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B-737 Crew's Unstabilized Approach Results in Overrun of a Wet Runway

Air traffic control instructions caused the Boeing 737 to be high, fast and close to the runway when the crew conducted a turn to establish the airplane on final approach to Burbank, California, U.S. Investigators concluded that the flight crew's only safe option at the time was a go-around.

FSF Editorial Staff

Twilight visual meteorological conditions (VMC) prevailed about 1811 local time on March 5, 2000, when a Boeing 737-300, being operated as Flight 1455 by Southwest Airlines, overran the departure end of Runway 8 during a landing at Burbank-Glendale-Pasadena (California, U.S.) Airport. The airplane struck a metal blast fence and an airport perimeter wall, and came to rest on a city street. The airplane was damaged extensively. Of the 142 occupants, two passengers received serious injuries, 41 passengers and the captain received minor injuries, and 94 passengers, three flight attendants and the first officer received no injuries.

In its final report on the accident, the U.S. National Transportation Safety Board (NTSB) said, "The probable cause of this accident was the flight crew's excessive airspeed and flight path angle during the approach and landing, and [the crew's] failure to abort the approach when stabilized-approach criteria were not met.

"Contributing to the accident was the controller's positioning of the airplane in such a manner as to leave no safe options for the flight crew other than a go-around maneuver."

The accident occurred during the first flight of a scheduled three-day flight sequence. Flight 1455 to Burbank was scheduled to depart at 1445 from McCarran International Airport in Las Vegas, Nevada.

The captain, 52, held several type ratings and had approximately 11,000 flight hours, including 5,302 flight hours as a B-737 pilot-in-command for Southwest Airlines, which hired him in July 1988.

"A first officer at Southwest Airlines with whom the accident captain had flown described [him] as easy to get along with and rated him as an average captain," the report said. "He indicated that he never felt uncomfortable flying with the captain and that the captain operated according to company procedures.

"Another Southwest Airlines captain described the accident captain as congenial, mild-mannered and [as] someone who got along well with everyone."

The captain told investigators that he went to bed about midnight the night before the accident, awoke about 0830, jogged four statute miles (six kilometers), lifted weights, ate breakfast, departed from his home in Las Vegas at 1330 and arrived at the airport at 1400.

The first officer, 43, held a B-737 type rating and had approximately 5,022 flight hours, including 2,522 flight hours

Boeing 737-300

The Boeing Co. in 1965 announced the decision to build a short-range, twin-turbofan transport. The aircraft, designated the 737, was designed to use many components and assemblies from the tri-engine B-727. The first B-737 flew in April 1967, and deliveries of the first production model, the B-737-200, began before the end of 1967.

Boeing in 1980 announced plans to build the B-737-300, a larger version that would accommodate more passengers and baggage, and have quieter and more fuel-efficient engines. Fuselage plugs were installed forward of the wing and aft of the wing carry-through structure to increase length by 8.7 feet (2.7 meters). The airplane can accommodate 128 passengers to 149 passengers and 1,068 cubic feet (30.2 cubic meters) of freight, compared with accommodations in the B-737-200 for 115 passengers to 130 passengers and 875 cubic feet (24.8 cubic meters) of freight.

The Pratt & Whitney JT8D-9A engines, each producing 14,500 pounds thrust (64.5 kilonewtons), on the B-737-200 were replaced with CFM International CFM56-B engines, each producing 20,000 pounds thrust (88.97 kilonewtons) on the B-737-300.

The prototype made its first flight in February 1984, and deliveries of production B-737-300s began in November 1984. Maximum standard takeoff weight is 124,500 pounds (56,473 kilograms). Maximum landing weight is 114,000 pounds (51,710 kilograms).

Maximum operating speed is Mach 0.84. Maximum cruising speed at an average cruise weight of 100,000 pounds (45,360 kilograms) at 33,000 feet is 462 knots (856 kilometers per hour [kph]). Economy cruising speed at 33,000 feet is Mach 0.73. Stalling speed in landing configuration at 103,000 pounds (46,720 kilograms) is 102 knots (189 kph).♦

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

as a B-737 first officer for Southwest Airlines, which hired him in November 1996. The first officer also flew Lockheed Martin F-16s for the U.S. Air Force Reserve.

"A captain who had flown with the first officer stated that [he] was very well qualified and was an above-average copilot with good aviation skills [and] was likable and pleasant," the report said. "Another captain who had flown with the first officer indicated that on their flights together, the first officer did a great job and displayed good judgment throughout the trip."

The first officer told investigators that he usually went to bed before 2300 and that he awoke between 0700 and 0730 on the morning of the accident, departed from his home in Salt Lake City, Utah, about 1000 and boarded a Southwest Airlines flight to Las Vegas, arriving at the airport about 1245.

The captain and first officer had not flown together previously.

"The flight crew met for the first time on their way to the departure gate at approximately 1400," the report said. "The first officer [told] the captain that the arrival of the airplane was delayed."

The delay was caused by rain and gusting winds in the Las Vegas area. Air traffic control (ATC) held the airplane on the ground at Los Angeles, California, until weather conditions improved in Las Vegas. The airplane arrived at the Las Vegas airport about 1630. The accident flight crew's preflight inspection of the airplane revealed no abnormalities or maintenance discrepancies.

The airplane departed from the gate about 1650. The captain was the pilot flying. The takeoff and the en route phase of the flight were normal and uneventful. The cruise portion of the flight was conducted at Flight Level 220 (approximately 22,000 feet).

The airplane was 30 nautical miles (56 kilometers) northeast of Burbank at 8,000 feet at 1748, when the first officer obtained automatic terminal information service (ATIS) Information Oscar, which included surface winds from 260 degrees at 18 knots, gusting to 26 knots, 10 statute miles (16 kilometers) visibility, a few clouds at 3,900 feet and broken ceilings at 6,000 feet and at 7,500 feet. Information Oscar said that landings were being conducted on Runway 26 and on Runway 33.

At 1802, the approach controller told the crew that ATIS Information Papa was current and that they should expect an instrument landing system (ILS) approach to Runway 8. The controller then told the crew to turn left to a heading of 190 degrees, to descend to 6,000 feet and to maintain an airspeed of 230 knots or greater. The controller said that the 190-degree heading was a vector to the final approach course. At the time, the airplane was about 20 nautical miles (37 kilometers) north of the outer marker for the ILS Runway 8 approach.

The first officer obtained ATIS Information Papa, which included surface winds from 240 degrees at six knots, 10 statute miles visibility, a few clouds at 6,500 feet and an overcast at 9,000 feet. Information Papa said that the ILS Runway 8 approach was in use and that landings and takeoffs were being conducted on Runway 8 and on Runway 15.

At 1804, the first officer told the captain that the target airspeed for the approach would be "thirty-three and five would be one [hundred] thirty-eight [knots]," that the winds were "down to six knots" and that landings were being conducted on Runway 8. (The airline's flight operations manual says that approaches with a tail wind should be flown at V_{REF} [landing reference speed] plus five knots.)

The airplane was 16 nautical miles (30 kilometers) north of the outer marker at 6,000 feet at 1805, when the controller told the crew to turn left to a heading of 160 degrees and to descend to 5,000 feet. The report said that this vector resulted in the airplane's interception of the final approach course about eight nautical miles (15 kilometers) from the runway threshold.

"This vector put the airplane in an unfavorable position for final approach, complicating the accident flight crew's approach planning and execution, and contributed to the unstabilized approach," the report said.

The controller told the crew, "If you'd like the visual approach, you will be following company [another Southwest Airlines airplane] right now at your one o'clock [position] and twelve miles [22 kilometers], turning onto the final out of forty-six hundred."

The first officer acknowledged the controller's radio transmission and asked the captain, "Do you want the visual if we find everybody?"

"Yeah, I think so," the captain said. "We'll wait just a second. I want to get through these clouds, but I think the visual will be fine."

The crew did not use the airplane's on-board performance computer (OPC) landing performance module, which provides specific aircraft flight manual performance data, such as landing speeds, landing distances and power settings, based on airplane gross weight and flap configuration, and runway condition.

"Southwest Airlines procedures indicate that the OPC landing module should be used when landing-performance capabilities are in question and when tail wind conditions exist, the airplane has a high gross weight, or the airplane is landing on a short runway," the report said. "The landing weight of the airplane was estimated to be 113,425 pounds [51,450 kilograms], which is near the maximum landing weight for the Boeing 737 of 114,000 pounds [51,710 kilograms], and Runway 8 was 6,032 feet (1,840 meters) long and did not have a 1,000-foot [305-meter] runway safety area."

At 1807, the controller told the crew to descend to 3,000 feet and said, "Company's over Van Nuys at three thousand."

The Van Nuys very-high-frequency omnidirectional radio (VOR) is about two nautical miles (four kilometers) north of the outer marker.

The report said that although the controller's instruction to maintain at least 230 knots was no longer warranted by the traffic situation, the controller did not cancel the instruction.

"Canceling the speed adjustment would have permitted the accident captain to begin to reduce his speed about 37 seconds sooner, thereby giving him more time to properly execute his approach to land," the report said. "In a postaccident interview, the … controller stated that he did not know why he did not cancel the speed restriction."

Although the controller's instruction to maintain at least 230 knots was no longer warranted by the traffic situation, the controller did not cancel the instruction.

At 1808, the captain told the first officer that he had the company airplane in sight. The first officer then told the controller that they had the company airplane in sight.

The controller told the crew to fly over the Van Nuys VOR at or above 3,000 feet and cleared the crew to conduct a visual approach to Runway 8.

The report said that this instruction was ambiguous because the crew was "not supposed to cross over Van Nuys" during the approach to Burbank; rather, the crew would fly the airplane abeam (i.e., to the right of) the VOR during final approach.

"This ambiguous clearance might have caused the flight crew to delay descent longer than necessary," the report said. "[The] controller positioned the airplane too fast, too high and too close to the runway threshold."

When the crew received clearance to conduct a visual approach, the airplane was 3.5 nautical miles (6.5 kilometers) northwest of the Van Nuys VOR at 4,200 feet; indicated airspeed was about 230 knots, and groundspeed was about 250 knots.

The crew's clearance to conduct a visual approach released them from the instruction to maintain an airspeed of at least 230 knots. The U.S. Federal Aviation Administration (FAA) *Aeronautical Information Manual* provides the following information about airspeed adjustments:

> ATC will issue speed adjustments to pilots of radar-controlled aircraft to achieve or maintain required or desired spacing. … If ATC determines (before an approach clearance is issued) that it is no longer necessary to apply speed-adjustment procedures, they will inform the pilot to resume normal speed. Approach clearances supersede any prior speed-adjustment assignments, and pilots are expected to make their own speed adjustments, as necessary, to complete the approach.

After the first officer acknowledged the controller's instructions, the controller told the crew to establish radio communication with Burbank Tower.

About this time, the captain flew the airplane through 3,800 feet and began a left turn to intercept the ILS Runway 8 final approach course. The airplane, which was being flown on autopilot, overshot the turn onto the final approach course. The autopilot then captured the ILS localizer, and the airplane passed over the outer marker — 6.1 nautical miles (11.3 kilometers) from the runway threshold — at 3,200 feet and at an indicated airspeed of 225 knots; groundspeed was about 255 knots.

The captain deployed the speed brakes and told the first officer to select "flaps five" and to extend the landing gear. He then disengaged the autopilot and told the first officer to select flaps 15.

The report said, "The captain indicated in a postaccident interview that at this point in the flight, he noted a 20-knot tail wind indication on the flight management system (FMS) screen. … No evidence exists on the CVR [cockpit voice recorder] transcript of a discussion between the pilots about the tail wind."

The captain did not use the airplane's head-up display (HUD) system during the approach.

"He stated that use of the HUD was at the discretion of the captain, except for CAT [Category] II and [CAT] III approaches," the report said. "He further stated that he only used the HUD enough to stay current and comfortable with it."

The captain told investigators that he did not remember observing the precision approach path indicator (PAPI) lights for Runway 8.

At 1809:56, the tower controller said that the surface winds were from 210 degrees at six knots and cleared the crew to land on Runway 8.

Burbank tower controllers told investigators that Runway 8 is the only runway with a precision approach and is the preferred landing runway because of terrain near the airport.

At 1810:01, the captain told the first officer to select flaps 25. He then voiced two expletives.

The airplane was descending through about 1,800 feet and its vertical speed was increasing above 2,900 feet per minute (fpm) when the CVR began recording the sounds of ground-proximity warning system (GPWS) warnings.

"From 1810:24 until 1810:59, [GPWS warnings] were being continuously broadcast in the cockpit, first as 'sink rate' and then, at 1810:44, switching to 'whoop, whoop, pull up,'" the report said.

The Southwest Airlines flight reference manual said that a GPWS sink rate warning is generated when descent rate is excessive (e.g., greater than 2,500 fpm at 1,000 feet radio altitude) and that a "pull up" warning is generated when descent rate becomes severe (e.g., greater than 3,500 fpm at 1,000 feet radio altitude).

The captain told investigators that he heard the GPWS sink rate warnings but did not believe that he needed to take action in response to the warnings.

The airline's flight operations manual (FOM) said that in instrument meteorological conditions, an escape maneuver must be conducted when a GPWS pull up warning is generated. The FOM said, "If a warning occurs when flying in day and VMC, and positive visual verification is made that no ground-contact hazard exists, the alert may be regarded as cautionary and the approach/cruise may be continued."

The captain told investigators that he heard the GPWS sink rate warnings but did not believe that he needed to take action in response to the warnings.

"[The captain] stated that he did not remember any other GPWS warnings during the approach," the report said. "The first officer indicated in a postaccident interview that he heard both the 'sink rate' [GPWS warnings] and the 'pull up' GPWS warnings but that he believed that the captain was correcting."

The captain told investigators that the approach was not conducted in compliance with the airline's guidelines for stabilized approaches. He said that the ATC instruction to maintain 230 knots and the tail wind contributed to the "fast approach."

"He stated that the airport looked normal at 500 feet but that he was not 'in the slot' because his airspeed was too high," the report said. "He indicated that he became 'fixated on the runway,' and he could not explain why he did not perform a go-around maneuver."

The report said that the first officer did not make altitude, airspeed and sink-rate callouts required by the airline and that the captain did not question the absence of callouts.

"If the first officer had made the airspeed [callouts] and sink-rate-deviation callouts, both the captain and the first officer might have been further alerted to the fact that the airplane's airspeed and sink rate were excessive," the report said.

At 1810:29, the captain told the first officer, "Flaps thirty. Just put it down. Put it to forty. It won't go, I know that. It's all right. Final descent checklist."

The first officer told investigators that when the captain called for flaps 40, indicated airspeed was about 180 knots. The first officer said that he pointed to his airspeed indicator to alert the captain that airspeed was above the flap-load limit speed. (The B-737 has a flap-load-relief system that prevents the flaps from extending to the 40-degree position when airspeed is above 158 knots.)

"The first officer stated in a postaccident interview that instead of reading the final descent checklist, he visually confirmed the checklist items and remembered seeing the captain arm the ground spoilers," the report said. "The final descent checklist includes notifying the flight attendants, checking the flight [instruments] and navigational instruments, placing the landing gear down, arming the speed brake, positioning the wing flaps, and disengaging the autopilot."

At 1810:42, the first officer said "attendant notification?"

The captain said "complete."

The first officer told investigators that he was concerned that the airplane's groundspeed was faster than normal but that he did not voice his concern to the captain.

The first officer told investigators that he was concerned that the airplane's groundspeed was faster than normal but that he did not voice his concern to the captain.

"The first officer further indicated to investigators that he felt that the approach was stabilized and that they were in a position to land," the report said.

At 1810:54, after four GPWS warnings, the captain said, "That's all right."

The report said, "Radar [data] and FDR [flight data recorder] data show that the airplane descended [from 3,000 feet] at an average flight path angle of about seven degrees until flare, at an average vertical speed of 2,200 [fpm] and at indicated airspeeds of between 182 [knots] and 200 knots. The airplane began to flare about 170 feet [above ground level] and flared for about nine seconds before touching down at 182 knots indicated airspeed on Runway 8. Average groundspeed during the flare was 195 knots, indicating that the airplane traveled about 3,000 feet [915 meters] during the flare."

At 1810:59, the CVR recorded a sound similar to the airplane touching down on the runway and a sound similar to an increase in engine speed as the captain applied reverse thrust. FDR data indicated that the airplane touched down on the runway with flaps extended to 30 degrees and that the flaps extended to 40 degrees at about 145 knots during the ground roll.

"The captain stated to [NTSB] investigators that after touchdown, the end of the runway appeared to be closer than it should have been and that he thought they might hit the blast fence wall," the report said. "The captain indicated that he braked 'pretty good' while attempting to stop the airplane."

The report said that Southwest Airlines had deactivated the autobrake systems in its B-737s "so that all cockpit configurations would be as similar as possible; therefore, Southwest pilots must use manual braking during landing."

The runway, which had a surface constructed of grooved asphalt, was wet.

FDR data and stopping-distance calculations performed by The Boeing Co. indicated that the airplane touched down about 2,150 feet (656 meters) beyond the threshold of Runway 8. The stopping-distance calculations indicated that with maximum manual braking, 4,700 feet (1,436 meters) of runway would have been required to bring the airplane to a stop.

At 1811:15, the first officer said, "Need any help?"

The captain voiced his own first name and several expletives.

The airplane was about 1,000 feet (305 meters) from the end of the runway when the first officer joined the captain in applying maximum wheel braking.

"The captain indicated that as the airplane neared the end of the runway, he initiated a right turn, using only the nosewheel-steering tiller (not the rudder pedals)," the report said.

The airplane departed the runway on a heading of about 110 degrees. From 1811:20 to 1811:28, the CVR recorded the sounds of several impacts. Groundspeed was about 32 knots when the airplane struck the blast fence, which was 32 feet (10 meters) from the runway end. The collision with the blast fence occurred 20 seconds after the airplane touched down on the runway.

"After penetrating the metal blast fence and an airport perimeter wall, the airplane came to rest on a four-lane city street east of the airport," the report said. "Tire marks in a gradual arcing right turn originated on the runway about 1,500 feet [458 meters] before the fence."

The airplane came to rest next to an automobile service station on Hollywood Way, a four-lane city street.

"The structure of the airplane was intact, and the entire airframe was accounted for at the accident site," the report said. "Major damage was confined to the nose section (mainly on the left side and the nosewheel-well area) and [a section of the fuselage], which collapsed circumferentially. The nose gear was severed from the drag brace and driven aft into the electronics bay."

At 1811:37, the captain announced on the airplane's public-address system, "Folks, remain seated. Remain seated. We're all right."

The captain did not order an evacuation.

"He said that he could hear the flight attendants calling for the evacuation and thought the flight attendants knew more about the cabin condition than he did," the report said.

The captain then shut down the engines and told the first officer, "Well, there goes my career."

At 1814:09, the captain told the tower controller, "You better send the emergency equipment over. We went through the barrier."

The controller said, "Affirmative, they should be over there already. … They're coming up Hollywood Way, sir. They'll be coming up off your left wing."

"OK, thank you," the captain said. "We're evacuating the aircraft at this time."

At 1814:49, the CVR recording ended with the sound of sirens.

During the accident, the Exit 1R (forward service door) escape slide detached and inflated inside the airplane. The slide blocked the aisle that leads from the passenger cabin to the two forward doors and trapped one of the two flight attendants who occupied the forward flight attendant jump seat. The first officer assisted the flight attendant in freeing herself from the slide.

The escape slides in B-737 series 300 through series 500 airplanes are restrained by a plastic cover attached at the bottom by two brackets connected by a latch. Investigators found that the Exit 1R escape slide cover in the accident airplane had disengaged from the latch brackets during impact, allowing the slide pack to slip out of the cover. As the slide moved on the galley floor, it pulled the lanyard that activates the inflation system.

The report said that modified slide-cover latch brackets are installed in B-737 series 600 through series 900 airplanes to prevent disengagement of the slide during a minor accident.

The inflated escape slide prevented both forward flight attendants from assisting passengers in evacuating the airplane. Another flight attendant and an off-duty flight attendant who was aboard as a passenger assisted the passengers in evacuating through the two overwing exits and the left rear door.

The accident also caused failure of the pivot-bracket assemblies that attach the forward flight attendant jump seat to the bulkhead between the cabin and the flight deck. Investigators found that the pivot-bracket mounting bolts were loose, causing the jump seat — a Trans Aero Industries Model 90835 — to collapse partially on impact.

As a result of these findings, NTSB on April 26, 2001, issued the following recommendations to FAA:

- Recommendation A-01-12 said that an airworthiness directive (AD) should be issued "to require all operators of [B-737 series 300 through series 500 airplanes] to replace the slide-cover-latch brackets on forward slide compartments with the type of slide-cover-latch brackets installed on the forward slide compartments of [B-737 series 600 through series 900 airplanes]."

- Recommendation A-01-13 said that an AD should be issued "to require initial [inspections] and periodic inspections (at appropriate intervals) of the pivot-bracket assemblies on all Trans Aero Industries Model 90835 jump seats installed on [B-737 series 300 through series 500 airplanes]."

[In response to recommendation A-01-12, FAA on July 9, 2002, issued a notice of proposed rule making (NPRM) to adopt an AD requiring installation, in compliance with Boeing Service Bulletin 737-25-1430, of "new, stronger" hinge assemblies on the forward escape slide compartments in B-737 series 300 through series 500 airplanes.[1] As of June 20, 2003, FAA had not taken final action on the NPRM.]

[In response to recommendation A-01-13, FAA on May 17, 2002, told NTSB that it "reviewed Southwest Airlines' maintenance-discrepancy reports of pivot-bracket assemblies on [Trans Aero Model 90835] jump seats from the past two years and concluded that the looseness of the pivot-bracket assembly observed on the accident airplane was an isolated event (that resulted from) a combination of forces experienced during the accident sequence." FAA said that "regulatory action is not warranted."[2] NTSB told FAA that its response to the recommendation was unacceptable and requested that FAA reconsider its decision not to take regulatory action.[3]]

The Southwest Airlines Pilots' Association (SWAPA) said, in a submission to NTSB during the investigation, that its analysis of the accident indicated that the probable cause was "a failure of the flight crew to detect a steep and fast approach created by substandard TRACON [terminal radar approach control] approach vectors and [by] tail winds at altitude."

SWAPA said, "The flight crew became task-saturated, failed to achieved prescribed [stabilized-approach] criteria and elected to continue the approach, resulting in an overspeed touchdown, overrun of the available runway and ground collision with airport obstructions."

The association said that the approach controller did not follow correct procedures in vectoring the crew to the final approach course.

"These errors resulted in an incorrect final-approach-intercept vector and high airspeed," SWAPA said. "This action set up the unstable approach and contributed to the overrun accident."

The association made the following recommendations:

- "This event should provide an appropriate example for controllers regarding how not following proper procedures could contribute to an unstable approach. Just as it is important for pilots to understand how not to get set up for an unstable approach, controllers should also receive training on how not to place aircraft in improper flight paths and profiles;
- "Crew resource management (CRM) training should teach crewmembers the 'red flags' that pilots may exhibit when their distraction is such that all situational awareness disappears;
- "Parameters for an unstable approach should be adequately defined. Criteria for making a missed approach should be specified in the flight manuals; [and,]
- "The FAA should implement and continue to support protective regulatory initiatives to ensure that voluntary safety reporting programs like ASAP [aviation safety action program] and FOQA [flight operational quality assurance] are implemented at all U.S. airlines. This includes regulatory guidance regarding enforcement prohibition for participation and support of industry safety-data-sharing efforts."

SWAPA said that flight-data-analysis programs (FDAPs), such as FOQA, have indicated that unstable approaches are not uncommon. After the accident, the association and Southwest Airlines developed the Voluntary Aviation Safety Information program, which includes an ASAP and an FDAP.

"[The program] will help [Southwest Airlines] to be proactive in eliminating unstable approaches and other safety issues from its operation," SWAPA said. "Collectively, the industry will have to work together to reduce the factors originating from ATC regarding unstable approaches."

In August 2001, FAA allocated US$1.9 million from Airport Improvement Program funds to install an engineered materials arresting system (EMAS) at the departure end of Runway 8 at the Burbank airport. The EMAS installed at Burbank in January 2002 measures 170 feet (52 meters) square and consists of cellular cement designed to break up on contact with an airplane's wheels and, as a result, to slow the airplane.♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board (NTSB) Aircraft Accident Brief DCA00MA030 (22 pages with illustrations), NTSB Safety Recommendation A-01-12 and -13 (four pages); and NTSB Docket ID 16752 (1,382 pages with illustrations).]

Notes

1. Docket No. 2001-NM-88-AD. *Federal Register* Volume 67 (July 9, 2002): 45412–45414.
2. Letter to U.S. National Transportation Safety Board (NTSB) Chairman Marion C. Blakey from U.S. Federal Aviation Administration (FAA) Administrator Jane F. Garvey, Dec. 19, 2001.
3. Letter to FAA Administrator Jane F. Garvey from NTSB Chairman Marion C. Blakey, May 17, 2002.

Further Reading From FSF Publications

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Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, associate editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

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