Aviation Investigation Preliminary Report

Location:	Houston, TX	**Accident Number:**	DCA24FA120
Date & Time:	March 8, 2024, 07:58 Local	**Registration:**	N27290
Aircraft:	Boeing 737-8	**Injuries:**	166 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

On March 8, 2024, at about 0758 central standard time, United Airlines flight 2477, a Boeing 737-8, N27290, experienced a runway excursion while exiting runway 27 onto taxiway SC at the George Bush Intercontinental Airport (IAH), Houston, Texas. The left main landing gear (MLG) departed the paved surface and contacted a concrete structure that was recessed into the ground, resulting in its separation. The 6 crew and 160 passengers were deplaned via airstairs. No injuries were reported. The flight was a Title 14 *Code of Federal Regulations* Part 121 scheduled domestic passenger flight from Memphis International Airport (MEM), Memphis, Tennessee to IAH.

In response to the accident, the NTSB traveled to Houston. As part of the investigative process, the NTSB invited qualified parties to participate in the investigation. These included the Federal Aviation Administration (FAA), United Airlines, The Boeing Company, and the Air Line Pilots Association (ALPA).

The parties were formed into specialized investigative groups led by NTSB group chairs in the areas of Operations, Human Performance, Systems, Structures, Digital Flight Data Recorder (DVDR) and Cockpit Voice Recorder (CVR).

History of Flight

According to the flight crew, the captain was the pilot flying and the first officer (FO) was the pilot monitoring. The captain said he observed the reported runway surface condition codes when checking the automatic terminal information system (ATIS) via his electronic flight bag (EFB). For runway 26L and 26R, he recalled seeing codes of 3/3/3 and for runway 27 codes of 5/5/5. The actual runway surface condition codes being broadcasted on the ATIS for runway 27 at the time were 3/3/3 which according to the runway condition assessment matrix (RCAM) indicated the runway was slippery when wet and “braking deceleration is noticeably reduced for the wheel braking effort applied or directional control is noticeably reduced.”

When the crew checked in with Houston Approach Control, they were told to expect a landing on runway 26L. The captain asked the FO to request a landing on runway 27 instead. The FO made, and the controller approved the request and issued instructions for the instrument landing system (ILS) approach to runway 27. After checking in with Houston Tower (about 12,000 feet msl according to the FO), the captain asked the FO to request approval to roll to the end of runway 27. The FO made the request. A tower controller approved it and instructed them, “keep your speed up”. The captain changed the autobrake setting from 2 to 1 (which would command a reduced deceleration rate). The approach was conducted in instrument meteorological conditions (IMC) and, according to the crew, the airplane broke out of the clouds between 800 and 1,000 feet msl. They reported that visibility under the clouds was good, and the captain recalled that the runway appeared dry. The FO recalled that the runway appeared wet.

The crew stated that the touchdown was uneventful, at an appropriate speed, and within the touchdown zone. The speed brakes extended normally, and the thrust reversers were deployed to idle reverse thrust. The captain said that, shortly after touchdown, he retracted the speedbrakes by the action of moving the speedbrake lever to its down and locked position, which disabled the autobrakes. He did not “slow too much initially” because the runway appeared dry, he wanted to expedite their time on the runway, and because he preferred decelerating gradually for passenger comfort.

The captain said he applied the brakes manually using the toe brakes at about 6,000 feet from the end of the runway but felt as if the deceleration was less than normal. DFDR data and automatic dependent surveillance-broadcast (ADS-B) data indicated that after the disabling of the autobrakes occurred, manual braking did not begin until the airplane was about 4,000 feet from the end of the runway. The captain recalled hearing the runway awareness and advisory system (RAAS) alert indicating 1,000 ft of runway distance remaining. He became concerned and began applying more pressure to the brakes. As he approached the end of the runway, he elected to attempt to turn onto taxiway SC, by utilizing the steering tiller and rudder pedals while pushing aggressively on the brake pedals.

During the turn onto the taxiway, he felt the fuselage and rudder/brake pedals begin to shake violently. He briefly released the brake pressure and the shaking ceased. He then reapplied aggressive brake pressure and the shaking resumed. The airplane slid off the runway and the left MLG tires and nose wheels tires entered the grass before the airplane came to a rest with its left wing low.

A postaccident examination of the accident site revealed that the left MLG tires had impacted a large concrete “manhole” designed as an electrical junction box for lights/utilities at the airport. As a result of the impact, the left MLG separated from the airplane at the fuse pins near the rear spar as designed to prevent more severe damage to surrounding structures. The airplane came to rest on the left engine nacelle, left winglet, and aft fuselage and sustained substantial damage to the left wing and aft fuselage.

Figure 1. Photograph showing the final resting position of the airplane.

Figure 2. Photograph showing concrete “manhole” impacted by left main landing gear. (Source: Boeing.)

Flight Crew

The captain was 61 years old and held an airline transport pilot (ATP) certificate with a rating for multiengine-land, commercial privileges for airplane single engine land, and type ratings on the B-727, B-737, B-757, B-767 which included the limitation English Proficient. He held an FAA first-class medical certificate dated October 4, 2023, with the limitation of must use corrective lenses to meet vision standards at all required distances.

The captain was hired by United Airlines on April 29, 1987, and had accumulated about 15,191 hours in B-737 aircraft with about 9,607 of those hours as pilot-in-command.

The FO was 38 years old and held an ATP certificate with a rating for multi-engine land, commercial privileges for airplane single engine land, and type ratings in the B-737, and L-188 which included the limitation of B-737 Circling approach VMC Only, and English Proficient. He held an FAA first-class medical certificate dated June 8, 2023.

The FO was hired by United Airlines on October 1, 2019, and had accumulated about 1,252 hours in B-737 aircraft.

Weather Conditions and Flight Crew Procedures

A Meteorological Aerodrome Report (METAR) at IAH was reporting at 0753 CST, wind from 190° at 5 knots, tower visibility 1 ½ mile in mist, ceiling broken at 800 ft agl, overcast at 1,800 ft, temperature 23°C (73°F), dew point temperature 22°C (71°F), altimeter 29.71 inches of mercury. Remarks: automated observation system with a precipitation discriminator, surface visibility 2 ½ miles, sea level pressure 1005.9-hPa, temperature 22.8°C, dew point 21.7°C. Photos and surveillance video during and immediately following the accident indicated wet runway and taxiway surface conditions.

United Airlines supplementary flight crew procedures required for "Landing on Wet or Slippery Runway" stated in part:

> *Use maximum reverse thrust as soon as possible after main wheel touchdown. Thrust reversers are most effective at high speed. Do not wait for the nose wheel to touchdown.*
>
> *Autobrake Stopping*
>
> *Determine the required distance to the desired runway exit point and select an autobrake setting of 3 or MAX, as appropriate. If any doubt exists, regarding runway conditions or braking action available, be conservative and use MAX autobrakes.*

Data

Data from the DFDR was sent to the NTSB's Vehicle Recorder Laboratory in Washington, DC, for analysis. A preliminary review of data has been completed and a plot showing the braking parameters is shown in figure 3. Data showed that at touchdown the speed brake lever position [Speed Brake Lever Pos] and auto brake parameters were full up and on for about 5 seconds before transitioning to down and locked and off for the remainder of the landing rollout.

The engine thrust reversers were deployed for the left and right engines for about 27 and 26 seconds respectively at idle reverse. The left and right brake pressure increased to their maximum pressure consistent with aggressive manual braking before and as the airplane's heading changed consistent with a right turn.

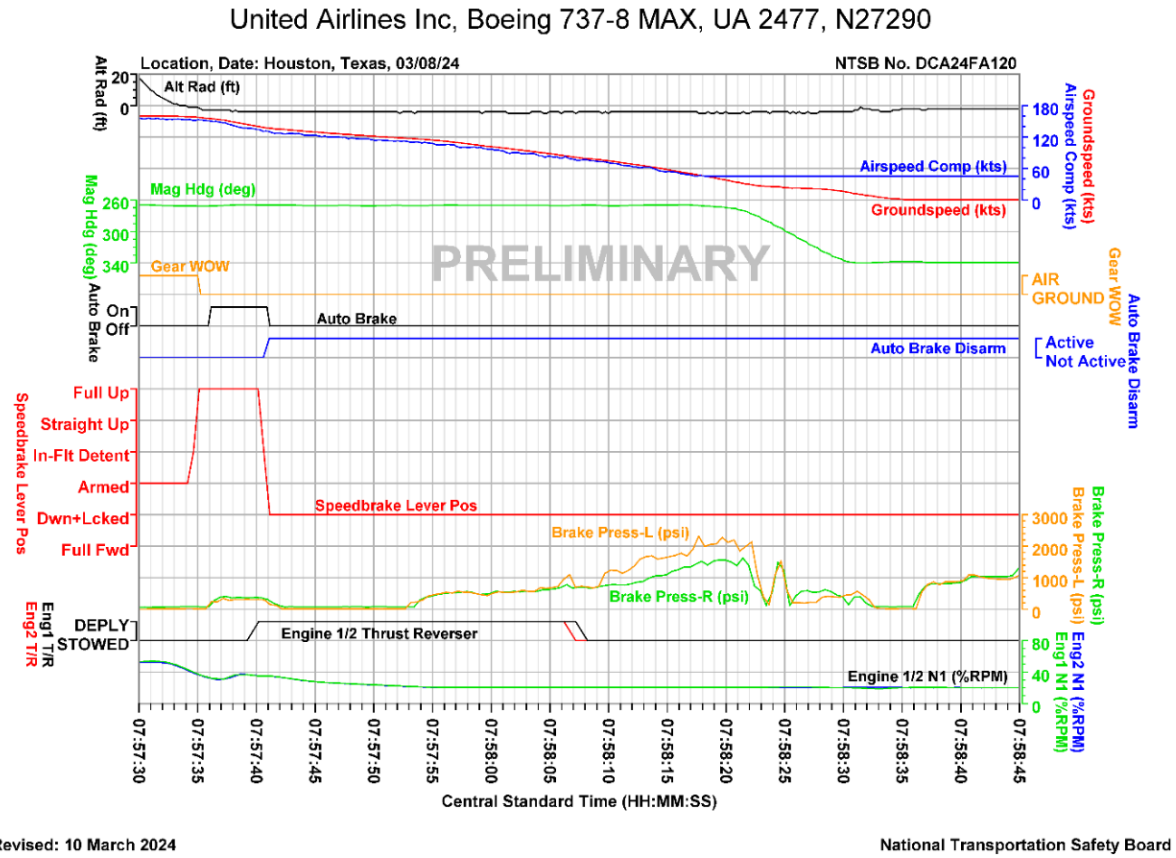

Figure 3. Plot of the FDR data from the accident landing.

The CVR was removed from the airplane and sent to the NTSB's Vehicle Recorder Laboratory in Washington, DC, for analysis.

Certified ADS-B data, which records more accurate latitude and longitude data than the DFDR, was provided to the NTSB by the FAA. Analysis of the ADS-B and DFDR data shows that the airplane touched down about 1,000 feet from the runway threshold with a groundspeed of about 158 knots. With about 1,000 ft and 500 ft of runway remaining the airplane groundspeeds were about 72 kts and 57 kts respectively. The right turn to exit the runway was initiated at about 39 kts groundspeed and the aircraft departed the end of the paved surface at about 22 kts (figure 4).

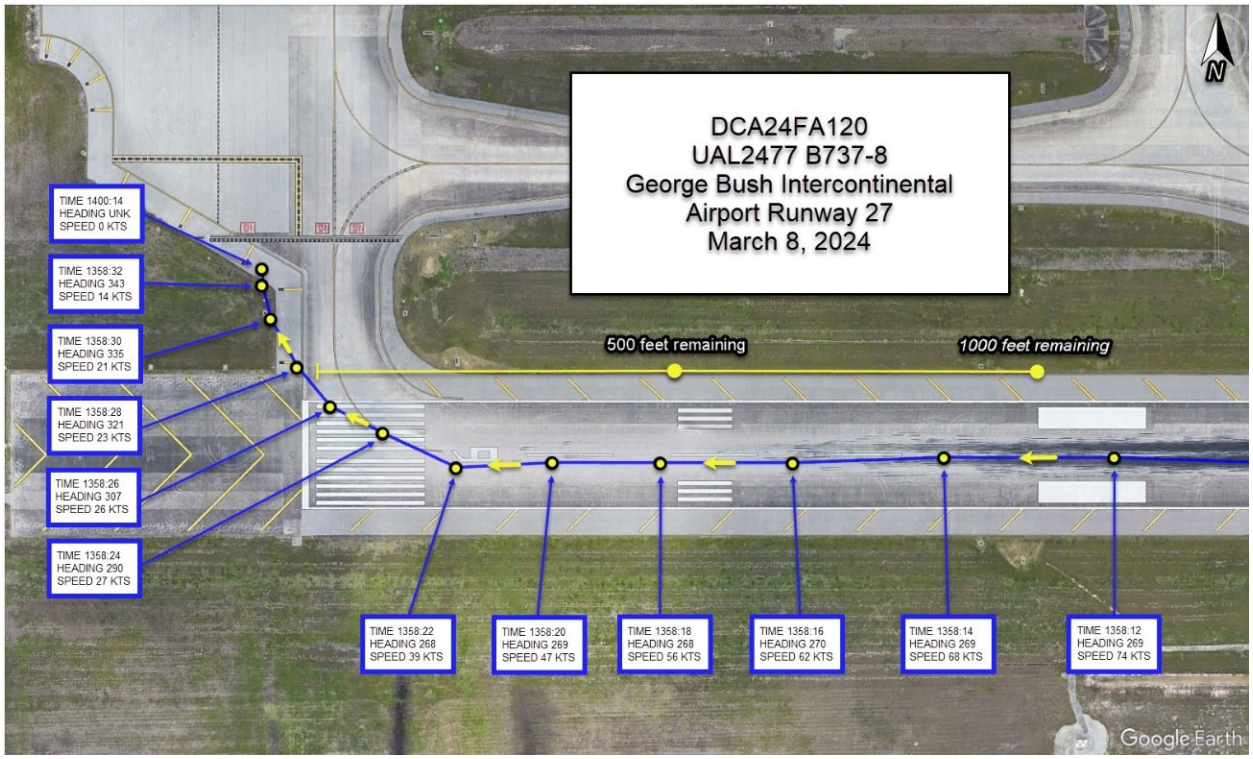

Figure 4. Accident airplane's landing rollout time, heading and speed from ADS-B data overlayed on a Google Earth image of runway 27 and taxiway SC at IAH. Yellow arrows indicate direction of travel.

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N27290
Model/Series:	737-8	**Aircraft Category:**	Airplane
Amateur Built:			
Operator:	UNITED AIRLINES INC	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Designator Code:			

Meteorological Information and Flight Plan

Conditions at Accident Site:	IMC	**Condition of Light:**	Day
Observation Facility, Elevation:	KIAH,105 ft msl	**Observation Time:**	07:53 Local
Distance from Accident Site:	1 Nautical Miles	**Temperature/Dew Point:**	23°C /22°C
Lowest Cloud Condition:		**Wind Speed/Gusts, Direction:**	5 knots / , 190°
Lowest Ceiling:	Broken / 800 ft AGL	**Visibility:**	1.5 miles
Altimeter Setting:	29.71 inches Hg	**Type of Flight Plan Filed:**	IFR
Departure Point:	Memphis, TN (MEM)	**Destination:**	Houston, TX

Wreckage and Impact Information

Crew Injuries:	6 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	160 None	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	166 None	**Latitude, Longitude:**	29.978134,-95.334248

Administrative Information

Investigator In Charge (IIC):	Banning, David
Additional Participating Persons:	Eddie Miller; FAA AVP-100 Carson King; United Steve Demko; ALPA Jacob Zeigler ; Boeing
Investigation Class:	Class 3
Note:	