FLIGHT SAFETY FOUNDATION
Accident Prevention
Vol. 54 No. 4 *For Everyone Concerned with the Safety of Flight* April 1997

During Nonprecision Approach at Night, MD-83 Descends Below Minimum Descent Altitude and Contacts Trees, Resulting in Engine Flame-out and Touchdown Short of Runway

Passengers were commanded to remove their shoes before evacuating the aircraft, which slowed the evacuation and could have caused injuries or loss of life in a fire or other critical situation, the official U.S. accident investigation report said.

FSF Editorial Staff

The crew of the American Airlines (AAL) McDonnell Douglas MD-83 was conducting a very high frequency omnidirectional radio range (VOR) instrument approach to Runway 15 at Bradley International Airport (BDL), Windsor Locks, Connecticut, U.S. (Figure 1, page 3). It was night and the flight was in instrument meteorological conditions (IMC). During the approach, the flight encountered moderate turbulence and moderate-to-heavy rain. The barometric pressure was falling rapidly, and the crew was advised of wind-shear alerts at BDL.

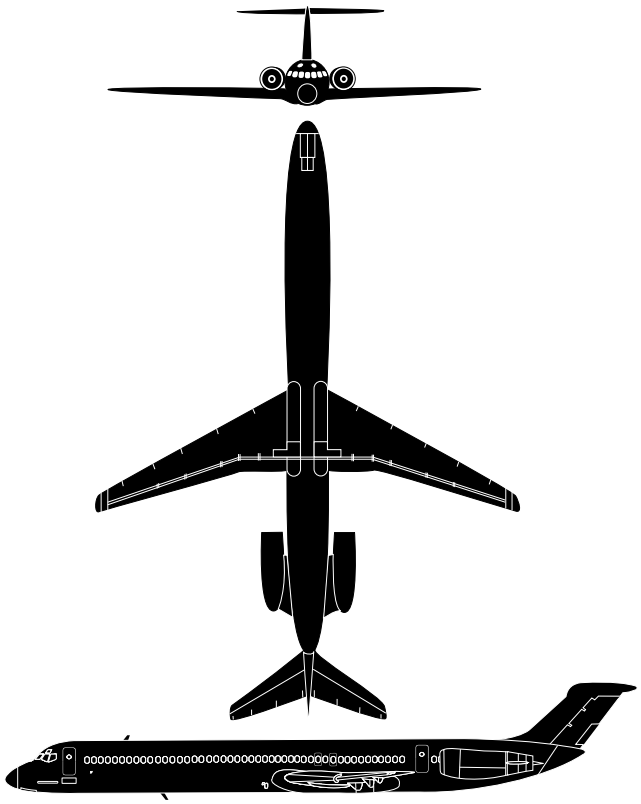
As the crew was descending the airplane to the published minimum descent altitude (MDA), the first officer looked outside the aircraft to locate the runway. He then glanced at the altimeter and noted that the airplane was below the MDA. The first officer alerted the captain — the pilot flying — of the discrepancy. Moments later, the MD-83 struck trees on a ridgeline, approximately 2.54 nautical miles (4.1 kilometers) northwest of the approach end of Runway 15.

The captain applied all available power and initiated a go-around. The left engine flamed out, but the right engine produced enough power to sustain flight. The aircraft collided with the localizer antenna array at the end of a safety overrun area, then landed on the edge of a stopway and rolled down Runway 15. The aircraft was evacuated.

One passenger received minor injuries in the Nov. 12, 1995, accident. The aircraft received damage in the amount of US$9 million. Damage to the airport equipment was $74,620.

The final report of the U.S. National Transportation Safety Board (NTSB) said that the probable cause of this accident was "the flight crew's failure to maintain the required minimum descent altitude until the required visual references identifiable with the runway were in sight. Contributing factors were the failure of the BDL approach controller to furnish the flight crew with a current altimeter setting, and the flight crew's failure to ask for a more current setting."

Flight 1572 (the accident flight) departed Chicago (Illinois, U.S.) O'Hare International Airport (ORD) for BDL at 2305 hours local time (one hour and 40 minutes behind schedule). Onboard were the captain, first officer, three cabin attendants and 73 passengers.



McDonnell Douglas MD-83

The McDonnell Douglas MD-80 series began as a higher-capacity variant of the DC-9. The MD-83 first flew in December 1984 and received U.S. Federal Aviation Administration (FAA) certification in 1985.

With the same cabin size as the MD-81 and -82, the MD-83 has a longer range than the two earlier versions because of increased fuel capacity made possible by two extra fuel tanks in the cargo compartment. Powered by two Pratt & Whitney JT8D-219 twin-turbofan engines, the MD-83 has a range of 2,501 nautical miles (4,635 kilometers) carrying 155 passengers and baggage, and a maximum takeoff weight of 72,575 kilograms (160,000 pounds). The aircraft has a cruising speed of 500 knots (925 kilometers per hour) and a service ceiling of 37,000 feet (11,285 meters).

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

When the flight was airborne, the AAL dispatcher provided the flight crew with updated weather and wind conditions at BDL via the aircraft's onboard automatic communications and recording system (ACARS). The message included the remark "PRESFR" (pressure falling rapidly) at BDL. ["PRESFR" when used in a weather report indicates a fall in pressure at the rate of 0.06 inch of mercury [Hg] per hour that totals 0.02 inch or more.]

The weather that night consisted of a deep low-pressure system (29.12 inches Hg [986 millibars (mb)]) over Quebec, Canada, with an occluded front extending south across eastern New York state. "A secondary low pressure center was located over New York [New York, U.S.]. There were strong southerly winds ahead of the front and strong westerly winds behind it," the report said. A large area of rain extended over the northeastern United States.

During the cruise portion of the flight, "the captain stated that he changed from a cruise altitude of FL [flight level] 330 (about 33,000 feet [10,065 meters]) to FL 350 (about 35,000 feet [10,675 meters]) to avoid an area of turbulence," the report said. The flight was cleared direct to BDL when it was 483 kilometers (300 miles) from the airport.

As the MD-83 descended from cruise, "the flight crew received two messages over the ACARS relating to the BDL weather," the report said. "The first message was sent by American's dispatcher at 0030, and provided the flight crew with the altimeter setting of 29.23 inches Hg [990 mb] that would cause the flight crew's altimeters to indicate feet above field elevation (QFE), and the altimeter setting of 29.42 inches Hg [996 mb] that would cause the standby altimeter to indicate feet [above] mean sea level (MSL) (QNH) at BDL."

AAL directs its flight crews to set their altimeters to QFE and the standby altimeters to QNH when operating below 10,000 feet (3,050 meters).

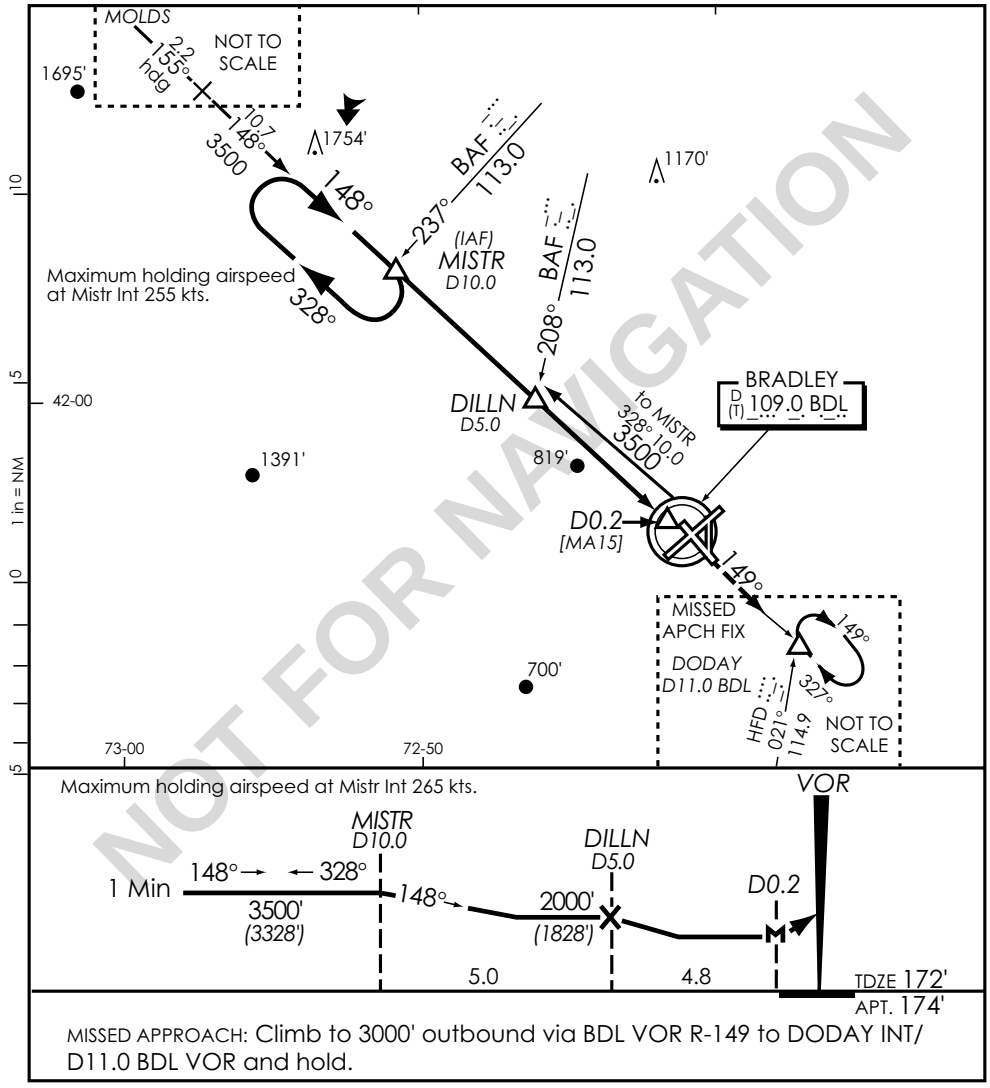
"After the accident, the primary altimeters were found set at 29.23 inches Hg, which is consistent with the setting given in the ACARS message," the report said. But, it added, "the standby altimeter was set at 29.47 inches Hg [998 mb], which does not match the setting found in the ACARS message, or with any of the other altimeter settings given to the flight crew." [The other settings included 29.50 inches Hg [999 mb], later given in an automatic terminal information service (ATIS) broadcast, and a setting of 29.40 inches Hg [996 mb], later given by the Boston (Massachusetts, U.S.) U.S. Federal Aviation Administration (FAA) air route traffic control center (ARTCC)].

At 0031, "another message was sent to the flight crew by the dispatcher advising [the crew] that airplanes had been making landings at BDL, and that those airplanes had been experiencing turbulence and wind shear on final approach," the report said.

Moments later, the flight was cleared to descend to FL 190 (19,000 feet [5,795 meters]) by the Boston ARTCC. "Also at that time, the cockpit voice recorder (CVR) recorded the last part of the [ATIS] information 'Victor' for BDL," the report said.

The ATIS information, which was 90 minutes old, "gave an altimeter setting of 29.50 inches Hg and stated that the significant meteorological information (SIGMET) 'X-ray three' was in effect, which reported severe turbulence below 10,000 feet," the report said.

Runway 15 Very High Frequency Omnidirectional Radio Range (VOR) Approach, Bradley International Airport, Windsor Locks, Connecticut, U.S.



NOT FOR NAVIGATION

Source: U.S. National Transportation Safety Board

Figure 1

At 0033, the flight was cleared to descend to 11,000 feet (3,355 meters) "and the [ARTCC] controller announced the Bradley altimeter setting to be 29.40 inches Hg," the report said. "The [first officer] acknowledged the altimeter setting and the clearance." The CVR indicated that the first officer then listened to the entire ATIS broadcast, and told the captain that the information was 90 minutes old.

During the descent for the approach, "the captain advised the flight attendants to secure the cabin due to turbulent conditions," the report said. "At 0038:45, as part of the before-landing checklist, the first officer asked, 'Altimeters?' The captain said, 'Twenty-nine fifty'. The first officer stated, 'They called twenty-nine forty seven when we started down … whatever you want.' The captain replied, 'OK.'" [The NTSB did not know why the first officer "announced an altimeter setting of 29.47 inches Hg."]

The flight crew briefed for the VOR instrument approach procedure to Runway 15. The CVR indicated that at 0042:48, the captain said, "One seventy-four's (174 feet [53 meters]) the [airport] elevation so, twenty-nine, twenty-three. Reset and cross-checked." The first officer said, "Minus uh," to which the captain said, "Showing seventy … check seventy feet [21.3 meters] difference," the report said.

At 0043:41, the flight contacted the BDL FAA terminal radar approach control (TRACON) and was told to expect the VOR

approach to Runway 15. About two minutes later, the flight was cleared to descend to 4,000 feet (1,220 meters). The controller told the flight crew that the surface winds at BDL were from 170 degrees at 29 knots (54 kilometers per hour [kph], with gusts to 39 knots (72 kph). The flight was vectored to the VOR Runway 15 final approach course, and at 0049:51 the flight was cleared for the approach.

The approach controller then told the flight crew that the BDL FAA air traffic control tower "was temporarily closed because of a problem with one of the windows, and to report the 'down time' on approach control frequency," the report said.

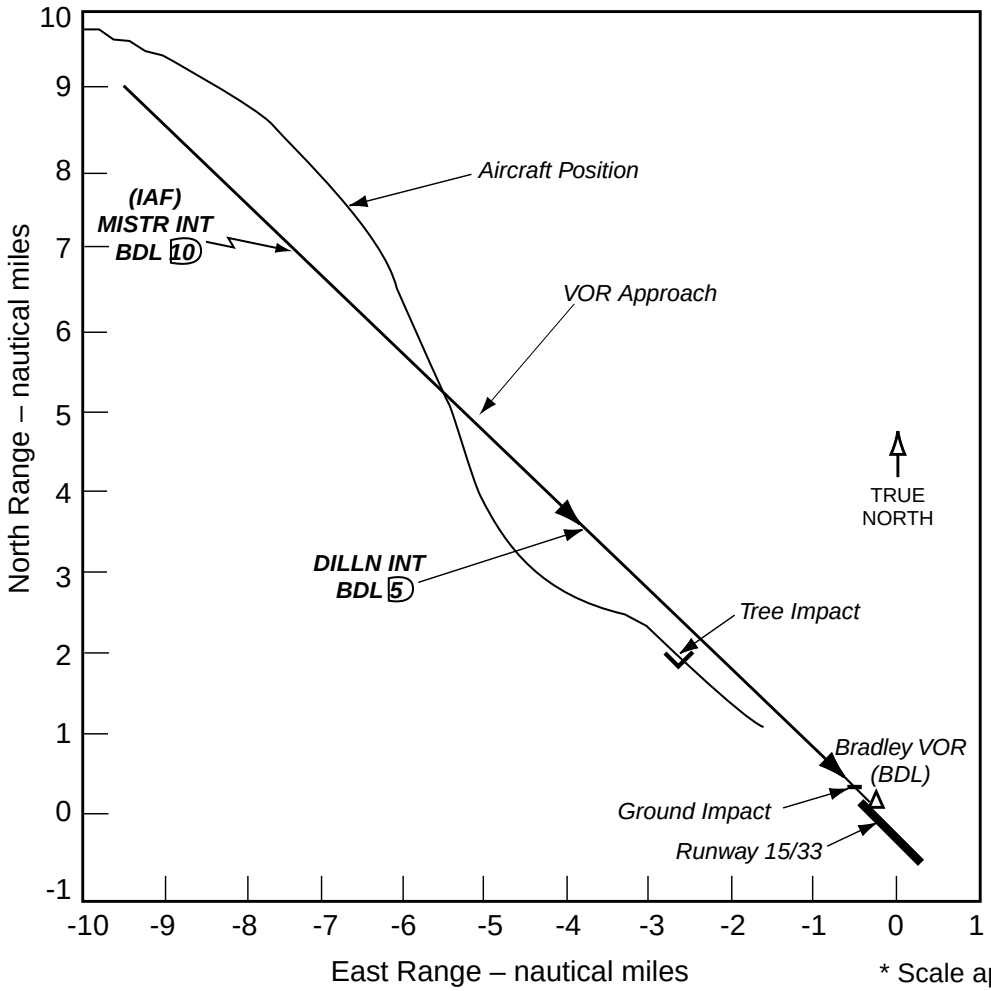
[The high winds on the night of the accident had caused one of the windows in the BDL tower to flex and water had leaked inside the tower cab. The tower had been temporarily closed so that repairs could be made, and the local and ground control frequencies were monitored in the BDL TRACON.]

The first officer said that the flight "intercepted the approach course at around 3,500 feet [1,067 meters] about [24.1 kilometers (15 miles)] from the airport, and the captain began configuring the airplane for landing," the report said. "The captain stated that he had the radar on the [32.2-kilometer (20-mile)] range, observed no convective activity between their position and the airport, and then turned the radar off."

The flight crew used the autopilot for the descent and approach. Figure 2 shows lateral radar-track data for Flight 1572's VOR approach to Runway 15.

"The captain stated that he selected the VOR/LOC (localizer) mode for the autopilot during the approach; however, due to the strong winds, the autopilot attempted to apply about a 30-degree course correction and the 'autopilot couldn't hold it,'" the report said.

Lateral Radar-track Data for Flight 1572 Very High Frequency Omnidirectional Radio Range (VOR) Approach, Nov. 12, 1995*

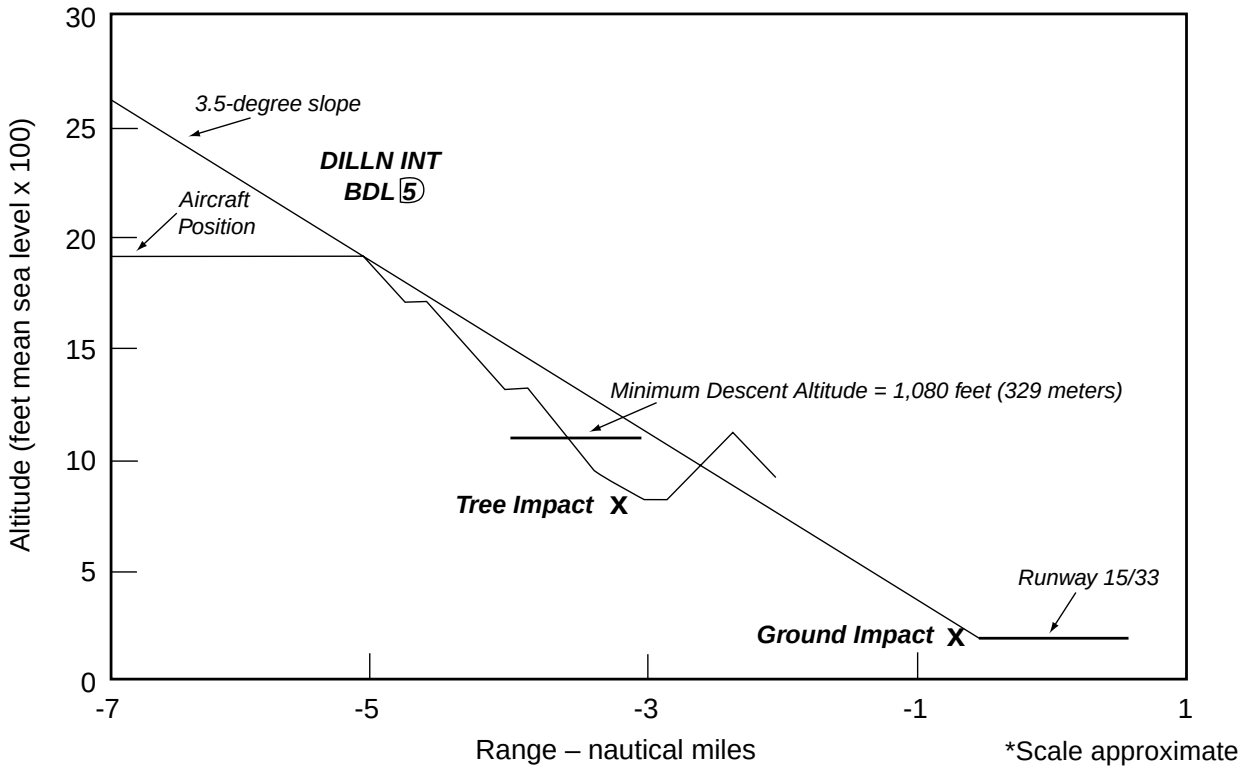


* Scale approximate

Source: U.S. National Transportation Safety Board

Figure 2

Descent Profile Radar-track Data for Flight 1572 Very High Frequency Omnidirectional Radio Range (VOR) Approach, Nov. 12, 1995*



Source: U.S. National Transportation Safety Board

Figure 3

The BDL TRACON controller then told the flight crew that the airplane was left of the final approach course. "The captain stated that he changed the mode of the autopilot to HDG SEL (heading select) to manually recapture the inbound course," the report said. "After crossing MISTR [the initial approach fix], the airplane was configured for landing with 40 degrees flaps and the landing gear down."

Also after crossing MISTR, the aircraft began to descend to 2,000 feet (610 meters), which was the minimum altitude for crossing DILLN (the final approach fix [FAF]). The captain used the vertical speed (VERT SPD) mode of the autopilot for pitch control. Figure 3 shows radar-track data for Flight 1572's descent profile.

During the descent to 2,000 feet, "the captain stated that the airplane encountered moderate turbulence and very heavy rain ... ," the report said. The autopilot captured the airplane's altitude at 2,000 feet before the aircraft crossed DILLN. After crossing DILLN, the report said that the captain "began the descent to the [MDA] of 908 feet [277 meters] above the field elevation, using the VERT SPD mode of the autopilot. At 0054:22, the captain asked the first officer to 'give me a thousand down' [a descent rate of 1,000 feet (305 meters) per minute]."

The BDL approach controller reported to the accident flight, "There is someone in the tower, it's not really officially open, but you can change to tower frequency one two zero point three," the report said. A supervisor, an instrument-rated pilot and a certificated flight instructor, from the BDL TRACON was in the tower as repairs were being made.

When the flight crew contacted BDL tower, the report said that the supervisor told the crew that "landing is at your discretion sir. The wind is one seven zero at two five, peak gust to four zero. And uh, the runway does appear clear. You can land and taxi to the gate at your discretion."

The report said that at 0054:51, the supervisor reported, "Windshear alert, uh, center field one seven zero at two five. The uh, northeast boundary, one seven zero at two four, one niner zero at twelve at the southeast boundary." The first officer acknowledged the transmission and said to the captain, "There's a thousand feet … cleared to land."

Moments later, the first officer told the captain, "Now, nine hundred and eight is your uh … ." The captain said, "Right." At this point, the report said, "The first officer later told investigators that he had ground contact 'straight down' and,

Cockpit Voice Recorder Transcript, American Airlines Flight 1572, Nov. 12, 1995

Time	Source	Content
0049:41	**APR**:	American fifteen seventy-two, you're five miles from MISTR. Cross MISTR at or above three thousand five hundred, cleared for the VOR runway one five approach.
0049:49	**RDO-2**:	OK we'll uh, we're cleared for the approach. And we'll cross MISTR at or above uh, thirty-five hundred. American fifteen seventy-two.
0049:55	**CAM-1**:	Set. Comin' down.
0049:57	**APR**:	American fifteen seventy-two, roger and uh, be advised uh, the tower is closed at this time. It's a, temporary closure, due to uh, problem with uh one of the windows uh, so I'll need a uh, a down uh time on you but you can stay on this frequency uh, for that.
0049:59	**CAM**:	[Sound similar to stabilizer in motion horn]
0050:16	**RDO-2**:	Roger and, what happened on the window?
0050:19	**APR**:	It's just loose. They've got carpenters up there now boarding it up …
0050:23	**CAM-2**:	It blew out.
0050:23	**APR**:	… but once that's done the tower should open.
0050:25	**RDO-2**:	Copy.
0050:28	**CAM-1**:	Flaps eleven, please.
0050:30	**CAM-2**:	You got it.
0050:34	**CAM**:	[Sound of rattling similar to aircraft going through turbulence]
0050:51	**CAM-2**:	OK, five hundred feet, looking good, you can go down to, step down to two thousand by five miles. But then it …
0050:58	**CAM-1**:	What's your **?
0051:03	**CAM-2**:	I think it's gonna be smoother once we get out of the weather.
0051:05	**CAM-1**:	Yeah.
0051:10	**CAM-2**:	OK, you're at thirty-five hundred *.
0051:16	**CAM-1**:	OK, we're cleared down to where?
0051:17	**CAM-2**:	You're cleared down to two thousand MSL at DILLN. By DILLN …
0051:21	**CAM-1**:	OK, two thousand set and armed.

as the airplane was 'at the base of the clouds,' he began looking for the field visually. He then looked back at his altimeter and saw the airplane was descending below the MDA."

The CVR recorded the aircraft flying through turbulence and, at 0055:26.3, the first officer said to the captain, "You're going below your … ," the report said. ["During a postaccident interview, the captain stated that the first officer said, '100 below' at that time, rather than 'you're going below your ... '".]

"The captain pushed the altitude hold button for the autopilot," the report said.

A "sink rate" warning was then heard on the CVR and, four seconds later, the sound of an impact could be heard. "The captain later stated that he then heard a 'loud report,' followed by severe turbulence," the report said. … Investigators determined that the first impact point was with trees on the top of a ridgeline approximately 2.54 nautical miles [4.1 kilometers] northwest of the approach end of Runway 15."

The first officer later told investigators that after the impact, "the captain called for a go-around and 'firewalled the throttles,'" the report said. "Flaps were selected to 15 degrees, and the landing gear handle was placed in the 'up' position. Both flight crew members reported that the onboard wind-shear warning system and the ground-proximity warning system (GPWS) activated after the impact … . The captain stated that in a 'second or two,' the turbulence stopped, and at 0055, according to the CVR recording, he said to the first officer, 'Left motor's failed.'

"The airspeed started to decrease, and the airplane began a slow descent," the report said. "The rain stopped, and the first officer saw the runway. According to the captain, the right engine was not sustaining full thrust, and, at 0056, he said, 'Tell 'em we're goin' down.' The first officer complied. The first officer then stated to the captain, 'You're going to make it,' and queried whether the captain wanted the landing gear lowered. The first officer then selected the landing gear to the 'down' position."

The report continued: "The captain stated that he then called for flaps to be lowered to 40 degrees to achieve a 'balloon effect' to reach the runway. The airplane clipped the top of a tree near the end of the runway, impacted and destroyed most of the ILS [instrument landing system] antenna array located at the end of the safety overrun area for Runway 33, and landed on the edge of the stopway. The airplane rolled down the stopway and continued down Runway 15, stopping on the runway beyond the intersection of Runway 6/24 near the [control] tower."

After the airplane stopped, the captain ordered an evacuation. "A flight attendant opened the aft emergency exit/galley door, but the slide did not inflate automatically, as intended," the

0051:22	**CAM-2**:	… five miles * so it's good. Two thousand is set and armed.
0051:27	**CAM-1**:	Flaps fifteen.
0051:28	**CAM-2**:	Down to flaps fifteen.
0051:30	**CAM**:	[Sound similar to flap/slat handle being moved and sound of rattling similar to aircraft going through turbulence]
0051:44	**CAM-1**:	OK, comin' down.
0051:44	**CAM-2**:	Ten miles.
0051:48	**CAM-1**:	Comin' back to idle.
0051:49	**CAM-2**:	Roger.
0051:56	**APR**:	American fifteen seventy-two uh, you show yourself on the final? Looks like you're uh, a bit to the left of it.
0052:01	**CAM-1**:	Yeah, looks like we're to the left of it.
0052:02	**RDO-2**:	Copy.
0052:03	**APR**:	American fifteen seventy-two roger, and the wind's now one seven zero at two four, gusts three five.
0052:07.9	**RDO-2**:	Roger.
0052:11	**CAM-1**:	How 'bout gear down, please.
0052:12	**CAM**:	[Sound similar to landing gear handle being operated followed sound similar to nose gear door opening]
0052:24	**CAM-2**:	* thousand and five.
0052:24	**APR**:	American fifteen seventy-two uh, K, there is someone in the tower, it's not really officially open, but you can change to tower frequency one two zero point three.
0052:34.5	**RDO-2**:	OK, you're not gonna need that down time?
0052:36	**APR**:	Negative.
0052:39.0	**RDO-2**:	See ya.
0052:39	**APR**:	Good day.
0052:42	**CAM-1**:	OK, it's two thousand feet until five miles.
0052:43	**CAM**:	[Sound similar to stabilizer-in-motion horn]
0052:45	**CAM-2**:	That's it.
0052:46	**CAM-1**:	Coming back. Flaps twenty-eight.
0052:47	**CAM**:	[Sound similar to flap handle being moved]
0052:50	**CAM-2**:	OK, going down to nine oh eight, huh?
0052:53	**CAM-1**:	Yeah.

report said. "[The flight attendant] pulled the manual inflation handle, and the slide then inflated. An unknown number of passengers and two flight attendants evacuated through this exit."

During the evacuation, "flight attendants shouted commands to passengers to remove their shoes (regardless of shoe style) and to leave carry-on luggage on the airplane," the report said. "About a third of the passengers who completed questionnaires [following the accident] stated that shoe removal either slowed their evacuation or that shoes in the aisle obstructed their exit. Passengers (including a woman carrying a 10-month-old baby) reported that they stumbled or tripped over piles of shoes in the aisle and galley areas."

The report said that the piles of shoes "could have caused injuries or loss of life in the case of an interior fire or other critical situation. The practice of commanding all passengers to remove shoes during evacuations was originally targeted primarily at high-heeled shoes, and was intended to prevent slide punctures. But modern slide design and strengthened fabric material now used in slide manufacturing make the policy outdated. In addition, with the exception of high-heeled shoes, safety is served by passengers wearing shoes because they can exit an airplane and move away from an evacuated airplane more readily.

"It may still be appropriate for crew members to instruct female passengers to remove high-heeled shoes that could cause injuries during an evacuation. Experience has shown that ankle and leg injuries are more likely to result from passengers wearing high heels. In addition, other injuries could also occur to rescue personnel and passengers, as the passenger wearing high heels slides down to waiting individuals at the bottom of the slide."

The report concluded: "Directing all passengers to remove shoes during evacuations may not be in the best interests of safety. There is no FAA policy regarding issuing commands for shoe removal during an evacuation. Although AAL is the only major carrier the [NTSB] is aware of that instructs passengers to remove shoes during an evacuation, the [NTSB] is concerned that there is no uniform policy or standard to which all operators (large and small) must adhere."

The NTSB recommended that the FAA "develop a uniform policy on shoe removal during evacuations, and require that all operators train their flight attendants to issue commands during an emergency evacuation consistent with that policy," the report said.

When investigators inspected the aircraft following the accident, the report said that they found that "the airplane was damaged from its impact with the trees and localizer antenna posts. There was no fire damage to the fuselage and no impact damage to the fuselage above the floor line. No impact damage or skin waviness was noted in the areas around the pitot tubes

0052:54	**CAM-2**:	Set and armed *.
0052:56	**CAM-1**:	Naw you don't have to do *, three thousand **.
0052:58	**CAM-2**:	Three thousand, missed.
0053:04	**CAM**:	[Sound similar to stabilizer-in-motion horn.]
0053:11	**CAM-2**:	* VOR, right on track.
0053:13	**CAM-1**:	OK.
0053:16	**CAM-2**:	Gear's down and green spoiler lever?
0053:18	**CAM**:	[Sound of click similar to spoiler lever being armed]
0053:19	**CAM-1**:	Armed.
0053:20	**CAM-2**:	You got brakes are going to medium.
0053:23	**CAM**:	[Unidentified high-frequency sound of decreasing pitch for approximately one second duration]
0053:26	**CAM-1**:	**.
0053:27	**CAM**:	[Sound similar to stabilizer-in-motion horn]
0053:27.7	**RDO-2**:	Hey tower, American fifteen seventy-two, we're on a six-mile final for runway five.
0053:32	**TWR**:	American fifteen seventy-two, 's Bradley tower uh, landing is at your discretion sir. The wind is one seven zero at two five, peak gust to four zero. And the runway does appear clear. You can land and taxi to the gate at your discretion.
0053:40	**CAM**:	[Unidentified high-frequency sound of decreasing pitch for approximately one second duration]
0053:43	**CAM-2**:	Showing you going through the course.
0053:46.3	**RDO-2**:	Are you uh and uh, what are you showing right now for winds?
0053:50	**TWR**:	One seven zero at two four.
0053:53.3	**RDO-2**:	Copy.
0053:58	**CAM**:	[Sound of rattling similar to aircraft going through turbulence]
0054:01	**CAM-1**:	Flaps forty.
0054:03.3	**CAM**:	[Sound of click similar to flap/slat handle being moved]
0054:04	**CAM-2**:	OK, annunciator lights checked, flaps and slats at forty forty and land, you're cleared to land dude.
0054:22	**CAM-1**:	OK, give me a thousand down.
0054:23	**CAM-2**:	One thousand down, you got it.
0054:34	**CAM-2**:	You're showin' **.

or static ports. The fuselage section forward of the wing front spar had no impact damage. The fuselage belly honeycomb fairing, aft of the wing front spar, sustained impact damage with numerous punctures and some scrape marks from forward to aft."

Both wings remained attached to the fuselage, with damage to the leading- and trailing-edge control surfaces. The damage to the left wing "consisted mainly of dents and tears, forming a semicircular shape, with wood fiber embedded at the impact locations," the report said. The leading-edge slats on both wings sustained impact damage. The trailing-edge flaps were extended to 40 degrees, and both sets of inboard flaps sustained impact damage.

The nose landing gear sustained minor impact damage. "Both nose landing-gear taxi lights were broken," the report said. "Small pieces of nose landing-gear taxi-light glass and a retainer ring were found on the ridge. Small tree limbs, about [20.3 centimeters (eight inches)] long and [2.5 centimeters (one inch)] in diameter were found wedged between the taxi-light fixtures."

The right-main landing gear sustained damage to the scissors assembly. "The outboard gear door was missing and was located on the ridge," the report said. The left-main landing gear sustained minor impact damage. "The outboard tire … had burst at some point in the accident sequence … ," the report said.

When investigators examined the engines, tree branches and sticks were found in both inlets. "The fan blades on both engines had soft body-impact damage and wood fibers were found on the underside of the midspan shrouds," the report said. "The right engine-fan duct and intermediate case were burned in the plane of the seventh- and eighth-stage compressor stages; however, the cowling was not burned."

An internal examination of the engines was conducted and "revealed that the left-engine low-pressure compressor (LPC) stages were damaged due to the impact of the rotors with the stators, particularly in the third-stage area," the report said. "The high-pressure compressor (HPC), high-pressure turbine (HPT) and low-pressure turbine (LPT) were not damaged, but they had metal spatter on the airfoil surfaces."

The report noted: "The right engine LPC stages were also damaged due to the impact of the rotor with the stator airfoils. The HPC seventh-, eighth- and ninth-stage blades were burned, almost down to the airfoil platforms. Metal spatter was found on the HPT and LPT airfoils."

The captain, 39, held an airline transport pilot (ATP) certificate, a flight engineer certificate with turbojet rating, and a valid first-class medical certificate with no limitations. He had 8,000 hours of flight time, with 1,514 hours as pilot-in-command in the DC-9/MD-80. The captain's last recurrent

0054:35	**CAM-1**:	**.
0054:41	**CAM-2**:	You got a long ways to go.
0054:47	**CAM**:	[Sound similar to stabilizer-in-motion horn]
0054:51	**TWR**:	Wind-shear alert uh, center field one seven zero at two five, the uh, northeast boundary, one seven zero at two four, one niner zero at twelve at the southeast boundary.
0055:01.6	**RDO-2**:	Copy.
0055:06.5	**CAM-2**:	There's a thousand feet. You got forty forty land, cleared to land.
0055:09	**CAM-1**:	OK.
0055:11	**CAM-2**:	* now. Nine hundred and eight is your uh …
0055:14	**CAM-1**:	Right.
0055:16	**CAM-2**:	Your * bug.
0055:18	**CAM**:	[Sound of rattling similar to aircraft going through turbulence]
0055:26.3	**CAM-2**:	You're going below your …
0055:26.8	**CAM-4**:	Sink rate …
0055:28	**CAM-2**:	**.
0055:29.5	**CAM-4**:	Sink rate …
0055:30.4	**CAM**:	[Sound of impact]
0055:31.2	**CAM-4**:	Sink rate …
0055:31.2	**CAM-4**:	[Sound of four beeps followed by]
0055:31.8	**CAM-4**:	Wind shear, wind shear …
0055:32	**CAM-?**:	Go.
0055:33.5	**CAM-4**:	Wind shear …
0055:32.9	**CAM-2**:	Go, go around.
0055:33	**CAM-1**:	We're going, going, going around, going around.
0055:34.3	**CAM**:	[Sound of horn]
0055:35.3	**CAM-4**:	Landing gear …
0055:36.9	**CAM**:	[Sound of horn]
0055:37.7	**CAM-4**:	[Sound of four beeps followed by]
0055:38.4	**CAM-4**:	Wind shear, wind shear, wind shear.
0055:39.1	**CAM-1**:	Flaps fifteen, positive rate, gear up.
0055:41.7	**CAM**:	[Sound of horn]
0055:42.7	**CAM-4**:	Landing gear.
0055:43	**CAM-2**:	You want the gear up?
0055:43	**CAM-1**:	Yep.
0055:44.4	**CAM**:	[Sound of horn]
0055:45.4	**CAM-4**:	Landing gear.
0055:46	**CAM-?**:	###.

training and proficiency check were on Aug. 21, 1995, and his last line check was on July 17, 1995.

The first officer, 39, held an ATP certificate for airplane multi-engine land, a commercial certificate for airplane single-engine land, and an FAA first-class medical certificate with no limitations. He had 5,100 hours of flight time, with 2,281 hours as second-in-command in the MD-80. The first officer's last recurrent training and proficiency check were on Aug. 19, 1995, and his last line check was on July 21, 1995.

The NTSB reviewed the airline's altimeter procedures. "AAL is the only United States airline that uses the QFE (height above field elevation) altimeter setting system during the takeoff, departure, approach and landing phases of flight," the report said. "Other U.S. airlines use the QNH (height above sea level) altimeter setting system during all flight phases. These airlines set all their altimeters to show altitudes above sea level at the departure and arrival airports."

When descending below 10,000 feet, AAL procedures require its flight crews "to set the captain's and first officer's altimeters to a QFE setting so that they read height above destination field elevation," the report said. "As a cross-check to ensure that the company-provided QFE setting is accurate, a comparison should then be made between the altitude shown on the flight crew's altimeters and that shown on the third standby altimeter containing the QNH (height above sea level) setting. The difference, in feet, between the flight crew's altimeters and the standby altimeter should equal the published elevation of the airport of intended landing."

The report continued: "During descent and prior to arrival at the [FAF], AAL procedures require the flight crew to use the standby altimeter with the QNH setting for intermediate air traffic control or approach plate–directed level-offs. According to AAL procedures, upon arrival at the FAF, the flight crew should begin using [its] primary altimeters, which are set QFE. If a missed approach is commenced, the flight crew should revert to the standby altimeter (QNH) for altimeter information. After landing, AAL flight crews' primary altimeters should read zero feet. Flight crews of [other] airlines that use the QNH system, on the other hand, should see altimeters that read the field elevation of the airport after landing."

AAL flight crews told investigators that one advantage of the QFE system "is the standardization of approaches with regard to altitudes seen by flight crews from the FAF until landing," the report said. "This is especially true, they said, during ILS approaches that usually have minimum altitudes of 200 feet [61 meters] above the ground. Most approaches flown by AAL flight crews are ILS approaches. Regardless of the field elevation above sea level, flight crews become accustomed to using 200 feet above the ground as a minimum altitude. Each approach, no matter what the airport elevation, will appear the same to flight crews, concerning minimum altitude."

0055:46.9	**CAM**:	[Sound of horn]
0055:47	**CAM-4**:	Landing gear.
0055:48	**CAM**:	[Sound of horn]
0055:50	**CAM-4**:	Landing gear.
0055:51	**CAM**:	[Sound of horn.]
0055:52	**CAM-4**:	Landing gear.
0055:53	**CAM-1**:	Left motor's failed.
0055:56	**CAM-1**:	**.
0055:57	**CAM-2**:	There's the runway straight ahead.
0055:58	**CAM-1**:	OK.
0056:00	**CAM-1**:	Tell 'em we're goin' down. Tell 'em emergency.
0056:02.6	**RDO-2**:	Tower call for emergency equipment. We have, we're goin' down on the runway.
0056:06	**CAM-2**:	You want the gear back down?
0056:07	**CAM-1**:	Yes, throw it down.
0056:10	**CAM-4**:	Sink rate … sink rate …
0056:12	**CAM-1**:	Oh God.
0056:12	**TWR**:	Is that State on ground control?
0056:12	**CAM-2**:	You're gonna make it.
0056:12	**CAM-1**:	OK.
0056:13	**CAM-4**:	Sink rate …
0056:13	**CAM-2**:	Flaps?
0056:14	**CAM-4**:	Sink rate …
0056:17	**CAM-1**:	Put 'em down.
0056:18	**CAM-2**:	***.
0056:20	**CAM-1**:	Whata we got?
0056:21	**CAM-2**:	We're still flying.
0056:21	**CAM-1**:	OK.
0056:22	**CAM-4**:	Sink rate … sink rate.
0056:23	**CAM-1**:	God #.
0056:23	**CAM-2**:	Keep goin', you're gonna make it.
0056:24	**CAM-4**:	Sink rate …
0056:25	**CAM-2**:	Keep coming.
0056:25	**TWR**:	Wind one seven zero at two two.
0056:26	**CAM-4**:	Too low, flaps.
0056:27	**CAM-4**:	Terrain, terrain.
0056:27.2	**RDO-2**:	Yeah, call for emergency. Call for emergency equipment.
0056:30	**TWR**:	They're comin', they're comin'.
0056:30	**CAM-4**:	Terrain.
0056:31	**CAM-4**:	Too low.

Investigators reviewed the altimeter settings used by the crew of the accident flight. "The altimeters settings (29.42 inches Hg [QNH] and 29.23 inches Hg [QFE]) received by the flight crew in the 0030 ACARS message were based upon a 2352 weather report," the report said. "Thus, these altimeter settings were 29 minutes old when the flight crew received them and 54 minutes old when the airplane struck the trees on the ridgeline."

The report added: "The altimeter setting [the flight crew] received from Boston Center [ARTCC] at 0033:27 (29.40 inches Hg) was 22 minutes old when they struck the trees. The altimeter setting they received in the ATIS message at 0034 (29.50 inches Hg) was based on a 2251 recording of the weather, and was one hour and 46 minutes old when the tree strike occurred."

Investigators determined that "about the time of the accident, the correct QFE altimeter setting for the airport was about 29.15 inches Hg [987 mb]," the report said. "Using this value, the [NTSB] concludes that the indicated altitude (height above airport elevation) that the airplane's QFE altimeter was indicating was about [23 meters (76 feet)] too high (based on the altimeter setting received at 0030), resulting in the airplane being 76 feet lower than indicated on the primary altimeters."

The report concluded: "Because [the flight crew] knew that the atmospheric pressure was falling rapidly, the flight crew should have requested a current altimeter setting from the BDL approach controller when one was not given by the controller, as required, upon initial radio contact. If [the flight crew] had done so, [it] would have received a current altimeter setting of 29.38 inches Hg [995 mb] (QNH), which would most likely have resulted in the aircraft being 40 feet [12 meters] higher than it was when it struck the trees, or approximately 71 feet [21.6 meters] above the terrain."

After the accident, a survey of the tree heights "indicated that trees in the area of initial impact were approximately 60 feet [18.3 meters] tall," the report said. "Therefore, an additional 40 feet might have given the aircraft enough clearance to miss the trees on the downslope of the ridge. Accordingly, the [NTSB] concludes that the flight crew's failure to request a current altimeter setting from the approach controller was a contributing factor in this accident."

When investigators examined the cockpit of the accident aircraft, they found that "the primary altimeters were found set at 29.23 inches Hg, which is consistent with the setting given in the ACARS message," the report said. "However, the standby altimeter was set at 29.47 inches Hg, which does not match the setting found in the ACARS message, or with any of the other altimeter settings given to the flight crew. During the descent, the first officer stated to the captain that 29.47 inches Hg (QNH) was what had been given to them when they started to descend. In fact, Boston ARTCC had given, and the first officer acknowledged, a setting of 29.40 inches Hg (QNH)."

0056:32	**CAM-2**:	You got it dude, you're gonna make it.
0056:33	**CAM-1**:	OK.
0056:34	**CAM-2**:	You got a long *.
0056:35	**CAM-1**:	Flaps, flaps forty. All the way down.
0056:36	**CAM-4**:	Don't sink.
0056:37	**CAM-1**:	All the way, flaps forty.
0056:38	**CAM-2**:	They're all the way.
0056:39	**CAM-1**:	OK, hold on guy.
0056:40.6	**CAM**:	[Sound of impact]
0056:41	**CAM**:	[Sound of horn]
0056:42	**CAM-4**:	F-u-l-a-p-s.
0056:44	**CAM**:	[Sound of vibration begins and continues for nine seconds]
0056:45	**TWR**:	One seven zero at two two.
0056:46	**CAM-1**:	Get it on, on the deck.
0056:47.4	**CAM**:	[Sound of impact]
0056:48	**CAM-1**:	Hold it down buddy, hold it down, hold it down, hold it down, hold it down…
0056:48	**CAM**:	[Sound of horn]
0056:48	**CAM-1**:	Hold it down.
0056:53	**CAM-2**:	God bless you, you made it.
0056:55	**CAM**:	[Sound of horn]
0056:56	**CAM-4**:	Landing gear. [Continues to the end of the recording.]
0056:59	**CAM**:	[Sound similar to engine RPM decreasing]
0057:02	**CAM-1**:	Shut down the motors.
0057:04	**CAM-?**:	Throttles closed.
0057:05	**CAM-2**:	Pull 'em both?
0057:06	**CAM-1**:	Yeah, pull both fire handles.
0057:08.1		[End of recording]

RDO = Radio transmission from accident aircraft
CAM = Cockpit area microphone voice or sound source
APR = Radio transmission from Bradley approach control
TWR = Radio transmission from Bradley control tower
-1 = Voice identified as pilot-in-command (PIC)
-2 = Voice identified as copilot
-4 = Aircraft mechanical voice
-? = Voice unidentified
* = Unintelligible word
# = Expletive
[ ] = Editorial insertion
… = Pause

Source: U.S. National Transportation Safety Board

In its analysis, the NTSB said: "If the flight crew had set the altimeters to 29.23 (QFE) and 29.42 (QNH), the settings would have produced the proper difference in indicated altitudes, which would have been equal to the field elevation (174 feet MSL). Although the flight crew used an incorrect standby altimeter setting during the initial descent below 18,000 feet [5,490 meters], the mistake could have been detected if the proper procedures had been used at the changeover altitude of 10,000 feet."

The report noted: "When the pilots switched from using the standby altimeter … , set in error at 29.47 (QNH), to their primary altimeters, set at 29.23 (QFE), their altimeters displayed an indicated altitude that was about 240 feet [73 meters] lower than the standby altimeter. Second, using the QFE setting of 29.23 inches Hg given the flight crew by the 0030 ACARS message, the field elevation would have been inconsistent with any altimeter setting on the third altimeter, except the setting of 29.42 inches Hg (QNH)."

When interviewed by investigators, "neither crew member stated that they remembered the ACARS message or the associated altimeter settings that the company provided to them," the report said. "However, documents retrieved from the accident airplane revealed that the ATIS information was handwritten on the ACARS message retrieved from the company. The [NTSB] could not determine who wrote this information on the message."

The report concluded: "Although the flight crew did not use the most current QNH setting [it] had available in the standby altimeter (29.40 inches Hg), this error did not affect the accident sequence of events because the flight crew had the correct, but outdated, QFE setting (29.23 inches Hg) in the altimeters [it was] using when the accident occurred."

Investigators reviewed the cockpit call-outs made by the flight crew during the approach and subsequent descent below the MDA. AAL procedures require the pilot who is not landing to call out 1,000 feet above the airport elevation, 100 feet above the MDA and when reaching MDA. The report said, "The first officer, who was the pilot not landing, called out: 'There's a thousand feet' at 0055:06. A correlation of the CVR with the [D]FDR [digital flight data recorder] revealed that this 1,000-foot call-out was made at [about] 1,140 feet (348 meters) AGL, based upon the flight crew's altimeter setting of 29.23 inches Hg (QFE)."

Although the first officer made the mandatory 1,000-foot call-out, he "did not follow additional company procedures by also calling out 100 feet above MDA (1,008 feet above the field elevation)," the report said. "However, five seconds later, at 0055:11, the first officer stated to the captain, 'Now nine hundred and eight is your uh … ,' which indicated that he was aware of the close proximity of the MDA (908 feet AGL) to the 1,000 [feet] above-field-level call-out. At that time, the airplane was about 1,050 feet AGL. The captain replied, 'Right.'"

The first officer told investigators "that he then looked out the airplane windshield to locate the airport," the report said. "When he looked back at the instrument panel, he saw that the airplane had descended below MDA. At 0055:25, the first officer said, 'You're going below your … .' At that time, the airplane was about 350 feet [107 meters] above the ground and five seconds away from contact with the trees."

The report noted: "Information from the DFDR indicates that a constant rate of descent of 1,100 feet [336 meters] per minute was maintained until the first officer uttered his 'you're going below your ... ' statement. The [NTSB] concludes that if the first officer had monitored the approach on instruments until reaching MDA and delayed his search for the airport until after reaching MDA, he would have been better able to notice and immediately call the captain's attention to the altitude deviation below the MDA."

The report said, "If the flight crew had computed a visual descent point (VDP) for [the] approach to Runway 15, as described in the AAL flight manual, the DME associated with the VDP would have provided the flight crew with a specific point in space to leave the MDA for landing. There would be no reason for the first officer or the captain to be looking away from the instruments and out the windscreen for the airport until just before or at the VDP. Both of them could have been concentrating upon the level-off at the MDA.

"However, in this case, no VDP was calculated, the first officer began looking for the airport prior to reaching the MDA in the critical stages of the descent to MDA and he was not adequately monitoring the flight instruments to serve as an additional back-up to the captain."

"The captain never took manual control of the airplane to either arrest his descent at the MDA or to initiate a more positive and immediate recovery to the MDA once he flew below this altitude."

[A VDP is defined as a point on the final approach course of a nonprecision straight-in approach procedure from which a normal descent from the MDA to the runway touchdown point may be commenced, provided the approach threshold of that runway, or approach lights, or other markings identifiable with the approach end of that runway are clearly visible to the pilot.]

The captain told investigators "that he attempted to 'level off' the airplane at MDA, using the altitude-hold button of the autopilot," the report said. "However, that feature of the autopilot was not engaged until after the first officer uttered his 'you're going below your ... ' statement. The captain never took manual control of the airplane to either arrest his descent at the MDA or to initiate a more positive and immediate recovery to the MDA once he flew below this altitude."

The report concluded: "Regardless of the outdated altimeter setting that affected the indicated altitude that the flight crew observed, [the flight crew] allowed the airplane to descend about 309 feet below the indicated MDA for the instrument approach. The captain initially did not recognize the descent below MDA, and he failed to react immediately when he was alerted to the altitude deviation by the first officer. The [NTSB] concludes that the flight crew's failure to maintain the required MDA until the required visual references identified with the runway were in sight directly caused this accident."

The report said "that the excellent crew resource management and flight skills that the flight crew used, as reflected on the CVR recording following [its] encounter with the trees, were directly responsible for limiting the number of injured passengers to one individual."

Investigators reviewed in detail the FAA's design of the instrument approach procedure (IAP) flown by the accident flight crew. The VOR Runway 15 IAP at BDL was first published and became effective in 1989. "The controlling obstacle in the final segment (the highest obstacle that could affect the approach) was 739 feet [225 meters] of terrain and an additional 80 feet [24 meters] tree height, for a total height of 819 feet [250 meters] MSL," the report said. "This is the ridgeline and trees that [the accident flight] initially struck."

The elevation of the ridgeline and trees is noted on the plan view of the VOR Runway 15 approach chart as "819" and is located about halfway between the FAF and the missed-approach point. "The single 819-foot obstacle depicted on the final approach course of most BDL Runway 15 VOR approach plates could lead flight crews to believe that there was one discrete obstacle, and that it was the only dangerous point on the final approach," the report said.

The report said, "The entire ridgeline is an obstacle, and ... it and similar terrain close to other airports should be fully depicted on the appropriate approach charts." As an example of how this obstacle should be depicted, the NTSB cited the BDL VOR Runway 15 approach chart published by British Airways, which clearly shows the ridgeline crossing the final approach course.

FAA Order 8260.3B, *U.S. Standard for Terminal Instrument Procedures (TERPS)*, requires a VDP to be established on a nonprecision approach, provided there is an obstacle-free zone in which to accomplish this in the final approach segment. The VDP is usually identified by a distance measuring equipment (DME) fix, and usually coincides with a point where the landing runway's lowest visual approach slope indicator (VASI) glideslope intersects the lowest MDA. Under ideal conditions, the VDP identifies a point on the final approach segment where a three-degree descent angle

can be commenced from the MDA to the runway, if the pilot can identify one of the required visual references for descent below the MDA.

Runway 15 at BDL is equipped with a VASI. "During the initial development of the BDL VOR Runway 15 approach, the [FAA] procedures specialist [who] designed the approach determined, based upon charts, that a 55-foot [16.7-meter] obstruction existed within the required obstacle-clearance plane of the VASI," the report said. (This obstruction was the ridgeline and trees that were struck by the accident aircraft.) As a result of this evaluation, no VDP was established when the VOR Runway 15 approach was first published in 1989.

Nevertheless, an in-flight inspection by the FAA of the VOR Runway 15 approach determined "that the obstacle-clearance plane was not penetrated by the ridgeline and trees," the report said. Therefore, a VDP was added to the approach. "The VDP was 3.1 nautical miles [five kilometers] from the BDL VOR, which is 2.86 nautical miles [4.6 kilometers] from the threshold of the runway," the report said.

In 1994, the Air Line Pilots Association, International (ALPA) notified the FAA that "several pilots had experienced GPWS warnings while descending from the five–nautical mile [eight-kilometer] FAF to the 3.1–nautical mile VDP," the report said. "ALPA stated that the steep nose-down attitude might have been exacerbated by the close proximity in that segment of the ridgeline struck by Flight 1572."

The FAA conducted an analysis of the VDP. "The FAA procedures analyst indicated that a 'no-VASI' standard (three-degree descent angle) had been used in the VDP placement, thereby placing the VDP at 3.1 nautical miles from the VOR," the report said. "This is 0.6 nautical mile [0.96 kilometer] farther away than the VDP would have been located using a 'with-VASI' standard (3.5-degree descent angle). Because a 3.5-degree VASI was already on Runway 15 at BDL, it was determined that the VDP located according to a no-VASI three-degree descent standard should not have been published, and it was removed … ."

The report said, "Based upon TERPS criteria for VDP location, the DME fix for the VDP should have been located on the flight path past the ridgeline and trees. This would provide flight crews with adequate required obstacle clearance and a defined point from which a visual descent could be made, past the ridgeline. It would also tend to keep approaching airplanes at a safer altitude until after passing the ridgeline where they would begin their descents to the MDA."

The investigation revealed a discrepancy between the FAA flight-procedures unit that developed the BDL VOR approach using maps, charts, surveys and other data to support its conclusions, and the FAA flight-inspection unit that used an airplane and an optical device to evaluate obstacles on the VOR approach.

The report concluded: "Quality control was inadequate within the FAA for accurately resolving the height of the trees on the ridgeline. Therefore, the [NTSB] believes that the FAA should examine and make more effective the coordinating efforts of the flight-inspection program and the procedures-development program, with emphasis placed on ensuring quality control during the development, amendment and flight-inspection process for instrument approaches."

The NTSB recommended that the FAA "evaluate TERPS design criteria for nonprecision approaches to consider the incorporation of a constant rate or constant angle of descent to MDA in lieu of step-down criteria," the report said.

The NTSB recommended that the FAA "consider the incorporation of a constant rate or constant angle of descent to MDA in lieu of step-down criteria."

[As part of its campaign to reduce by 50 percent the number of controlled-flight-into-terrain (CFIT) accidents, Flight Safety Foundation in 1994 submitted to the International Civil Aviation Organization (ICAO) a number of recommendations. One recommendation was to "recognize the deficiencies of many nonprecision instrument approach procedures and the need to improve these procedures." Deficiencies, the Foundation said, included "shallow final-approach angles and VOR/DME step-down approaches," and it recommended a standard three-degree approach slope except where prohibited by obstacles.]

The NTSB also recommended that the FAA establish a VDP on the BDL VOR Runway 15 approach. In 1996, the FAA published a VDP at 2.3 nautical miles [3.7 kilometers] (BDL 2.4 DME) on the approach. The VDP descent angle is 3.5 degrees, which coincides with the Runway 15 VASI glideslope.

Investigators reviewed the actions of the BDL approach controller when handling the accident flight. FAA Order 7110.65J, *Air Traffic Control*, requires an approach controller to issue a current altimeter setting on initial contact with an arriving flight. The BDL approach controller did not issue the current altimeter setting when first contacted by the accident flight. "The controller said that the omission was inadvertent," the report said.

The report said: "If the controller had issued the current altimeter setting on initial contact, the aircraft would most likely have been 40 feet higher than it actually was when it

struck the trees. … An additional 40 feet might have given the aircraft enough clearance to miss the trees on the downslope of the ridge. Accordingly, the [NTSB] concludes that this omission by the controller was a contributing factor in this accident."

The atmospheric pressure was dropping rapidly as the accident crew flew the approach, but there was no requirement for the BDL approach controller to issue updated altimeter settings. "The [NTSB] concludes that it would have been prudent for the approach controller to have issued the altimeter-setting changes as the airplane neared the airport," the report said.

If the flight crew had received and used the most current altimeter setting, "it would have resulted in the aircraft being approximately 60 feet higher, thus likely enabling it to clear the trees on the ridgeline," the report said.

"This accident illustrates the safety hazards that may result when flight crews of landing aircraft are not informed of current altimeter settings in circumstances of rapidly falling atmospheric pressure," the report said. "Therefore, the [NTSB] believes that for arriving aircraft executing instrument approaches at all airports, during periods in which the weather observer has included in the weather report the remark, 'pressure falling rapidly,' controllers should be required to issue, as frequently as practical, altimeter-setting changes to flight crews in addition to the altimeter setting issued on initial contact."

The report concluded that the "TRACON supervisor's communications with the flight were appropriate and aided the flight crew."

The NTSB reviewed the decision to close the BDL control tower after water leaked into the tower cab. The report concluded: "The closure of the tower was a good managerial decision because the safety of people in the tower was compromised by the adverse wind and rain. The TRACON supervisor's presence in the tower to monitor repairs, and his provision of wind and runway information to the [accident] aircraft was beneficial to the flight. … This information would not otherwise have been provided to the flight crew."

The report said, "Although additional information regarding the current altimeter setting would have been even more helpful to the flight crew, the TRACON supervisor was not required to provide that, or any, information. He was voluntarily assisting the flight by providing advisory information, and he was not officially serving as an air traffic controller."

The report concluded that the "TRACON supervisor's communications with the flight were appropriate and aided the flight crew. He acted in a professional manner, and should be commended for his willingness to assist the flight under the circumstances."

At the time of the accident, the weather and airport information on the BDL ATIS broadcast was almost two hours old. The NTSB recommended that "as part of the tower closure procedure, the ATIS broadcast should have been updated to reflect the temporary tower closure, and it should have advised flight crews to obtain local weather and airport information from another source," the report said.

The BDL TRACON was equipped with minimum safe altitude warning (MSAW), which is a computer program that warns when an airplane descends or will descend below a predetermined altitude. "If the radar does not receive a signal from a target, the program cannot function," the report said. "The MSAW at BDL was set to alarm if the aircraft transmitted two mode C returns at or below 1,050 feet [320 meters] MSL (30 feet [9.1 meters] below the MDA for the Runway 15 VOR approach). There was no alarm as Flight 1572 descended below the MDA because the aircraft was not in radar contact at that point because of shielding by the ridgeline."

The accident flight was out of radar contact for three radar sweeps, and therefore no MSAW alarm sounded. "Then, a single radar return was recorded at 900 feet [274 meters], followed by another radar sweep with no recording of the flight, and then two radar returns were recorded at 800 feet [244 meters]," the report said. "The MSAW then sounded an alarm, as it should have under those conditions. However, this alarm sounded about four seconds after the airplane had struck the trees."

The investigation determined that "because the last radar return before the airplane struck the trees was recorded at 1,300 feet [396 meters], the lowest altitude at which the MSAW could be programmed to activate and be effective is 1,300 feet," the report said. "Therefore, to have full MSAW coverage, the approach minimums for this approach would have to be raised from 1,080 feet MSL to somewhat above 1,300 feet MSL, to keep the MDA above the alarm point for the MSAW."

Because raising the MDA for the VOR approach to Runway 15 would result in unrealistically high minimums, and that "despite the lack of full MSAW coverage along the approach, the MSAW operated properly, and that because of topographical limitations of the BDL local area, it is not practical to provide full MSAW coverage," the report said.

Investigators evaluated the winds and turbulence during the accident flight's approach to determine whether the conditions could have contributed to the flight crew's descent below MDA. "During the approach to Runway 15, to the point at which Flight 1572 struck the trees, the airplane would

have encountered moderate turbulence and localized updrafts and downdrafts due to the interaction between strong low-altitude winds and rough terrain along the flight path," the report said.

"Wind shear due to strong gusty low-altitude winds also occurred following the tree strike, as the airplane was on approach to the runway," the report said. "An estimated mean wind profile indicated a decreasing headwind as the airplane descended to the runway."

The NTSB analysis revealed that "although wind shear was occurring as the airplane approached and passed over the ridgeline, it was the gustiness of the low-altitude winds, rather than a small-scale weather feature, that significantly affected airplane performance," the report said. "Airspeed excursions amounted to only about 10 knots [19 kph]. Further, a descent rate of about 1,100 feet per minute was initiated by the flight crew from about 1,840 feet [561 meters] MSL and was maintained until tree contact."

The report said, "The linear nature of the pressure-altitude trace indicates that the airplane's flight path was probably not significantly affected by updrafts, downdrafts or wind shear. Such an effect would be seen as a deviation from the near-linear pressure-altitude trace. Therefore, the [NTSB] concludes that the decreasing headwind shear seen in the estimated mean wind-profile data was not severe enough to cause the flight crew to deviate below the MDA."

The BDL airport is equipped with a low-level wind-shear alerting system (LLWAS). The investigation revealed that "the northwest LLWAS sensor [at BDL] was physically out of alignment by 38 degrees and was corrected subsequent to the accident," the report said. "The [NTSB] could not determine whether the LLWAS system would have provided another wind-shear alert [during the accident flight's approach] if the sensor had not been misaligned."

The NTSB could not rule out the possibility that an LLWAS alert from the northwest sensor might have prompted the accident flight crew to execute a missed approach. "However, the [NTSB] believes that it is more likely that if the flight crew had received a northwest LLWAS alert from the tower controller, [it] would have continued the approach because under the known turbulence and erratic wind conditions, LLWAS alerts are to be expected … ," the report said. "Therefore, the [NTSB] concludes that the misaligned LLWAS sensor did not contribute to this accident."

Investigators examined why one of the emergency evacuation slides failed to inflate when it was deployed by one of the cabin crew. The escape slide failed to deploy because the inflation cable had been improperly rigged.

The report said, "Because of the ambiguous instructions that appeared in the Douglas maintenance manual, operators of MD-80 and DC-9 series airplanes could be misrigging emergency evacuation slides. Therefore, the [NTSB] believes that the FAA should require all operators to inspect immediately all MD-80 and DC-9 floor-level exits to ensure that evacuation slides have been properly rigged."

Following the accident, "[AAL] took immediate action to clarify instructions in its maintenance manual and is conducting a fleetwide inspection of all emergency evacuation slides on its MD-80 airplanes," the report said.

Also as a result of this accident, Douglas Aircraft Co. revised its maintenance manual instructions for installing evacuation slides to improve diagrams for proper rigging of the inflation cables. The NTSB reviewed the revised instructions and believed that the terminology used in the instructions could still result in confusion and misrigging of the cables.

The report concluded: "Therefore, the [NTSB] believes that the FAA should require Douglas Aircraft Co. to review and amend its MD-80 and DC-9 maintenance manuals so that terminology used in graphics and instructions pertaining to the installation and removal of evacuation slides are clear and consistent."♦

Editorial note: This article was adapted from *Collision with Trees on Final Approach, American Airlines Flight 1572, McDonnell Douglas MD-83, N566AA, East Granby, Connecticut, November 12, 1995*. U.S. National Transportation Safety Board, Report no. NTSB/AAR-96/05. November 1996. The 128-page report contains figures and appendices.

Further Reading fr om FSF Publications

Enders, J.H.; Dodd, R.; et al. "Airport Safety: A Study of Accidents and Available Approach-and-landing Aids." *Flight Safety Digest* Volume 15 (March 1996).

Khatwa, R; Roelen, A.L.C. "An Analysis of Controlled-flight-into-terrain (CFIT) Accidents of Commercial Operators, 1988 Through 1994." *Flight Safety Digest* Volume 15 (April–May 1996).

"Helicopter Strikes Water on Approach After Pilots Lose Altitude Awareness." *Helicopter Safety* Volume 22 (July–August 1996).

"Different Altimeter Displays and Crew Fatigue Likely Contributed to Canadian Controlled-flight-into-terrain Accident." *Accident Prevention* Volume 52 (December 1995).

"Commuter Crew's Loss of Situational Awareness During Night Takeoff Results in Controlled Flight into Terrain." *Accident Prevention* Volume 52 (October 1995).

Disaster Response Planning Workshop for Business Aviation

June 5–6, 1997
Atlanta Airport Hilton and Towers
Atlanta, Georgia, U.S.

Who Should Attend?

- Department managers (flight, maintenance, scheduling and administration);
- Flight safety managers;
- Corporate safety/disaster response managers;
- Corporate security managers;
- Human resource/personnel managers;
- Public relations/communications managers;
- Risk/insurance and financial managers; and,
- Administrative managers.

Why Should You Attend?

- Develop your own disaster response plan—now!;
- Update your current disaster response plan (at least every other year);
- Increase the number of people in your department with skills and expertise in disaster response (one or two aren't enough);
- Improve corporate managers' understanding of the unique issues involved in an aviation-related disaster (you'll want all the help you can get); and,
- Help your department's staff after a nonaviation disaster (automobile accident, fire or act of violence).

Presented by

Flight Safety Foundation

The VanAllen Group, Inc.

For more information, contact: Steve Jones, Flight Safety Foundation
Telephone: (703) 739-6700 • Fax: (703) 739-6708

Visit our World Wide Web site at: http://www.flightsafety.org

ACCIDENT PREVENTION
Copyright © 1997 FLIGHT SAFETY FOUNDATION INC. ISSN 1057-5561

Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks and equipment manuals, or to supersede government regulations.

Staff: Roger Rozelle, director of publications; Rick Darby, senior editor; Russell Lawton, editorial consultant; Glenn Orthmann, editorial assistant; Karen K. Ehrlich, production coordinator; Ann Mullikin, assistant production coordinator; and David A. Grzelecki, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: US$80 (U.S.-Canada-Mexico), US$85 Air Mail (all other countries), twelve issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S. • Telephone: (703) 739-6700 • Fax: (703) 739-6708

We Encourage Reprints

Articles in this publication may be reprinted in the interest of aviation safety, in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All reprints must credit Flight Safety Foundation, *Accident Prevention*, the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions apply to all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Accident Prevention*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for submitted material. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.