Aviation Investigation Final Report

Location:	Brookshire, Texas	**Accident Number:**	DCA22MA009
Date & Time:	October 19, 2021, 10:00 Local	**Registration:**	N987AK
Aircraft:	McDonnell Douglas DC-9-87 (MD-87)	**Aircraft Damage:**	Destroyed
Defining Event:	Flight control sys malf/fail	**Injuries:**	2 Serious, 1 Minor, 20 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

Accident Sequence

The captain (who was the pilot flying) initiated the takeoff roll, and the airplane accelerated normally. According to the cockpit voice recorder (CVR) transcript, the first officer made the "V1" and then "rotate" callouts. According to the captain (in a postaccident interview), when he pulled back on the control column to rotate the airplane, "nothing happened," and the control column felt like it "was in concrete" and "frozen." The CVR captured that the first officer subsequently made the "V2" callout, then the captain said "come on" in a strained voice. Both pilots recalled in postaccident interviews that they both attempted to pull back on the controls, but the airplane did not rotate. The CVR captured that the first officer called out "abort." The first officer pulled the thrust levers to idle and applied the brakes, and the captain deployed the thrust reversers. (See "Execution of Rejected Takeoff" for more information.)

The airplane overran the departure end of the runway and continued through the airport perimeter fence and across a road, striking electrical distribution lines and trees before coming to rest in a pasture, where a postcrash fire ensued. The pilots, two additional crewmembers, and all passengers evacuated the airplane. Two passengers received serious injuries, and one received a minor injury. (See "Emergency Evacuation" for more information.) Postaccident examination of the airplane and the related flight data recorder (FDR) data revealed no evidence of preimpact malfunction of the engines or thrust reversers that would have precluded their normal operation. Examination of the elevators and a review of FDR data for elevator position determined that both elevators were jammed trailing-edge-down, which prevented the airplane from rotating during the takeoff roll.

Jammed Elevator Condition

The investigation determined that, at some point during the 6 months since the airplane was last flown, the inboard geared tab linkages for both elevators had moved beyond their normal range of travel into an overcenter position, resulting in the jammed condition of the elevators in the trailing-edge-down position. No evidence of any other mechanical malfunction, elevator or pitch control system failure, structural failure, or actions by the flight crew or maintenance personnel was identified that could have resulted in the jammed condition. Further, the jammed condition was not detectable during the flight control check the first officer performed during taxi; the elevator control system design is such that, even with this type of jammed elevator condition, the control column feel and travel would be normal during taxi (when the aerodynamic forces on the elevator control tabs would be minimal).

Since the airplane was last flown, it was parked outside at the departure airport and exposed to two significant high-wind events: the passage of a squall line about 5 months before the accident (with gusts to 46 kts reported at the airport) and a tropical storm about 1 month before the accident (with gusts of 35 to 45 kts reported over a 5-hour period). The possibility of elevator jamming on DC-9/MD-80 series airplanes as a result of exposure to certain high-wind conditions while parked is known and evidenced by two previous events – a rejected takeoff event in 1999 in Germany and a runway overrun accident in 2017 in Ypsilanti, Michigan.

The NTSB's investigation of the Ypsilanti accident determined that the airplane's right elevator became jammed. Although The Boeing Company (the type certificate holder for the airplane) indicated that the MD-80 series airplane was designed to withstand a 65-kt horizontal ground gust from any direction while parked or taxiing, the jamming occurred even though the highest reported wind gust was 55 kts during the time that the airplane was parked. The investigation included a wind simulation study that determined that the airflow at that airplane's parked location was affected by the presence of a large hangar (located upwind of the airplane) that generated localized turbulence with a dynamic, vertical component.

Based on the wind simulation information, the NTSB developed an elevator test plan that determined that the vertical gust loads at the Ypsilanti accident airplane's parked location were sufficient to enable the inboard geared tab linkages for the right elevator to move into an overcenter position and jam the right elevator. The investigation found that the airworthiness standard for transport-category airplanes specified that the airplanes must be designed for the limit loads generated when subjected to a 65-kt horizonal ground gust; however, the version of the standard that applied to MD-80 series airplanes allowed for the assumption of only static loads and did not require consideration of dynamic, vertical wind components. (In 2019, the NTSB issued a safety recommendation to the Federal Aviation Administration [FAA] related to the standard. See "Previously Issued Safety Recommendations" for more information.)

The accident airplane (like the Ypsilanti accident airplane) had been parked near a hangar. Although the highest reported gust or sustained wind at the airport never exceeded 46 kts while the accident airplane was parked, the localized wind conditions in the immediate vicinity

of the parked airplane may have differed from the wind conditions detected by the nearest weather sensor in speed or dynamic characteristics, or both. The presence of localized differences is further supported by the fact that another DC-9 (MD-87) airplane that was parked on the ramp near the accident airplane since the accident airplane had last flown did not sustain jammed elevators. Thus, the accident airplane's jammed elevators resulted from the airplane's exposure to high-wind conditions while parked, which likely included localized turbulence with a vertical component.

Flight Crew Procedures and Training for Exterior Inspections of Elevators

In 2019, the NTSB issued Safety Recommendation A-19-2 (as a result of its investigation of the Ypsilanti accident), which recommended that Boeing develop new preflight procedures or other mitigations for DC-9/MD-80 series airplanes that will enable a flight crew to verify before takeoff that the elevators are not jammed. In response to this recommendation, in 2020, Boeing published Operations Bulletin 80-2-017, "ELEVATORS NOT JAMMED VERIFICATION" and Temporary Revision 80-2-153 to the MD 80 Flight Crew Operating Manual (FCOM), both of which included a warning stating that, before every flight, the flight crew must confirm that the elevator surfaces are not jammed in the trailing-edge-down position.

According to the warning, which was added as an update to the FCOM's Exterior Inspection Procedures, confirmation involves visually verifying that the elevators are faired (even) with or above the stabilizer surface. This flight crew verification applied to every flight, regardless of the airplane's ground wind exposure. The bulletin also explained that, for the previous known jammed elevator events, the control column feel and travel were normal during the control checks the crews performed during taxi. As a result of Boeing's publication of this bulletin and revised procedures, the NTSB classified Safety Recommendation A-19-2 Closed—Acceptable Action.

During postaccident interviews, the captain and the first officer indicated that they were unaware of the elevator inspection procedure. Although both elevators were visibly trailing-edge-down when the first officer performed a preflight inspection of the airplane (as was evident in a photograph he took of the airplane that morning), he did not recognize the condition as anomalous. Although the flight crew accepted the 14 *CFR* Part 91 accident flight as contract work for the operator, 987 Investments LLC, they were trained by and used the airplane manuals and procedures from their primary employer, Everts Air Cargo, a 14 *Code of Federal Regulations* (*CFR*) Part 121 cargo operator.

Although Boeing had distributed Operations Bulletin 80-2-017 to Everts through its MyBoeingFleet system, and Everts was required (per 14 *CFR* 121.141) to keep its airplane flight manuals current, a review of Everts' MyBoeingFleet activity data showed no evidence that any Everts personnel had viewed or downloaded the bulletin before the accident. As a result, the company had not updated the FCOM with the revised warning or updated its pilot training materials to include the new preflight exterior inspection procedures for visually confirming

that the elevators are not jammed. In a postaccident interview, Everts' director of operations stated that he was unaware of the Boeing operations bulletin until after the accident.

Following the accident, Everts updated its manuals and developed a detailed pilot training presentation that included photographs and a video to show the visual difference between the faired and trailing-edge-down elevator positions when viewed from the ground.

Execution of the Rejected Takeoff

According to Everts' procedures, the captain was responsible for deciding, declaring, and initiating a rejected takeoff. Before the takeoff, the captain briefed the first officer on the rejected takeoff criteria, stating that they would reject after V1 only if the airplane would not fly. (This procedure is consistent with longstanding FAA and industry guidance indicating that, generally, a takeoff rejected after V1 will result in a runway overrun.) Based on the NTSB's airplane performance study and a review of the FDR data, the airplane's lack of rotational response did not become apparent to the captain until after V1.

The CVR transcript showed that the first officer made the "rotate" callout at 0959:48.0 (which was about 1 second after the "V1" callout). The FDR data showed that a change in the control column position began about 1 second after the "rotate" callout, consistent with the captain beginning his attempt to rotate the airplane. FDR data from the accident flight and the airplane's two previous takeoffs showed similar control column position behavior for all three flights. The data showed that, during the two previous takeoffs, the airplane's nose-up pitch response began about 2 to 4 seconds after the control column movement. However, during the accident flight, the control column response felt abnormal to the captain, and the airplane's pitch did not increase.

Following the first officer's "rotate" callout, the captain pulled back on the control column (and was joined briefly by the first officer) before the first officer called out "abort" about 4 seconds later. Although, procedurally, the captain should have been the one to call for and initiate the rejected takeoff, the first officer recognized that the airplane was not going to fly and appropriately took action. Human performance research has shown that the average reaction time to an unexpected driving event is about 1.5 seconds. However, stress and increased task demands associated with an unexpected emergency (such as the abnormal control column feel and the airplane's failure to rotate as usual) can increase a pilot's reaction time and degrade a pilot's ability to accurately assess how to respond.

About the time that the first officer made the "abort" callout, pulled the thrust levers to idle, and applied the brakes, the airplane was traveling at 150 kts with only 1,500 ft of runway remaining (and a 600-ft runway safety area beyond that). The airplane reached a maximum speed of 158 kts at 0959:55 (about 2 seconds after the "abort" callout) before it began decelerating. Based on Boeing's calculations, at this speed and position on the runway, an overrun was inevitable; Boeing calculated that it would have taken 2,450 ft to stop the airplane from the maximum speed on a dry, paved runway using maximum braking and reverse thrust.

The FDR data showed the left and right thrust reversers momentarily unlocked and the spoilers deployed (consistent with the captain's deployment of the thrust reversers) about 0959:59 but then the thrust reversers relocked. The airplane performance study determined that the airplane's speed was about 121 kts when it exited the paved surface at 1000:01; the FDR data became unreliable at 1000:03.

Actual thrust reverser positions during the accident sequence could not be determined from the FDR data (the thrust reverser position parameters were invalid for both the accident flight and previous flights). Although a witness stated that he saw the thrust reversers deploy before he lost sight of the airplane, the lack of damage on and debris inside the thrust reversers' lower doors was consistent with them having been fully stowed by the time that the airplane began striking tree branches and other vegetation. In the absence of any mechanical anomaly or an intentional command by a crewmember to stow the thrust reversers, it is possible that a crewmember may have inadvertently pushed the thrust reverser levers down during the accident sequence.

Emergency Evacuation

According to the captain, once the airplane came to a stop, he saw flames out the left cockpit window and commanded for everyone to evacuate. The captain stated that his main concern was getting the passengers off the airplane and away from the fire. He inadvertently did not shut down the engines (per the emergency evacuation procedure), and the right engine continued to run throughout the evacuation. The investigation determined that damage to the fuel system sustained during the final seconds of the impact sequence resulted in the left engine's power loss.

The passengers and crew successfully evacuated the airplane despite the running engine and other challenges, including smoke and flames outside the airplane that deterred them from using some exits. The emergency response was timely and effective. Although the airplane's cabin included two passenger seat positions not identified on the supplemental type certificate (STC) for the airplane's cabin modification, the additional seats did not hinder the emergency evacuation.

Previously Issued Safety Recommendations

As a result of the NTSB's investigation of the Ypsilanti accident, in 2019, the NTSB issued safety recommendations intended to prevent future occurrences. These included Safety Recommendation A-19-1, which recommended that Boeing modify DC-9/MD-80 series airplanes to prevent the possibility of elevator jamming due to exposure to high-wind conditions while parked or taxiing. However, that same year, Boeing responded that, due to airplane structural limitations, neither a physical travel stop on the elevator structure (to prevent a jammed condition) nor a sensor (to provide a cockpit indication of a jammed condition) was feasible. Based on Boeing's response, the NTSB classified Safety Recommendation A-19-1 Closed—Reconsidered.

Thus, the accident airplane was not equipped with any design feature that could prevent the possibility of elevator jamming or provide the flight crew with a cockpit indication that the elevators were jammed.

The NTSB also issued Safety Recommendation A-19-3, which recommended that Boeing lower the ground gust criterion for requiring physical inspections and operational checks of the elevators of DC-9/MD-80 series airplanes by maintenance personnel. In response, in 2019, Boeing established a 55-kt ground wind exposure criterion (which lowered the previous inspection criterion of about 65 kts) that would require a maintenance inspection to ensure that the elevators were not jammed.

Although the lowered wind exposure criterion was in effect before this accident, the reported wind at the airport never met nor exceeded the 55-kt criterion during the time that the airplane was parked since its last flight. Thus, no maintenance inspection of the elevators was required for the accident airplane before the accident flight. However, had such high wind conditions existed, neither the maintenance manager for 987 Investments nor the Everts personnel who provided him with maintenance information was aware that an inspection would have been required.

In addition, NTSB Safety Recommendation A-19-5 (issued as a result of the Ypsilanti accident investigation) asked the FAA to ensure that operators of DC-9/MD-80 series airplanes have procedures that define who is responsible for monitoring the wind that affects parked airplanes and for notifying maintenance personnel when conditions could meet or exceed the specified ground gust criterion.

At the time of the accident, the FAA had not yet completed its planned actions in response to Safety Recommendation A-19-5. (However, as stated above, the wind at the airport where the accident airplane was parked never met nor exceeded the ground gust criterion that would have required a maintenance inspection of the elevators.) On June 14, 2022, the FAA issued Safety Alert for Operators 22001, “Recommended Procedures for Operators of Boeing DC-9/MD-80 Series and B717 Model Airplanes When Wind/Ground Gusts Meet or Exceed Criteria Specified in the Applicable Aircraft Maintenance Manual.”

According to the FAA (at the time of this report), it was developing a notice that will be included in FAA Order 8900.1, Flight Standards Information Management System, to ensure that operators have procedures within their Continuous Airworthiness Maintenance Program defining who is responsible for monitoring the wind that affects parked airplanes and who is responsible for notifying maintenance personnel when conditions could meet or exceed the ground gust criteria specified in the Aircraft Maintenance Manual. The FAA stated that it anticipated releasing the notice by December 31, 2023. At the time of this report, Safety Recommendation A-19-5 was classified Open—Acceptable Response.

In addition, NTSB Safety Recommendation A-19-4 asked the FAA to determine whether the gust load limits specified in 14 *CFR* 25.415 adequately ensure that critical flight control

systems are protected from hazards introduced by ground gusts that contain dynamic, vertical wind components. The FAA responded in June 2022 that the requirements of 14 *CFR* 25.415 were revised on December 11, 2014, to include consideration of dynamic loads, and the FAA determined that the ground gust limit loads specified for transport-category airplanes were adequate and appropriate for current and foreseeable future designs. The FAA also noted that the requirement for considering dynamic loads did not exist when the DC-9/MD-80 series airplanes were certified. Based on the FAA's review of 14 *CFR* 25.415 and other related material and its determination that the current regulations were adequate, Safety Recommendation A-19-4 was classified Closed—Acceptable Action.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The jammed condition of both elevators, which resulted from exposure to localized, dynamic high wind while the airplane was parked and prevented the airplane from rotating during the takeoff roll. Also causal was the failure of Everts Air Cargo, the pilots' primary employer, to maintain awareness of Boeing-issued, required updates for its manuals, which resulted in the pilots not receiving the procedures and training that addressed the requirement to visually verify during the preflight checks that the elevators are not jammed.

Findings

Aircraft	Elevator control system - Malfunction
Environmental issues	High wind - Effect on equipment
Organizational issues	(general) - Other institution/organization

Factual Information

History of Flight

Takeoff	Flight control sys malf/fail (Defining event)
Takeoff-rejected takeoff	Runway excursion

On October 19, 2021, at 1000 central daylight time, a McDonnell Douglas DC-9-87 (MD-87) airplane, N987AK, owned and operated by 987 Investments LLC, overran the departure end of runway 36 at Houston Executive Airport (TME), Brookshire, Texas, after the flight crew executed a rejected takeoff. (All times in this report are central daylight time unless otherwise indicated.) Of the 19 passengers and 4 crewmembers on board the airplane, 2 passengers received serious injuries, and 1 passenger received a minor injury. A postcrash fire ensured, and the airplane was destroyed. The personal flight was operated under Part 91 and was destined for Laurence G. Hanscom Field Airport (BED), Bedford, Massachusetts.

The captain and the first officer accepted the accident flight as contract work while they were off duty from their primary employer, Everts Air Cargo, a Part 121 air cargo operator headquartered in Fairbanks, Alaska. The airplane was based at TME and kept parked on the ramp, and it had not been flown since April 26, 2021. The captain had flown the airplane on its last trip (and numerous other trips); the first officer had not flown it before. According to the captain, they used an Everts quick reference handbook and checklist for the airplane.

On the day of the accident, the captain and the first officer arrived at the airport about 0800. The first officer performed the preflight exterior inspection of the airplane, which included a visual check of the elevators, and he noted no anomalies. An airframe and powerplant mechanic who worked for 987 Investments (and was a crewmember on board the accident flight) said he performed an exterior walk-around of the airplane, and he noted no anomalies.

The CVR began recording about 0928:50 and captured that the captain, who was the pilot flying, and the first officer, who was the pilot monitoring, discussed various checks and procedures while the passengers boarded. The CVR captured that the captain told the first officer that they would be using normal Everts procedures. The captain briefed the rejected takeoff procedures, during which he stated that they would reject the takeoff after V1 “only if the airplane won’t fly.” (V1, also known as the decision speed, is defined, in part, as the maximum speed by which a rejected takeoff must be initiated to ensure that the airplane can be stopped on the remaining runway.)

The captain and the first officer subsequently started the engines, and, at 0952:33, the TME air traffic controller provided their clearance to taxi to runway 36. According to the first officer, as

the captain taxied the airplane, the first officer conducted a flight control check, which included pushing the control column all the way forward then pulling it all the way back and turning the yoke left and right. (The FDR recorded data consistent with a control check being performed during taxi.) The first officer noted no anomalies during the control check.

The TME air traffic controller cleared the flight for takeoff about 0959. Shortly after, the CVR captured the captain's callout that the takeoff thrust was set and the first officer's acknowledgement then confirmation that the engine and instrument indications were normal. According to FDR data for the accident flight, the takeoff began with the flaps, slats, and horizontal stabilizer set correctly.

At 0959:36.3, the first officer called out "80 kts," followed by "V1" at 0959:47.2 and "rotate" at 0959:48.0. Based on the FDR data, the captain's attempt to rotate the airplane began about 1 second after the "rotate" callout, but the airplane's pitch never increased. (See the "Aircraft Performance Study" section.) The captain stated in a postaccident interview that, when he pulled back to move the control column aft, "absolutely nothing happened." The captain said it felt to him like the control "was in concrete." When asked to clarify whether he moved the yoke and the airplane didn't lift off, or whether the yoke was stuck, the captain replied "no" to both scenarios and stated that the yoke was "frozen."

The CVR captured that the first officer subsequently made the "V2" callout (an airspeed reference relevant to single-engine climb performance) and that the captain then said "…come on" in a strained voice at 0959:51.7. Both pilots recalled in postaccident interviews that they both then attempted to pull back on the yoke. At 0959:53.3, the first officer called out "…abort."

According to the captain, the first officer was faster than he was at reaching for the thrust levers, and, when he saw that the first officer pulled the thrust levers to idle, he (the captain) activated the thrust reversers. The first officer said that he heavily applied the brakes and could feel the airplane decelerating, but it overran the departure end of the runway. The airplane crossed the runway safety area and continued through the airport perimeter fence and across a road, striking electrical distribution lines and trees before coming to rest about 1,400 ft beyond the end of the runway in a privately owned pasture.

The CVR had ceased recording audio shortly after the airplane departed the runway surface, and no crew conversations after the "abort" callout were captured. According to the captain, once the airplane came to a stop, he saw flames out the left cockpit window and commanded for everyone to evacuate.

All passengers and crew evacuated the airplane, and airport and emergency response personnel soon arrived. (See the "Survival Aspects" section.)

Pilot Information

Certificate:	Airline transport; Flight engineer	**Age:**	67,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	September 15, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 29, 2021
Flight Time:	(Estimated) 22000 hours (Total, all aircraft), 4000 hours (Total, this make and model), 0 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Pilot Information

Certificate:	Airline transport; Flight instructor; Remote	**Age:**	46,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	August 23, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 31, 2021
Flight Time:	(Estimated) 10000 hours (Total, all aircraft), 700 hours (Total, this make and model), 0 hours (Last 90 days, all aircraft), 0 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Captain

At the time of the accident, the captain worked for Everts as a simulator instructor and check airman. He previously worked as Everts' chief pilot in the DC-9/MD-80 series airplanes for about 2.5 years until he turned 65 and was no longer eligible to fly under Part 121 regulations.

The captain's most recent Part 121 training events at Everts included recurrent ground and flight training in October and November 2020, respectively, a requalification proficiency check in June 2021, and emergency procedures training in October 2021.

The captain resided in Las Vegas, Nevada. On October 16, 2021 (3 days before the accident), he was in Fairbanks, Alaska, and awoke about 0515 Alaska daylight time (AKDT) for a 0700 AKDT flight home, where he arrived about 1830 Pacific daylight time (PDT). He did not nap during the day, and he went to bed about 2130 PDT. The next day, he awoke between about 0600 and 0700 PDT, did routine personal errands throughout the day, and went to bed about

2200 PDT. The day before the accident, he awoke about 0630 PDT and had a 1000 PDT flight to Houston, where he arrived about 1530. He met the first officer for dinner, went back to the hotel to watch a football game, and went to bed about 2230 to 2245. On the day of the accident, he awoke about 0630, had breakfast, and arrived at the airport about 0800 The captain said he had no problems falling asleep at night and felt rested the morning of the accident.

In the 72 hours preceding the accident, the captain did not consume any alcohol or other drugs, including prescription or nonprescription medications, that might have affected his performance. He had no major changes in his personal life, finances, or health in the previous 12 months.

Toxicology testing performed by the FAA's Forensic Sciences Laboratory on the captain's blood identified no evidence of impairing drugs.

First Officer

The first officer worked for Everts since June 2019. Previous employment included flying corporate airplanes for several years in the United States and overseas.

The first officer's most recent Part 121 training events at Everts included recurrent ground and flight training in January and July 2021, respectively, a proficiency/qualification check in July 2021, and emergency procedures training in January 2021.

The first officer resided in Bruce, South Dakota. On October 16, 2021 (3 days before the accident), he awoke between 0800 and 0900, did routine housework throughout the day, and went to bed between 2200 and 2300. The next day, he awoke between 0800 and 0900, did routine housework, and went to bed about 2200. The day before the accident, he awoke about 0530 and caught an 0800 flight to Houston, arriving at his hotel at 1438. He took a 45-minute nap, met the captain for dinner, the returned to the hotel to relax and watch TV before going to bed about 2130 to 2200. On the day of the accident, he awoke about 0700 and had breakfast before heading to the airport. The first officer said he usually fell asleep quickly at night and would sometimes toss and turn. He characterized his sleep as "pretty decent" in the days before the accident and said he felt rested on the day of the accident.

In the 72 hours preceding the accident, the first officer did not consume any alcohol or other drugs, including prescription or nonprescription medications. He had no major changes in his personal life, finances, or health in the previous 12 months.

Toxicology testing performed by the FAA's Forensic Sciences Laboratory on the first officer's blood identified no evidence of impairing drugs.

Other Crewmembers

According to the airplane's owner, he acted as a cabin crewmember and performed such duties as setting out food, drinks, and blankets before the passengers arrived and providing the pretakeoff safety briefing, which included the use of the seatbelts and the emergency exits.

(See the “Survival Aspects” section.) The owner knew all of the passengers on the accident flight (either personally or through business), and most had traveled on the airplane before. According to the captain, the owner typically provided the passenger safety briefings, was thorough, and ensured that everyone paid attention.

According to the airplane’s owner, a mechanic (usually the maintenance manager) always traveled on board the airplane to be available in case any maintenance needs arose when the airplane was away from base. On the day of the accident, the maintenance manager was not feeling well enough to travel, but he went to the airport before the flight departed, met with the flight crew, and provided instructions to the on-board mechanic (who had not traveled with the accident airplane before).

Aircraft and Owner/Operator Information

Aircraft Make:	McDonnell Douglas	**Registration:**	N987AK
Model/Series:	DC-9-87 (MD-87) DC-9/MD-80 series	**Aircraft Category:**	Airplane
Year of Manufacture:	1988	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	49404
Landing Gear Type:	Retractable - Tricycle	**Seats:**	27
Date/Type of Last Inspection:	October 18, 2021 Continuous airworthiness	**Certified Max Gross Wt.:**	149500 lbs
Time Since Last Inspection:	0 Hrs	**Engines:**	2 Turbo fan
Airframe Total Time:	49566 Hrs at time of accident	**Engine Manufacturer:**	Pratt & Whitney
ELT:	Installed	**Engine Model/Series:**	JT8D-219
Registered Owner:	987 Investments, LLC	**Rated Power:**	
Operator:	987 Investments, LLC	**Operating Certificate(s) Held:**	None

At the time of the accident, The Boeing Company held the type certificate for the DC-9-87 (MD-87) airplane (generally referred to as a DC-9/MD-80 series airplanes). The owner of 987 Investments purchased the accident airplane in 2015 and maintained it based on Boeing maintenance planning document ME80-020-TNK, dated August 1, 2019.

According to the maintenance manager, maintenance checks and inspections to maintain airworthiness were accomplished since the airplane was last flown in April 2021. According to the mechanic, on the day of the accident, he completed a 72-hour service check and daily walk-

around tasks, which included checking the security and condition of the airplane's exterior, including the vertical and horizontal stabilizer surfaces.

Cabin Configuration

The accident airplane was originally delivered with a commercial cabin configuration, but maintenance records showed that it was modified in 2008 under an STC that specified 19 passenger seating positions (with 1 additional state room seat subject to a limitation that prohibited occupancy during taxi, takeoff, and landing).

The accident airplane's cockpit had seats for the captain and the first officer and included one retractable observer's seat (which was unoccupied during the accident flight). According to interviews with the airplane's owner and multiple passengers, the cabin had 22 passenger seats, each of which was equipped with a lift-latch lap belt. The owner said he was unaware that the cabin configuration differed from that specified in the STC.

Elevator System

The DC-9-87 (MD-87) airplane has a T-tail design, such that the elevators and horizontal stabilizer are attached near the top of the vertical stabilizer about 30 ft above ground level (agl). The left and right elevators are attached by hinges to the rear spar of the horizontal stabilizer, and each is equipped with control, geared, and antifloat tabs attached to the trailing edge (see figure 1).

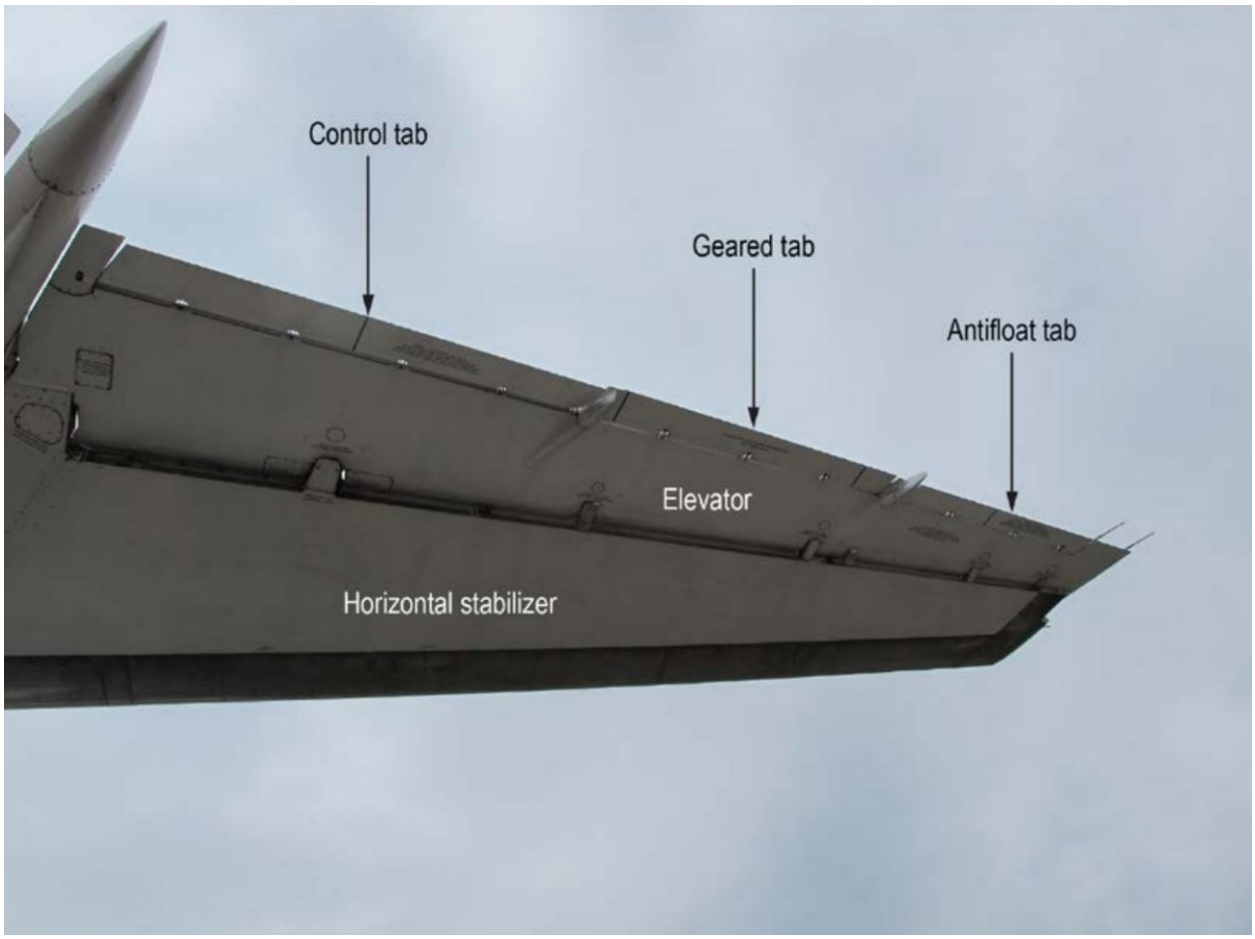

Figure 1. Exemplar airplane (viewed from the ground looking up) showing respective locations of right horizontal stabilizer, elevator, control tab, geared tab, and antifloat tab. (Source: Boeing)

Generally, elevator control is accomplished via the elevator control tabs, which are mechanically connected to and directly controlled by the cockpit control columns. During takeoff (at Vr or higher), when a pilot provides aft control column input to command rotation, the control tabs mechanically deflect in response to the control column inputs, and the resultant aerodynamic forces on the deflected control tabs move the elevators to produce the change in airplane pitch.

Elevator geared tabs, which mechanically deflect in response to elevator movements, are attached to the horizontal stabilizer through a system of drive linkages. The geared tab drive linkage consists of a pushrod that is attached to the horizontal stabilizer spar by means of an actuating crank and links (see figure 2).

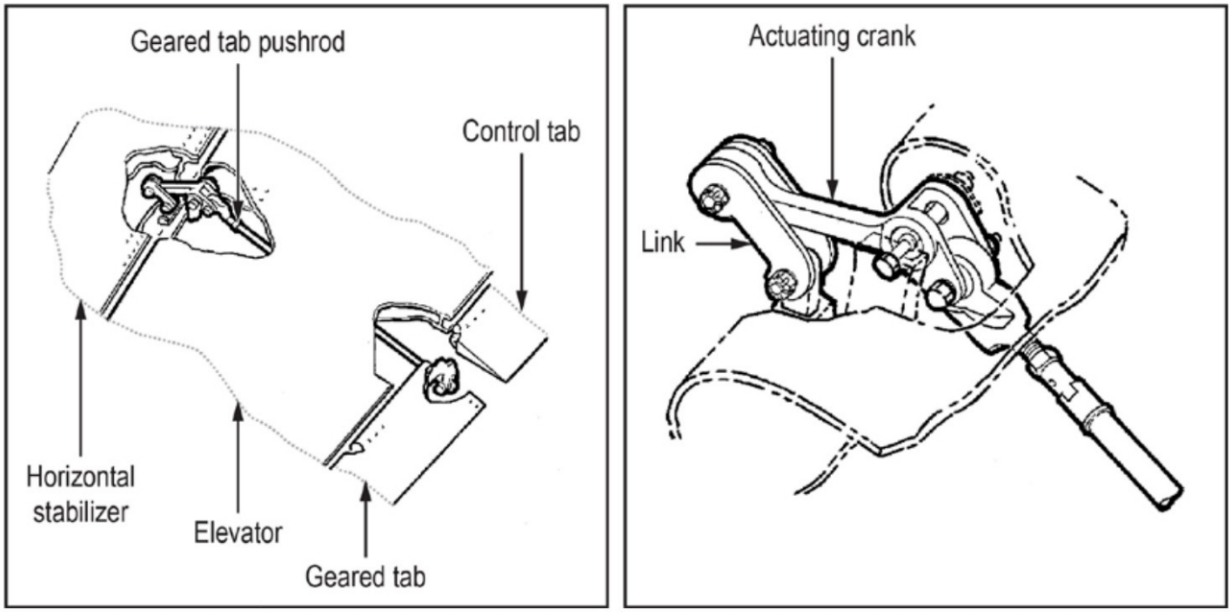

Figure 2. Installed location of geared tab linkage components (left) and closer view of the links and actuating crank (right). (Source: Boeing; some labels and revisions added by NTSB)

The antifloat tabs (which prevent down-float of the elevator) are mechanically connected to the horizontal stabilizer, and their positions are driven by the stabilizer position.

When the airplane is parked, each elevator is free to move independently within the confines of the mechanical stops if acted upon by an external force, such as wind. The elevator system (by design) has no gust lock.

Automatic Spoiler System

The accident airplane was equipped with an automatic spoiler system designed to automatically deploy to reduce lift and increase drag for more effective braking whenever reverse thrust is commanded. The system, which is electrically controlled and hydraulically actuated, becomes armed when a flight crewmember sets the speed brake handle before takeoff. In the event of a rejected takeoff, when a crewmember raises the thrust levers to the reverse thrust position, electrical signals are sent to the automatic spoiler actuator, which pushes the speed brake handle to its full extension, simultaneously actuating the spoilers on each wing.

Owner/Operator Information

The owner and operator of the airplane, 987 Investments LLC, was a privately held company that contracted with the maintenance manager, mechanics, and current and qualified pilots to operate the airplane, which the company acquired about 6 or 7 years before the accident. According to the owner, he paid a fee to Everts Air Cargo to provide the maintenance manager with information on the items due for the airplane, such as periodic inspections and airworthiness directives. The maintenance manager said that he had been overseeing the maintenance on the accident airplane for about 5 years. He said that the airplane was

maintained under the Boeing maintenance program and that Everts would send him maintenance information weekly that detailed any work that needed to be done and when it was due.

For the accident flight, the maintenance manager contacted Everts to inquire about a crew for the upcoming planned flight. For such requests, Everts' director of operations would check to see which pilots were off duty on the requested days and ask them if they wanted to conduct the flight; if the pilots agreed, the director of operations would provide their contact information to the representative of 987 Investments so they could arrange the logistics. According to records maintained by the FAA's Houston Flight Standards District Office, in September 2017, an Everts representative submitted an e-mail request to the office to operate the accident airplane under Part 91 with Everts' pilots who were pilot-in-command-qualified.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KTME,166 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	09:55 Local	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear / 12000 ft AGL	**Visibility**	8 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.11 inches Hg	**Temperature/Dew Point:**	22°C / 16°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Brookshire, TX (KTME)	**Type of Flight Plan Filed:**	IFR
Destination:	Bedford, MA (KBED)	**Type of Clearance:**	IFR
Departure Time:	10:00 Local	**Type of Airspace:**	Air traffic control;Class D

Weather at Accident Site

National Weather Service (NWS) surface analysis station models near the accident site at the time of the accident depicted east-to-southeasterly winds of 10 kts or less and clear skies. A review of the national composite radar mosaic revealed no significant echoes within 1 hour of the accident.

About 0958, the TME air traffic controller informed the flight crew that the wind was from 090° at 6 kts.

Previous High-Wind Events

A review of high wind events affecting TME between April 26, 2021 (when the airplane had last flown) and the day of the accident identified 23 days with wind gusts of more than 25 kts for more than one consecutive hour. The two strongest wind events included reported gusts up to 46 kts and 45 kts, respectively, as follows:

- On May 18, 2021, a line of thunderstorms developed across central and southern Texas and merged into a bow echo configuration with embedded supercell thunderstorms. The line was responsible for producing an extensive area of strong wind, large hail, and several tornadoes. An NWS surface analysis chart for that day depicted a squall line with a distinct wind shift moving across the TME area. An NWS composite radar mosaic for the same day showed a line of echoes of extreme intensity was immediately west of the airport when strong wind conditions were reported. TME weather observations that day included a report at 2115 of wind from 200° at 34 kts gusting to 46 kts; at 2135, wind from 340° at 13 kts gusting to 30 kts; and at 2155, wind from 040° at 19 kts gusting to 28 kts.
- On September 13 and 14, 2021, the TME area was affected by Hurricane/Tropical Storm Nicholas, which had come ashore as a hurricane west of Sargent Beach, Texas, before weakening and moving into the Houston area. TME weather observations indicated wind gusts of more than 25 kts on September 13 and 14, with a peak gust of 45 kts and gusts of 35 to 45 kts reported over a 5-hour period. Similar high-wind observations of 39 to 50 kts were reported over the Houston area, with Houston Hobby Airport (about 39 miles east of TME) reporting the highest gust of 50 kts.

According to the airport manager at TME, the high wind associated with Tropical Storm Nicholas blew in an 8-ft sliding door at a fixed based operator next to where the accident airplane was parked, requiring replacement of the door.

An NWS National Hurricane Center wind speed probability chart issued on September 14 indicated a greater than 50 percent probability of wind greater than 50 kts for the TME area with a greater than 90 percent probability for the area immediately south of TME.

Airport Information

Airport:	Houston Executive Airport TME	**Runway Surface Type:**	Asphalt
Airport Elevation:	166 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	36	**IFR Approach:**	None
Runway Length/Width:	6610 ft / 100 ft	**VFR Approach/Landing:**	None

TME was a privately owned airport located about 28 miles west of Houston. TME was serviced by a nonfederal control tower that operated from 0600 to 2200 daily and was staffed by one controller (which was the normal staffing level) who was qualified in all positions (local control, ground control, and supervisor). The runway safety area (RSA) at the end of runway 36 extended north 600 ft from the end of the runway to the airport fence and was 500 ft wide. Based on its operations (and as a privately owned airport), TME was not subject to the requirements that applied to airports certificated under 14 *CFR* Part 139, which included (among other provisions) requirements to provide and maintain RSAs as described in 14 *CFR* 139.309 and the guidance in FAA advisory circular (AC) 150/5300-13B, *Airport Design*, and others. (Generally, based on these guidelines, a standard RSA for a similar runway at a Part 139 certificated airport would be 1,000 ft long.)

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	Destroyed
Passenger Injuries:	2 Serious, 1 Minor, 16 None	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Serious, 1 Minor, 20 None	**Latitude, Longitude:**	29.818027,-95.898046

The airplane came to rest about 1,400 ft from the end of the runway. No parts of the airplane were found on the runway or south of the airport perimeter fence. The nose landing gear remained attached and was folded aft with damage to its supporting structure. The lower section of the left main landing gear, including the axle and wheels, was found separated in the debris field about 150 ft from the main wreckage. The right main landing gear was found in its respective wheel well.

The airplane structure forward of the empennage was heavily damaged by fire. All of the upper fuselage structure (except for a small section of the upper nose structure and empennage) was consumed by fire. An outboard portion of the left wing was found separated due to contact with several trees. The inboard portion of the left wing was attached to the fuselage and showed heavy fire damage. Most of the right wing was partially attached to the fuselage and showed heavy fire damage near the wing root.

The empennage was partially intact with the vertical and horizontal stabilizers, rudder, and elevators attached (see figure 3).

Figure 3. View of the wreckage (from front left looking aft) showing heavy fire damage forward of the empennage.

Elevators

Postaccident examination found both elevators in a trailing-edge-down position, and attempts to move them upward (using hand pressure) were unsuccessful (see figure 4).

Figure 4. Both elevators as found in the trailing-edge down position.

Impact and fire damage precluded establishing control cable continuity for the elevator system. The control columns were consumed by fire, and the control cables from the cockpit to the tail were covered in melted metal and debris.

Examination found that the inboard actuating cranks for both elevators' geared tabs were bent, and their respective attachment linkages were bent outboard (see figure 5).

Figure 5. Left and right elevator inboard geared tab linkages (left and right, respectively), viewed from underneath each elevator. Each linkage is bent outboard.

The actuating crank and linkages were found locked overcenter beyond their normal range of travel. Once the actuating cranks were disconnected and the bent linkages removed, the elevators could be moved (using hand pressure) through their normal range of motion. No other elevator or pitch control system component anomalies were identified. Tests and examinations of the components removed from the system revealed no evidence of mechanical failures or damage, or any actions by the flight crew or maintenance personnel, that could have caused the overcenter condition.

The first officer provided a photograph he took of the airplane on the morning of the accident, before the flight crew performed any manipulations of the cockpit flight controls. The photograph showed that the forward portion of each elevator's outboard balance weight was visible above the top surface of the horizontal stabilizer, consistent with both elevators in a trailing-edge-down position (see figure 6).

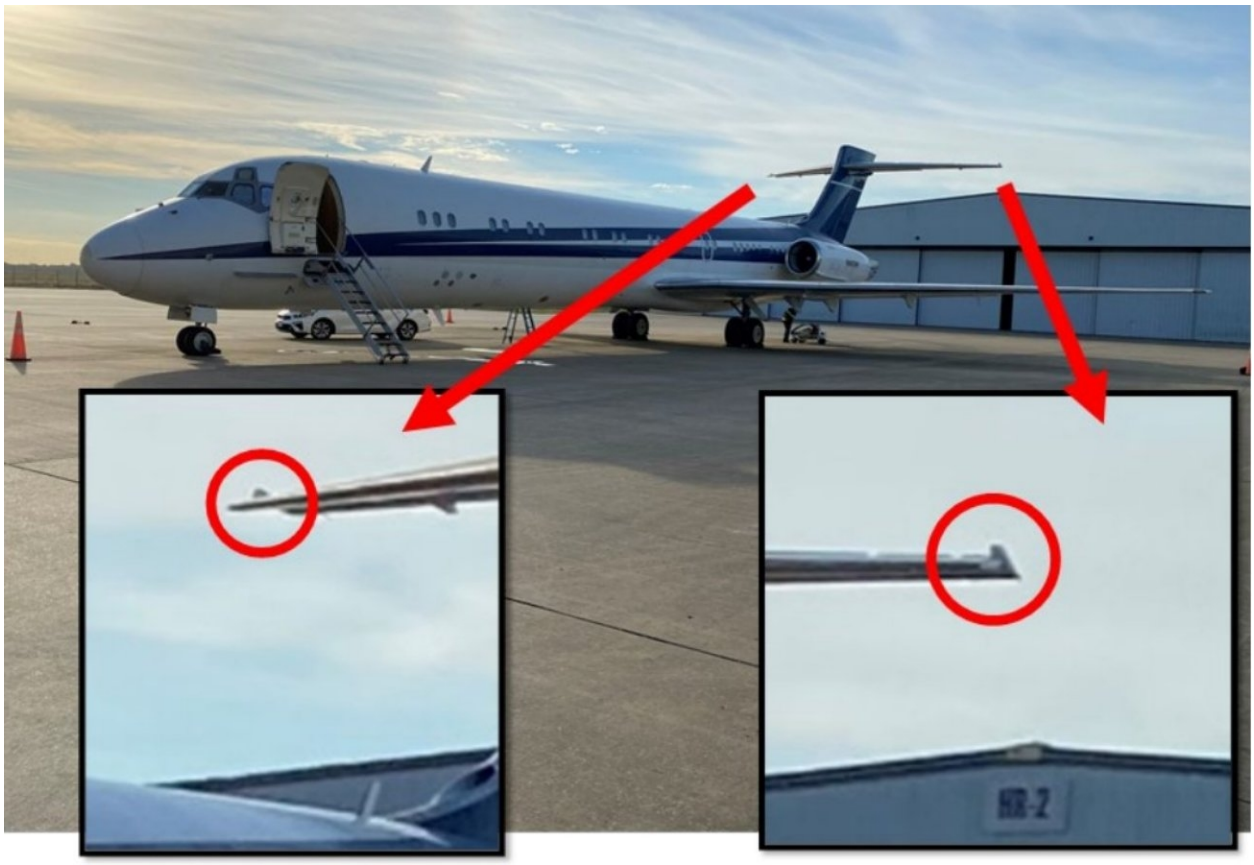

Figure 6. Accident airplane on the morning of the accident. Insets show the outboard balance weight for each elevator.

Powerplants

Both engines were found attached to their respective engine mounts and connected to the empennage in their normal orientation. The thrust reversers for both engines were found intact and stowed, and the leading edges of the lower doors showed no damage or scoring from contact with stationary objects. No damage or debris was found under the thrust reverser doors.

An exhaust pattern of burned earth and singed grass extended about 90 ft behind the exhaust duct of the right engine, consistent with engine operation after the airplane came to rest. No such pattern was observed behind the left engine.

Examination of the right engine and nacelle revealed minor impact damage. Examination of the left engine revealed impact damage to the lower right quadrant of the nacelle and the inlet duct assembly, most of which was found separated on the ground. The left engine's fuel control unit and fuel pump were impact-damaged, with their internal components exposed. The last 500 ft of the airplane's ground track included a cluster of trees on the left side that showed fractured and burned branches. The alignment of fire damage patterns observed on the left engine components was consistent with exposure to a ground fire.

Seat Restraints and Exits

Postaccident fire damage precluded documentation of the cabin seat restraints. The forward-left door was fire-damaged and found on the ground with the door hinge attached to the deformed door frame. The door and the handle were in the open position, and a portion of the evacuation slide was found under the door. The forward-right door and the surrounding fuselage structure were fire-damaged, and the lower portion of the door and door frame indicated that the door was closed; the evacuation slide was destroyed by fire. The tailcone exit was destroyed by fire, and its evacuation slide was in its packaging. Both overwing exits were destroyed by fire.

Flight recorders

The airplane was equipped with a Honeywell 6022 CVR designed to record a minimum of 30 minutes of analog audio on a continuous loop tape in a four-channel format: one channel for each pilot, one channel for a cockpit observer, and one channel for the cockpit area microphone. The CVR showed thermal damage but the data downloaded normally and consisted of 31 minutes 14 seconds of fair quality audio from the captain's channel and poor-quality audio from the cockpit area microphone.

The airplane was equipped with a Honeywell Universal FDR designed to record about 25 hours of flight information (which included the accident flight and previous flights) in a binary format, using analog signals, onto eight tracks of magnetic tape. The FDR showed external thermal damage, and the magnetic tape showed minor damage of an undetermined nature. Recorded data parameters included airspeed, engine performance, left and right elevator positions, airplane pitch angle, control column position, left and right brake pressures, left and right thrust reverser lock/unlock, left and right thrust reverser position, spoiler position, and acceleration information. Due to the nature of the tape-based recorder system and readout equipment, data dropouts (gaps in data) were noted, especially at the end of the accident flight recording. Further, a review of the data for the accident flight and previous flights determined that the left and right thrust reverser position parameter was not valid for any of the flights on the recording.

Survival Aspects

After all the passengers boarded, the mechanic stowed the stairs, closed the main cabin door, and notified the pilots that the door was closed before he took a seat in the right crew room (at the front of the cabin) and fastened his seatbelt. The airplane's owner stated that he ensured that all passengers were paying attention when he provided them with a safety briefing, which included the use of the seatbelts and the location of the emergency exits. According to the CVR transcript, about 12 minutes before takeoff, the CVR captured the owner's voice speaking in a cadence consistent with that of a passenger briefing, detecting the word "forward" and a discussion of seat positioning. The owner said he walked through the cabin and ensured that all passengers were seated with their seatbelts fastened before he took a seat in the left crew room (at the front of the cabin) and latched the lap belt portion of his restraint.

Emergency Evacuation

During the accident sequence, two passengers who had removed their seatbelts during taxi were ejected from their seats but were not injured. The mechanic said he unbuckled his seatbelt during the accident sequence to be mobile and able to evacuate faster.

As described in the "History of Flight" section, as soon as the airplane came to rest, the captain saw that it was on fire and commanded the evacuation. The captain said that his main concern was getting the passengers off the airplane and away from the fire. The first officer said he left the cockpit before the captain and saw that the forward-left door was already open, and passengers were evacuating. The first officer said he began walking aft through the cabin to ensure no one was still on board, but the captain told him to evacuate.

The captain said he walked aft through the cabin but made it only about two-thirds of the way back before encountering dense smoke. The captain said he yelled to make sure no one was in the back of the airplane before he exited and that, just as he was exiting through the forward-left door, the first officer asked him if he had shut down the engines, and he responded that he had not. According to the captain, not shutting down the engines (per the emergency evacuation procedure) was an omission.

Once the airplane came to a stop, passengers heard shouts indicating a fire and the need to evacuate. The mechanic said he ran to the forward-left door, looked out the window, and saw flames outside. As the mechanic moved to the forward-right door, a passenger came forward, opened the forward-left door, and jumped out before the evacuation slide inflated. The passenger said he felt a sharp pain in his ankle when he landed on the ground, but he was able to run away from the airplane.

The mechanic said he saw the passenger jump out, and he went back to the forward-left door and "kicked the girt bar" to help the slide inflate "faster." Passengers reported that the slide was fully inflated at the beginning of the evacuation but became less inflated as the evacuation continued. The mechanic exited through the forward-left door and assisted passengers as they came down the slide. A passenger who was seated near the left overwing exit opened it, experienced intense heat from the flames outside, then attempted to close it

(with the help of another passenger) but was unsuccessful; she subsequently ran forward to use the forward-left door. The passenger who had assisted her moved to the right overwing exit, opened it, and exited through it, along with one other passenger. No other passengers or crew used the overwing exit.

Two passengers who had first headed aft toward the tailcone exit turned around after observing smoke in the back of the airplane and exited through the forward-left door. One passenger, who was described as having a preexisting back injury that was exacerbated during the accident sequence, couldn't walk and was assisted by the airplane's owner and others in evacuating and moving away from the airplane. The airplane's owner said he walked aft through the cabin to make sure no passengers were still on board before he exited through the forward-left door.

Emergency Response

The TME air traffic controller saw the airplane exit the runway into the trees and initiated the emergency response procedures. The airport manager also saw the event, ran into the terminal, and yelled for someone to call 911 then immediately drove to the scene. Emergency responders were dispatched about 1001, police officers arrived on scene about 1007, and the first firefighting vehicle arrived about 1013; responders noted an "intense" fire. Responders encountered passengers walking away from the airplane and toward the road, with about nine gathered at a locked gate to the pasture. Emergency responders used bolt cutters to open two locked gates to access the pasture, and a road grader working nearby assisted the airport director with forcing open a third.

Responders placed the passenger with the back injury onto a backboard, and several passengers helped carry him to the emergency response vehicles. Ambulances transported this passenger and a passenger who sustained a lung injury (from the intense heat she encountered when she opened the left overwing exit) to a local hospital. Another passenger, who sustained a self-reported ankle fracture, later went to a local hospital via private transport.

Tests and Research

Aircraft Performance

According to dispatch information, the accident airplane's gross takeoff weight was 111,770 lbs, and the center of gravity was at 22.8% of the mean aerodynamic cord, both of which were within the certified envelopes for the airplane. Based on these data and the weather and surface conditions for the accident flight, Boeing calculated that the distance for the airplane

to accelerate to V1 (the captain's calculated decision speed of 129 kts) and then be brought to a stop was 5,607 ft. The captain calculated that Vr (rotation speed) was 132 kts. (See "Reduced Thrust Takeoff Procedures" for more information.)

Based on the NTSB's aircraft performance study (which used both recorded FDR parameters and automatic dependent surveillance-broadcast data for the accident flight), during the takeoff roll, the first officer made the "rotate" callout at 0959:48.0, and a change in control column position (consistent with the captain's attempt to rotate the airplane) began about 1 second later, when the airplane was traveling about 134 kts. However, both elevators remained in the nearly full trailing-edge-down position, and the airplane's pitch never increased.

A review of FDR data from the accident flight and airplane's previous two takeoffs showed similar control column position behavior for all three flights. However, the elevator movement and airplane pitch behavior following control column movement during the accident takeoff were inconsistent with the airplane's previous two takeoffs. The data showed that, generally, during the previous takeoffs, as the airplane accelerated down the runway, the elevator deflections gradually converged around or slightly below neutral until about 1 to 2 seconds after the initiation of control column position movement, at which point the elevators moved to a trailing-edge-up position, and the airplane's nose-up pitch response began about 1 to 2 seconds later.

The airplane performance study determined that, during the accident takeoff, the airplane's speed was about 150 kts when the crew initiated the rejected takeoff about 0959:53.3, as evidenced by the increase in the left and right brake pressures and a reduction in engine thrust. At this point, about 1,500 ft of runway remained. The airplane reached a maximum speed of 158 kts at 0959:55 before it began decelerating. Boeing estimated that it would have taken 2,450 ft to stop the airplane from the maximum speed on a dry, paved runway for the given airplane configuration using maximum braking and reverse thrust (or 2,800 ft without the use of reverse thrust).

The FDR data indicated that, about 0959:59, the left and right thrust reversers momentarily unlocked and the spoilers deployed but then the thrust reversers relocked. In the absence of valid data parameters for left and right thrust reverser position (separate parameters from the unlock data), the actual positions of the thrust reversers during the accident sequence could not be determined. The airplane performance study determined that the airplane's speed was about 121 kts when it exited the paved surface about 1000:01; the FDR data became unreliable about 1000:03.

During postaccident interviews, the captain stated that he pulled the thrust reverser levers "all the way up" to deploy the thrust reversers. The captain stated that he couldn't recall where his hand was positioned after he deployed the thrust reverser levers but noted that he did not ever intentionally stow them or consciously push them down. The first officer described the runway excursion as "a pretty violent ride."

An airport maintenance worker located in a field adjacent to the runway reported that he saw the thrust reversers deploy and a puff of smoke from hard braking but lost sight of the airplane as it continued off the end of the runway. The airplane's owner said he felt the heavy braking but did not hear the thrust reversers, and the mechanic said the thrust reversers may have come open but he did not hear them.

Organizational and Management Information

The captain and the first officer accepted the Part 91 accident flight as contract work for 987 Investments. Their primary employer was Everts Air Cargo, which trained them and provided the quick reference handbook, checklist, and procedures they chose to use for the accident flight.

Exterior Inspection Procedures

According to the exterior inspector procedure in Everts' MD-80 operating manual, the checklist item for the elevators and tabs indicates that the crew is to check for "CONDITION GOOD."

Everts also provided its pilots with a pictorial, "Exterior Preflight General Instructions," that included 150 slides detailing the exterior preflight inspection of the airplane. One slide stated the following:

> Airplanes that are exposed to high and sustained winds, or wind gusts, greater than 65 knots, are susceptible to elevator damage or jamming. There are procedures from the Aircraft Maintenance Manual for airplanes suspected to have been subjected to such conditions, requiring visual and physical inspections (moving the surfaces from the cockpit controls) to assure proper flight control operation.

The pictorial contained five slides detailing what pilots should look for when inspecting the elevators. The slides discussed observing the condition of the leading edges of the horizontal and vertical stabilizer, the ram air inlet, static wicks, rudder deflection, and elevator and rudder attach points.

Everts' MD-80 operating manual did not include a copy of the Boeing MD-80 FCOM Temporary Revision 80-2-153, dated May 15, 2020, that provided an exterior inspection procedure that included the following warning and caution regarding jammed elevators (emphasis in original):

> **WARNING: Prior to every flight, elevator surfaces must be confirmed as not jammed in the Trailing Edge Down (TED) position. If both elevators are faired with or above the stabilizer surface, confirmation is complete.**

CAUTION: Airplanes that are exposed to high-sustained winds, or wind gusts, greater than 55 knots are susceptible to elevator damage and/or jamming. Airplanes suspected to have been subjected to these conditions must be inspected per the Aircraft Maintenance Manual prior to the flight.

Operations Bulletin 80-2-017 (also issued by Boeing in 2020) provided operators methods to comply with the warning statement contained in FCOM Temporary Revision 80-2-153 and confirm before each flight that the elevators are not jammed in the trailing-edge-down position.

The operations bulletin stated that, during the exterior inspection procedure, an elevator that is not faired with or above the trailing edge of the stabilizer can be verified as not jammed by moving the control column to the full aft stop and confirming (using an external observer) that the elevator moves in the trailing-edge-up direction. According to the bulletin, when the control column is pulled full aft, the elevator control tab moves during the first 95 percent (approximately) of control column travel, and the elevator moves during the last 5 percent. The bulletin stated that, if an external observer sees no elevator movement when the control column is pulled fully to its aft stop, a maintenance inspection of the elevators is required.

Both Operations Bulletin 80-2-017 and the Boeing MD-80 FCOM Temporary Revision 80-2-153 established maintenance inspection requirements for airplanes exposed to wind of 55 kts or greater. This wind threshold lowered the previously established threshold of about 65 kts.

Further, Operations Bulletin 80-2-017 included information about two previous jammed elevator events in 1999 and 2017 involving DC-9/MD-80 series airplanes that had been exposed to high winds and gusts while parked. The bulletin stated that, in both cases, the control column feel and travel were normal during the control checks performed during taxi. The 1999 event involved a successful rejected takeoff in Germany, and the 2017 event was a runway overrun accident in Ypsilanti, Michigan, investigated by the NTSB. As a result of the NTSB's investigation of the Ypsilanti accident, the NTSB issued three safety recommendations to Boeing [Safety Recommendations A-19-1 through -3] and one to the FAA [Safety Recommendation A-19-5] that were specific to DC-9/MD-80 series airplanes and intended to prevent future occurrences. (Discussed in the "Previously Issued Safety Recommendations" section of this report.)

Boeing made the operations bulletin available to airplane owners, operators, and maintenance, repair, and overhaul centers through its MyBoeingFleet website. According to a Boeing representative, the MyBoeingFleet system would also send an e-mail to the contact person for operators listed within the system to inform them of any new bulletins published for their specific aircraft.

Everts was listed in the MyBoeingFleet system as an operator, and a review of select activity data for Everts between 2019 and 2021 identified numerous views and downloads of various technical publications from the system. Everts' director of operations stated that he unaware of Operations Bulletin 80-2-017 before the accident, and the MyBoeingFleet activity data

showed that an Everts representative first accessed the bulletin 4 days after the accident. No representative of 987 Investments, which was listed in MyBoeingFleet as an airplane owner, had ever accessed the system, and the maintenance manager was unaware of Operations Bulletin 80-2-017 and the maintenance inspection requirement for airplanes exposed to wind of 55 kts or greater.

During interviews, an Everts representative stated that the 2017 jammed elevator event was discussed during pilot training and that the scenario was performed in the simulator. The captain stated that Everts' jammed elevator training addressed only the effects of jammed elevator in flight. The first officer stated that he was not sure if he ever had training to deal with a jammed elevator. Another Everts pilot described that, in checking the elevators, "Generally…we just did the control checks in the airplane as we were taxiing. No binding, no stiffness, no anything like that….It seems like if [the elevators] were jammed, you wouldn't be able to move the yoke."

Normal Takeoff Procedures

The normal takeoff procedures in Everts' MD-80 operating manual stated the following (in excerpt):

- The pilot monitoring makes the "V1" callout when the airplane's speed is about 5 kts below V1 and the "rotate" callout at Vr (rotation speed).
- The pilot monitoring makes the "rotate" callout at Vr (rotation speed), and the pilot flying "verifies airspeed and smoothly rotates to initial takeoff attitude (maximum 20° pitch). Rotation rate should be approximately [2.5] seconds to liftoff (8° pitch) and [2.5] seconds from liftoff to takeoff attitude in one smooth, continuous pitch change."
- The captain will make the decision to abort, if necessary.

Reduced Thrust Takeoff Procedures

The reduced thrust takeoff procedures in Everts' MD-80 operating manual stated (in part) that, when the airplane's actual takeoff weight is less than the maximum allowable, the takeoff may be made with normal takeoff thrust or with reduced thrust, if the proper conditions are satisfied. Per the manual, when determining the flap setting and takeoff speeds for a reduced thrust takeoff, the flight crew should "[r]ead down the appropriate wind column to a weight equal to or greater than the actual takeoff weight."

Based on the flight release paperwork for the accident flight, the takeoff weight for the accident flight was 111,770 lbs (converted from 50,700 kgs), which was below the airplane's maximum takeoff weight of 149,000 lbs.

According to the captain, he chose a reduced thrust takeoff for the accident flight because the airplane's low takeoff weight allowed it, and he preferred to use reduced thrust takeoffs whenever possible to help maintain the engines. He stated that, when determining the V speeds for the reduced thrust takeoff, the accident airplane's takeoff weight fell between

110,000 lbs and 119,000 lbs (the increments available on the takeoff performance chart), so he used the numbers that corresponded with 119,000 lbs. Based on the chart, the captain determined that, for the accident flight, V1 was 129 kts, Vr was 132 kts, and V2 was 140 kts.

The Everts MD-80 operating manual that the captain referenced was for an airplane equipped with Pratt & Whitney JT8D-217 engines, and the accident airplane was equipped with -219 engines. A Boeing review of airplane flight manuals (AFMs) for both -217 and -219 equipped airplanes identified minimal difference between the resultant calculated V speeds (such that rounding the results to the nearest knot yielded equivalent V speeds) when using the graphical takeoff performance charts and the accident airplane's takeoff weight.

Rejected Takeoff Procedures

The rejected takeoff procedures in Everts' MD-80 flight operation manual stated the following (in excerpt):

> The captain "has the sole responsibility for the decision to reject the takeoff…Rejecting the takeoff after V1 is not recommended unless the captain judges the airplane to be incapable of flight."

According to Everts' general operations manual, if a flight crewmember "detects any malfunction during the takeoff run, call out the type of malfunction. The captain makes the decision, declares, and initiates the abort."

Emergency Evacuation

Everts' quick reference handbook's "Emergency Evacuation" procedure for the airplane for the "on ground" phase of flight included (in excerpt) positioning the fuel levers to "off," pulling the engine fire handles, initiating the evacuation command, confirming all passengers and crew are evacuated, and, if time and conditions permit, turning the battery switch "off."

Additional Information

Postaccident Inspection of Other DC-9 Airplane Parked at TME

The owner of the accident airplane owned another DC-9 (MD-87) airplane that was parked on the ramp at TME since before the accident airplane had last flown. According to the maintenance manager, after becoming aware of the maintenance inspection specified in Operations Bulletin 80-2-017 after the accident, he performed the inspection on the other airplane to verify that the elevators were not jammed. (The airplane was not in flying condition but its elevator system and controls had integrity sufficient to perform the inspection.) The maintenance manager said the inspection involved having a person in the cockpit manipulate the flight controls while a person outside the airplane on a lift observed the tail surfaces. He said the inspection worked well. This airplane, which had been parked near the accident airplane during the high-wind events at TME on May 18 and September 13-14, 2021, did not sustain jammed elevators.

Everts' Postaccident Actions

Following the accident, Everts updated its manuals and developed an illustrated pilot training presentation that referenced this accident and the previous known elevator jamming events, the Boeing operations bulletins, and the flight crew preflight inspection procedure for the elevators. The presentation included photographs to show the visual difference (when viewed from the ground) between the faired and trailing-edge-down elevator positions and a video to show elevator movement.

Administrative Information

Investigator In Charge (IIC):	Hauf, Michael
Additional Participating Persons:	James E. Talay ; Boeing Air Safety Investigations David A. Gerlach; Federal Aviation Administration Al Castillejo; Pratt & Whitney Paul Quirion; Everts - Director of Operations
Original Publish Date:	September 28, 2023
Last Revision Date:	
Investigation Class:	Class 2
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=104129