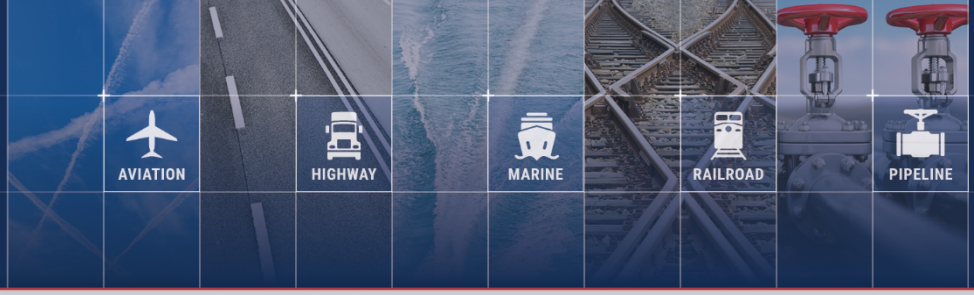

Aviation Investigation Final Report

Location:	CLEVELAND, Ohio	**Accident Number:**	IAD97FA052
Date & Time:	March 5, 1997, 21:07 Local	**Registration:**	N275AA
Aircraft:	McDonnell Douglas DC-9-82	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	3 Minor, 106 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The DC-9 was number 2 for the ILS approach behind a commuter airplane, and was placed in holding while chemicals were applied to the runway due to snow and slush. The DC-9 captain requested a braking action report, which the tower controller relayed to the commuter airplane that had not yet landed. A braking action report was not received prior to the DC-9 landing. The captain elected to continue the approach with full auto-land selected to a contaminated runway, without a braking action report and a crosswind component of 13 knots. On the runway, the auto-pilot responded and attempted to return the airplane to the centerline of the runway. After 18 seconds and with the airplane's nose drifting left, the captain disengaged the auto-pilot, and applied full right rudder and brake to stop the left drift. The DC-9 departed the left side of the paved runway approximately 5,500 feet down the 8,998 foot runway, and facing 80 degrees left of the runway heading. A review of the manual revealed that the operator's flight manual contain no guidance or limitations for pilots regarding the use of full auto land and roll-out on contaminated runways

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot in command did not maintain control while utilizing the full auto-land system. Factors to this accident were a contaminated runway, a crosswind, and inadequate guidance provided in the aircraft manual.

Findings

Occurrence #1: LOSS OF CONTROL - ON GROUND/WATER
Phase of Operation: LANDING - ROLL

Findings
1. (F) TERRAIN CONDITION - SLUSH COVERED
2. (F) TERRAIN CONDITION - SNOW COVERED
3. (F) WEATHER CONDITION - CROSSWIND
4. (C) AUTOPILOT - CONTINUED - PILOT IN COMMAND
5. (C) DIRECTIONAL CONTROL - NOT MAINTAINED - PILOT IN COMMAND
6. (F) AIRCRAFT MANUALS - INADEQUATE

Factual Information

HISTORY OF FLIGHT

On March 5, 1997, about 2107 eastern standard time, a McDonnell Douglas DC-9-82, N275AA, operated as American Airlines flight 320, was substantially damaged as it slid off the left side of runway 5R during landing rollout at Cleveland Hopkins International Airport (CLE), Cleveland, Ohio. The certificated airline transport pilot, first officer, and four flight attendants were uninjured. Three of the 103 passengers reported minor injuries. The scheduled domestic passenger flight, was conducted under 14 CFR Part 121. Night instrument meteorological conditions existed and a instrument flight rules flight plan was filed for the flight which originated from the Dallas/Fort Worth International Airport, Dallas/Fort Worth, Texas, at 1824.

A review of the Federal Aviation Administration radar data and the Cockpit Voice Recorder (CVR) revealed that flight 320 was vectored to and cleared for the ILS 5R approach, at 2100. Less than 2 minutes later, flight 320 was instructed to switch to the tower frequency and told that "there's commuter traffic four miles ahead. He's going to give a braking action report." The local controller cleared flight 320 to land and stated "wind three five zero at one six", at 2102:33. The pilot responded with a request for a braking action report, and the controller was heard answering, "I don't know sir. It (the runway) just opened up. We had chemicals applied to the runway. You'll be number two to the runway. As soon as I get something, I'll let you know."

On the CVR, the controller was heard requesting a braking action report from the commuter, at 2103:53. After the commuter landed, the tower controller again requested a braking action report, but was unsuccessful. At 2105:29, the commuter switched to the ground frequency and attempted to give a braking action report, but was unable due to frequency congestion.

The Flight Data Recorder (FDR) from flight 320 captured the touch down, at 2106:46. The airplane traveled 5,500 feet down the 8,998 foot runway, exiting the left side after taxiway "Romeo". The airplane stopped facing about 80 degrees left of the runway heading.

The accident occurred during the hours of darkness at about 041 degrees 24.5 minutes North latitude, and 81 degrees 51 minutes West longitude.

FLIGHT CREW INFORMATION

CAPTAIN

The Captain held an Airline Transport Pilot Certificate for airplane single and multiengine land, and was type rated in the DC-9 in November, 1995, with additional type ratings for the Embraer

120 and the Boeing 727. He had accumulated nearly 900 hours of Pilot-in-Command time in the DC-9, with over 2,525 hours Second-in-Command time. He possessed both Flight Instructor and Flight Engineer (Turbojet) Certificates. His most recent Federal Aviation Administration (FAA) First Class Medical Certificate was issued on January 22, 1997, with no limitations or waivers.

The Captain was hired in October 1984, and flew as a Flight Engineer on the Boeing 727. This was the second day of the Captain's trip, and the second leg for the day. His reported total flying experience was 14,500 hours.

FIRST OFFICER

The First Officer held an Airline Transport Pilot Certificate for airplane single and multiengine land, and was type rated in the L300. He had accumulated 2,700 hours Second-in-Command time in the DC-9. He possessed a Flight Engineer (Turbojet) Certificate for Boeing 727. His most recent FAA First Class Medical Certificate was issued on October 21, 1996, with no limitations or waivers.

The First Officer was hired in January, 1990, and flew as a Flight Engineer on the Boeing 727. This too, was his second day of his trip, and the second leg for the day. His reported total flying experience was 5,200 hours.

APPROACH

The CVR/DFDR and the captain's statement indicated that he flew a coupled approach with auto-land and rollout programmed. The Manufacturer's Flight crew Operating Manual (FCOM) and the Aircrew Operations Manual (AOM) both state that the use of auto-land had a crosswind component limitation of 15 knots, that may be reduced by the prevailing visibility.

AIRCRAFT INFORMATION

The airplane was equipped with two Pratt & Whitney JT8D engines. Each engine had 20,000 pounds of thrust, with reverse available. The left engine had accumulated 1,044 hours since last inspection, and the right had accumulated 7,839 hours.

A review of the airplane's maintenance records did not reveal any repetitive discrepancies related to the engines, brakes or flight controls.

METEOROLOGICAL INFORMATION

Weather at Cleveland, Detroit (Alternate #1), and Indianapolis (Alternate #2)was:

KCLE (Cleveland Hopkins International Airport) at 060154Z: Winds 350013KT; Visibility 1/2 SM; Snow Fog; Ceiling 100 FEET OVERCAST; TEMPERATURE 33 DEGREES FAHRENHEIT;

DEWPOINT 32 DEGREES FAHRENHEIT; ALTIMETER 29.77 Inches HG.

SPECI KDTW (Detroit Metro Airport) at 060134Z: Winds 31006KT; Visibility 1 3/4 SM; LIGHT SNOW; MIST; Ceiling 600 OVERCAST; TEMPERATURE 32 DEGREES FAHRENHEIT; DEWPOINT 30 DEGREES FAHRENHEIT; ALTIMETER 29.85 Inches HG.

SPECI KIND (Indianapolis International Airport) at 060112Z: Winds 31015KT; Visibility 6SM; MIST; Ceiling 1,600 OVERCAST; TEMPERATURE 32 DEGREES FAHRENHEIT; DEWPOINT 30 DEGREES FAHRENHEIT; ALTIMETER 30.04 Inches HG.

American Airlines Dispatch sent a message to flight 320 at 2058. It stated, "Cleveland implemented an internal ground stop for aircraft landing Cleveland until 2115. The airport management has closed runway 5L for treatment. Runway 5R will close after that, also for treatment. Users can expect up to 30 minutes of airborne holding."

AERODROME INFORMATION

The CLE elevation was 792 feet msl, and was located about 9 miles southwest of Cleveland. It was owned and operated by the City of Cleveland, and was certificated in accordance with the applicable provisions of Title 14 CFR Part 139. It had a Federal Aviation Administration (FAA) approved snow and ice control plan in accordance with 14 CFR Part 139.313. CLE was the winner of the Balchen/Post award for snow and ice control in the large commercial airport category for the winter of 1995-1996.

Runway Conditions

CLE runway 5R was concrete, 8,999 feet long, 150 feet wide, and transverse grooved full length. Runway 5R was configured and approved for category II instrument landings, and was equipped with high intensity runway edge lights, and centerline lights. It was equipped with pavement surface condition sensors, which detected and reported pavement surface conditions, and were used to plan and initiate snow removal operations. Prior to and following the accident, all sensors recorded surface conditions as wet, with surface temperatures varying between 32 and 34 degrees Fahrenheit.

The CLE operations department logbooks and written statements taken from airport operations and maintenance personnel, reported that the runway was covered with less than 1/8 inch of slush, at 2033, and snow plows were not considered because the amount of snow was insufficient to plow. Radar data showed that Flight 320 was put in holding at the outer marker at 2041. The CLE operations department logbooks showed entries for CLE maintenance personnel applying sodium formate to runway 5R/23L, at 2046, and finished, at 2055. CLE operations personnel issued a Notice to Airmen (NOTAM), at 2059, which stated: "Runway 5R/23L has a thin cover of wet snow. Chemical applied 30 feet either side of centerline. (Tapley braking action for runway) 5R: 35-30-24."

Sodium Formate was applied to combat the snow and ice which began to accumulate on the runway. The application procedure utilized for applying the chemical was two trucks, one on each side of the runway centerline and about 10 feet from the center. Each truck traveled about 20 to 30 mph, applying potassium acetate through a pre-wetting system to the sodium formate. It was dispensed at a rate of 3 gallons per minute, and about 1 1/4 tons of the chemical per mile was applied. The dispensing spinners were set to cast the chemical a width of 40 feet with the majority of the chemical landing in a swath of 25 feet. At the end of the runway, the trucks made a 180 degree turns and made a second pass about 20 to 30 feet off each side of the centerline. According to the onboard computer measuring system, both trucks put down a total in excess of 7 tons of sodium formate.

The de-icing procedures utilized by CLE personnel were the published procedures of the chemical manufacturer, and no inspection of the de-icing truck was requested at the time of the accident.

COCKPIT VOICE RECORDER

The cockpit voice recorder (CVR) committee convened on March 18, 1997, and a transcript was prepared for the entire 31:40 minutes of recording. The pilots were invited to review the CVR transcript to suggest corrections or additions, and declined the invitation.

According to the transcript, approach control was heard stating that "runway 5R was just closed, and I'm not sure how long it should be closed. I'll give an update as soon as I can find out." The captain and first officer discussed fuel requirements to alternate airports, Detroit and Indianapolis. In their discussions, Detroit was ruled out because weather was lower than forecasted. Indianapolis, although further away, was chosen with a fuel requirement of 14,000 pounds (This total was computed from 7,000 pounds burn off to Indianapolis, and on the ground at Indianapolis with 7,000 pounds). The flight crew stated to approach control that they had 1,000 pounds of fuel for holding before they would have to divert to Indianapolis. Approach control responded by stating that the runway was closed for another 15 to 20 minutes.

The transcript also revealed that the flight crew discussed diverting to Indianapolis with American Airlines CLE Operations. A second discussion ensued with American CLE Operations, who was on the telephone with the American Dispatcher in Dallas/Fort Worth. The amount of fuel the flight had for holding was discussed. The flight crew responded that they had 13,900 pounds of fuel, the runway would open on the hour, and they "will give it one shot" to land at CLE.

During the approach, the flight crew asked if the runway lights were up, and the tower controller responded that "they were set at four, and will put them at five for you." At 300 feet, the captain stated the approach lights were in sight.

DIGITAL FLIGHT DATA RECORDER

Although, the digital flight data recorder (DFDR) was taken to the Safety Board's laboratory for readout and evaluation, American Airlines (AAL) conducted the readout of the DFDR, which was utilized for the initial phases of the investigation. The AAL readout was consistent with the data produced by the Safety Board; however, the sign convention used by AAL for rudder position was opposite to that used by the Safety Board, and a subsequent readout of the data was conducted by the Safety Board. The following are summary references from selected flight recorder parameters:

The total elapsed time from main gear touchdown to when the airplane came to a stop was 28 seconds.

The data was consistent with an auto land approach/landing and rollout on runway 5 at CLE. Just prior to main gear touchdown, the Automatic Flight (AF) modes for roll and pitch changed from "AUTO LAND" to "ALIGN" and "FLAIR", respectively.

There was 5 seconds from main gear touched down to when the nose gear touched down, at which time the AF modes for roll and pitch changed to "ROLL OUT".

Within the first two seconds (6-7 second elapsed time) following nose-gear touchdown, the ground spoilers reached 60 degrees and the thrust reversers deployed symmetrically while the engines remained at idle. During the next 5 seconds (8-12 second elapsed time), the thrust was increased to approximately 60% N1, the heading swung 7 degrees to the left reaching 042 degrees. Also, the localizer deviation increased to 49mv, the rudder position reached approximately 10 degrees (left rudder), and the "AUTO LAND" Roll Out mode remained engaged.

Over the next 5 seconds (13-17 second elapsed time), the heading continued to swing to the left reaching 031 degrees, while the right rudder position swung in the opposite direction reaching full travel right...the "AUTO LAND" Roll Out mode remained engaged.

The auto pilot was disengaged within a second after full right rudder was reached (about 18 second elapsed time). During the 8.5 second period after the auto pilot was disengaged and before the vertical acceleration data indicated the airplane departed the paved surface of the runway, the heading values showed a continuous swing to the left reaching 337 degrees, or nearly 80 degrees deviation from the runway heading.

WRECKAGE AND IMPACT INFORMATION

The airplane came to rest upright, about 80 degrees left of the runway heading, with the nose landing gear turned 90 degrees left, and the right main landing gear collapsed. The airplane was resting on the right wing, with damage to the leading edge slats and the trailing edge flaps. Mud and grass was seen on the inside of the engine inlets for both the #1 and #2 engines. The ground underneath and around the airplane was saturated with fuel leaking from

the right wing. It was estimated by the American Airlines Safety department that about 7,000 pounds (1,044 gallons) of fuel leaked from the wing. An examination of the airplane was done by American Airlines damage assessment team on March 7, 1997, it revealed that extensive repairs to the airframe would be required prior to the airplane being returned to service.

ADDITIONAL INFORMATION

OPERATIONS GROUP

The Captain and the First Officer left Cleveland the day after the accident without being interviewed by the NTSB. American Airlines offered the NTSB the opportunity to attend the company's review board (ASAP) in order to "interview the pilots" at their facility. The offer was declined and the Operations Group Chairman interviewed the pilots 2 weeks after the accident.

During a review of the pilots training jackets, 2 weeks after the accident, it was discovered that the Captain and the First Officer received a line check while flying together on the flight prior to the accident. This line check was not mentioned by American Airlines, or the Captain check airman, who administered the line check. The Captain check airman had arrived in Cleveland the day after the accident, and participated in the accident investigation as a party to the investigation for American Airlines safety department.

An Operations Group met with the NTSB group chairman in Dallas/Fort Worth from March 18 to March 22, 1997. Areas of interest that the Operations Group considered were: Other runway excursions at CLE during the same winter season, the flight crew not receiving the runway braking action prior to landing, encroachment of the ILS critical areas by taxiing airplanes, the de-icing procedures utilized by CLE personnel, and the inspection of the de-icing truck after the accident.

A review of the other winter runway excursions at CLE did not reveal any correlation with this accident.

RECORDED RADAR STUDY

Continuous Data Recording (CDR) obtained from the Cleveland Hopkins Air Traffic Control Tower (ATCT) provided radar reinforced target data of the accident airplane and other aircraft, that departed 3 minutes prior and landed 4 minutes after the accident took place.

The FAA provided the Instrument Landing System (ILS) information from a Flight Inspection Report-Instrument Landing System, dated March 4, 1997. This data was combined with the pertinent data on the airplane, which allowed a computer to calculate the localizer with the (left and right limits), and glide slope with the (upper and lower limits). It also depicted that the airplane remained within the parameters of those limits with no interference from the other airplanes.

AIRPORT SPECIALIST REPORT

The data and information compiled from CLE Operations Department Logbooks and written statements from airport operations and maintenance personnel depicted their effort to handle the rapidly moving weather, which changed from rain to sleet, and then, to snow in less than an hour. The actions taken by CLE personnel were in compliance with the FAA and industry standards.

AMERICAN AIRLINES FLIGHT MANUAL

DC-9 OPERATING MANUAL, TITLED: "LANDING UNDER ADVERSE WEATHER CONDITIONS" stated:

"a slippery runway and crosswind obviously make a bad combination. Avoid touchdown on the downwind side of the runway. Aim for the center line or slightly on the upwind side." It continued, "after touchdown on a slippery runway with a crosswind, the airplane may weathervane into the wind..." It further stated that "one of the worst situations occurs when there is a crosswind and sufficient water and speed to produce total tire hydroplaning." It continued that during the application of reverse thrust, "if you should find yourself weather-vaning into the wind...you may find it necessary to release the brakes and possibly stop reversing to regain cornering control and re-establish alignment with the runway."

A review of the manual revealed that the AA Flight Manuals contain no guidance or limitations for pilots regarding the use of full auto land and roll-out on contaminated runways.

STATEMENT BY COMMUTER FLIGHTCREW

The pilots of the commuter airplane which landed ahead of flight 320, stated that they utilized heavy reverse thrust and no brakes during their rollout. As they made their turn onto taxiway "Mike", they applied heavy braking and judged the braking action to be "fair to poor". Once parked and stepping on the tarmac (runway 18/36 was being used as a parking space) the pilot estimated that the snow and slush to be less than 1/2 inch.

Wreckage Release

The airplane was verbally released on March 7, 1997, to the American Airlines maintenance crew who assessed the damage incurred during the accident.

Pilot Information

Certificate:	Airline transport; Flight engineer; Flight instructor	**Age:**	42,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	January 22, 1997
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	14500 hours (Total, all aircraft), 4500 hours (Total, this make and model), 13000 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	McDonnell Douglas	**Registration:**	N275AA
Model/Series:	DC-9-82 DC-9-82	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	49272
Landing Gear Type:	Retractable - Tricycle	**Seats:**	147
Date/Type of Last Inspection:	Continuous airworthiness	**Certified Max Gross Wt.:**	149500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	37922 Hrs	**Engine Manufacturer:**	P&W
ELT:	Installed, not activated	**Engine Model/Series:**	JT8D
Registered Owner:	MARMID AIRCRAFT LEASING CORP	**Rated Power:**	20000 Lbs thrust
Operator:	AMERICAN AIRLINES, INC.	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	AALA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	CLE ,777 ft msl	**Distance from Accident Site:**	
Observation Time:	20:54 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Unknown	**Visibility**	0.5 miles
Lowest Ceiling:	Overcast / 100 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	13 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	350°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	1°C
Precipitation and Obscuration:	N/A - None - Fog		
Departure Point:	DAL/FORT WORTH (DFW)	**Type of Flight Plan Filed:**	IFR
Destination:	(CLE)	**Type of Clearance:**	IFR
Departure Time:	17:24 Local	**Type of Airspace:**	Class B

Airport Information

Airport:	CLEVELAND HOPKINS INTL CLE	**Runway Surface Type:**	Concrete
Airport Elevation:	777 ft msl	**Runway Surface Condition:**	Slush covered;Snow;Wet
Runway Used:	5R	**IFR Approach:**	ILS
Runway Length/Width:	8998 ft / 150 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	6 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Minor, 100 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Minor, 106 None	**Latitude, Longitude:**	41.430133,-81.82048(est)

Administrative Information

Investigator In Charge (IIC):	Cain, Jim
Additional Participating Persons:	DANIEL E SCHMIDT; CLEVELAND , OH ROBERT STAMM; CLEVELAND , OH P D WESTON; WASHINGTON , DC C L LEWIS; DALLAS/FW , TX
Original Publish Date:	February 28, 2000
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=28129