National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Airplane Performance Study

Specialist Report
Timothy Burtch

A. ACCIDENT

Location: Brookshire, Texas
Date: October 19, 2021
Time: 1500 GMT (1000 CDT)
Airplane: McDonnell Douglas DC-9-87, N987AK
NTSB Number: DCA22MA009

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On October 19, 2021, at about 1000 central daylight time (CDT), a McDonnell Douglas DC-9-87, N987AK, owned by 987 Investments, LLC, overran runway 36 during takeoff and came to rest about a 1/4 mile off the departure end of the runway 36 at Houston Executive Airport (TME), Brookshire, Texas. (See Figure 1.) Of the 23 passengers and crew on board, two passengers received serious injuries, and one passenger received minor injuries. There was a post-crash fire, and the airplane was destroyed. The flight was operating under 14 Code of Federal Regulations Part 91 from TME to Laurence G. Hanscom Field Airport (BED), Bedford, Massachusetts.

Times in the study are quoted in CDT. Greenwich Mean Time (GMT) = CDT + 5 hr.

D. THE AIRPLANE

A picture of the accident airplane, a McDonnell Douglas DC-9-87, is shown in Figure 2. The airplane was manufactured by McDonnell Douglas in 1987 and registered to 987 Investments, LLC.

E. WEATHER SUMMARY

The TME weather observation at 0955 CDT, five minutes before the accident, was:

METAR KTME 191455Z AUTO VRB07KT 8SM CLR 22/16 A3011

The automated surface weather observation at Houston Executive airport on October 19 at 0955 CDT was wind variable at 7 knots (kt); visibility 8 statute miles; clear below 12,000 ft above ground level; temperature 22˚ Celsius (C), dew point 16˚C; altimeter 30.11" mercury.

F. PERFORMANCE STUDY

The airplane performance study is based on data recovered from the Flight Data Recorder (FDR) as well as Automatic Dependent Surveillance-Broadcast (ADS-B) data provided by the Federal Aviation Administration (FAA). ADS-B is a primary technology supporting the FAA's Next Generation Air Traffic Control System, or NextGen, which is shifting airplane separation and air traffic control from ground-based radar to satellite-derived positions. ADS-B broadcasts an airplane's Global Positioning System (GPS) position[1] to the ground where it is displayed to Air Traffic Control. The GPS position is also transmitted to other airplanes with ADS-B receivers, either directly or relayed through ground stations, to allow self-separation and to increase situational awareness.

ADS-B speed data were used to compute local time for the FDR parameters because the FDR only contained a relative time parameter. This was done by aligning ADS-B and FDR speed information to determine central daylight time for the FDR parameters. In addition, the ADS-B position data were used as boundary conditions for the FDR accelerometer integration. See the Flight Data Recorder Specialist's Factual report for more details.

Based on dispatch information, N987AK had a take-off gross weight of 111,710 lb and a center of gravity (CG) location at 22.8% of the mean aerodynamic chord. These are within the certified weight and CG envelopes for the DC-9-87. In addition, Boeing calculated a take-off Balanced Field Length[2] (BFL) of 5,607 ft for the day of the accident. Runway 36 at TME has 6,610 ft available.

The take-off began with the flaps, slats, and horizontal stabilizer set correctly. Figure 3 shows the FDR altitude, speed, and elevator positions during N987AK's take-off attempt. Figure 3 includes both the recorded indicated airspeed and the groundspeed calculated from integrating the recorded longitudinal acceleration; these two speeds were very similar during the accident sequence, so reference to speed in this study indicates both the indicated airspeed and the groundspeed. The recorded elevator positions indicate that the flight crew attempted to rotate that airplane at about 0959:50 and 130 kt. However, the airplane's pitch attitude never

[1] GPS position has an accuracy of approximately 20 meters (m) in both the horizontal and vertical dimensions. GPS augmented with the Wide Area Augmentation System (WAAS) is accurate to approximately 1.5 – 2 meters. WAAS collects, processes, and corrects GPS information to ensure that the data the pilot receives can be trusted: https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=14974&omniRss=fact_sheetsAoc&cid=103_F_S

[2] A Balanced Field occurs when it takes the same distance to accelerate to decision speed, V_1, and then stop as it does to take-off and climb to 35 ft following an engine failure. Because runway 36 at TME is longer than the BFL, the accident flight crew should have been able to stop the airplane on the runway if the take-off had been rejected before the decision speed of 129 kt. However, the airplane had reached a calibrated airspeed of 150 kt before the flight crew initiated the rejected take-off.

increased; both the left and right elevators remained negative in the nearly full trailing-edge-down (TED) position, never reaching an airplane-nose-up or trailing-edge-up (TEU) position[3].

The First Officer called for a rejected take-off at approximately 0959:53.3 when the airplane's speed was around 150 kt. At the same time, the brake pressures for the left and right brakes increased to 2,500 psi and 3,000 psi, respectively, and the engine thrust was reduced. The spoiler positions, e.g., ground spoiler positions, are unknown because they were not, nor were they required to be, recorded.

The recorded airspeed reached a maximum of 158 kt at 0959:55. The FDR data ended shortly after the airplane departed the hard surface at 1000:01 and 121 kt. (The ADS-B data recorded one additional data point with the airplane in the grass off the end of the runway.)

The FDR data indicate that the thrust reversers[4] momentarily unlocked and then re-locked about the time the airplane departed the runway; however, the FDR data became unreliable about the same time[5]. As a result, the actual positions of the thrust reversers during the accident sequence are unknown.

Figure 6 indicates the FDR recorded a 1.5g vertical load factor when the airplane went off the runway. The figure also shows a 0.6g deceleration and a 0.1g acceleration to the left about six seconds before the airplane departed the hard surface or about the same time the first officer called for a rejected take-off.

[3] The position of the control column is not known with certainty. The airplane was delivered before control column position was a required FDR parameter.

[4] The FDR parameters "Eng 1/2 TR Lock" appear valid for most of the take-off attempt. However, the FDR parameters "Thrust Reverser Eng-1/2 Reverse" were invalid.

[5] The FDR altitude went to -4,095 ft and FDR bank angle went to -76˚ when the airplane went off the runway. This is not possible.

G. SUMMARY AND CONCLUSIONS

The recovered FDR data indicate that both the left and right elevators never reached an airplane-nose-up position as would be required for rotation and take-off. The FDR recorded a maximum airspeed of 158 kt at 0959:55, well above the 132 kt rotation speed.

The first officer called for a rejected take-off at 0959:53.3 and 150 kt at about the same time the FDR recorded an increase in the brake pressures and a decrease in engine thrust. At this point there was approximately 1,500 feet of runway remaining. Boeing estimates that it would have taken 2,450 ft to stop from the maximum speed on a dry, paved runway for the given airplane configuration using reverse thrust[6].

The wreckage was found scattered beyond the airport perimeter fence which is located about 600 ft beyond the end of the runway. The tail section shown in Figure 6 was one of the pieces that was furthest out, and it was located approximately 1,450 ft beyond the runway end.

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[6] Boeing estimates that it would have taken 2,800 ft of dry runway to stop the airplane from the maximum speed without reverse thrust.

H. FIGURES

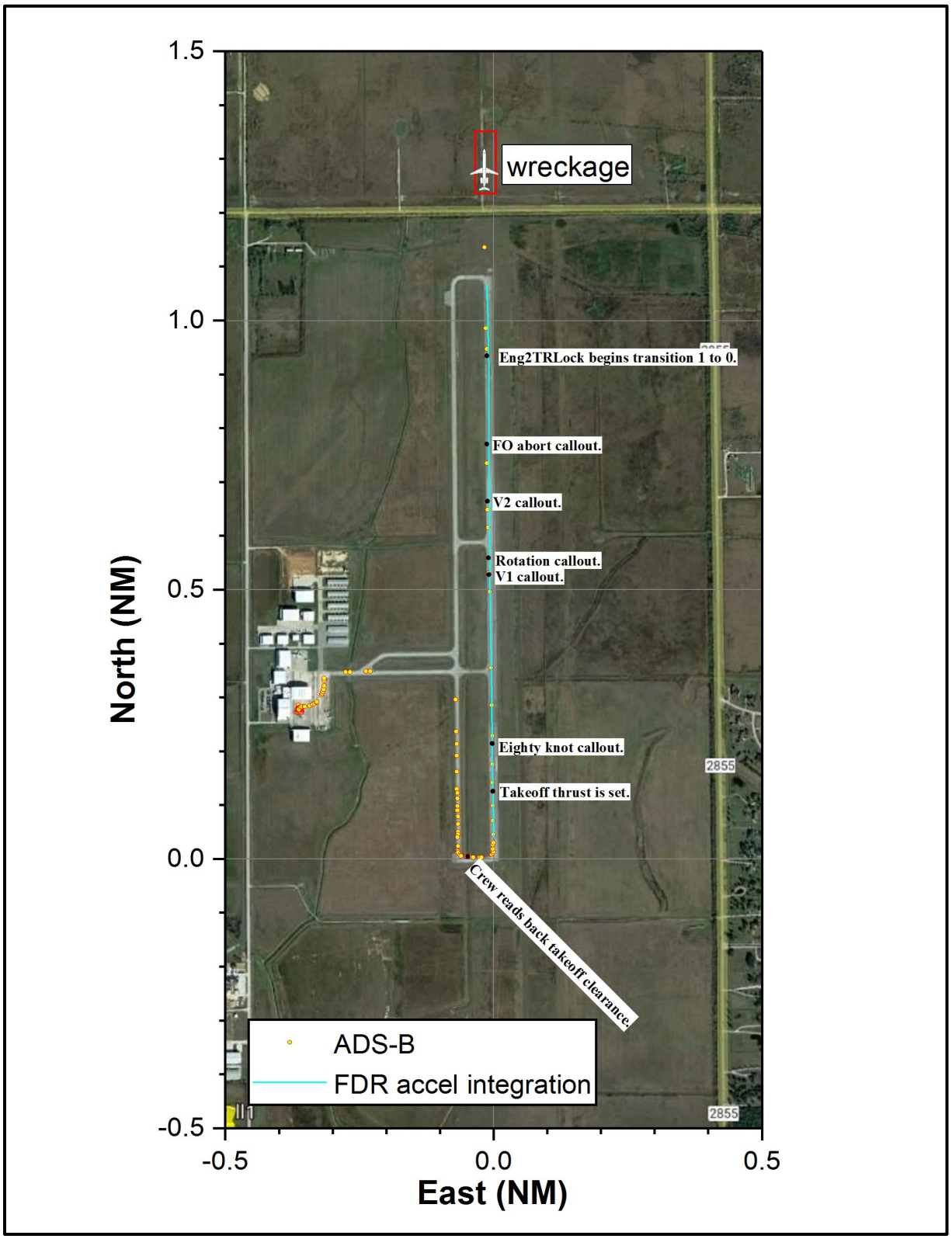

Figure 1: Part 91 Flight Personal Flight Part 91 from Houston Executive Airport, Brookshire, Texas, to Laurence G. Hanscom Field, Boston, Massachusetts

Figure 2: Accident Airplane, N987AK, a McDonnell Douglas DC-9-87

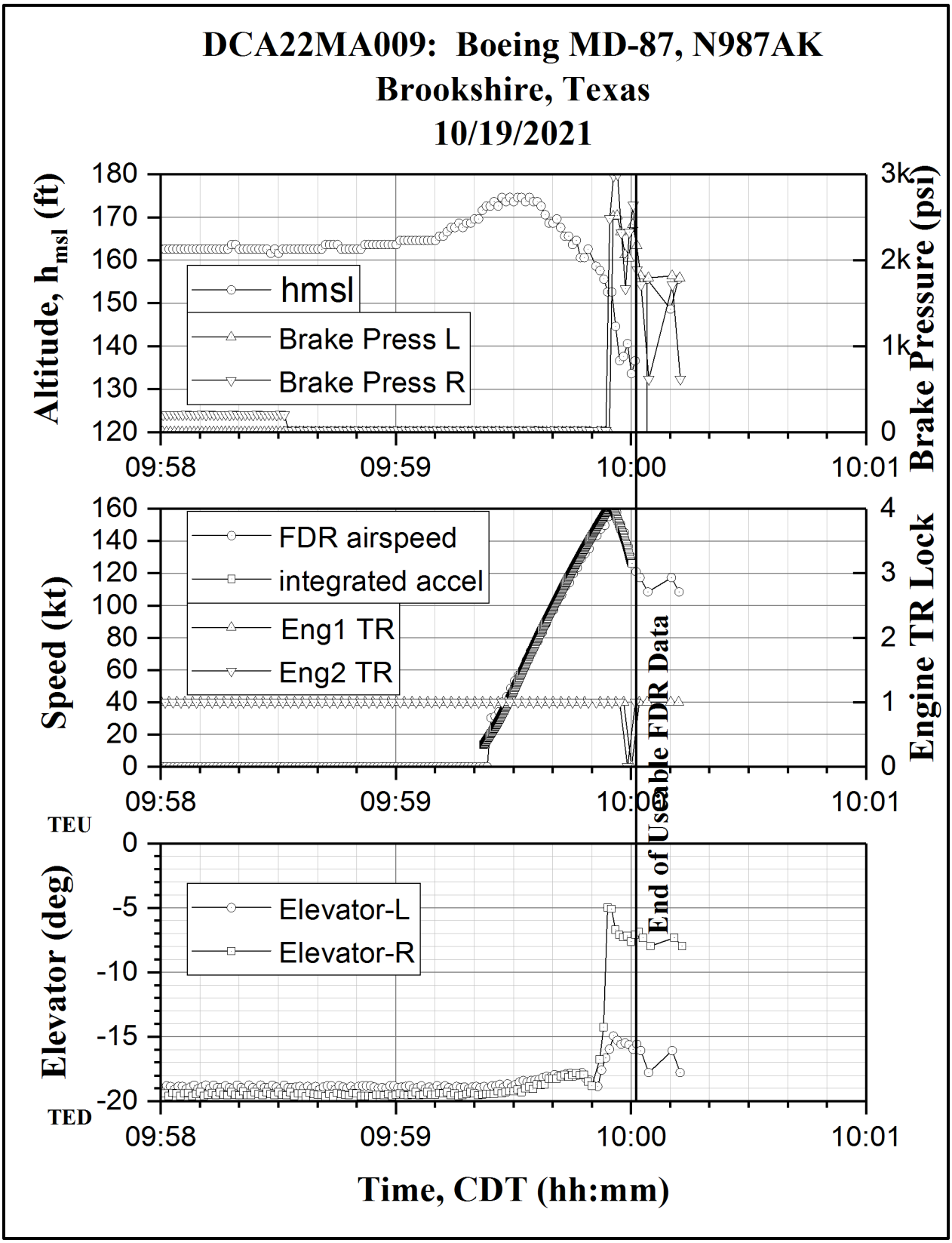

Figure 3: FDR Altitude and Airspeed during the Accident Take-off Attempt

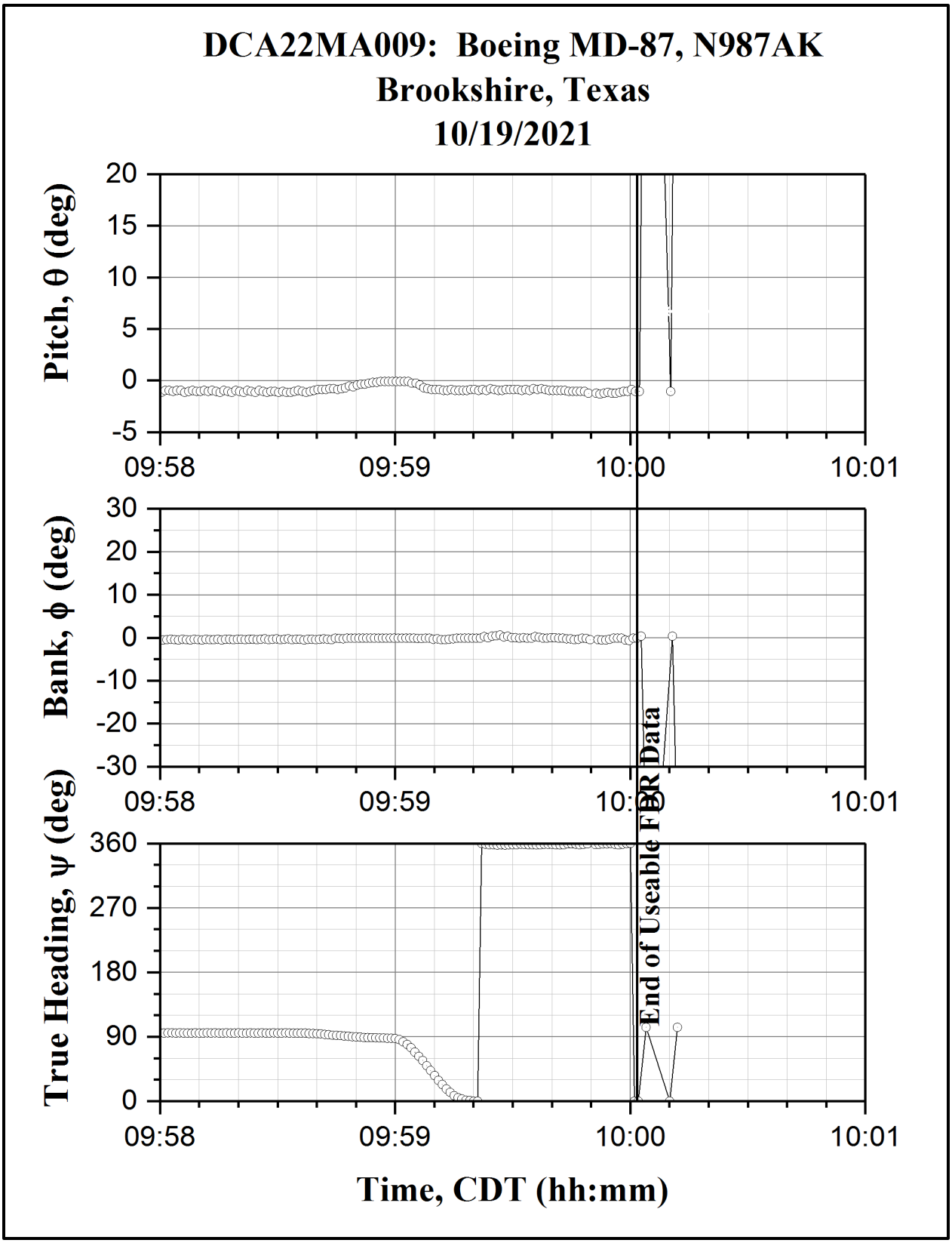

Figure 4: FDR Pitch, Bank, and Heading during the Accident Take-off Attempt

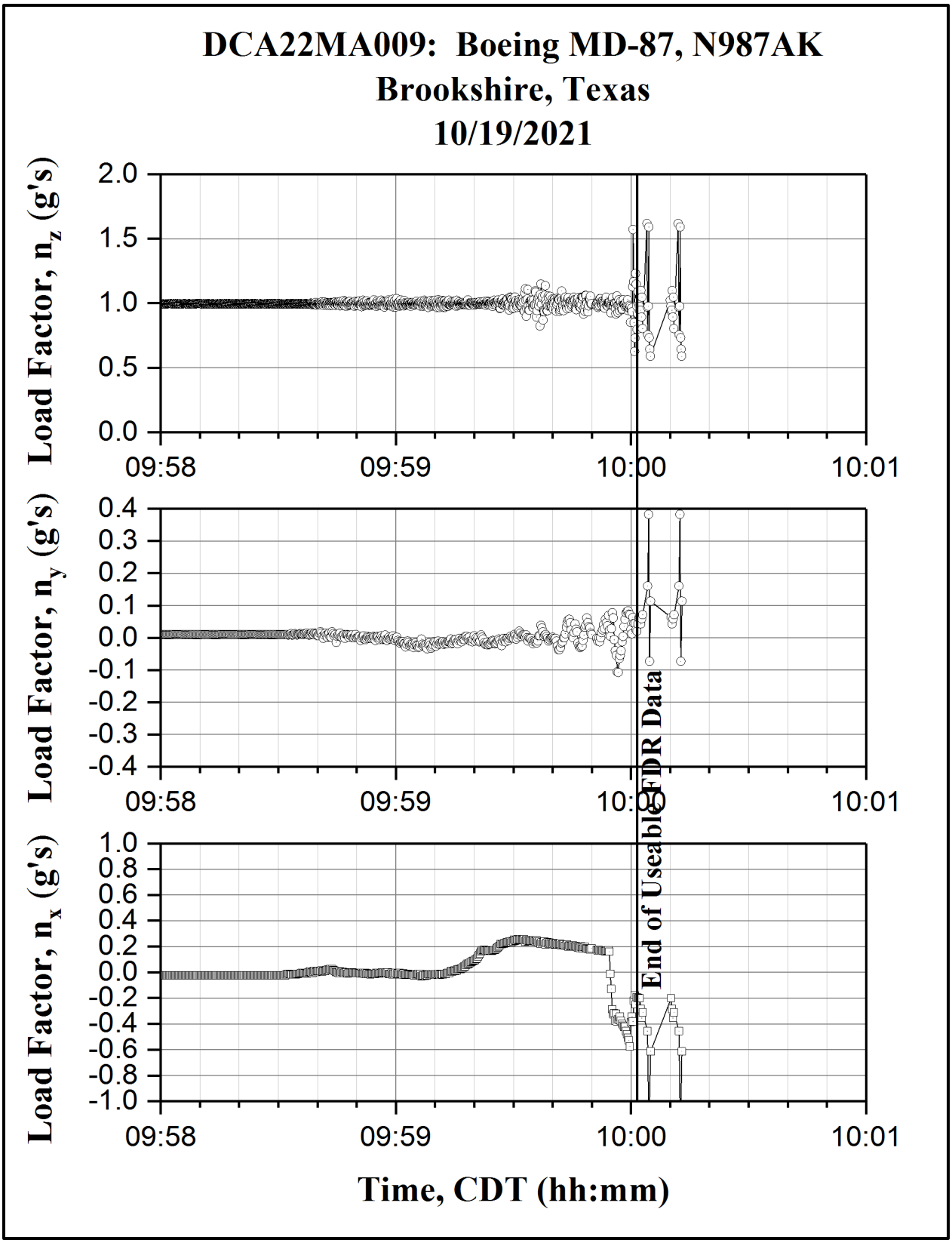

Figure 5: FDR Accelerations during the Accident Take-off Attempt

Figure 6: Photo of Tail Section