of the accident, and an invitation was extended to participate in the investigation. The Director, Technical Supervision, Subsecretary of Transport, WAC, was appointed as the Accredited Representative of Mexico. He arrived on June 19, 1994, with a team of technical advisors and participated in the investigation. A draft copy of the final report was provided to him on December 2, 1994 for review and comment. He did not have any comment on the report.

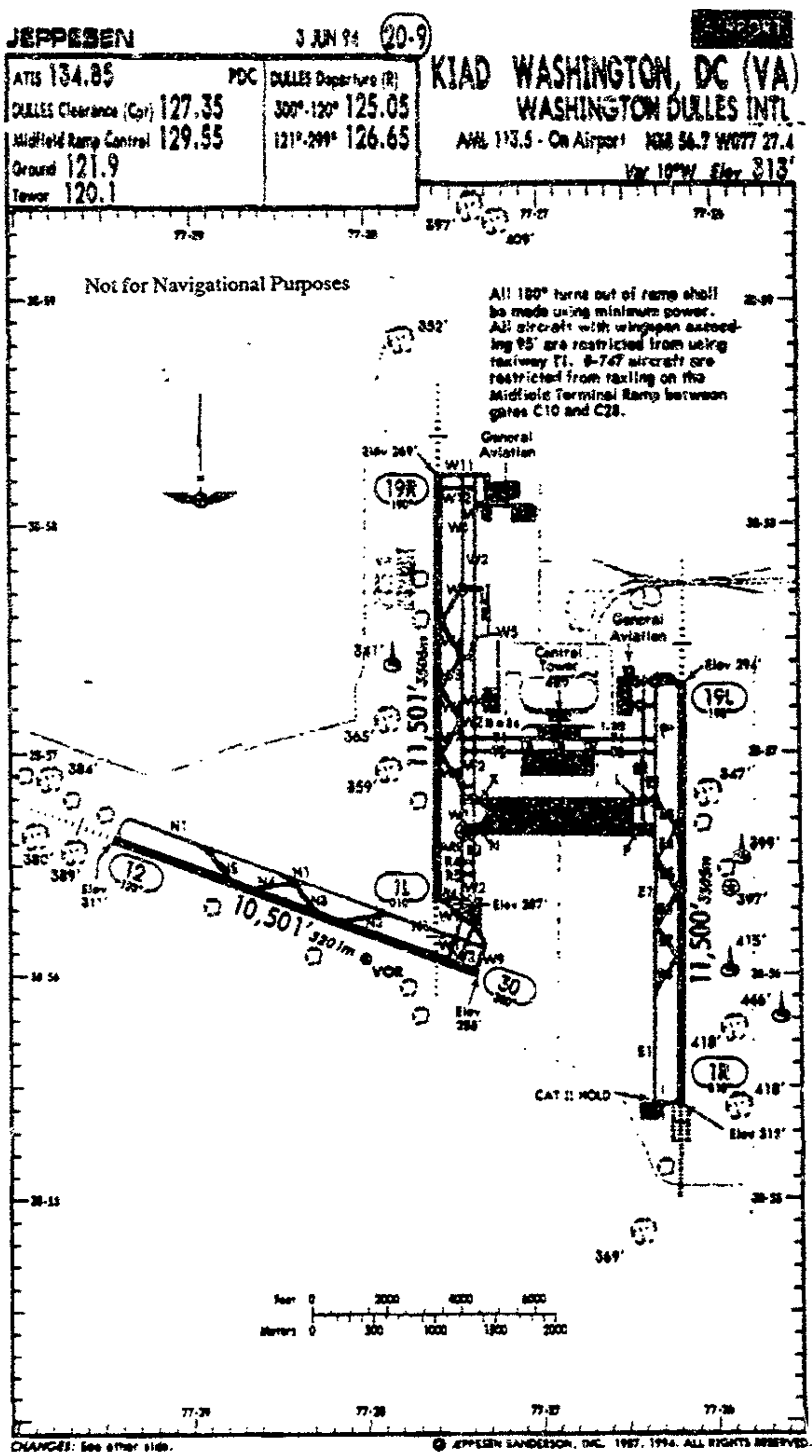
Parties to the investigation were the FAA, TAESA, Learjet, Inc., General Electric Aircraft Engines, and the Metropolitan Washington Airports Authority.

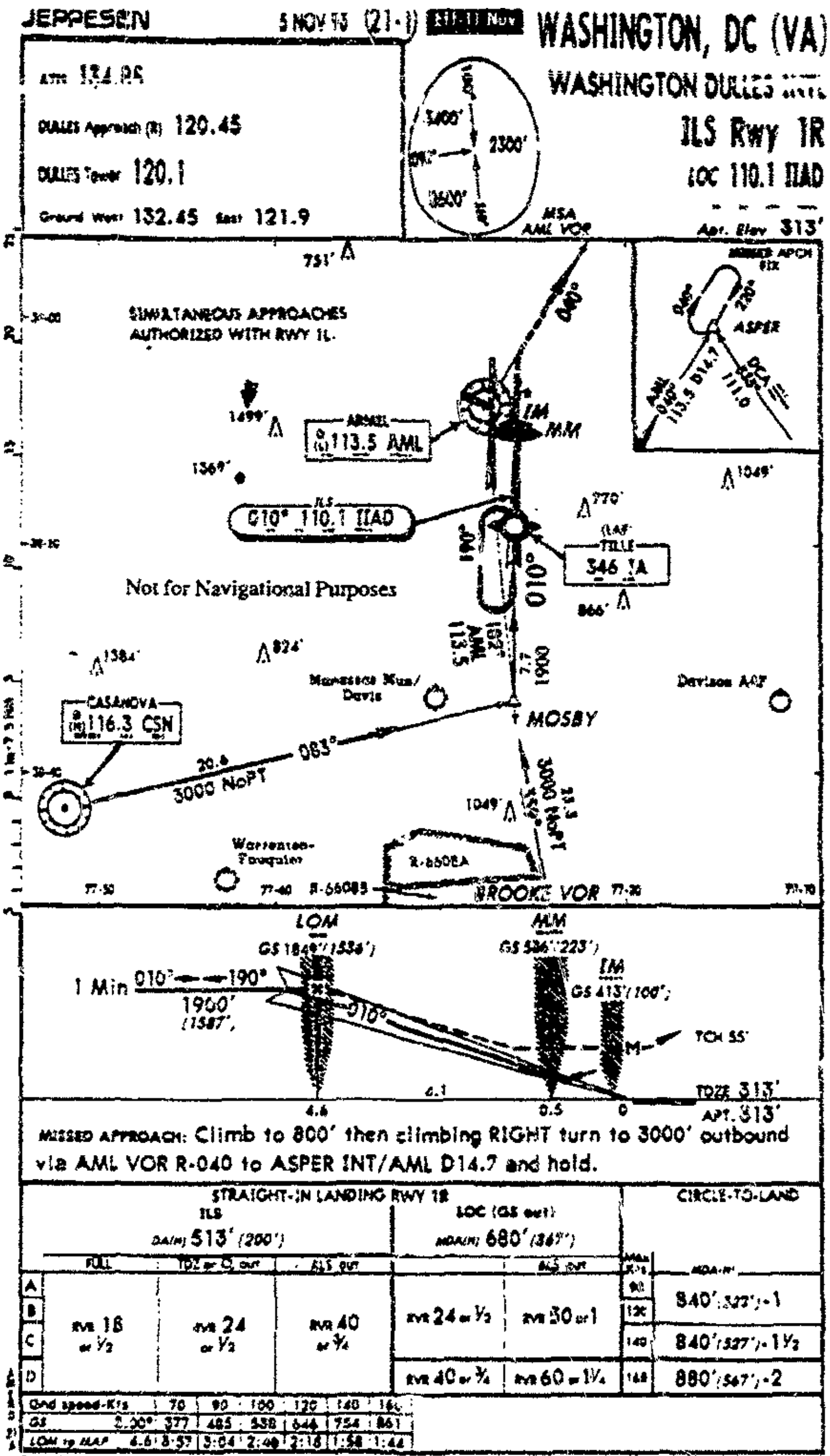
2. Public Hearing

There was no public hearing held in connection with this accident investigation.

APPENDIX B

RUNWAY INFORMATION




JEPPESEN
WASHINGTON, DC (VA)
WASHINGTON DULLES
ILS Rwy 1R
LOC 110.1 IIAD
DULLES Approach (R) 120.45
DULLES Tower 120.1
Ground West 132.45 East 121.9
3400'
2300'
3600'
MSA AML VOR
Apt. Elev 313'
SIMULTANEOUS APPROACHES AUTHORIZED WITH RWY 1L.
MISSED APCH FIX
ASPER
113.5 AML
010° 110.1 IIAD
346 TA
Not for Navigational Purposes
010°
190°
CASANOVA
116.3 CSN
083°
3000 NoPT
MOSBY
Davison AAF
Warrenton-Fauquier
R-6608A
BROOKE VOR
LOM
MM
IM
1 Min
1900'
(1587')
TCH 55'
TDZE 313'
APT. 313'
MISSED APPROACH: Climb to 800' then climbing RIGHT turn to 3000' outbound via AML VOR R-040 to ASPER INT/AML D14.7 and hold.
STRAIGHT-IN LANDING RWY 1R
ILS
DA(H) 513' (200')
LOC (GS out)
MDA(H) 680' (367')
CIRCLE-TO-LAND
RVR 18 or 1/2
RVR 24 or 1/2
RVR 40 or 3/4
RVR 24 or 1/2
RVR 50 or 1
RVR 40 or 3/4
RVR 60 or 1 1/4
840' (527')-1
840' (527')-1 1/2
880' (567')-2
CHANGES: Ground frequencies. Mosby Int redesignated.
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[illegible]

JEPPESEN 3 JUN 94 (20-9A)

WASHINGTON, DC (VA)
WASHINGTON DULLES INTL

GENERAL

CAUTION: Deer on airport.
Birds in vicinity of airport.
Low-level wind shear alert system.

ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS: LANDING BEYOND Threshold	USABLE LENGTHS: LANDING BEYOND Glide Slope	USABLE LENGTHS: Threshold to Intersecting Runway	TAKE-OFF	WIDTH
1R	HIRL CL ALSF-II TDZ grooved RVR		10,450' 3185m			150' 46m
19L	HIRL CL MALSR grooved RVR		10,501' 3201m			
1L	HIRL CL MALSR grooved		10,451' 3185m			150' 46m
19R	HIRL CL SSALR TDZ grooved RVR		10,400' 3170m			
12	HIRL CL MALSR TDZ VASI grooved		9501' 2896m	1L/19R 7050' 2149m		150' 46m
30	HIRL CL REIL PAPI-L (angle 3.0°) grooved					

TAKE-OFF

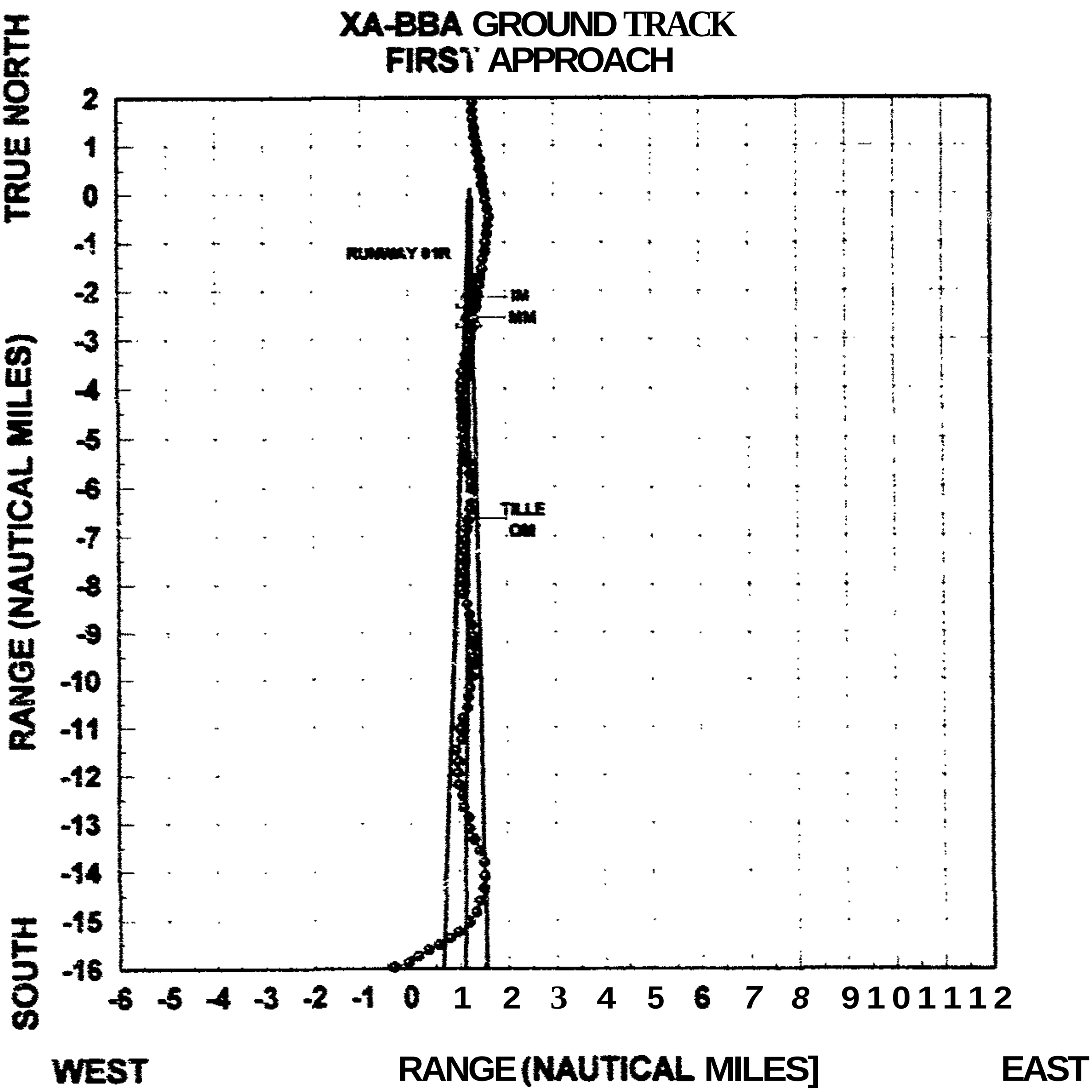
	Rwys 1R, 19L			Rwys 1L, 12, 19R, 30	
	CL & RCLM any RVR out, other two req.	Adequate Vis Ref	STD	Adequate Vis Ref	STD
1 & 2 Eng	TDZ RVR 6 Mid RVR 6	RVR 16 or 1/4	RVR 50 or 1	RVR 16 or 1/4	RVR 50 or 1
3 & 4 Eng	Roll-out RVR 6		RVR 24 or 1/2		RVR 24 or 1/2

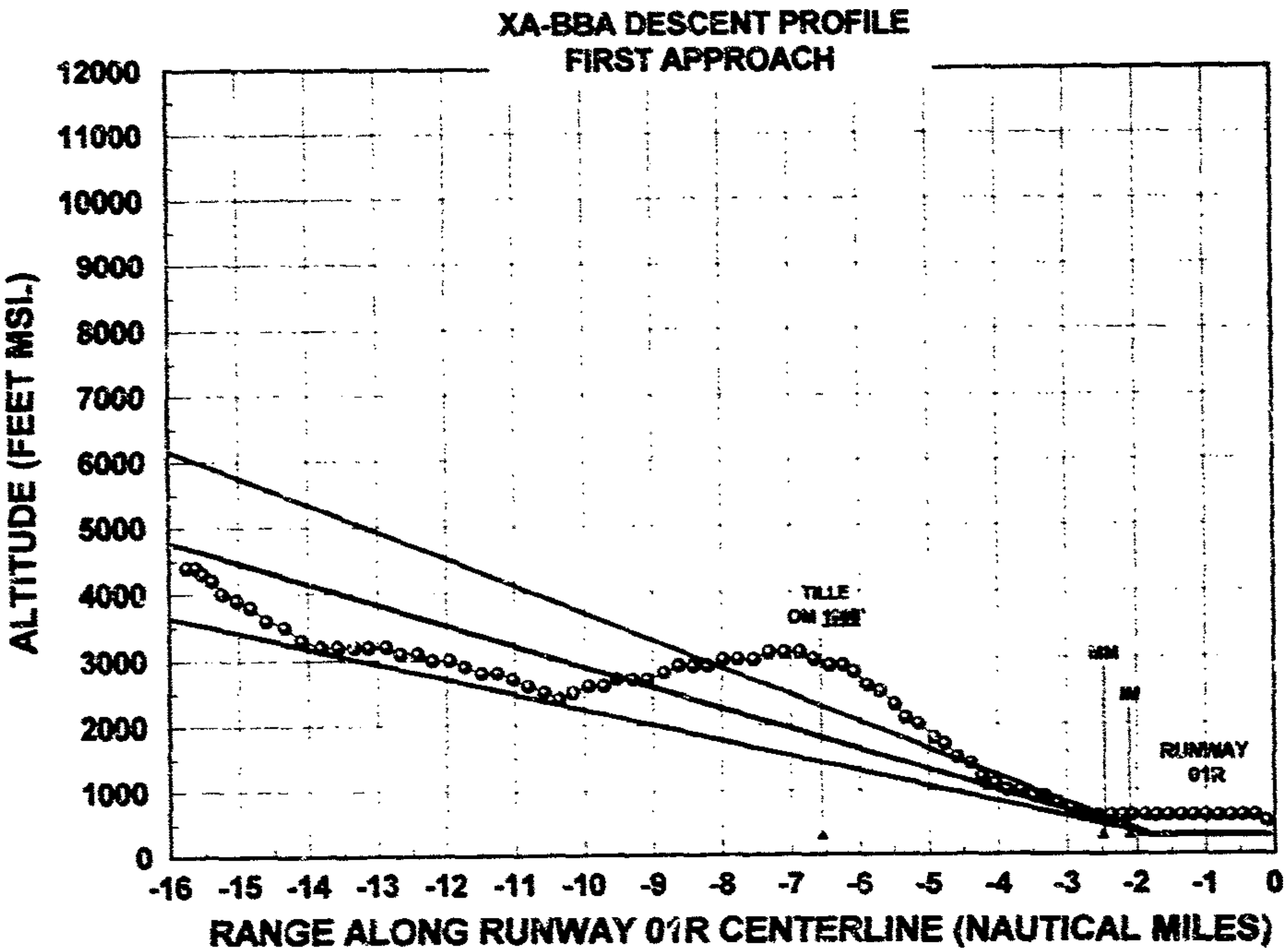
FOR FILING AS ALTERNATE

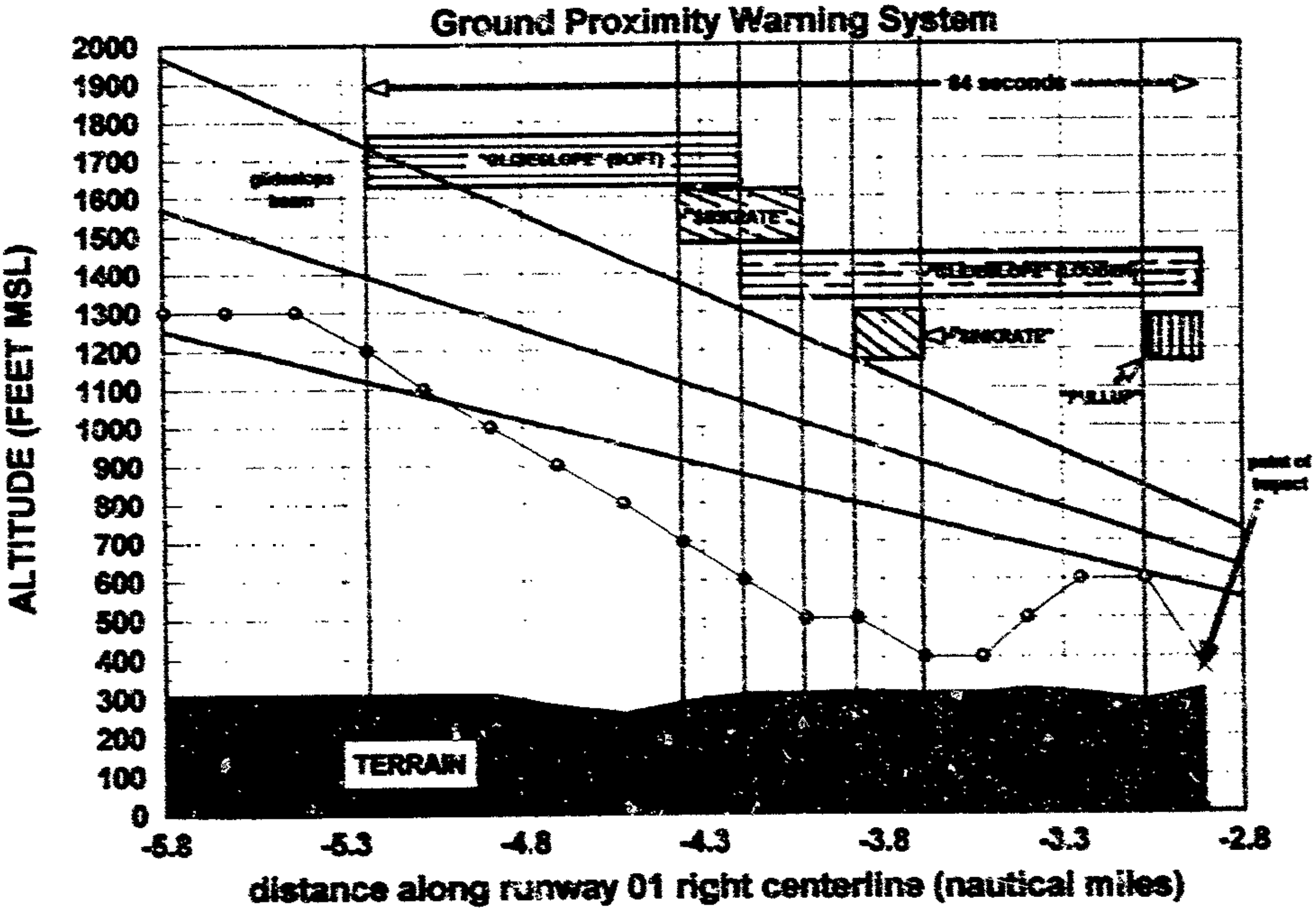
	ILS Rwy 1R ILS Rwy 12 ILS Rwy 19L ILS Rwy 19R ILS DME Rwy 1L	LOC Rwy 1R LOC Rwy 12 LOC Rwy 19L LOC Rwy 19R LOC DME Rwy 1L VOR DME Rwy 12 NDB Rwy 1R	Converging ILS Rwy 19L Converging ILS Rwy 19R Converging ILS Rwy 12
A B C	600-2	800-2	NA

APPENDIX C

GROUND TRACK AND APPROACH PROFILES



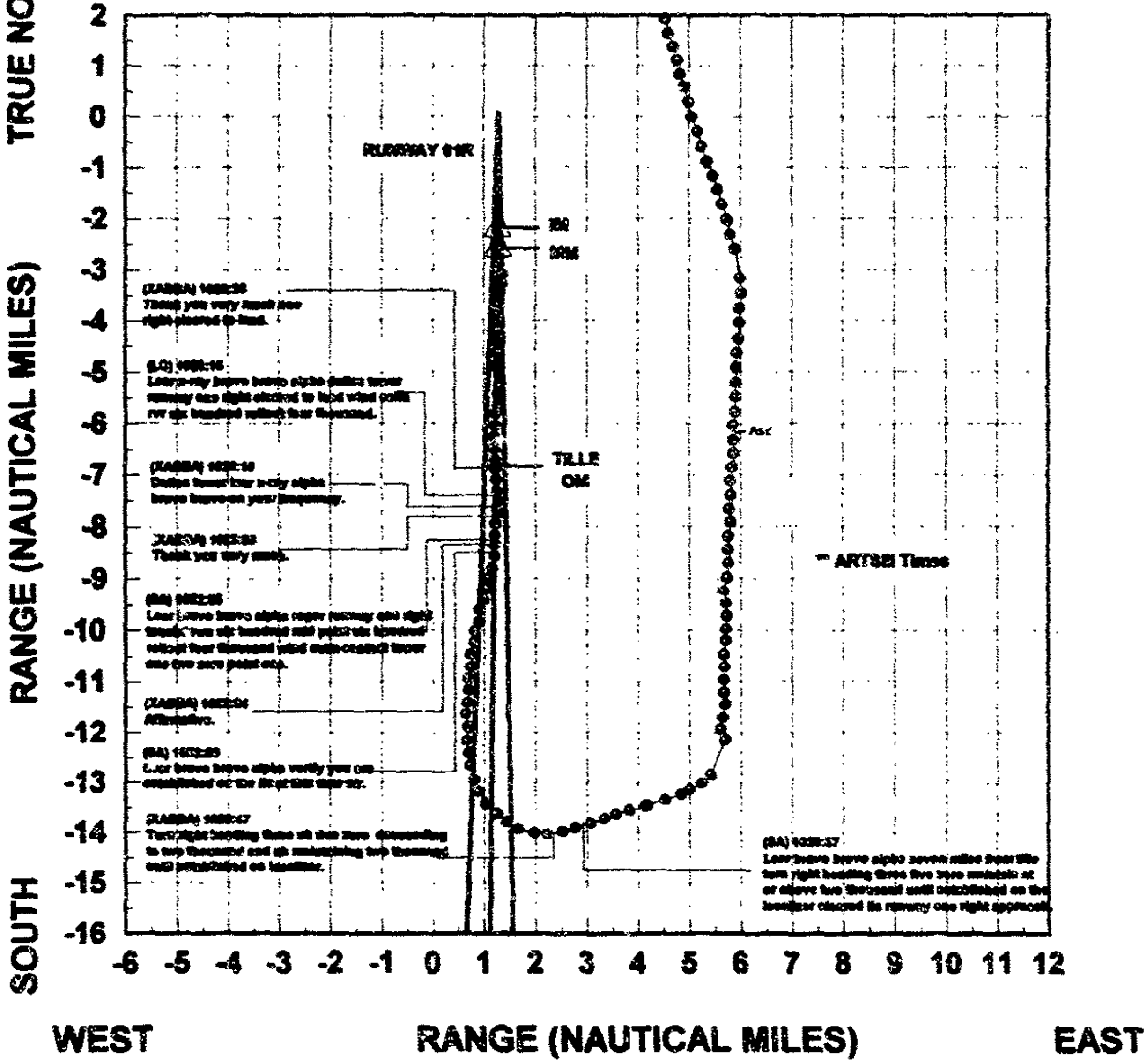

XA-BBA DESCENT PROFILE
FIRST APPROACH
ALTITUDE (FEET MSL)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
TILLE
OM
MM
IM
RUNWAY
01R
-16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0
RANGE ALONG RUNWAY 01R CENTERLINE (NAUTICAL MILES)

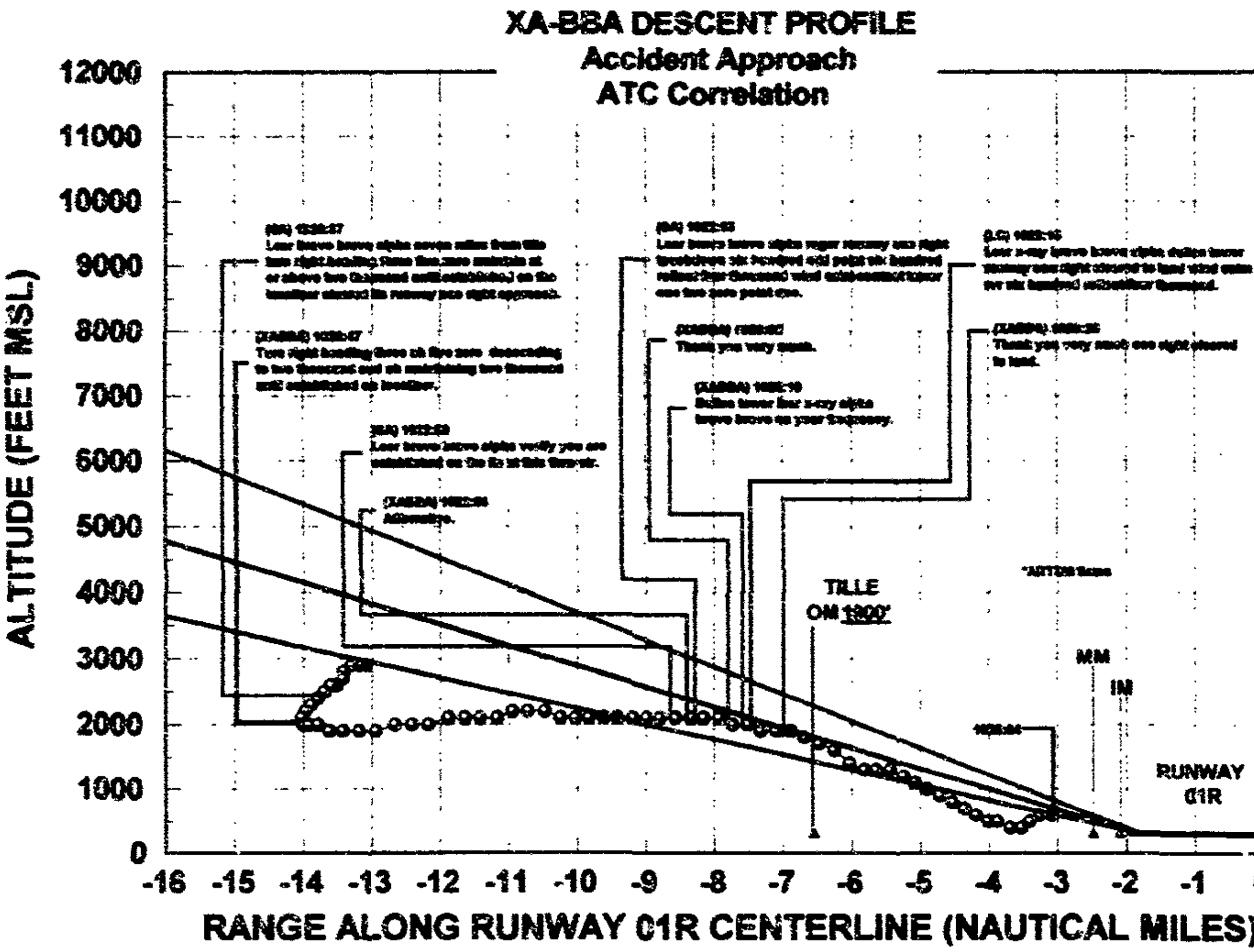


MODE 1 - Excessive Rate of Descent
- "sink rate"
- "pull up"

MODE 5 - Descent Below Glideslope
- "glideslope"

XA-SBA GROUND TRACK
Accident Approach
ATC Correlation




XA-BBA DESCENT PROFILE
Accident Approach
ATC Correlation
ALTITUDE (FEET MSL)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0
RANGE ALONG RUNWAY 01R CENTERLINE (NAUTICAL MILES)
TILLE
OM 1900'
MM
IM
RUNWAY
01R

APPENDIX D

SAFETY RECOMMENDATIONS

MSAW AND LLWAS

National Transportation Safety Board
Washington, D.C. 20594
Safety Recommendation

Date: November 21, 1394

In reply refer to: A-94-186 through -188

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

The National Transportation Safety Board's investigation of a recent accident involving a landing approach, in instrument meteorological conditions, at Washington Dulles International Airport (IAD), has revealed software discrepancies with the minimum safe altitude waming system (MSAW) and low level windshear alert system (LLWAS) operating at IAD at the time of the accident The discrepancies are believed to affect the accuracy of the warning systems. The Safety Board believes that action is required to correct the discrepancies at IAD, and may be required to correct similar discrepancies at other airports throughout the country.

The investigation found two apparent discrepancies in the site variables used in the MSAW program at IAD. Both were identified from the Absolute Assembly of MSAWD for A305-LO Dulles (IAD) document, dated October 29, 1993. The first discrepancy was found in the document on page 9, line 6570. This site variable is the definition of the runway 1R threshold in Cartesian coordinates (distance) relative to the air surveillance radar antenna. The Safely Board was informed by the Federal Aviation Administration (FAA) that the Automated Radar Terminal System (ARTS) III software at IAD was programmed for a 10° west variation, which is the current angular difference between true north and magnetic north at the Dulles airport However, when a 10° variation was applied to establish the coordinate reference, the resultant position for the runway 1R threshold did not correlate to the actual geographic runway location. It was found that the radar established position was 700 feet to the northeast from the actual runway threshold. It was determined that when a 7° west variation was used to establish the radar coordinate reference (instead of the correct 10° west variation) the coordinates for the runway 1R threshold corresponded to the actual location. The apparent 700-foot error in the radar position for the runway 1R threshold resulted in a similar displacement of the radar MSAW capture box from its intended position with respect to the actual approach path to runway 1R. This displacement might compromise the protective intent of the MSAW system.

Although the Safety Board examined the coordinates for the runway 1R threshold only, the Board believes that similar discrepancies exist in the radar locations for the other runway thresholds at Dulles.

The second discrepancy identified in the MSAW program was the defined minimum descent altitude (MDA) €or the runway 1R capture box. Document NAS-MD-633, Section 3.2 states:

> ILS localizer only MDA should not be used where another nonprecision approach exists. Nevertheless, some locations may, because of particular operational characteristics; e.g., absence of another nonprecision approach to a runway, need to adapt ILS localizer only MDA.

The lower limit for the runway 1R capture box was 267 feet above ground level (agl). This altitude was derived by subtracting the 313-foot field elevation and a 100-foot margin from the localizer-only MDA of 680 feet mean sea level (msl). However, runway 1R has a nondirectional beacon (NDB) approach with an MDA of 760 feet msl. Based on the information and criteria provided to the Safety Board, it appears that the NDB approach MDA should have been csed in establishing the runway 1R capture box lower limit. This would produce an alarm at 347 feet agl, 80 feet higher than the existing capture box. The Safety Board has not been provided with a written rationale, if one exists, for using the 267-foot base rather than a 347-foot base for the capture box. The offset of the MSAW capture box should be corrected, and it would seem prudent to conduct a one-time campaign of all MSAW programs io ensure that they are correctly configured. In addition, the lower limit of the MSAW capture box should conform to published criteria, or documentation that details the allowable deviations from the criteria should be published.

An FAA memorandum, dated July 7, 1994, responding to an official investigative request for information about the IAD LLWAS, stated that the geometric configuration file (GCF) in use was actually the GCF for Tampa International Airport, Florida. The memorandum further stated:

> It seems likely that IAD was using the incorrect LLWAS configuration at the time of the incident. However, IAD is currently using the correct configuration file.

Although the Safety Board believes that the basic windshear detection function of LLWAS would be unaffected by the discrepancy, the FAA Environmental Support Engineering Branch (AOS-220) advised us that to realize the capability of the enhanced Phase II LLWAS software, to provide optimum microburst detection, it is necessary to input an appropriate GCF that is distinct and unique to the airport of concern.

The Safety Board notes that the GCF at IAD has been corrected, but it is concerned that other airports with LLWAS installations may also have installed inappropriate configuration files.

As a result of its investigation of this accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Review the calculations establishing the runway threshold coordinates for all runways at IAD with respect to the air surveillance radar to verify proper alignment of the MSAW capture boxes. (Class II, Priority Action) (A-94-186)

> Conduct a complete national review of all radar environments using MSAW systems. This review should address all user-defined site variables for the MSAW programs that control general terrain warnings, as well as runway capture boxes, to ensure compliance with prescribed procedures. (Class II, Priority Action) (A-94-187)

Ensure that all airports equipped with the Phase II (enhanced) LLWAS are using geometric configuration files appropriate to those facilities. (Class II Priority Action) (A-94-188)

Chairman HALL, and Members LAUBER, HAMMERSCHMIDT and VOGT concurred in these recommendations.

By: Jim Hall
Chairman