National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

DCA22MA009

STRUCTURES

Specialist's Factual Report

February 24, 2023

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A. ACCIDENT

Location:	Brookshire, Texas
Date:	October 19, 2021
Time:	about 1000 Central Daylight Time (1500 UTC)
Airplane:	McDonnell Douglas DC-9-87, Reg Number: N987AK (S/N: 49404)

B. STRUCTURES

Group Chair	Pocholo Cruz National Transportation Safety Board Washington, DC
Group Member	James Talay The Boeing Company Seal Beach, CA

C. SUMMARY

On October 19, 2021, at about 10:00 am central daylight time, a McDonnell Douglas DC-9-87, N987AK, operated by 987 Investments LLC, overran the departure end of runway 36 at Houston Executive Airport (TME), Brookshire, Texas, after the crew executed a rejected takeoff. Of the 23 passengers and crew onboard the airplane, two passengers received serious injuries and one received minor injuries. A post-crash fire ensured, and the airplane was destroyed. The airplane was operating as a 14 Code of Federal Regulations Part 91 flight from TME to Laurence G. Hanscom Field Airport (BED), Bedford, Massachusetts.

D. DETAILS OF THE INVESTIGATION

1.0 Airplane Description

Registration Number:	N987AK
Airplane Serial Number:	49404
Airplane Manufacturer:	McDonnell Douglas
Model:	DC-9-87 (MD-87)
Engine Manufacturer:	Pratt & Whitney
Model:	JT8D-219
Airplane Year:	1988
Airworthiness Certificate:	Standard
Approved Operations:	91
Aircraft Type:	Fixed Wing Multi-Engine
Engine Type:	Turbo Fan

Airplane Category:	Transport
Number of Engines:	2
Total Time:	49,566.2 Hours
Total Cycles:	31,977 Cycles
Type Certificate	A6WE Revision 30

2.0 Wreckage Location

The airplane overran the end of the runway, went through the airport's perimeter fence, through power lines and came to rest in a field adjacent to the airport about 1,400 feet from the end of the runway.

The airplane came to rest about 1,400 feet from the end of the runway on a heading of about 235°. No parts of the airplane were found on the runway or prior to the airport perimeter fence. Pieces of the airplane were found in the field between the perimeter fence and the main wreckage. Initial examination of the airplane by investigators found that 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.

Both engines remained attached to their respective engine mounts, which were still connected to the empennage of the airplane and were in their normal orientation. There was no evidence of uncontainment and both thrust reversers were intact and in their fully closed position. An exhaust pattern of burned earth and singed grass, approximately 90 feet long was observed behind the exhaust duct of the right hand (No.2) engine, consistent with engine operation while stationary, after the airplane came to rest.

See Attachment 1; Figures 1-10.

3.0 Fire Damage

The majority of the airplane's fuselage structure was heavily damaged due to the post-crash fire. The empennage of the airplane was partially intact. The left and right engine sustained fire damage.

See Attachment 2; Figures 11-20.

4.0 Airplane Structure

The fuselage shell was a semi-monocoque structure with skin, longitudinal longerons and circumferential frames and bulkheads. The fuselage was a complete torque box throughout its length. Cutouts for doors, windows, escape hatches, and

other fuselage openings are reinforced by a local framework of frames, sills, and doublers.

The fuselage had a passenger entry door at the forward left-hand side of the fuselage (L1), a galley service door on the forward right side of the forward fuselage (R1), two over wing exit doors on each side of the aircraft, and one air stair exit at the aft section of the cabin. There were also three lower lobe cargo doors (LCD) on the right side of the fuselage. The entry doors are inward then outward opening plug type doors. All three of the LCD are inward opening, upper hinged type cargo doors. The forward and center cargo doors are located forward of the wings, the aft cargo door is located aft of the wings.

The airplane structure was heavily damaged due to the fire that ensued after the airplane came to rest during the accident sequence. Fire consumed approximately more than two thirds of the structure. All of the upper fuselage structure (except for a small section of the upper nose structure) was consumed by fire.

Damaged structure (from approximately STA 41 to approximately STA 351), was visible on the left side of the airplane. The damage in this area encompassed a partial Left Hand Main Entry door opening structure causing the plug forward entry door to sag and lay on the ground. Sooting and fire damage can be found on some of the panel below the window cutouts. Similarly, damage to the right side of the airplane from approximately STA 41 to STA 370 was visible. Heavy sooting and fire damage can be seen toward the forward end of the structure. Much of the aft pressure bulkhead structure at approximately STA 1152 was consumed by fire damage during the accident

The Left Hand Main Entry Door remained partially attached to the airplane but was heavily damaged due to the fire. The Right Hand Forward Service Door, Four Overwing Emergency Exit Doors, and Cargo Doors (Forward, Mid and Aft) were all consume by fire. The electrical/electronics compartment door was found detached and under the flight deck wreckage.

See Attachment 3; Figures 21-31.

5.0 Airplane Wings

The wing was comprised of the leading-edge structure, the in-spar wing box, and the trailing edge structure. The wing box structure consisted of the upper and lower skin panels and the front and rear spars with ribs located perpendicular to the rear spar. Major fittings that interface with the outboard wing box include the flap support structure and the main landing gear support structure.

5.1 Left Wing

During the accident sequence an outboard portion of the left wing and left wing tip was separated due to contact with several trees and impact with the ground. There was approximately 15 feet of the left wing still attached to the fuselage. The wing was heavily damaged due to the fire. Leading edge control surfaces were found extended and remained attached to the wing but were damaged due to impact.

5.2 Right Wing

The majority of the right wing remained partially attached to the wing root, but sustained heavy fire damage towards the wing root. Similarly, the wing skin upper surface showed signs of fire damage in the same area. The right tip remained attached to the right wing but was considerably damaged due to impact with the ground. Leading edge control surfaces were found extended and remained attached to the wing but were damaged due to impact.

See Attachment 4; Figures 32-41

6.0 Airplane Pylons and Engines

6.1 Engine Pylons

Both the left and right hand pylons were intact and exhibited no evidence of obvious structural damage but showed signs of sooting due to the post-crash fire when viewed from the ground.

6.2 Engines

Both left and right engines were still attached to the airplane with damage to the fan cowls of both engines due to the fire/accident sequence. Further information on the engines can be found in the Powerplants Factual Report.

See Attachment 5; Figures 42-45

7.0 Airplane Landing Gear

The MD-87 has a nose gear and two main landing gears. The main landing gear is a two-wheeled, single chambered gear, supported by a trunnion (located at the top of the gear post) and a side brace. The side brace is connected to the trapezoidal fitting near the side-of-body in the wheel well.

The nose gear is a two-wheeled, single chambered shock strut gear supported by a trunnion and drag brace.

7.1 Nose Landing Gear

The nose gear was identified in the main wreckage. The gear was found folded aft in the Electrical and Equipment Compartment. The nose landing gear's supporting structure failed with a portion of the structure still attached to the nose gear.

7.2 Left Main Landing Gear

The lower section of the left main landing gear, including the axle, wheels, and inner cylinder was found in the wreckage field, separated from the airplane. The gear departed the aircraft during the aircraft accident sequence and was found approximately 150 feet from the main wreckage. The tires and brake assemblies were still attached to the gear. Both brake wear pins on the left gear wheels showed approximately 1.5 inches of pin extension remaining. Several left main landing gear internal components including inner cylinder static and dynamic seals, and the MLG Shock Strut Restrictor, were found in the wreckage path.

The upper portion of the left main landing gear strut was still connected to the wheel well structure, but the outer cylinder was found failed. The main landing gear actuating cylinder was still connected at the top of the actuator, but the exposed piston was bent.

7.2 Right Main Landing Gear

The right main landing gear was found in the right main gear wheel well. The actuating cylinder piston was bent approximately 90 degrees.

See Attachment 6; Figures 46 – 49

8.0 Airplane Empennage

8.1 Vertical Stabilizer and Rudder

Both the vertical stabilizer and the majority of the rudder exhibited no obvious evidence of structural damage when viewed from the ground. However, the lower aft trailing edge of the rudder tab showed some signs of delamination.

8.2 Horizontal Stabilizers and Elevators

Both the right and left hand stabilizers and elevators exhibited no obvious signs of structural damage when viewed from the ground. Upon closer examination both Left and Right hand control tab hinges were observed deformed/broken. Further examination can be seen in the Systems Group Chairman Factual Report.

See Attachment 7, Figures 50-59.

E. ATTACHMENTS

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Attachment 2 – Fire Damage
Attachment 3 – Structure
Attachment 4 – Wings
Attachment 5 – Pylons and Engines
Attachment 6 – Landing Gear
Attachment 7 - Empennage

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Aerospace Engineer

Attachment 1
Wreckage Location

Figure 1. *Google Map view of wreckage location*

Figure 2. *View down Runway 36 towards airport perimeter fence*

Figure 3. *View past Runway 36 towards airport perimeter fence*

Figure 4. *View from Morton Road toward the wreckage site*

Figure 5. *View of separated left wing as the airplane hit trees during the accident sequence*

Figure 6. *View of burned parts of the airplane as it hit trees during the accident sequence*

Figure 7. *View looking back towards Morton Road with LH MLG outboard tire marks*

Figure 8. *View looking back towards Morton Road*

Figure 9. *View of wreckage from the field*

Figure 10*. View of LH MLG separated during the accident sequence*

ATTACHMENT 2
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Figure 15. *Right Wing Fire Damage looking aft*

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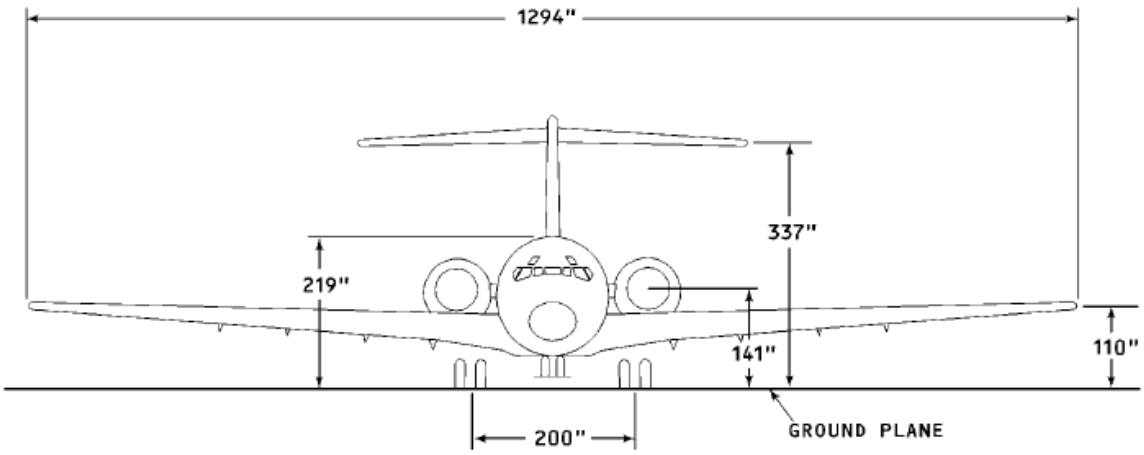
Figure 18. *Left Wing Fire Damage looking inboard*

Figure 19. *Fire Damage on Aft Pressure Bulkhead and Engines*

Figure 20. *Left Engine Fire Damage looking forward*

ATTACHMENT 3
Structure



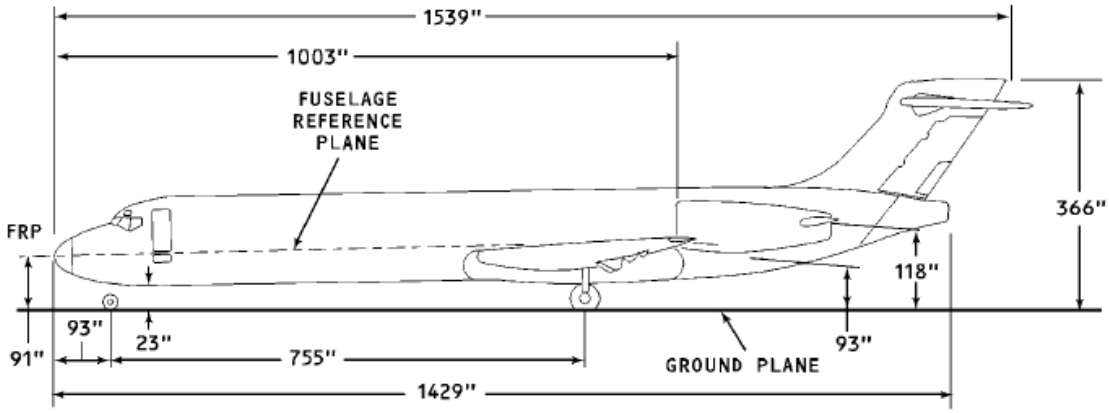


Figure 21. *MD-87 Major Dimensions – Boeing Copyright Image. Reproduced with permission.*

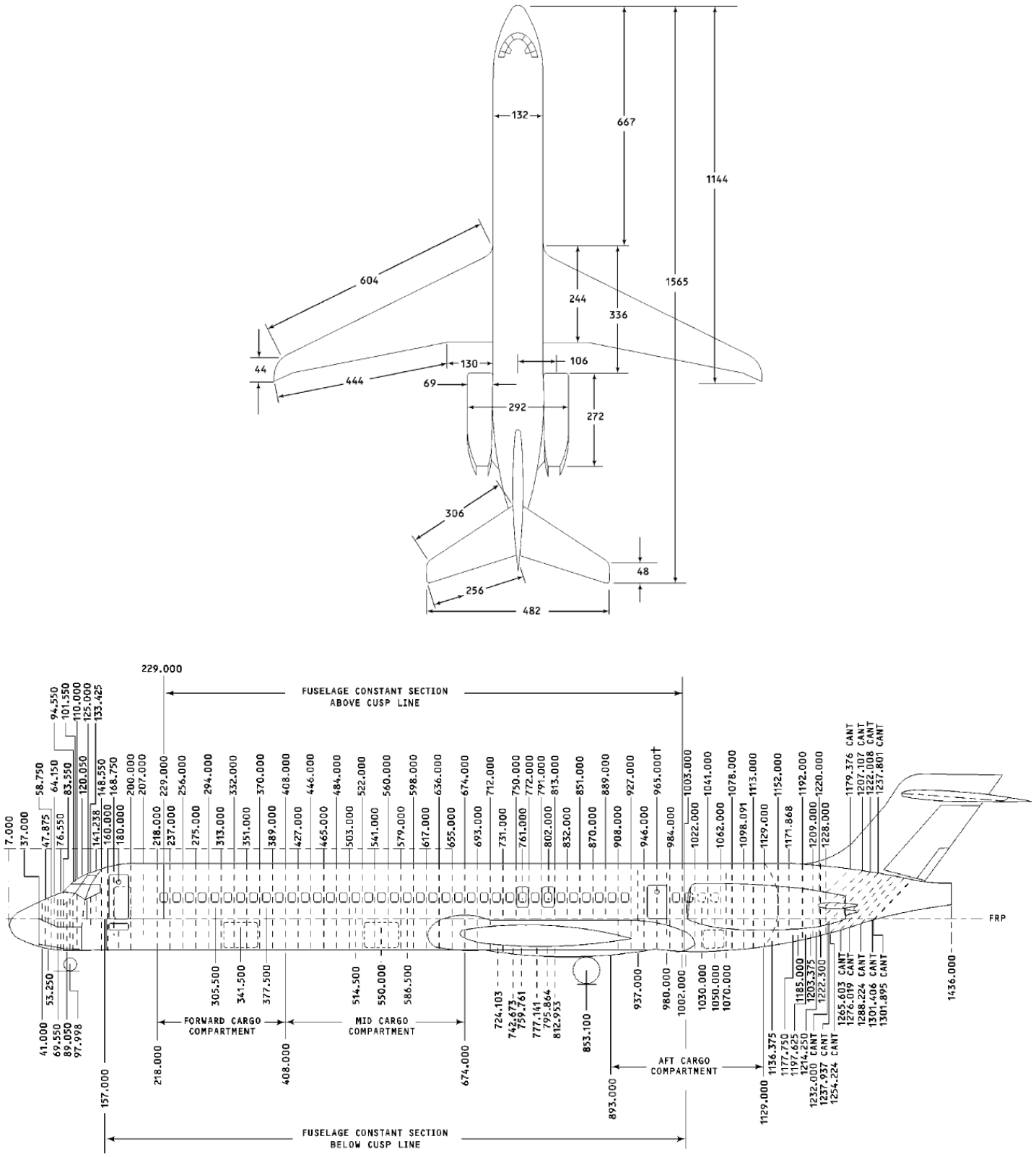


Figure 22. *MD-87 Major Dimensions and Fuselage Stations – Boeing Copyright Image. Reproduced with permission.*

Figure 23. *View of Nose of the airplane looking aft*

Figure 24. *View airplane looking aft*

Figure 25. *View of airplane from inside cabin looking forward*

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Figure 28. *Aft Pressure Bulkhead*

Figure 29. *View of right side of airplane fuselage*

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Figure 31. *View of left side of airplane from inside cabin*

ATTACHMENT 4
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Figure 35. *View of Right Wing looking outboard*

Figure 36. *View of Right Wing looking forward*

Figure 37. *View of Right Wing looking forward*

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Figure 40. *Right Wing leading Edge looking aft*

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ATTACHMENT 5
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Figure 57. *RH Horizontal stabilizer and elevator removed from aircraft*

Figure 58. *RH elevator and elevator control tab*

Figure 59. *RH elevator's geared tab inboard linkage*