National Transportation Safety Board
Washington, D.C. 20594

Aircraft Accident Brief

Accident Number:	DCA00MA030
Operator/Flight Number:	Southwest Airlines flight 1455
Aircraft and Registration:	Boeing 737-300, N668SW
Location:	Burbank, California
Date:	March 5, 2000
Adopted On:	June 26, 2002

HISTORY OF FLIGHT

On March 5, 2000, about 1811 Pacific standard time (PST),[1] Southwest Airlines, Inc., flight 1455, a Boeing 737-300 (737), N668SW, overran the departure end of runway 8 after landing at Burbank-Glendale-Pasadena Airport (BUR), Burbank, California. The airplane touched down at approximately 182 knots, and about 20 seconds later, at approximately 32 knots, collided with a metal blast fence and an airport perimeter wall. The airplane came to rest on a city street near a gas station off of the airport property. Of the 142 persons on board, 2 passengers sustained serious injuries; 41 passengers and the captain sustained minor injuries; and 94 passengers, 3 flight attendants, and the first officer sustained no injuries. The airplane sustained extensive exterior damage and some internal damage to the passenger cabin. During the accident sequence, the forward service door (1R) escape slide inflated inside the airplane; the nose gear collapsed; and the forward dual flight attendant jumpseat, which was occupied by two flight attendants, partially collapsed. The flight, which was operating on an instrument flight rules flight plan, was conducted under 14 *Code of Federal Regulations* (CFR) Part 121. Visual meteorological conditions (VMC) prevailed at the time of the accident, which occurred in twilight lighting conditions.

According to Southwest Airlines records, the accident flight was the flight crew's first flight of what was scheduled to be a 3-day flight sequence that consisted of five flights. The accident flight originated at McCarran International Airport (LAS), Las Vegas, Nevada, and was scheduled to depart about 1445 for BUR. The first officer of the accident flight stated to National Transportation Safety Board investigators that he arrived at LAS about 1245, and the captain indicated that he arrived about 1400. The first officer reported in a postaccident interview that he met the captain on the way to the gate. Southwest Airlines records indicate that the accident

[1] Unless otherwise indicated, all times in this report are PST, based on a 24-hour clock, and are taken from the cockpit voice recorder (CVR) transcript. In some instances, the air traffic control (ATC) transcript indicates times that are different from those in the CVR transcript.

airplane arrived at LAS from Los Angeles International Airport, Los Angeles, California, about 1630, almost 2 hours behind schedule, because of rain and gusting winds in the LAS area. The accident flight crew indicated that the preflight inspection was normal and that no maintenance discrepancies were noted.

Flight 1455 departed the gate about 1650, more than 2 hours behind schedule. During postaccident interviews, the flight crew indicated to Safety Board investigators that the takeoff and en route portions of the flight to BUR were normal and uneventful. The first officer stated that after the flight crossed the PMD very high frequency omni-directional radio range (VOR)[2] navigation transmitter at 8,000 feet, he obtained information Oscar from the BUR airport terminal information service (ATIS), which indicated that winds were from 260° at 18 knots, gusting to 26 knots, and that aircraft were landing on runways 33 and 26. At 1754:21, the captain stated, "plan on [runway] three three at the moment. [A]pproach descent checklist when you get the chance."

At 1802:52, the flight crew was advised by the Southern California terminal radar approach control (SCT) Woodland controller that the current ATIS was information Papa and that they should expect an instrument landing system (ILS) landing on runway 8. At 1803:29, when the airplane was about 20 nautical miles (nm) north of the BUDDE outer marker[3] at an altitude of about 8,000 feet mean sea level (msl), the Woodland controller instructed flight 1455 to turn left to a heading of 190° and to descend to and maintain 6,000 feet msl. The first officer acknowledged the instructions.

At 1804:02, when the airplane was about 19 nm north of the BUDDE outer marker at an altitude of about 7,800 feet msl, the SCT Woodland controller stated, "Southwest fourteen fifty five, maintain two thirty or greater 'til advised please." The captain acknowledged the airspeed adjustment assignment.[4] The Woodland controller indicated in a postaccident interview that he imposed the speed restriction as part of sequencing Southwest flight 1455 between Southwest flight 1713 and Executive Jet flight 278.

After the first officer obtained information Papa, he switched back to the approach control frequency. At 1804:42, he informed the captain that the target airspeed for the approach would be 138 knots and, at 1804:49, that winds were "down to six knots." A few seconds later, he confirmed that aircraft were landing at BUR on runway 8. At 1805:08, when the airplane was about 16 nm north of the BUDDE outer marker at an altitude of about 6,000 feet msl, the SCT Woodland controller instructed flight 1455 to "turn left heading one six zero." At 1805:13, the captain indicated to the first officer that ATC "wants two hundred thirty knots or greater, for a while."

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[2] The PMD VOR, which is located in Palmdale, California, is 30 miles northeast of BUR.

[3] The BUDDE outer marker is located 6 miles west of BUR's runway 8 threshold.

[4] The first officer indicated in postaccident interviews that while he was obtaining the new ATIS information, the captain communicated with ATC.

At 1805:54, the SCT Woodland controller cleared flight 1455 to descend to and maintain 5,000 feet and advised the pilots that they were following company traffic (Southwest Airlines flight 1713) that was at their "one o'clock and twelve miles [ahead of them] turning onto the final out of forty six hundred." The first officer acknowledged the clearance. At 1807:43, the Woodland controller cleared flight 1455 to descend to and maintain 3,000 feet. The first officer acknowledged the clearance. At 1808:18, the first officer notified ATC that he had the Southwest traffic in sight. At 1808:19, the Woodland controller issued an altitude restriction by stating, "cross Van Nuys at or above three thousand,[5] cleared visual approach runway eight."[6] The first officer acknowledged the clearance. At 1808:36, as the airplane was descending through about 3,800 feet msl, the captain began turning to the left for the final approach.

In postaccident interviews, the flight crew told investigators that, during the approach, the captain's navigation radio was tuned to the ILS frequency for runway 8, and the first officer's radio was tuned to the Van Nuys VOR. They indicated that the autopilot was engaged in the VOR/LOC mode[7] and that the airplane captured the localizer course but then overshot the centerline before correcting back.[8] The captain stated to investigators that as the flight passed about 2 miles west of Van Nuys at 3,000 feet at approximately 220 to 230 knots, he deployed the speed brakes.

According to the CVR, at 1809:28, when the airplane was at an indicated airspeed of about 220 knots, the captain called for "flaps five." At 1809:32, the flaps began to extend. At 1809:43, the captain called for "gear down." The captain indicated in a postaccident interview that at this point in the flight, he noted a 20-knot tailwind indication on the flight management system (FMS) screen.[9] At 1809:53, the BUR tower controller stated, "Southwest fourteen fifty five, wind uh…two one zero at six [knots], runway eight, cleared to land." Simultaneously, the captain called for "flaps fifteen."[10] At 1810:01, the captain again called for "flaps…fifteen" and "[flaps] twenty five."

From 1810:24 until 1810:59, the ground proximity warning system (GPWS) alerts were being continuously broadcast in the cockpit, first as "sink rate" and then, at 1810:44, switching to "whoop, whoop, pull up." At 1810:29, the captain stated, "flaps thirty, just put it down." At 1810:33, the captain stated, "put it to [flaps] forty. [I]t won't go, I know that. [I]t's all right.

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[5] According to the Pilot/Controller Glossary, restrictions are defined as "[a]n altitude or altitudes, stated in the order flown, which are to be maintained until reaching a specific point or time. Altitude restrictions may be issued by ATC due to traffic, terrain, or other airspace considerations."

[6] Flight 1455's 230-knot airspeed adjustment assignment was no longer applicable after the SCT Woodland controller issued the visual approach clearance. (For more information about speed adjustment assignments, see the section titled, "Company Procedures.") In a postaccident interview with Safety Board investigators, the controller stated that he did not know why he did not cancel the restriction sooner.

[7] The VOR/LOC mode is used to command the autopilot to intercept the selected localizer radio course.

[8] FAA radar data show that the airplane crossed the BUDDE outer marker at about 3,200 feet msl at an indicated airspeed of about 225 knots.

[9] No evidence exists on the CVR transcript of a discussion between the pilots about the tailwind.

[10] At 1809:54, the flaps extended to 5°; at 1810:01, the flaps extended to 10°; at 1810:08, the flaps extended to 25°; at 1810:29, the flaps extended to 30°; and at 1811:05, the flaps extended to between 30° and 40°.

[F]inal descent checklist." After the GPWS "whoop, whoop, pull up" alert sounded at 1810:47, the captain stated, "that's all right," at 1810:53. A final "sink rate" warning was recorded at 1810:55. The first officer stated in a postaccident interview that instead of reading the final descent checklist,[11] he visually confirmed the checklist items and remembered seeing the captain arm the ground spoilers. The first officer also stated that when the captain called for flaps 40°, the airspeed was about 180 knots and went as high as 190 knots during the approach.[12] The first officer indicated that he pointed to his airspeed indicator to alert the captain of the flap limit speed of 158 knots at flaps 40°.

The captain told Safety Board investigators that he remembered hearing the "sink rate" warning from the GPWS but that he did not react to the warning because he did not feel that he had to take action. He stated that he did not remember any other GPWS warnings during the approach. The first officer indicated in a postaccident interview that he heard both the "sink rate" and the "pull up" GPWS warnings but that he believed that the captain was correcting.

The first officer also indicated to investigators that he selected the "Progress" page[13] on the FMS cockpit display unit but that he could not recall what the wind values were during the approach. He stated to investigators that he was concerned that the ground speed was faster than normal but added that he did not verbalize 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 captain stated in a postaccident interview that he was aware that Southwest Airlines' standard procedure[14] was for the captain and first officer to call "1,000 [feet above ground level (agl)], airspeed, and sink rate" when descending through 1,000 feet. However, no such callouts were recorded by the CVR. The captain also stated in a postaccident interview that he visually perceived that the airplane was "fast" as it crossed the approach end of runway 8. CVR and FDR data indicate that the airplane touched down at 1810:58 with flaps extended to 30° at about 182 knots; flaps then extended to 40° during the ground roll at about 145 knots.

The captain stated to Safety Board 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 captain indicated that he braked "pretty good" while attempting to stop the airplane. FDR data indicate that the captain unlocked the thrust reversers 3.86 seconds after touchdown and that the thrust reversers deployed 4.91 seconds after touchdown. The first officer stated to investigators that the captain applied the wheel brakes before the airplane had

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[11] The final descent checklist includes notifying the flight attendants, checking the flight and navigational instruments, placing the landing gear down, arming the speed brake, positioning the wing flaps, and disengaging the autopilot.

[12] Flight data recorder (FDR) and radar data indicate that at 1810:33, the airspeed was about 190 knots.

[13] The "Progress" page indicates dynamic flight and navigation data, including track, path, temperature, speed, and headwind or tailwind information.

[14] For more information about Southwest Airlines' procedures, see the section titled, "Company Information."

decelerated to 80 knots[15] and that, as the airplane passed the Southwest Airlines passenger boarding gates,[16] he joined the captain in braking the airplane and applied the brakes as hard as he could. 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).

At 1811:20, the cockpit area microphone (CAM) recorded impact sounds. The airplane departed the right side of the runway about 30° from the runway heading, penetrated a metal blast fence and an airport perimeter wall, and came to a stop on a city street off of the airport property. An emergency evacuation ensued, and all crewmembers and passengers successfully exited the airplane.[17]

PERSONNEL INFORMATION

Both flight crewmembers were certificated pursuant to Southwest Airlines and Federal Aviation Administration (FAA) certification requirements. A review of FAA records indicated that the flight crewmembers had no history of airplane accidents or enforcement actions. In addition, both flight crewmembers held valid driver's licenses for the states in which they lived. Records at the National Driver Register found no indication of driver's license revocation or suspension for either pilot. Further, both flight crewmembers provided urine specimens and breath samples for postaccident drug and alcohol testing, the results of which were negative.

The Captain

At the time of the accident, the captain, age 52, held an airline transport pilot (ATP) certificate, issued October 25, 1979, with the ratings and limitations of airplane multiengine land; commercial privileges for airplane single engine land; and type ratings for 737, Gulfstream G-159, and Convair CV-240, -340, and -440 airplanes. His most recent FAA first-class medical certificate was issued on October 19, 1999, with the limitation that he must possess corrective glasses while flying.[18]

According to the captain, he served as a pilot in the U.S. Air Force (USAF) from 1970 to 1975 at Mather Air Force Base, Sacramento, California. In 1976, he acquired his 737 type rating through United Airlines and, from 1977 to 1979, flew as a 737 first officer for Wien Air Alaska. From 1979 to 1980, he flew Gulfstream G-159s and King Airs as a captain for Coleman Air Transport. From 1980 to 1988, he was employed by the EG&G Corporation and flew 737s as captain and first officer.

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[15] For more information about Southwest Airlines' braking procedures, see the section titled, "Company Information." Pilots are advised to initiate braking after 80 knots under normal landing conditions or before 80 knots if conditions require earlier use.

[16] The Southwest Airlines passenger boarding gates are parallel to runway 8 and are located about 1,000 feet before the end of the runway.

[17] For more information about the emergency evacuation, see the section titled, "Survival Aspects."

[18] The captain indicated to Safety Board investigators that he normally wore glasses while flying at night.

The captain began his employment at Southwest Airlines on July 7, 1988. According to the captain, at the time of the accident, he had accumulated a total of approximately 11,000 hours of flight time. He had flown 737s for Southwest Airlines for a total of 9,870 hours, 5,302 of which were as pilot-in-command. The captain had flown for Southwest Airlines 123.3, 88.8, 52.1, and 15 hours in the 90, 60, 30, and 7 days, and 1.4 hours in the 24 hours, before the accident, respectively. The captain's most recent systems training took place on October 10, 1999, and his most recent proficiency check and training took place on October 11, 1999. His most recent 737 line check was on October 29, 1999.

During postaccident interviews, a first officer at Southwest Airlines with whom the accident captain had flown described the accident captain as easy to get along with and rated him as an average captain. 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 someone who got along well with everyone.

At the time of the accident, the captain lived in the Las Vegas, Nevada, area. He indicated that, during the 3 days before the accident, he exercised moderately by jogging and playing golf. He stated that he normally went to bed about 2300 and awoke between about 0730 and 0830. The captain stated that on March 4th, he went to bed about midnight and felt well rested when he awoke on March 5th about 0830. He indicated that he called crew scheduling about 0900, jogged 4 miles, lifted weights, and ate breakfast. He reported that he left his home about 1330 and arrived at LAS about 1400.

The First Officer

At the time of the accident, the first officer, age 43, held an ATP certificate, issued December 18, 1995, with the ratings and limitations of airplane multiengine land, commercial privileges for airplane single engine land, and type rating for the 737. His most recent FAA first-class medical certificate was issued on October 18, 1999, with no limitations.

The first officer reported to investigators that he had completed 12 years of active duty in the USAF during which he flew F-15 fighter airplanes. He stated that, after completing his active service, he flew F-16s in the USAF reserve. His total military flight time at the time of the accident was approximately 2,500 hours.

The first officer was hired by Southwest Airlines on November 14, 1996. According to the first officer, at the time of the accident, he had accumulated a total of approximately 5,022 hours of flight time. He had flown 737s for Southwest Airlines for a total of 2,522 hours. The first officer had flown for Southwest Airlines 212.1, 123.8, 60.7, and 22.5 hours in the 90, 60, 30, and 7 days, and 1.4 hours in the 24 hours, before the accident, respectively. The first officer received his initial 737 type rating on December 18, 1995, and completed his 737 initial operating experience on December 26, 1996. His most recent systems training took place on October 25, 1999, and his most recent proficiency check and training took place on October 31, 1998. His most recent 737 line check was on October 29, 1999.

During postaccident interviews, a captain who had flown with the first officer stated that the first officer was very well qualified and was an above-average copilot with good aviation skills who was likable and pleasant. 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.

At the time of the accident, the first officer lived in the Salt Lake City, Utah, area. He indicated that, during the 3 days before the accident, he performed light household chores and worked at the USAF reserve unit, performing paperwork duties on March 2nd and flying an F-16 fighter airplane for one flight on March 3rd. He stated that he normally went to bed about or before 2300 and awoke between about 0700 and 0730. The first officer stated that he awoke on March 5th about 0800. He indicated that he called crew scheduling and notified them that he would report directly to LAS for the flight to BUR. He stated that he left his home about 1000; boarded the Southwest Airlines flight from Salt Lake City, Utah, to LAS about 1120; and arrived at LAS about 1245.

The Air Traffic Controller

The SCT Woodland controller on duty at the time of the accident, who was also a private pilot with about 145 hours of flight time, was hired by the FAA in May 1989. He received his initial ATC training in Oklahoma City, Oklahoma, and began work at Gillespie Field Airport, San Diego, California, as a full performance level controller. In April 1992, he went to Lindbergh Airport, San Diego, California, and, in September 1998, he was transferred to SCT. The day of the accident was the second day of a 5-day work week for the Woodland controller, who was assigned the 1300-to-2100 shift.

AIRPLANE INFORMATION

N668SW, a 737-300, serial number (S/N) 23060, was registered to Southwest Airlines on January 25, 1996, and was equipped with two CFM International CFM56-3 engines. The maximum landing weight of the airplane is 114,000 pounds (lbs).[19]

The 737 is configured with a flap load limiter system that prevents the flap panels from extending to the 40° position until the airspeed is below 158 knots, even if the flap handle is placed in the 40° position above that speed.

The 737 has 10 spoiler panels (5 on each wing), 4 of which are flight spoilers that are used for maintaining lateral control, reducing airspeed in flight, and aiding braking after touchdown, and 6 of which are ground spoilers that are used to aid braking after touchdown.

[19] The landing weight of the accident airplane was estimated to be 113,425 lbs.

According to Southwest Airlines, its 737 autobrake systems are deactivated so that all Southwest cockpit configurations will be as similar as possible. Therefore, Southwest pilots must use manual braking during landing.

METEOROLOGICAL INFORMATION

The transcription of ATIS information Papa follows:

> burbank airport information papa zero one five three zulu wind two four zero at six visibility one zero few clouds at six thousand five hundred ceiling niner thousand overcast temperature niner dew point one altimeter two niner six five i l s runway eight approach in use arriving and departing runway eight and runway one five.

Weather observations at BUR were made by an automated surface observation system and augmented by ATC under the limited aviation weather reporting station. Weather conditions reported about 1653, about 1 hour and 17 minutes before the accident, were the following:

> wind from 270 degrees at 18 knots gusting to 26 knots, visibility 10 miles, a few clouds at 3,900 feet, ceiling overcast at 5,500 feet, temperature 11.1 degrees C [Celsius] (52 degrees F [Fahrenheit]), dew point 2.2 degrees C (36 degrees F), altimeter 29.60 inches of hg [mercury].

Weather conditions reported about 1820, about 10 minutes after the accident, were the following:

> wind from 250 degrees true at 6 knots, visibility 10 statute miles, ceiling overcast at 9,500 feet, temperature 9 degrees…[C] (48 degrees F), dew point temperature 0 degrees C (32 degrees F), altimeter 29.66 inches of…hg.

The BUR airport reported that 0.77 inch of rain had fallen in the 8 hours before the accident and that a wind shift associated with a cold frontal passage had occurred. Runway 8 was wet at the time of the accident.

AIRPORT INFORMATION

BUR is located about 3 miles northwest of Burbank, California, at an elevation of 775 feet. The airport is in the east-southeastern end of the San Fernando Valley, between the San Gabriel Mountains and the Pacific coastline. BUR is owned by the Burbank-Glendale-Pasadena Airport Authority and is operated under contract by a private company, Airport Group International. BUR has an FAA-approved airport emergency plan and is certified by the FAA as

an aircraft rescue and firefighting (ARFF) index C[20] facility under 14 CFR Part 139. The last FAA annual airport certification inspection took place from December 8 through 10, 1999.

BUR has two grooved asphalt runways, 8/26 and 15/33. During postaccident interviews, BUR ATC tower personnel indicated to investigators that runway 8, which is used "most of the time" for landings, is the only arrival runway that avoids high terrain and that runway 26 is used infrequently by air carriers for landing because of terrain to the south and east of the airport. They stated to investigators that runway 33 is used for landings when the tailwind component for runway 8 exceeds 10 knots and wind is from the northwest. They also indicated that no instrument approach is available for runway 33, and rising terrain is located under the left base segment of the traffic pattern to this runway. BUR ATC tower personnel stated that, for runway 15, aircraft must be established on final approach for landing before descending out of 3,000 feet. They indicated that the San Gabriel Mountains are located north of runway 15 and that hang glider activity sometimes exists in the area of the final approach to runway 15.

Runway 8

Runway 8, which is 6,032 feet long and 150 feet wide, is configured for precision instrument landings and equipped with high-intensity runway edge lights, distance-to-go markers, and a medium-intensity approach lighting system with runway alignment indicator lights. A precision approach path indicator (PAPI) is located 1,520 feet from the approach end of runway 8 on the left side of the runway.

Runway Safety Areas

Title 14 CFR 139.309 defines the requirements for the provision and maintenance of runway safety areas (RSA). The design and construction standards of RSAs are further defined in Advisory Circular (AC) 150/5300-13, "Airport Design," dated September 29, 1989. The AC indicates that the longitudinal dimensions of an RSA should extend for the full length of the runway and 1,000 feet beyond the physical threshold of each runway end. The AC further indicates that the lateral dimensions of an RSA should extend 250 feet both left and right of the runway centerline and for the full length of the longitudinal RSA.

The lateral dimensions of the runway 8 RSA measure 250 feet on each side of the runway centerline, except for the southern edge of runway 8 east of the runway 15/33 intersection, which measures 125 feet and is marked with a movement/nonmovement area delineator line. The passenger terminal is located south of runway 8 in this area. The longitudinal dimensions of the RSA at the arrival end of runway 8 measure 200 feet, and no significant longitudinal RSA exists on the departure end of runway 8. A metal blast fence is located 32 feet from the departure end of runway 8.

[20] According to 14 CFR 139.315 and 139.317, an ARFF index C facility should have two or three firefighting vehicles with a total of at least 3,000 gallons of water and aqueous film-forming foam.

On March 16, 2000, the Burbank-Glendale-Pasadena Airport Authority Executive Director sent a letter to the Safety Board's Airport/Emergency Response Group Chairman to clarify the status of RSAs at BUR. In his letter, he stated the following:

> The Authority determined that the greatest safety concern and risk to life and property was the close proximity of the passenger terminal and the close proximity of parked and taxiing aircraft adjacent to both runways. The Authority made the decision to pursue replacement of the passenger terminal as its highest priority….Concurrently with the process of replacing the terminal, the Authority has pursued the acquisition of clear zone properties and has considered the possibility of lowering Hollywood Way for the purpose of creating a[n] overrun area. The Authority did successfully acquire some existing parking lots in the RPZ (runway protection zone).

On August 14, 2000, the airport authority submitted an application to the city of Burbank to construct a replacement passenger terminal that would be located 1/2 mile north of the current terminal. However, in an April 10, 2002, letter, the Burbank-Glendale-Pasadena Airport Authority Executive Director informed the Safety Board that "58% of the voters of Burbank approved an initiative that deprives the Burbank City Council of its power to approve any terminal project agreement with the Airport Authority unless and until a lengthy series of conditions[22] is met." As a result, on December 4, 2001, the City of Burbank "imposed a moratorium on the issuance of building permits for any and all activities at the airport that would require permits…[which] has effectively halted all development activity at the airport."

Engineered Materials Arresting System

On August 17, 2001, the FAA's Airport Improvement Program awarded $1.9 million to BUR to install an engineered materials arresting system (EMAS) at the departure end of runway 8.[23] The investigation revealed that installation of an EMAS was completed in January 2002 and that the system was fully operational. The system is about 170 feet long and 170 feet wide. No other EMASs are projected to be installed at BUR.

FLIGHT RECORDERS

Cockpit Voice Recorder

The airplane was equipped with a Fairchild A-100A CVR, S/N 52619. The CVR's exterior showed no evidence of structural damage, and the interior sustained no heat or impact damage. The recording consisted of good quality audio information, including the captain's and first officer's CAMs. The recording started at 1743:16, before the approach to BUR, and

[21] The Part 161 study began in December 2001.

[22] These conditions primarily involve the resolution of noise and environmental issues.

[23] EMAS is a system that slows an aircraft when its wheels roll through frangible cellular cement.

continued uninterrupted until 1814:49, shortly after the airplane departed the end of runway 8 and came to a stop. A transcript was prepared of the 31-minute recording and is available in the public docket for this accident.

Flight Data Recorder

The airplane was equipped with an Allied Signal Aerospace solid-state FDR model 980-4700-001, S/N 792. A readout of the FDR data was prepared and is available in the public docket for this accident.

WRECKAGE INFORMATION

After penetrating a metal blast fence and an airport perimeter wall, the airplane came to rest on a four-lane city street east of the airport. Tire marks in a gradual arcing right turn originated on the runway about 1,500 feet before the fence. The structure of the airplane was intact, and the entire airframe was accounted for at the accident site. Major damage was confined to the nose section (mainly on the left side and the nosewheel well area) and fuselage station BS 515, which collapsed circumferentially. The nose gear was severed from the drag brace and driven aft into the electronics bay after rotating the nose gear assembly 90°. A portion of the nose cone and left wing tip were severed from the airframe. The major damage to the left and right wings was confined to the leading edge devices.

No preimpact failures were noted in the aileron, elevator, or rudder systems or the leading and trailing edge flaps and slats. Several spoilers on each wing were damaged during the accident sequence. There were no preimpact failures noted to any spoiler system hydraulic line or valve in the wheel well area.

SURVIVAL ASPECTS

An emergency evacuation was initiated after the airplane came to a complete stop. During the accident sequence, the 1R escape slide inflated inside the airplane. Flight attendants reported that the slide began inflating while the airplane was still moving. The inflated slide extended nearly across the entire width of the airplane, blocking the aisle from the passenger cabin to both forward doors (1R and 1L) and preventing the two flight attendants seated on the forward jumpseat from assisting in the evacuation. The 1R escape slide was not deflated until after the evacuation (through the overwing exits and the 2L door) was complete. In addition, the forward flight attendant jumpseat partially collapsed and impeded the inboard flight attendant's exit from the seat.

As a result of this accident investigation, on April 26, 2001, the Safety Board issued Safety Recommendations A-01-12 and -13 to the FAA. Safety Recommendation A-01-12 asked the FAA to "issue an airworthiness directive to require all operators of Boeing 737-300 through -500 series 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 Boeing 737-600 through -900 series airplanes." Safety Recommendation A-01-13 asked the FAA

to "issue an airworthiness directive to require initial and periodic inspections (at appropriate intervals) of the pivot bracket assemblies on all Trans Aero Industries Model 90835 jumpseats installed on Boeing 737-300 through -500 series airplanes."[24]

Emergency Response

About 1811, the BUR ATC tower notified the BUR ARFF station of the accident via the direct "crash phone." BUR ARFF personnel responded with three ARFF fire trucks, one rescue truck, and six firefighters. One of the ARFF trucks radioed that the trucks should use Gate 300[25] to access the accident site. After 30 seconds, during which multiple unsuccessful attempts were made to open the gate with the Gate 300 access key card, the gate opened,[26] and the trucks proceeded to the accident site. Firefighters estimated that their response time was between 1 1/2 and 1 3/4 minutes. Firefighters aided passengers and crewmembers in evacuating the airplane.

TESTS AND OTHER RESEARCH

Airplane Performance

The Safety Board conducted an airplane performance study in conjunction with this accident investigation. FDR and radar data indicate that the airplane began its final descent to BUR about 3 nm from the runway 8 threshold. Taking into account the airplane's altitude of 3,000 feet msl at the beginning of the descent and the 725-foot msl elevation of the touchdown zone (TDZ)[27] on runway 8, geometry calculations indicate that the airplane would have had to have descended at an average flightpath angle of about 7° to touch down in the runway 8 TDZ.[28] Radar and FDR data show that the airplane descended at an average flightpath angle of about 7° until flare, at an average vertical speed of 2,200 feet per minute (fpm), and at indicated airspeeds of between 182 and 200 knots. The airplane began to flare about 170 feet agl and flared for about 9 seconds before touching down at 182 knots indicated airspeed on runway 8. Average ground speed during the flare was 195 knots, indicating that the airplane traveled about 3,000 feet during the flare.

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[24] In a June 14, 2001, letter to the Safety Board, the FAA indicated that it would issue a notice of proposed rulemaking (NPRM) proposing to adopt an airworthiness directive to address Safety Recommendation A-01-12. The FAA further indicated that it was reviewing the design of the jumpseat to determine what actions were needed. On August 9, 2001, the Board classified Safety Recommendations A-01-12 and -13 "Open—Acceptable Response." In a December 19, 2001, letter to the Board, the FAA indicated that it was still planning on issuing an NPRM to address Safety Recommendation A-01-12. The FAA further indicated that it did not believe that action was warranted in response to Safety Recommendation A-01-13. On May 17, 2002, the Board classified Safety Recommendation A-01-12 "Open—Acceptable Response" and Safety Recommendation A-01-13 "Open—Unacceptable Response."

[25] A gate access key card was required to open Gate 300.

[26] The BUR airport fire chief at the time of the accident indicated to investigators that after the accident, the key card for Gate 300 was tested and revealed no anomalies. He further stated that the magnetic key card opening system was replaced after the accident with remote openers that can be activated from each ARFF vehicle.

[27] The TDZ is the first 3,000 feet of usable runway for landing beginning at the runway threshold, unless otherwise specified by the FAA or other applicable authority.

[28] Typical flightpath angles for visual and instrument approaches are about 3°.

At the request of the Safety Board's Airplane Performance Group, Boeing ran stopping distance simulations for this accident wherein maximum, medium, and minimum 737 autobrake applications, as well as maximum manual brake applications, were simulated for wet runway conditions after the 182-knot touchdown. These data indicate that the accident airplane would have required about 5,000 feet of runway length after touchdown to stop using maximum autobrakes and about 4,700 feet of runway length after touchdown to stop using maximum manual brakes. Boeing stopping distance calculations based on FDR acceleration data show that the accident airplane traveled about 4,150 feet from touchdown to impact with the blast fence, indicating that the airplane touched down about 2,150 feet beyond the runway 8 threshold in the TDZ.[29]

COMPANY INFORMATION

Southwest Airlines is certified to operate as an air carrier and conduct common carrier operations under the provisions of 14 CFR Part 121. Southwest Airlines began service on June 18, 1971.

Company Procedures

Approach Briefing

The Southwest Airlines FOM,[30] "Performance," "General," "OPC [Onboard Performance Computer][31] Normal Landing Overview" (Chapter 10, Section 1), states, in part, the following:

> The [OPC] Landing Module provides advisory landing distance information, go-around climb performance, maximum quick turn limitations, and low RVR [runway visual range] restrictions…the Landing Module should be used anytime landing performance capabilities are in question (approach climb and/or maximum quick turnaround limitations) and include (but are not limited to) the following landing conditions:…Tailwind…High gross weight…Short runway.

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[29] The Southwest Airlines Flight Operations Manual (FOM) indicates that "[t]ouchdown should occur between 1000 and 1500 feet from the landing threshold with the runway centerline between the main landing gear." For more information, see the section titled, "Company Procedures."

[30] According to the Flight Reference Manual (FRM) (Chapter 2, Section 1), "the Flight Operations and Reference Manuals contain comprehensive explanations of Southwest Airlines operating procedures, aircraft systems, and related operational considerations. Pilots are required to have a 'working knowledge' of information in the Flight Operations and Reference Manual[s]." The FOM is required to be carried on all Southwest Airlines flight operations, whereas the FRM, which contains information that is not normally referred to in daily operations, is not required to be carried on Southwest Airlines flight operations.

[31] According to the FOM, the OPC is an approved modified presentation of the performance data contained in the aircraft flight manual. The landing module provides operational landing data, including landing distances, approach and landing speeds, and go-around power settings.

During postaccident interviews, the first officer indicated to Safety Board investigators that he did not use the OPC landing module before the accident airplane landed on runway 8. The CVR transcript indicates that the captain did not call for the use of the OPC landing module during the approach.

Approach Procedures

The Southwest Airlines FOM, "Normal Operations," "Introduction," "Checklist Use" (Chapter 3, Section 1), states, in part, the following:

> The success attained by flightcrews in the execution of normal and emergency procedures is attributable largely to the dual reliability of the challenge and response checklist system….The checklist will be removed from its holder and read out loud in a clear voice. Responses should be equally loud and clear and answered as listed….The checklist reader should continue challenging an item until a proper response is obtained. The checklist reader is responsible for visually confirming that the proper action has been taken. When a checklist is completed, the reader will announce: '_____ **Checklist complete**.'…The Approach Descent Checklist will be completed silently by the pilot not flying.

As indicated previously in the section titled, "History of Flight," the first officer stated in a postaccident interview that he visually confirmed the items on the final descent checklist, which includes notifying the flight attendants, checking the flight and navigational instruments, placing the landing gear down, arming the speed brake, positioning the wing flaps, and disengaging the autopilot.

The Southwest Airlines FOM, "Normal Operations," "Approach," "Approach Target Speeds" (Chapter 3, Section 6), states, in part, "Fly V_{ref}[32] + 5 knots for tailwind landings." The CVR transcript indicates that, at 1804:42, the first officer informed the captain that the target airspeed would be 138 knots.

The Southwest Airlines FOM, "Normal Operations," "Approach," "Visual Crew Coordination and Callouts" (Chapter 3, Section 6), states, in part, the following:

	Captain	**First Officer**
1000 feet above TDZE [TDZ elevation]	Call out, "**1000 feet**." **Airspeed**_____ **Sink rate**_____	Call out, "**1000 feet**."
On Final Approach	Radio altimeter callouts below 200 feet are at the Captain's discretion when the First Officer is flying.	Altitudes above TDZE: "**500**" feet "**400**" feet "**300**" feet "**200**" feet

[32] V_{ref} is the target airspeed for the approach.

		If Captain lands the aircraft continue callouts on radio altimeter. "**100**" feet "**50**" feet "**30**" feet "**10**" feet

The Southwest Airlines FOM, "Normal Operations," "Approach," "Deviation Callouts for All Approaches" (Chapter 3, Section 6), states, in part, the following:

> If any of the following parameters are exceeded, the pilot not flying will make the corresponding callout and verify that the pilot flying takes appropriate corrective action. The pilot flying will acknowledge the callout verbally or with immediate corrective action.

Parameter	**Limit**	**Callouts**
Airspeed	Target speed minus 5 knots Target speed plus 10 knots Anytime below V_{REF}	**Airspeed**
Localizer	±1 DOT displacement	**Localizer**
Glideslope	±1 DOT displacement	**Glideslope**
Sink Rate	2000 fpm (when below 2000') 1000 fpm (when below 1000') Significant change (when below 50')	**Sink Rate**

During postaccident interviews, the first officer indicated that his attention was focused primarily outside the airplane and acknowledged that he did not call out airspeed or sink rate deviations to the captain. The CVR did not record the first officer or captain making any callouts during the final approach.

The Southwest Airlines FOM, "Normal Operations, "Approach," "Approach Envelope for All Approaches" (Chapter 3, Section 6), states, in part, the following:

> Go-around must begin whenever adverse factors have piled up against you and the aircraft is not in the "slot."...Entry Slot 1000' AGL Landing Gear Down Final Flaps
>
> Final "Slot" Conditions
> Proper sink rate and on glidepath Proper speed (for existing conditions) Proper runway alignment—no further turning required…Trimmed for zero stick forces; Steady-state thrust setting In final landing configuration IF NOT IN THE "SLOT," YOU ARE NOT PREPARED FOR A NORMAL LANDING.

The Southwest Airlines FOM, "Normal Operations," "Approach," "Go-around and Missed Approach" (Chapter 3, Section 6), states, in part, the following:

> Go-around/missed approach procedures have been designed to make execution of the procedure as simple as possible. The procedure is nearly the same for every profile….A missed approach must be executed if…the pilot determines that a landing cannot be safely accomplished in the touchdown zone.

In an interview with Safety Board investigators, the Southwest Airlines Vice President of Operations indicated that, for VMC approaches, "a pilot had to be in the slot, on glidepath, on airspeed, and in a position to make a landing." He stated that these conditions should exist at the time of the 1,000-feet agl callout when the airplane should be fully configured and meet airport and operational restrictions. He also stated that, to be fully configured at 1,000 feet, the flaps should be at 5° and the airspeed between about 170 to 180 knots with the airplane on glideslope. He indicated that the airplane approach criteria at 500 feet included an airspeed within ±5 knots and a rate of descent less than 1,000 fpm.

When Safety Board investigators asked the captain in a postaccident interview whether he was within company operating guidelines at 1,000 and 500 feet, the captain responded, "No." He stated that the airport looked normal at 500 feet but that he was not "in the slot" because his airspeed was too high. When Board investigators questioned the captain about whether Southwest Airlines had guidance concerning the abandonment of an approach, the captain stated that if the airplane was not set up at 1,000 feet, with flaps at 5°, gear extended, and on glideslope, a go-around maneuver should be performed. He indicated that he became "fixated on the runway," and he could not explain why he did not perform a go-around maneuver.

The Southwest Airlines FOM, "Non-normal Operations," "QRH 737-300/-500," "Ground Proximity Alert" (Chapter 11, Section 2), states, in part, the following:

> If an [GPWS] alert occurs when flying under Day and VMC conditions, and positive visual verification is made that no hazard exists, the alert may be regarded as cautionary and the approach may be continued. If the verification cannot be made, immediately check/correct the aircraft flightpath, or go-around if necessary.

The Southwest Airlines FRM, "Pilot Techniques," "First Officer Operating Technique," "Close In Descent Calculations" (Chapter 4, Section 2), states, in part, the following:

> If you are really behind—the best choice: Level off, configure all the way to flaps 40—then start down. Remember the flaps blow up to 30 just above 150 knots flaps 40, Landing Gear down and 140 knots will give about 1000 feet per nautical mile (almost 1 for 1).
>
> In any case, have the engines spooled up by 500 feet AGL. You must lead with power—a good technique is to begin advancing power as the glideslope comes off the bottom of the case or the upper VASI [visual approach slope indicator] turns pink.

According to the accident flight crew and other Southwest Airlines pilots interviewed after the accident, Southwest did not teach special procedures for a "high and hot approach" to expedite traffic. The captain indicated that having to keep his speed up (to 230 knots) and the tailwind contributed to the fast approach.

The *Aeronautical Information Manual*, Section 4-4-11, "Speed Adjustments," states, in part, the following:

> 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.

Investigators who reviewed Southwest Airlines manuals could not find any written guidelines describing procedures for pilots to make their own speed adjustments, as necessary, after ATC has issued an approach clearance. Southwest Airlines management personnel stated that Southwest uses speed adjustment guidance contained in Jeppesen Airway Manuals.

Landing Procedures

The Southwest Airlines FOM, "Normal Operations," "Landing and Postflight," "Normal Landing Dry Runway" (Chapter 3, Section 7), states, in part, the following:

> Once the landing runway has been visually acquired whether from a visual or instrument approach, remain on centerline and on the proper glideslope (ILS, VASI, PAPI, etc.) until the middle marker or further descent is necessary for a safe landing. Maintain briefed target speed and do not descend below the glideslope or "duck under" to solely facilitate an early turn off from the runway. Touchdown should occur between 1000 and 1500 feet from the landing threshold with the runway centerline between the main landing gear.
>
> At touchdown, verify that the automatic speedbrakes have deployed or deploy them manually while lowering the nose to the runway. Initiate reverse thrust as the nosewheel touches down by rapidly raising the reverse thrust levers aft to the reverse idle interlock. After the interlock is released, modulate reverse thrust as required and avoid exceeding engine limits. A minimum of 65 [percent]…should be attained. When required, maximum allowable go-around thrust may be used. At 80 knots, the pilot not flying will call, "**80 knots**." Normally, the pilot flying will begin braking at 80 knots and gradually reduce the reverse thrust levers so as to be out of reverse thrust when reaching taxi speed. On short runways or with adverse landing conditions, do not hesitate to initiate braking prior to 80 knots if required.

As indicated in the section titled, "Airplane Performance," the accident airplane touched down 2,150 feet beyond the runway 8 threshold. Further, the CVR indicates that the 80-knot callout was not made. As noted in the section titled, "History of Flight," the first officer stated to Safety Board investigators that the captain applied the brakes before 80 knots. FDR data show that the brakes were likely applied shortly after touchdown.

ADDITIONAL INFORMATION

A comparison of the recorded radar data of the accident airplane to 70 other airplanes that had landed at BUR on runway 8 between 1000 and 2200 on June 13 and 14, 2000,[33] showed that of the 16 airplanes vectored from the north side of BUR to land on runway 8, 12 were vectored to intercept the final approach course between 9 and 15 nm west of the runway threshold. Flight 1455 was given vectors that resulted in interception of the final approach course about 8 nm west of the runway threshold. The comparison also showed that the glidepaths of most airplanes approaching runway 8 were between 3° and 4°. The accident airplane's glidepath was 7°.

[33] Ninety-one airplanes landed at BUR during this time period; however, the data for 21 small general aviation aircraft were removed from the comparison because these airplanes have different operating characteristics than the accident airplane.

ANALYSIS

General

The captain and first officer were properly certificated and qualified in accordance with applicable Federal regulations and company requirements.

Visual meteorological conditions prevailed at the time of the accident. Runway 8 was wet, and a 6-knot tailwind existed at the time of the accident.

The airplane was properly certificated and equipped in accordance with Federal regulations and approved procedures. No evidence indicated preexisting engine, system, or structural failures.

Flight Crew Actions

The first officer did not use, and the captain did not call for the use of, the Onboard Performance Computer (OPC) landing module during the approach. Southwest Airlines procedures indicate that the OPC landing module should be used when landing performance capabilities are in question and when tailwind conditions exist, the airplane has a high gross weight, or the airplane is landing on a short runway. At 1804:42, after the first officer had obtained information Papa, he indicated to the captain that a 6-knot tailwind existed. Further, the landing weight of the airplane was estimated to be 113,425 pounds (lbs), which is near the maximum landing weight for the Boeing 737 of 114,000 lbs, and runway 8 was 6,032 feet long and did not have a 1,000-foot runway safety area, as defined in Advisory Circular 150/5300-13, "Airport Design." The OPC landing module would have provided the flight crew with useful landing information about the configuration and condition data for computation of landing distance, speeds, and power settings for the airplane's actual landing weight.

The accident airplane's airspeed was not reduced to the target airspeed for the approach. The Southwest Airlines Flight Operations Manual (FOM), "Normal Operations," "Approach," "Approach Target Speeds" (Chapter 3, Section 6), states, in part, "Fly V_{ref} + 5 knots for tailwind landings." The cockpit voice recorder (CVR) transcript indicates that at 1804:42, the first officer informed the captain that the target airspeed would be 138 knots. This statement indicates that the flight crew was aware of the target airspeed for the approach. In addition, the first officer did not call out airspeed or sink rate deviations to the captain. Southwest Airlines procedures indicate that if certain parameters are exceeded during the approach, including the target airspeed plus 10 knots and the sink rate, the pilot not flying should make a callout regarding the deviation and verify that the pilot flying takes corrective action. The first officer acknowledged during an interview that after the captain called for flaps 40°[34] at 1810:33, he saw the airspeed go as high as 190 knots during the approach. He indicated that he pointed to the airspeed indicator to alert the captain but noted that his attention was focused primarily outside the airplane. Further, the

[34] The flap limit speed for flaps 40° is 158 knots.

ground proximity warning system's (GPWS) "sink rate" alert sounded several times during the approach.

Further, the CVR transcript indicates that the first officer did not make, and the captain did not question the absence of, the required altitude callouts. Southwest Airlines procedures indicate that the first officer should make altitude callouts at 1,000; 500; 400; 300; 200; 100; 50; 30; and 10 feet. The Safety Board notes that if the first officer had made the airspeed and sink rate deviation callouts or altitude 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. Flight data recorder (FDR) data show that the airplane touched down at about 182 knots, which is 44 knots over the reference speed for this flight. The Safety Board concludes that the flight crew landed the airplane at an excessive airspeed.

Radar and FDR data indicate that the accident airplane's flightpath angle of 7° during descent to the Burbank-Glendale-Pasadena Airport (BUR) was steeper than the typical 3° flightpath angle used for visual and instrument approaches. During the accident airplane's descent, the GPWS "sink rate" and "whoop, whoop, pull up" alerts sounded several times. The GPWS warnings should have given the flight crew a strong indication that the approach was unstabilized. Although visual flight rules conditions existed (and, therefore, according to the FOM, the approach could be continued after visual verification that no hazard existed), prudent pilots should check the cockpit instruments to note the airspeed and sink rate of the airplane. This information should have alerted the flight crew that the approach was unstabilized. In a postaccident interview, the captain acknowledged that he was not within company operating guidelines at 500 feet. He stated that the airport looked normal at 500 feet but that he was not "in the slot" because his airspeed was too high.

According to Southwest Airlines procedures, a go-around maneuver should be performed when the aircraft is not "in the slot." Southwest Airlines' listing of "slot conditions" included "proper sink rate and on glidepath" and "proper speed (for existing conditions)." The first officer indicated in postaccident interviews that the approach appeared to be "out of the slot" and that he did not mention this to the captain because it appeared that the captain was correcting back to the slot. However, no evidence exists from CVR, FDR, or radar data that the airplane was going to be able to reduce its airspeed, vertical speed, or flightpath angle during final descent such that it would be "in the slot." Therefore, the Safety Board concludes that the accident airplane's approach was unstabilized and not in compliance with Southwest Airlines operating procedures. The Safety Board further concludes that because the airplane was not in the proper position to land, a go-around maneuver should have been performed. The Southwest Airlines FOM indicates that touchdown should occur "between 1000 and 1500 feet from the landing threshold." The accident airplane landed about 2,150 feet from the runway 8 threshold, further indicating that the airplane was not in the proper position to land.

After the airplane landed, the flight crew applied manual brakes to stop the airplane. The first officer indicated (and FDR data confirm) that the captain applied the wheel brakes before 80 knots. Stopping distance calculations show that the airplane traveled about 4,150 feet from touchdown to impact with the blast fence. Stopping distance simulations for wet runway

conditions further indicate that the accident airplane would have required about 4,700 feet of runway length after touchdown to stop using maximum manual brakes. The Safety Board concludes that even if the accident flight crew had applied maximum manual brakes immediately upon touchdown, the airplane would not likely have stopped before impacting the blast fence.

Air Traffic Control

At 1804:02, the Southern California terminal radar approach control (SCT) Woodland controller stated, "Southwest fourteen fifty five, maintain two thirty or greater 'til advised please." The captain acknowledged the airspeed adjustment assignment. At 1808:19, the Woodland controller stated, "Southwest fourteen fifty five, cross Van Nuys at or above three thousand, cleared visual approach runway eight." According to the *Aeronautical Information Manual*, Section 4-4-11, the issuance of an approach clearance cancels an earlier speed assignment. Therefore, the 230-knot speed adjustment assignment for flight 1455 was automatically cancelled when the controller issued the approach clearance.

The Safety Board recognizes that the flight crew could have asked the controller to remove the speed adjustment assignment before the approach clearance was issued, but the CVR transcript indicates that no such request was made. After the SCT Woodland controller instructed the flight to descend to 3,000 feet at 1807:43, traffic conditions no longer warranted the speed adjustment for flight 1455. 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. In a postaccident interview, the Woodland controller stated that he did not know why he did not cancel the speed restriction before issuing the approach clearance. Flight crew interviews and CVR, FDR, and radar data indicate that the flight crew did not extend the speed brakes or flaps until about 1809, more than 1 minute after the approach clearance was issued. The captain's delay in reducing airspeed and configuring the airplane caused the flight crew to initiate final descent at a higher altitude and a faster airspeed than normal, contributing to the unstabilized approach.

At 1805:08, the SCT Woodland controller instructed flight 1455 to "turn left heading one six zero." A comparison of the recorded radar data of the accident airplane to 70 other airplanes that had landed at BUR on runway 8 between 1000 and 2200 on June 13 and 14, 2000, showed that of the 16 airplanes vectored from the north side of BUR to land on runway 8, 12 were vectored to intercept the final approach course between 9 and 15 nm west of the runway threshold. Flight 1455 was given vectors that resulted in interception of the final approach course about 8 nm west of the runway threshold. This vector put the airplane in an unfavorable position for final approach, complicated the accident flight crew's approach planning and execution, and contributed to the unstabilized approach.

Further, the controller's restriction to flight 1455 at 1808:19 to "cross Van Nuys at or above three thousand" was ambiguous. According to the Pilot/Controller Glossary, restrictions are defined as "[a]n altitude or altitudes, stated in the order flown, which are to be maintained until reaching a specific point or time. Altitude restrictions may be issued by ATC [air traffic control] due to traffic, terrain, or other airspace considerations." The flight was on a

160° heading, and crossing over the specific point of Van Nuys was not part of the accident flight's approach. The flight passed abeam of the Van Nuys very high frequency omni-directional range navigation transmitter by about 2 miles but was not supposed to cross over Van Nuys. This ambiguous clearance might have caused the flight crew to delay descent longer than necessary.

In summary, the Safety Board concludes that the actions of the SCT Woodland controller positioned the airplane too fast, too high, and too close to the runway threshold to leave any safe options other than a go-around maneuver.

Survival Factors

The inflation of the forward service door (1R) escape slide inside of the accident airplane and the partial collapse of the forward flight attendant jumpseat did not preclude the safe exit of crewmembers and passengers from the airplane. However, the evacuation was slowed considerably because of the blocked forward exits. If the airplane had caught fire after the accident, the unavailability of the forward exits and the prolonged evacuation would have dramatically affected the survivability of the occupants. As a result, on April 26, 2001, the Safety Board issued Safety Recommendations A-01-12 and -13 to the Federal Aviation Administration (FAA). Safety Recommendation A-01-12 asked the FAA to "issue an airworthiness directive to require all operators of Boeing 737-300 through -500 series 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 Boeing 737-600 through -900 series airplanes." Safety Recommendation A-01-13 asked the FAA to "issue an airworthiness directive to require initial and periodic inspections (at appropriate intervals) of the pivot bracket assemblies on all Trans Aero Industries Model 90835 jumpseats installed on Boeing 737-300 through -500 series airplanes."[35]

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the flight crew's excessive airspeed and flightpath angle during the approach and landing and its 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.

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[35] In a June 14, 2001, letter to the Safety Board, the FAA indicated that it would issue a notice of proposed rulemaking (NPRM) proposing to adopt an airworthiness directive to address Safety Recommendation A-01-12. The FAA further indicated that it was reviewing the design of the jumpseat to determine what actions were needed. On August 9, 2001, the Board classified Safety Recommendations A-01-12 and -13 "Open—Acceptable Response." In a December 19, 2001, letter to the Board, the FAA indicated that it was still planning on issuing an NPRM to address Safety Recommendation A-01-12. The FAA further indicated that it did not believe that action was warranted in response to Safety Recommendation A-01-13. On May 17, 2002, the Board classified Safety Recommendation A-01-12 "Open—Acceptable Response" and Safety Recommendation A-01-13 "Open—Unacceptable Response."