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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

OPERATIONAL FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

American Airlines flight 1420
Little Rock, Arkansas
June 1, 1999

DCA99MA060

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

November 29, 1999

Group Chairman's Factual Report

OPERATIONAL FACTORS

DCA99MA060

A. ACCIDENT

Operator:	American Airlines, Inc.
Location:	Little Rock, Arkansas
Date:	June 1, 1999
Time:	2351 Central Daylight Time[1]
Airplane:	McDonnell Douglas MD-82, N215AA Serial Number 49163

B. OPERATIONAL FACTORS GROUP

Captain B. David Tew - Chairman Operational Factors (AS-30) National Transportation Safety Board 490 L'Enfant Plaza East, SW Washington, DC 20594	Captain David J. Ivey - Member Operations Factors (AS-30) National Transportation Safety Board 490 L'Enfant Plaza East, SW Washington, D.C. 20594
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[1] All times are Central Daylight Time (CDT) based on a 24-hour clock, unless otherwise noted. Actual time of accident is approximate, determined by the Flight Data Recorder (FDR) and Air Traffic Control (ATC) transcripts.

C. SUMMARY

On June 1, 1999, at 2351 Central Daylight Time (CDT), a McDonnell Douglas MD-82, N215AA, operated by American Airlines (AA) as flight 1420, regularly scheduled passenger service from Dallas, Texas, overran the end of runway 4R and collided with the approach light stanchion at the Little Rock/Adams Field (LIT), in Little Rock, Arkansas. The captain and 10 passengers sustained fatal injuries; the remaining 134 passengers and crewmembers sustained injuries. Shortly before the accident, the weather conditions at the airport were reported as: wind from 180 degrees at 9 knots, visibility 7 miles with thunderstorms, few clouds at 7,000 feet in cumulonimbus clouds, ceiling broken at 10,000 feet; temperature 77 degrees F, dewpoint 73 degrees F; altimeter, 29.86 Hg; Remarks - ASOS observation - thunderstorm began at 23 minutes after the hour, frequent lightning in clouds, and cloud-to-cloud, located from the west through the northwest; thunderstorms west through northwest moving northeast. The airplane was being operated in accordance with 14 CFR 121, and an instrument flight rules (IFR) flight plan had been filed.

D. DETAILS OF THE INVESTIGATION

The Operational Factors group convened at 1300 on June 2, 1999 in Little Rock, Arkansas. The accident site was visited by the group and interviews were conducted with the First Officer (F/O), two check airmen, a manager of crew scheduling, three pilots who had flown with the accident crew and the two pilots who had flown the airplane prior to the accident flight. This field phase of the accident investigation was concluded on June 6, 1999.

On June 22, 1999, NTSB Investigator David Ivey conducted a phone interview with a passenger from the accident flight.

The Operational Factors group and the Human Performance group jointly convened at 0800 between July 19 and 21,1999 in Dallas, Texas at the AA Training Academy. Interviews were conducted with AA MD-80 Fleet Manager, AA MD-80 Fleet Supervisor, the base manager of the Chicago-O'Hare Airport, Chicago, Illinois (ORD) base who was also one of four chief pilots at ORD, a check airman who conducted initial operating experience (IOE) training on the accident F/O, three check airmen who also instructed in the flight simulator, two human factor instructors, a F/O who flew with the accident captain, the dispatcher of the accident flight, the Director of Flight Safety, and the Federal Aviation Administration (FAA) Aircrew Program Manager (APM) of the AA MD-80 fleet. NTSB Investigator David Tew and Boeing Test Pilot Randy Wyatt each observed a simulator training session that was dedicated to landing and takeoff training on the MD-80. On July 22, 1999, the Operational Factors group traveled to Los Angeles, California to re-interview the accident F/O. This second field phase of the accident investigation was concluded on July 22, 1999.

1.0 HISTORY OF FLIGHT

The flight crew was scheduled for a three-day sequence. The first day consisted of three flight segments that commenced at O'Hare International Airport (ORD), Chicago, Illinois, proceeded to Salt Lake City International Airport (SLC), Salt Lake City, Utah, and continued to Dallas-Fort Worth International Airport (DFW), Dallas-Fort Worth, Texas. The third flight segment, which was the accident flight, continued to Little Rock/Adams Field Airport (LIT), Arkansas.

According to company records, Captain Buschmann reported for the sequence at 1038 and F/O Origel reported at 1018. Flight 1226 departed ORD at 1143 and arrived in SLC at 1358 Mountain Daylight Time (MDT). Captain Buschmann was the pilot flying (PF) and the flight time accrued for this leg was three hours and fifteen minutes. The crew departed SLC for DFW on flight 2080 at 1547 MDT and arrived in DFW at 2010. F/O Origel was the PF to DFW and the flight time accrued for this leg was three hours and twenty-three minutes enroute.

Flight 1420, the accident flight, was scheduled to depart DFW at 2028 as flight 1420. The airplane scheduled for use on the flight was delayed due to weather and according to the dispatcher of flight 1420, using the original airplane, would not allow the flightcrew to remain within the contractual crew duty day limit of 14 hours[2]. As a result, the accident airplane, N215AA, was substituted for flight 1420.

In DFW, the flightcrew received departure paperwork for the flight[3] that included airplane information, weight and balance information, and weather information. The weather information included a SIGMEC[4] that indicated a line of thunderstorms (TRW) along the planned flight path.

At 2240, flight 1420 departed DFW two hours and twelve minutes late. At 2254, the dispatcher sent an ACARS[5] message to the flightcrew advising them of enroute weather and the weather in the LIT area and said it may be a factor during the arrival at LIT. The dispatcher suggested expediting the arrival in order to beat the TRWs to LIT if possible. The flightcrew acknowledged receipt of the message. According to the F/O, both pilots used the airborne weather radar while enroute to LIT and both observed the weather along the route and in the LIT area. The accident F/O said he "felt a sense of urgency to land at LIT because the weather was moving in" and also said "there was no discussion of delaying or diverting the landing."

Upon arrival in the LIT area, the flightcrew contacted the approach controller. According to the ATC transcript, about 2334, they were advised of the weather at the LIT

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[2] See attachment 2.
[3] See attachment 4.
[4] Significant Meteorological Conditions: a weather advisory issued by AA weather services that might have some influence on the safety of AA flight operations.
[5] Aircraft Communications Addressing Reporting System.

airport and that the wind was from 280 degrees at 28 knots (kts.) with gusts to 44 kts. At about 2335, the controller notified the crew to expect an instrument landing system (ILS) approach for a landing on runway 22L. At about 2339, the controller issued a clearance to descend to an altitude of 3,000 feet and asked the crew "how is the final for two two left looking." The crew said "okay we can see the airport, from here we can barely make it out but we should be able to make two two...that storm is moving this way like your radar says it is but a little farther off than you thought." The controller asked if they would like to make a visual approach to the runway. The crew responded that "at this point, we can't really make it out. We are going to have to stay with you as long as possible."

At about 2340, the controller notified the flightcrew of a wind shear alert at the airport and reported the current centerfield wind as 330 degrees at 10 kts., the north boundary wind as 330 degrees at 25 kts., and the northwest boundary wind as 010 degrees at 15 kts. The flightcrew requested runway 4R to have a headwind during landing and the controller assigned flight 1420 a heading for a vector to runway 4R.

F/O Origel said that when the controller reported the winds, he thought about the crosswind limitations and made a comment about taking out the Operating Manual to check the wind limitations, but the captain said "put it away," so the F/O did not check the manual.

F/O Origel stated that on downwind they knew rain was in the area and the runway was wet.

At about 2343, the flightcrew reported visual contact with the airport about four miles to their right. The controller offered a clearance for a visual approach to runway 4R and the flightcrew accepted. At about 2344, the controller cleared flight 1420 to land, and reported the wind as 330 degrees at 21 knots.

At about 2344:33, the F/O informed the controller that they had lost sight of the airport due to a cloud between them and the airport. At about 2344:40, the controller began assigning the crew radar vectors for an ILS approach.

At about 2346:39, the controller notified flight 1420 that it was three miles from the outer marker and was cleared for the ILS 4R approach. The flight crew acknowledged the clearance.

At about 2346:52, the controller reported heavy rain at the airport and advised that the current ATIS[6] was incorrect. He reported the visibility as less than one mile and the runway visual range (RVR) for runway 4R as 3,000 feet. The flight crew acknowledged the report.

At about 2347:08, the controller cleared flight 1420 to land and reported the wind as 350 degrees at 30 knots with gusts to 45 knots. At about 2347:54, the controller issued a second windshear alert for the airport. He reported the winds as: centerfield wind 350

[6] Automatic Terminal Information Service (ATIS).

degrees at 32 kts. with gusts to 45 kts., north boundary wind 310 degrees at 29 kts., and northeast boundary wind at 320 degrees at 32 kts.

At about 2348:12, the controller reported the runway 4R RVR as 1,600 feet. According to the AA Jeppesen approach plate[7], an RVR of 2,400 feet was the lowest authorized for runway 4R at LIT. At about 2348:27, the crew reported they were established on the inbound portion of the ILS.

At about 2348:27, the controller cleared AA1420 to land. At about 2348:41, the flight crew acknowledged the transmission. This was the last transmission received from flight 1420.

The accident F/O stated that he thought the approach was stabilized until about 400 feet AFL when they drifted to the right of course and he estimated that they were displaced "about a runway width" to the right. The F/O stated that "at 400 feet because of the conditions, the wind, the weather, and [the fact the] runway was only 7,000 feet. We were going right of course and I thought it's getting more and more difficult to handle. So I thought it would be safer to go around." The F/O said that he thought he said "go-around" at that time. He said he looked at the captain to see if he had heard him, but the captain was intent on flying and was doing a "good job", except "his azimuth was off." He said that he thought to himself that the captain knows what he is doing and he was flying the airplane.

F/O Origel said they did not use autobrakes, because the captain elected to use manual brakes for landing.

F/O Origel said the touchdown was on the centerline and "not that far down the runway". He said at touchdown, both main gear were to the right of the runway centerline and the nose of the airplane was pointed left. He said they touched down "sort of flat," sideways, and it was "violent." He said, after they landed, the captain went into reverse immediately, and he saw all the reverser indicator lights come on. F/O Origel said he noticed when the captain went into reverse thrust that "he really honked on it" and the EPRs read 1.6 to 1.8.

F/O Origel said he did not remember if the spoilers extended after touchdown. He said if the spoilers came out, they came out automatically.

He said he did not experience normal landing sensations where you felt the brakes, spoilers, and reverse.

F/O Origel said that, immediately after touchdown, it felt like they had no control of the airplane and it did not feel like the airplane ever had contact with the ground. He said that, immediately after landing, he noticed the aircraft was not moving straight down the runway and he felt the airplane skidding "right off the bat" in a straight line sideways

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[7] See attachment 6.

to the right. He said "we then started to drift to the left across the runway" and he described the sensation as "like a roller coaster." As they progressed down the runway, they went to the left but came back toward the center of the runway, and he felt they had it under control. He said his main concern was the speed and the hydroplaning. He said, at one point, he felt the airplane was "fishtailing" and he "felt like we might ground loop."

F/O Origel said, at one point, the captain came out of reverse and it looked like he was either going to do a go-around or to regain directional control of the airplane. They "kind of drifted" on the runway and when the captain brought it out of reverse it seemed to be under control but going fast. He said the captain then went back into reverse thrust, but even that didn't seem to be working. F/O Origel said, at first, the captain was not using the thrust reversers to control the airplane's direction, but when the airplane got out of control, he thought the captain began using the reversers for control. He said he was certain the captain was using brakes but he couldn't see them from his position.

The airplane was sliding sideways down the runway and both main gear went off the left side of the runway and the nose gear remained on the runway. The F/O said he thought he asked, "you got it" a couple of times.

As the airplane continued down the runway, F/O Origel said he saw the alternating red and white centerline lights that began 3,000 feet from the far end of the runway. He said he thought that "this is not going the way we want it to, but at the same time, the airplane was on the runway and we were using brakes and thrust." He said that when their speed was about 80 kts and they were near the end of the runway, the captain said "brakes" and the F/O got on the brakes with him. F/O Origel said he did not help with the flight controls except for the brakes at the end

F/O Origel said G-forces from the airplane's movement down the runway restricted his movement and, as a result, he did not have a lot of mobility.

The airplane exited the far end of the runway and collided with an approach light support structure.

F/O Origel said that when the airplane stopped, the lights went out and he thought the captain had been ejected from the airplane because he could not see him from the F/O position. He undid his seatbelt and tried to get out of his seat but collapsed on his broken left leg and fell backwards. As he was sitting in his seat, he asked about the F/As and the captain and heard someone say the captain was still in his seat.

2.0 WEIGHT AND BALANCE

The following information was taken from the flight departure paperwork.

Basic Operating Weight....................................83,123 lbs.
Passenger Weight..25,020 lbs.

Baggage Weight	3,475 lbs.
Zero Fuel Weight	111,618 lbs.
Maximum Zero Fuel Weight Allowed	122,000 lbs.
Fuel	24,500 lbs.
Ramp Weight	136,118 lbs.
Maximum Ramp Weight Allowed	150,500 lbs.
Taxi Fuel Burn	2,080 lbs.
Actual Takeoff Weight	134,038 lbs.
Maximum Takeoff Weight Allowed	136,300 lbs.
Estimated Fuel Burn to LIT	6,289 lbs.
Estimated Landing Weight	127,749 lbs.
Maximum Landing Weight Allowed	130,000 lbs.

Takeoff center of gravity (CG) was 16.7 percent of the mean aerodynamic chord (% MAC) and was within the approved limits of the airplane.

3.0 FLIGHT CREW INFORMATION

Both crew members were certificated under AA and FAA certification requirements.

3.1 Captain Richard Warren Buschmann

Date of birth: [redacted] 1950
Date of hire with American Airlines: July 16, 1979
Airline Transport Pilot Certificate Number: [redacted]

At the time of the accident, Captain Buschmann held a First Class medical certificate dated February 9, 1999, with no restrictions.

A review of FAA records found no accident, incident or enforcement action.

Captain Buschmann was a graduate of the Air Force Academy and also Michigan State University, where he earned a master's degree in chemistry. He served seven years as a member of the United States Air Force where he flew the T-33 and EB-57 Canberra airplanes. He was hired by American Airlines, but, after one year, was furloughed for three and a half years. During his furlough, He worked for Westinghouse Electric Corporation as a nuclear plant engineer on submarine propulsion plants. After recall by American Airlines, his progression included flying all three positions in the B-727. He later became a captain and then a check captain on the MD-80. He was a Lt. Colonel in the United States Air Force Reserves and did admissions counseling for high school students interested in attending the Air Force Academy.

Flight Times: based on AA employment records

Total flying time:	10,234 hours
Total Pilot-in-Command (PIC) time:	9,001 hours
Total American Airlines PIC time:	7,384 hours
Total MD-80 PIC time:	5,518 hours
Total flying time last year:	411 hours
Total flying time last 24 hours:	7.9 hours
Total flying time last 30 days:	14 hours
Total flying time last 90 days:	54 hours

Initial Type Rating (MD-80)	August 31, 1991
Additional Type Rating:	B-727
Last recurrent ground training:	July 19,1998
Last proficiency check (single visit training):	July 19,1998
Last PIC line check:	July 26, 1998

3.2 First Officer Michael Henry Origel

Date of birth: [redacted] 1963
Date of hire with American Airlines: January 4, 1999
Airline Transport Pilot Certificate Number: [redacted]

At the time of the accident, F/O Origel held a First Class medical certificate dated November 12, 1998, with no restrictions.

A review of FAA records found no accident, incident or enforcement action.

F/O Origel obtained a pilots license after high school. He graduated from the University of Southern California and then entered the United States Navy in 1988. In 1991, he was released from the Navy due to a reduction-in-force. He began flying in corporate aviation about 1991, where he flew the Lear 35 Jet and a King Air E-90. He was a chief pilot for one company and the Director of Operations for a charter service. He was also a flight instructor in 1991 and 1992. At one time, his father, uncle, sister, and cousin all worked for American Airlines in Los Angeles, California. His father and uncle worked for American Airlines for 35 years and his sister had been a flight attendant for over 30 years.

Approximate Flight Times:

Total flying time:	4,292 hours
Total PIC time:	2,887 hours
Total American Airlines PIC time:	0 hours
Total MD-80 time:	182 hours
Total flying time last 24 hours:	7.9 hours
Total flying time last 30 days:	65 hours
Total flying time last 90 days:	176 hours

Last recurrent ground training: N/A
Last proficiency check (single visit training): February 22,1999
Last line check: March 10,1999

4.0 AERODROME INFORMATION[8]

At the time of the accident, Little Rock/Adams Field elevation was 260 feet above mean sea level (MSL), and was located two miles east of Little Rock, Arkansas. The airport had three grooved runways that were 150 feet wide. Runway 4L/22R was 8,273 feet long, runway 4R/22L was 7,200 feet long, and runway 18/36 was 5,124 feet long.

Runways 4R/22L and 4L/22R had high intensity runway lights (HIRL) and centerline lights (CL). Runways 4R and 4L had medium intensity approach lighting system with runway alignment indicator lights (MALSR). Runway 22L had a medium intensity approach lighting system with sequenced flashing lights and a precision approach path indicator (PAPI). Runway 22R had a visual approach slope indicator system (VASI).

5.0 TECHNIQUES

The AA DC-9 Operating Manual, Volume 1, CONDITIONALS section, page 1[9] stated in part:

> *Techniques are not procedures, but are suggested ways of accomplishing a task. These suggestions are based on experience and recognized practices. Generally, they offer the best method to complete the task in most cases. However, another technique may be just as appropriate, or even better, when considering the particular circumstances.*

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section included suggested information on the "Stabilized Approach Concept", information on "rudder blanking." This section also included the technique of returning the reverse levers to idle thrust to regain directional control and restore rudder effectiveness if the airplane started to drift across the runway while reversing.

6.0 AMERICAN AIRLINES APPROACH PROCEDURES

6.1 Approach Briefing

The AA Flight Manual, Part 1, Section 10, page 12[10] stated in part:

> *Prior to every approach, the captain will ensure the F/O (and F/E [flight engineer] if applicable) are briefed on the arrival, the instrument approach to be conducted, and the runway of intended landing. The Captain will specify which pilot will fly the approach and landing, particularly if it will be*

[8] See attachment 6.
[9] The MD-80 is a version of the DC-9. See attachment 7.
[10] See attachment 9.

other than the "pilot flying." Refer to the OM [Operating Manual] for specific approach briefing guidance.

The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 87[11] stated in part:

Captain will ensure completion of an approach briefing that includes:

- *Landing runway and reported visibility or RVR*
- *Type of approach to be conducted, e.g., Non-Precision (VOR[12], NDB[13], etc.), CAT I ILS, CAT II, CAT IIIa*
- *If a Non-Precision or Cat I ILS, who will be the pilot-flying*
- *Approach chart to be used and applicable minimum visibility or RVR*

For the following briefing items, the 'briefing strip' (if available) on the approach chart can be used:

- *Approach facility and frequency*
- *Final approach course*
- *Airport elevation*
- *Outer marker crossing altitude or minimum crossing altitude at Final Approach Fix*
- *MDA[14], DA[15], DH[16], as applicable*
- *Missed approach procedure*

Also from approach chart:

- *Minimum safe altitude*
- *Initial approach altitude*
- *Terrain awareness*

6.2 Before Landing Checklist

The Before Landing Checklist was accomplished using a mechanical checklist in the cockpit[17]. The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 71 described the before landing checklist[18] and how it was to be accomplished. The Operating Manual stated in part:

After each item has been accomplished, the pilot-not-flying [PNF] will call out that item on the checklist, call out the appropriate response, and then move the corresponding switch on the Mechanical Checklist. Any item that cannot be verified by the pilot-not-flying as accomplished will require a challenge and response. ALTIMETERS and FLT INSTR & BUGS [flight instruments and airspeed indicators] will be challenged by the pilot-not-flying

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[11] See attachment 10.
[12] Very High Frequency Omni Range (VOR).
[13] Non Directional Beacon (NDB).
[14] Minimum Descent Altitude (MDA).
[15] Decision Altitude (DA).
[16] Decision Height (DH).
[17] See attachment 11.
[18] See attachment 12.

and responded to by both pilots." When all items have been accomplished, the PNF will advise, - "Before Landing checklist complete."

The AA Instructor/ Check Airman, MD-80 Pilot Supplement, Section 3.01, page 9[19] guide stated in part:

Before Landing Checklist - PNF will accomplish the checklist.

There were 10 items on the before landing checklist and according to AA procedures, only two items required a response from both pilots. All other items, including arming the spoilers, were accomplished only by the PNF who both challenged and responded.

6.3 Spoiler Arming Prior To Landing

Interviews with AA pilots, instructors, and check airmen revealed that pilots were instructed during simulator training that the PNF armed the spoilers. Pilots interviewed said that during line flying either pilot would arm the spoilers, but most said that the captain usually did because the spoiler lever was on his side of the center console. No written procedure could be found in AA manuals stating which pilot had the responsibility to physically arm the spoilers for landing.

A review of three major Part 121 airlines' manuals indicated that AA's checklist procedures were similar to those procedures. Delta airlines had altered the response to the Spoiler Lever item on the Before Landing checklist and required that both pilots acknowledge that the spoilers were armed before landing. This change was in response to several incidents where spoilers were not armed prior to landing.

6.4 LIT Arrival Weather Information[20]

The crew received enroute and LIT weather information in their flight departure papers prior to leaving DFW. While enroute, the dispatcher sent an ACARS[21] message to the crew that stated "Right now on radar there is a large slot to LIT. TRWs[22] are on the left and right and LIT is in the clear. Sort of like a bowling alley approach. TRWs are MVG E/NE twds LIT and they may be a factor for our arrival. I suggest expediting our arrival in order to beat the TRWs to LIT if psbl." This message was acknowledged by the crew.

The flight was operated under Category I minimums and Category I minimums for runway 4R at LIT required an RVR of 2,400 feet and a DH of 200 feet.

The following information was provided by the ATC controller to flight 1420:

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[19] See attachment 14.

[20] For detailed weather information, see weather factual.

[21] See attachment 8.

[22] TRW was the meteorological shorthand for a thunderstorm.

- At about 2334:13, the controller advised the crew that just northwest of the airport, there was a thunderstorm that was moving through the area at that time. The crew acknowledged and said they could see lightning.

- At about 2339:45, the controller advised of a windshear alert at LIT and reported the current winds as: "centerfield wind is 340 at 10, north boundary wind is 330 at 25, northwest boundary wind 010 at 15

- At about 2342:27, the controller advised flight 1420 that "it appears we have a second part of the storm moving through."

- At about 2346:52, the controller advised flight 1420 there was heavy rain at the airport and that the current weather on the ATIS[23] was not correct. The controller said he did not have the current weather, but that the runway 4R RVR was 3,000 feet.

- At about 2347:54, about 4 minutes before the accident, the controller advised flight 1420 of a second windshear alert.

- At about 2348:12, according to the ATC transcript, he advised flight 1420 that the runway 4R RVR was now 1,600 feet.

- At about 2348:27, the controller advised flight 1420 it was cleared to land on runway 4R, the RVR was 1,600 feet and the wind was 340 degrees at 31 kts.

- At about 2349:12, the controller reported the wind as 330 degrees at 28 kts.

6.5 Stabilized Approach

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section, page 19[24] stated in part:

> *The stabilized approach concept requires that before descending below the specified minimum stabilized approach altitude, the airplane should be –*
> - *in the final landing configuration (gear down and final flaps),*
> - *on Approach Speed,*
> - *on the proper flight path and at the proper sink rate,*
> - *and at stabilized thrust.*
>
> *These conditions should be maintained throughout the rest of the approach. The minimum recommended stabilized approach altitudes are:*
> - *VFR[25] - 500 feet AFL[26]*

[23] See attachment 15.
[24] See attachment 16.
[25] Visual Flight Rules (VFR).
[26] Above Field Level (AFL).

- *IFR[27] - 1,000 feet AFL*

The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 89[28], stated in part:

> *On final, a callout will be made anytime any crewmember observes LOC[29] displacement greater than 1/3 dot and/or a GS[30] displacement greater than 1/2 dot [indications on the navigation instruments]. The other pilot will acknowledge this deviation.*

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section, page 19[31] stated the minimum recommended stabilized approach altitude for IFR conditions was 1,000 feet AFL and said "in all cases, select landing flaps by 1,000 feet AFL." The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 73[32] stated in part: "make final flap selection prior to 1,000 feet AFL.

The AA DC-9 Operating Manual, Volume 1, NORMALS page 102[33] stated in part:

> ***Requirements to Continue Approach Below DA/ DH (FAR[34] 121.651)***
>
> - *Airplane must be continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers and where that descent rate will allow touchdown to occur within the touchdown zone of the runway of intended landing.*

During the course of the investigation, several Part 121 airlines' manuals were reviewed.

The Delta Airlines Flight Operations Manual, Normal Procedures Section stated in part:

> ***Stabilized Approach Requirements***
>
> *Any significant deviation from planned flight path, airspeed, or descent rate must be verbalized. The decision to execute a go-around is no indication of poor performance.*
>
> ***Warning***
>
> *IMC [in Instrument Meteorological Conditions]*
>
> *At 1,000 feet AFE, and on final, the aircraft must be:*
>
> - *Configured for landing.*
> - *Maintaining stabilized descent rate, if descending.*

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[27] Instrument Flight Rules (IFR).
[28] See attachment 17.
[29] Localizer (LOC).
[30] Glideslope (GS).
[31] See attachment 16.
[32] See attachment 19.
[33] See attachment 20.
[34] Federal Aviation Regulation (FAR).

- *On target airspeed within tolerance, or speed being reduced toward target airspeed if higher was necessary.*

At 500 feet AFE, the aircraft must be:

- *Maintaining stabilized descent rate not to exceed 1,000 FPM [feet per minute], if descending.*
- *On target airspeed within tolerance.*
- *Established on course.*

Warning

These conditions must be maintained throughout the rest of the approach for it to be considered a stabilized approach. If the above criteria cannot be maintained, at or below 500 feet AFE, initiate a go-around.

The Continental Airlines MD-80 Flight Manual, Section 4, Pages 157,158,193, and 194 stated in part:

Stabilized Approach

The most optimum and consistent landing performance is achieved through the use of a stabilized approach. The optimum stabilized approach is defined as flight on the glidepath (visual or electronic) at a steady rate of descent, on the "target[35]" approach speed, in the landing configuration, in trim, and with the proper thrust setting. The dynamics of flight often dictate that flight parameters will vary from optimum. However experience has shown that a stabilized approach is essential for a safe operation.

Approaches will be considered unstable, and result in a missed approach, if aircraft is below 1,000 feet above TDZE[36] in IMC (500 feet above TDZE in VMC) and:

- *The airspeed is greater than + 15 knots from target speed, OR*
- *Rate of descent is greater than 1,500 FPM.*

These parameters must be met before reaching 1,000 feet above TDZE in IMC or a go-around will be announced by the PM [pilot monitoring]. While continuing the approach with operating parameters within the stated limits is acceptable, the aircraft must be correcting or trending toward the desired stable conditions.

6.6 MISSED APPROACH PROCEDURE

The AA Flight Manual, Part 1, section 10, page 21[37] dated April 15, 1998, MISSED APPROACH section stated in part:

[35] Continental defined target approach speed as the airplanes approach speed based on weight + 5 knots for landing in reported winds of 0 to 10 knots. In higher wind conditions, an additive of ½ the steady wind and the full value of the gust was to be combined with the target approach speed. This additive was not to exceed 20 knots.

[36] Touchdown Zone Elevation (TDZE).

Missed Approach Procedure
A. When a landing cannot be accomplished and, upon reaching the MAP[38] *defined on the approach chart, the pilot must comply with the missed approach procedure or with an alternate missed approach procedure specified by ATC."*

AA Flight Manual, Part 1, section 10, page 21[39] was revised, after the accident, on August 15, 1999 and a new paragraph titled "General" was added to the MISSED APPROACH section that stated in part:

American Airlines has a no-fault go-around policy, recognizing that a successful approach can end in a missed approach. Captains are required to execute/order a missed approach if the aircraft is not stabilized by 1000' [feet] AFL (IFR) or 500' AFL (VFR), or if in the pilot's judgement a safe landing cannot be accomplished within the touchdown zone, or the aircraft cannot be stopped within the confines of the runway.

The Continental Airlines MD-80 Flight Manual, section 4, pages 157 and 158 stated in Part:

Decision Regime Performance Limits
The decision regime will be from 500 feet above the TDZE to thrust reverser deployment during rollout. Performance limits in the decision regime are:

- *Airspeed: plus or minus 5 knots of target speed.*
- *Glideslope: Significant deviation not to exceed plus or minus 1 dot.*
- *Localizer: Category 1 [approach]: 1 dot right or left of centered CDI*[40]*.*

Any violation of these performance limits in the decision regime mandates an immediate go-around.

6.7 Approach and Landing Minimums

The AA Flight Manual Part I, Section 10, page 13[41] stated in part:

Weather Deterioration After Approach has Started (FAR*[42] *121.651).

A. After the aircraft is established on the final approach segment, if the weather is reported to be below published minima, the approach may be continued to the appropriate DH or MDA, and landing may be accomplished in accordance with the conditions for the type approach being conducted.

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[37] See attachment 21.
[38] Missed Approach Point (MAP).
[39] See attachment 22.
[40] Course Deviation Indicator (CDI).
[41] See attachment 18.
[42] Federal Aviation Regulation (FAR).

The final approach segment for an ILS approach begins on the glide slope at the glide slope intercept altitude as shown in the profile [on the approach chart].

The AA Flight Manual Part 1, section 10, page 20[43] wind landing limits section indicated that the maximum demonstrated dry runway crosswind was 30 kts and that approaches conducted with a visibility of less than 4000 RVR feet or ¾ mile shall not exceed a crosswind component of 15 kts and that approaches with a visibility less than 1800 RVR or ½ mile shall not exceed a crosswind component of 10 kts. The Flight Manual page 20 also stated in part:

If, in the Captain's judgement, environmental conditions or braking reports indicate that the runway is wet or slippery, the maximum acceptable crosswind should be reduced to 20 kts.

The AA Flight Manual Part 1, Section 12, page 3[44] stated in part:

Aircraft Operating Limitations: the latest surface wind for use for crosswind and/or headwind limitations would be that in the latest weather observation unless a more recent oral report was available from an operating control tower.

The AA Flight Manual Part 1, Section 10, page 25[45] stated in part:

A runway is considered dry when there is no report of snow, slush, ice, or water and no more than the following weather conditions are reported for the airport concerned:

(1) Scattered showers in the area.
(2) Intermittent drizzle of no more than moderate intensity.
(3) Intermittent light rain with surface temperature above freezing.

The AA DC-9 Operating Manual, NORMALS section, page 99[46] stated in part:

With less than 4,000 RVR or ¾ mile *[visibility].*

- *[Airplane] Landing weight based on wet runway limits.*

F/O Origel stated that on downwind they knew rain was in the area and the runway was wet.

6.8 Windshear

AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 13[47] stated in part:

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[43] See attachment 23.
[44] See attachment 41.
[45] See attachment 24.
[46] See attachment 25.
[47] See attachment 26.

Avoid areas of known severe windshear.

Search for clues which may indicate the presence of severe windshear. Severe windshear has been encountered under the following conditions:

- *Thunderstorm and convective clouds*
- *Rain and snow showers*
- *Frontal systems*
- *Strong or gusty surface winds.*

AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 14[48] stated in part:

Landing

When positive indications of severe windshear exist, avoid the areas by:

- *Diverting around the areas.*
- *On approach, initiate a go-around and/or hold until conditions improve.*

A definition of severe windshear could not be found in the AA DC-9 Operating Manuals or the AA Flight Manual Part 1.

The AA Flight Manual Part 1, Section 12, page13[49] stated in part:

LLWAS - Low Level Windshear Alert Systems

- *These wind reports are advisory only. The reported surface winds, as presently obtained from the centerfield instrumentation, are controlling for our [AA] Flight Operations.*

While flight 1420 was making an approach to runway 4R, the controller made two reports of windshear using LLWAS information.

6.9 Crew Coordination Procedures on Category I ILS Approaches.

The AA DC-9 Operating Manual, Volume 1, NORMALS section, pages 101 and 102[50] stated in part:

Cat I ILS Approach – Crew Coordination Procedures

- *Use of autopilot (if operative) is recommended with less than 4,000 RVR.*
- *Either pilot to callout – "Radio Altimeter Alive"*
- *Captain callouts:*
  - *"Track – Track"*
  - *"Outer Marker" and MSL crossing altitude*
  - *'Auto Go – Auto Land" (if applicable)*

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[48] See attachment 27.

[49] See attachment 44.

[50] See attachments 20 and 28.

Pilot-Flying *- Fly approach*
When advised that visual references are in sight, confirm requirements to descend below DA are satisfied, callout - "Landing" and complete approach and landing.

Pilot-Not-Flying *- Monitor approach*
Callouts:

- *"1,000 feet" AFL on barometric altimeter - Verbally verify when flaps/slats at landing setting.*
- *" 500 feet" AFL on barometric altimeter – Airspeed plus or minus Approach Speed and Descent Rate.*

At 100 feet above DA (on Baro *[barometric]* ***Altimeter)***
[PNF] Callouts:

- *" 100 feet above."*
- *visual references when in sight.*

At DA (on the Baro *[barometric]* ***Altimeter)***

- *[PNF] Callout: "Decision Altitude."*

Callouts

- *[PNF] "100" AGL on Radio Altimeter*
- *[PNF] "50, 40, 30, 20, 10" AGL on Radio Altimeter (if automated voice callouts are inoperative)*

7.0 LANDING PROCEDURES

7.1 Brake Selection and Anti-skid

AA procedures were that the anti-skid system, if operative, was to be used on all landings. The anti-skid system adapted pilot-applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure applied to each individual wheel for maximum braking effort. The AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 4[51] stated in part:

> *When brakes are applied on a slippery runway, several skid cycles will occur before the anti-skid system establishes the right amount of brake pressure for the most effective braking. If the pilot modulates the brake pedals, the anti-skid system is forced to readjust the brake pressure to re-establish optimum braking. During this readjustment time, braking efficiency is lost.*
>
> *On extremely slippery runways at high speeds, the pilot is confronted with a rather gradual deceleration and may interpret the lack of an abrupt sensation*

[51] See attachment 30.

of deceleration as a total anti-skid failure. The natural response might be to pump the brakes or turn off the anti-skid. Either action will degrade braking effectiveness."

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section, page 21[52] stated in part:

Autobrakes
Unless circumstances dictate otherwise, manual braking is generally recommended for landing.

The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 74[53] stated in part:

Use aggressive manual braking or MAX [maximum] autobrakes on short or slippery runways.

Autobrakes on a MD-80, if armed, are applied approximately two seconds after touchdown.

During observation of an AA Takeoff and Landing simulator training period[54], which was usually day six of the simulator schedule, one instructor recommended to his students to use "heavy manual" braking on contaminated runways and said that he did not like the autobrakes for landings. During another observation of an AA Takeoff and Landing simulator training period[55], a different instructor advised his students that medium autobrakes should be used on a wet runway.

The AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 3[56] stated in part:

Manual Brake Stopping

- *For short or slippery runways, immediately after nose gear touchdown, use full brake pedal.*

The AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 4[57] operating manual stated in part:

Autobrakes slow the airplane at a programmed rate of deceleration which varies with the setting [of autobrakes selected].

On short or slippery runways, wheel braking may be least effective at the end of the runway because of rubber deposits, snow, or ice. In these conditions, since the middle of the runway offers the best friction for wheel braking,

[52] See attachment 30.
[53] See attachment 31.
[54] See attachment 42.
[55] See attachment 43.
[56] See attachment 32.
[57] See attachment 29.

brakes should be aggressively applied by the use of MAX autobrakes or manual braking immediately after touchdown.

The Continental Airlines MD-80 Flight Manual, Section 4, Page 198 stated in part:

It is estimated that manual braking techniques frequently involve a four to five second delay between main gear touchdown and brake pedal application even when actual conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in the loss of 800 to 1,000 feet of runway. Directional control requirements for crosswind conditions and low visibility may further increase the above delays. Note: Autobrakes, if available, should be used when landing rollout distance is critical.

7.2 Spoiler Extension After Landing

If the spoilers were armed prior to landing, the MD-80 spoiler actuator would automatically extend the ground spoilers with main gear wheel spin-up or when the nose strut compressed.

The AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 3[58] stated in part:

The braking force available from the tires is proportional to the area in contact with the runway, the force on the tires perpendicular to the runway, the brake coefficient, and the friction between the tires and runway. The contact area normally changes little during the braking cycle. The coefficient of friction depends on the tire condition and runway surface (concrete, asphalt, dry or wet, or icy). The perpendicular force comes from the airplane weight and any downward aerodynamic force. Raising the speedbrakes spoils the lift of the wing at high speed and places approximately 70 percent of the airplane weight on the wheels. This increases the effectiveness of the brakes, when required, during the high speed portion of the landing roll.

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section, page 21[59] states in part:

Monitor the automatic deployment of the spoilers after touchdown. If the spoilers do not deploy automatically, the captain should manually deploy them.

The AA DC-9 Operating Manual, Volume 1, NORMALS section, page 75[60] Landing Checklist stated in part:

[58] See attachment 32.
[59] See attachment 30.
[60] See attachment 33.

If Spoiler Lever does not move back to full aft [extend] position, the Captain, regardless of which pilot is making the landing, will manually deploy the spoilers."

Investigators who reviewed AA manuals could not find any written procedures detailing who was responsible for monitoring the automatic deployment of the spoilers.

Investigators who reviewed AA manuals could not find any written procedures detailing callout procedures in the event ground spoilers did not extend or deploy after landing.

During observation of an AA Takeoff and Landing simulator training period[61], one instructor did not include any "failed spoiler" scenarios[62] during the landing training. During observation of another AA Takeoff and Landing simulator training period[63], the instructor included seven "failed spoilers" scenarios during the period. The crew noticed two of the seven "failed spoiler" events, and in both instances the F/O manually extended the spoilers.

The Boeing Commercial Airplane Group does include a callout procedure in it's manuals. The Boeing MD-80 Flight Crew Operating Manual, Section 2, page 48[64] stated in part:

If a spoiler lever does not move aft or does not remain at EXT [extend] position, PNF call "No Spoilers," PF move lever aft to full extend position and up to latched position.

A review of the procedures at three major Part 121 airlines revealed one carrier, Delta Airlines, required a callout of "Spoilers Up" when spoilers deployed after touchdown.

7.3 Use of Reverse on Landing

7.3.1 Canted Reverse

A McDonnell Douglas All Operators Letter[65] (AOL) issued to all MD-80 operators on February 15, 1996, indicated that the reverse thrust buckets of the MD-80 were canted to change the reverser efflux pattern to prevent debris from being picked up and placed directly in the engine path. As a result, the aerodynamic forces acting on the vertical stabilizer and rudder were disrupted by an increase in reverse thrust above approximately 1.3 engine pressure ratio (EPR) and reduced the ability of the rudder and vertical stabilizer to provide optimum directional control. As the reverse thrust increased above 1.3 EPR, the rudder and

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[61] See attachment 42.
[62] Events in which the automatic spoilers were failed after being armed so that they would not automatically extend after touchdown.
[63] See attachment 43.
[64] See attachment 34.
[65] See attachment 35.

vertical stabilizer effectiveness continued to decrease until at reverse thrust greater than approximately 1.6 EPR, the rudder and vertical stabilizer provided little or no directional control. The AOL stated further that on a wet/slippery runway it was possible that the only directional control would be from the rudder.

7.3.2 Published Procedures

The AA DC-9 Operating Manual, Volume 1, TECHNIQUES section, page 21[66] stated in part:

> *The application of reverse thrust tends to blank out the rudder. The effectiveness of the rudder starts decreasing with the application of reverse thrust and at 90 knots, at 1.6 EPR (in reverse) it is almost completely ineffective.*

The AA DC-9 Operating Manual, Volume 1, ENVIRONMENTAL section, page 7[67] stated in part:

> *One of the worst situations occurs when there is a crosswind and sufficient water to produce total tire hydroplaning. Reverse thrust tends to disrupt airflow across the rudder and increases the tendency of the airplane to drift downwind, especially if a crab or yaw is present.*
>
> *As reverse thrust increases above 1.3 EPR, rudder effectiveness decreases until it provides no control at about 1.6 EPR. Do not exceed 1.3 EPR reverse thrust on the slippery portions of the runway, except in an emergency.*

Boeing MD-80 Flight Crew Operating Manual (FCOM), Section 2, page 48[68] stated in part:

> ***Landing Roll Expanded Procedures***
> *On wet or contaminated runways and without Intermediate Reverse Thrust Detent installed[69], reverse thrust of no more than 1.3 EPR should be used, except in an emergency.*

The AA Instructor/ Check Airman Guide, MD-80 supplement, did not contain any guidance for instructing crosswind landings or landings on a wet/slippery runway. AA said the company policy was to have the Instructor Guide refer to the appropriate company manuals for training information to avoid the content of the instructors manuals getting "out of synch" with the Flight Manual and the Operating Manual.

A review of the AA DC-9 Initial and Transition Syllabus, page 24[70] indicated that slippery runway and crosswind landing training was scheduled during Period 6 of the long

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[66] See attachment 30.
[67] See attachment 36.
[68] See attachment 34.
[69] AA does not have the Intermediate Reverse Thrust Detent installed on their MD-80 airplanes.
[70] See attachment 37.

training course or Period 3 of the short training course. There was no description of the specific scenarios taught during those periods, other than a reference to the AA DC-9 Operating Manual, Volume 1, Environmental section.

During observation of an AA Takeoff and Landing simulator training period[71], there was no briefing or training of limiting reverse thrust to 1.3 EPR during landing on a wet/contaminated runway. All of the training focused on setting the normal 1.6 EPR for reverse thrust on landing. During another observation of an AA Takeoff and Landing simulator training period[72], the students applied 1.6 EPR reverse thrust during about 12 wet runway landings before the instructor noticed in his AA DC-9 Operating Manual, Volume I that 1.3 EPR should have been the maximum reverse thrust used. The instructor then advised the students of this information.

The AA DC-9 Operating Manual, ENVIRONMENTAL section, Page 27[73] gave guidance for landing on slippery runways and stated in part:

- *Use aggressive manual braking or maximum autobrakes and auto spoilers.*
- *Apply reverse thrust as soon as possible after nosewheel touchdown. Do not exceed 1.3 EPR reverse thrust on the slippery portions of the runway, except in an emergency.*
- *When reversing, be alert for yaw from asymmetric thrust. If directional control is lost, bring engines out of reverse until control is regained.*
- *Do not come out of reverse at a high RPM [revolutions per minute]. Sudden transition of reversers before engines spool down will cause a forward acceleration."*

AA written procedures did not require a briefing for reverse and EPR procedures when landing on a wet runway.

8.0 COMPANY INFORMATION

At the time of the accident, AA had 9,661 pilots. There were 3,112 total MD-80 pilots, including 1,440 captains, 1,372 first officers. AA had MD-80 bases in Boston, Massachusetts (BOS), Washington, D.C. (DCA), New York, New York (LGA), Chicago, Illinois (ORD), Dallas, Texas (DFW), Los Angeles, California (LAX), San Francisco, California (SFO), Reno, Nevada (RNO), Las Vegas, Nevada (LAS), and Seattle, Washington (SEA).

At the time of the accident, AA had a total of 498 check airmen of which 108 were MD-80 check airmen. There were 17 of the MD-80 check airmen designated to perform pilot certification work under the supervision of the FAA.

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[71] See attachment 42.
[72] See attachment 43.
[73] See attachment 38.

There were a total of 279 MD-80 airplanes in the AA fleet.

9.0 FAA OVERSIGHT

The FAA Certificate Management Office (CMO) for American Airlines was located in Dallas, Texas. The operation's staffing for the AA Certificate Management Team (CMT) was 16 inspectors for 1997, 20 inspectors for 1998, and 19 inspectors for 1999. In September 1997, an Assistant Aircrew Program Manager was added to the MD-80 fleet. There were 18 geographic inspectors assigned to AA CMT under the Air Transportation Oversight System (ATOS) and 11 were fully trained at the time of the accident. A geographic inspector was considered fully trained for the ATOS program when he had completed an ATOS course at the Transportation Safety Institute in Oklahoma City, Oklahoma and received additional specific airline training from the Certificate Management Office of the airline to which he was assigned. The remaining seven geographic inspectors were being trained or were scheduled for training.

Mr. Dexter Taylor was the FAA Aircrew Program Manager (APM) for the AA MD-80 program. He had worked on the AA certificate since 1973 and became the MD-80 APM in 1984.

During the early seventies, Inspector Taylor was a part of the FAA Flight Operations Evaluation Board and worked on the early evaluations of the MD-80. At the time of the accident, he was current and qualified on the MD-80.

Inspector Taylor and his assistant program manager were responsible for the entire operations part of the AA MD-80 fleet. Their responsibilities included approval or acceptance of all MD-80 manuals, approval of all changes to the manuals, and monitoring of the training program.

He stated that his workload did not allow him or his assistant time to monitor many proficiency check rides or type rating certifications of pilots. Under his supervision, he had approximately 17 AA check airmen who were aircrew program designees (APD) and they did most of the certifications. An aircrew program designee was an AA pilot who was appointed by the FAA to conduct airman certification activity on a particular type of airplane. Inspector Taylor said, " I have to rely on the designees [APDs] to do the work" because he did not always have the time. He said that currently the only certification work he performed was when a new designee had to be examined or when a pilot had failed two consecutive check rides and was being rechecked.

He said the MD-80 fleet had about 75 percent of the new upgrade captains and about 50 percent of the new hire pilots were assigned to the airplane.

When asked about his oversight of the designees, Inspector Taylor said "right now, I don't have time to observe them on a periodic basis. We've got so many other things going on, but usually we try to look at them at least once a year in one of the functions they do; the oral, or their sim check." He said, in accordance with FAA Order 8400.10[74], "we're supposed to look at them each year before we renew them. Sometimes we can do it and sometimes we can't. We might not have time to do that." He said he did attempt to meet with the designees each quarter of the year when AA had their fleet-wide standardization meeting and would discuss "whatever they wanted to talk about."

He said he did not have the "luxury" of observing all of the AA check airmen on a regular basis and said that the only check airmen we are looking at right now are the new check airmen. He said the required observation of check airmen at least every two years was done in accordance with the FAA Order 8400.10[75].

He said, at the present time, he did "very little" observation of training in the simulator and that "about the only training I see now is when I watch a new check airman doing a proficiency check." He said, " we just do not have time to come over here and sit for six hours a day in the simulator." When asked if that was normal, he replied that "it was not normal, but with the manpower restraints we have right now, it is what we are stuck with." He said "we are spread thin and right now it is extremely difficult to cover all the things that are going on at American Airlines, from an observation standpoint of training." He and his assistant were the only people in his office that had the responsibility to observe AA MD-80 training.

He said he had two free days on his schedule that month. The other days were taken up with observation of new check airmen and IOEs. In addition, he said he had just been informed that he would have to begin doing inspections of certain cities that American flew into.

He said he received assistance from other geographic FAA offices on observation of IOE training and line checks.

A review of FAA's Program Tracking and Reporting Subsystem (PTRS) showed the following inspections completed on the AA MD-80 fleet during 1998 and until the date of the accident in 1999:

ACTIVITY	PTRS CODE #	FY-1999	FY-1998
Surveillance of Check Airmen	1642	9	27
Enroute Surveillance	1624/1625	537	795
Surveillance of Check Airman Administering a Line Check	1644	18	25
Surveillance of Check Airman During IOE Instruction	1645	49	60

[74] FAA Order 8400.10, Volume 5, pages 5-291 and 5-292. See attachment 39.

[75] FAA Order 8400.10, Volume 3, pages 3-367 and 3-368. See attachment 40.

Submitted by: [redacted]

Dave Tew
Air Safety Investigator, Operations
November 29, 1999

DCA99MA060
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