National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

DCA22FA132

AIRCRAFT PERFORMANCE STUDY

July 7, 2023

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A. ACCIDENT

Location: Miami International Airport (MIA), Miami, Florida
Date: June 21, 2022
Time: 1738 Eastern Daylight Time (EDT)
2138 Coordinated Universal Time (UTC)
Airplane: Boeing (McDonnell Douglas) DC-9-82 (Serial No. 53027), Dominican Republic Registration HI1064, RED Air flight 203

B. AIRCRAFT PERFORMANCE SPECIALIST

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C. SUMMARY

On June 21, 2022, about 1738 eastern daylight time, RED Air flight 203, a Boeing (McDonnell Douglas) DC-9-82 airplane, HI1064, experienced a left main landing gear failure shortly after landing on runway 9 at Miami International Airport (MIA), Dade County, Miami, Florida. The airplane departed runway 9 and came to a stop in the grassy area between runways 9 and 30. A post-crash fire occurred and was extinguished by Airport Rescue and Fire Fighting (ARFF). The airplane was evacuated, and 4 passengers received minor injuries. The flight was operated as a Title 14 *Code of Federal Regulations* Part 129 scheduled international passenger flight from Las Américas International Airport (SDQ), Santo Domingo, Dominican Republic, to MIA.

1. Introduction

The accident airplane was equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR) that were collected and processed by NTSB specialists. Witness marks and airplane components on the runway and along portions of the ground track were documented by NTSB aerial drone survey. Video footage from nine (9) sources that captured the accident flight was also collected and processed. Other NTSB groups or specialists collected and/or documented additional factual evidence including Federal Aviation Administration (FAA) Automatic Dependent Surveillance–Broadcast (ADS-B) data, the airplane position and orientation at final rest, airplane component locations, powerplants, structures, systems, weather, flight dispatch paperwork, fuel and cargo records, crew operating manuals, airframe and engine maintenance records, witness statements, and airplane performance data.

An NTSB aircraft performance group was not formed due to the limited scope of this study, which included 1) collection and distribution of aircraft performance data, 2) preparation of image sequence summaries from relevant video recordings, 3) time alignment and visualization of recorded aural, parametric, and video data, and 4) determination of the HI1064 RED Air flight 203 main landing gear touchdown location.

2. Objective and Scope of the *Aircraft Performance Study*

The objectives of the study were to 1) document pertinent video evidence, 2) quantify the airplane main gear touchdown location, and 3) reconstruct the accident airplane flight path and ground track.

3. Summary of Results

Based on available ADS-B, FDR, CVR, and video factual evidence, RED Air flight 203 main landing gear touchdown occurred about 2,750±50 feet beyond the displaced threshold of MIA runway 9, within the first third of the landing distance available (LDA).

D. DETAILS OF THE INVESTIGATION

1. Method

The aircraft performance study provides data-driven, quantified assessments based on available HI1064 factual evidence (including ADS-B, FDR, CVR, video, and survey data) and Airplane Flight Manual (AFM) data.

2. Boeing (McDonnell Douglas) DC-9-82

The DC-9-82 (commonly referred to as the MD-82) is a single-aisle, transport category passenger airplane powered by two Pratt & Whitney JT8D-219 high bypass ratio, turbofan engines mounted on the aft fuselage. The MD-82 is a variant of the MD-80, and a three-view drawing of the MD-80 is provided in Attachment 1.

3. Miami International Airport (MIA) Runway 2/20

Miami International Airport (MIA) is located about 8 miles northwest of Miami, Florida. Runway 9/27 is 13,016 feet long, 150 feet wide, constructed of grooved asphalt, and has precision markings. The runway 9 heading is 092° magnetic and 087° true, with a magnetic variation of 5°W. The runway 9 approach end elevation is 8.1 feet and the departure end elevation is 9.0 feet, resulting in an average runway 9 upslope of 0.0 percent [(9.0 - 8.1)/13,016 = 0.0001]. Runway 9 has a displaced threshold of 1,358 feet. The runway 9 declared distances in feet are Takeoff Run Available (TORA) 13,016, Takeoff Distance Available (TODA) 13,016, Accelerate-Stop Distance Available (ASDA) 12,755, Landing Distance Available (LDA) 11,397. Runway 9 has a 4-light precision approach path indicator (PAPI) located on the left side that provides guidance for a 3.00° glide path. An MIA airport diagram and an aerial image are included in Attachment 2.

4. Meteorological Conditions

The hourly MIA Automated Surface Observing System (ASOS) data near the accident time were:

[1453 EDT] METAR KMIA 211853Z 06011G20KT 10SM SCT037 SCT110 BKN250 30/22 A3011 RMK AO2 SLP197 T03000217

[1553 EDT] METAR KMIA 211953Z 05013G18KT 10SM FEW030 BKN250 30/21 A3010 RMK AO2 SLP191 T03000206 $

[1653 EDT] METAR KMIA 212053Z 05010G18KT 10SM FEW030 BKN250 30/19 A3008 RMK AO2 SLP187 T03000194 $

[1753 EDT] METAR KMIA 212153Z 05009G16KT 10SM FEW030 FEW045 BKN250 30/16 A3008 RMK AO2 SLP187 T03000161 $

[1853 EDT] METAR KMIA 212253Z VRB04KT 10SM FEW030 BKN250 29/19 A3008 RMK AO2 SLP185 T02940194 $

[1953 EDT] METAR KMIA 212353Z 03008KT 10SM FEW030 SCT250 28/21 A3007 RMK AO2 SLP183 T02780211 10306 20278 58004 $

At 1753 EDT, the MIA ASOS reported a wind from 050° at 9 knots gusting to 16 knots, visibility of 10 statute miles or greater, a few clouds at 3,000 feet above ground level (agl), a few clouds at 4,500 feet agl, broken ceiling at 25,000 feet agl, temperature of 30° Celsius (C), dew point temperature of 16°C, and altimeter setting of 30.08 inches of mercury;

Remarks included: automated station with a precipitation discriminator, sea level pressure of 1018.7 hectopascals (hPa), temperature of 30.0°C and dew point temperature of 16.1°C.

Five-minute MIA ASOS data preceding the accident time (highlighted in light gray color) [Source: https://mesonet.agron.iastate.edu/request/download.phtml?network=FL_ASOS]:

KMIA 212100Z AUTO 05014KT	10SM FEW030	30/18 A3008 RMK T03000180
KMIA 212105Z AUTO 03009KT	10SM FEW030	30/18 A3008 RMK T03000180
KMIA 212110Z AUTO 04009KT	10SM FEW030	31/18 A3008 RMK T03100180
KMIA 212115Z AUTO 05013KT	10SM FEW030	30/18 A3008 RMK T03000180
KMIA 212120Z AUTO 04014KT	10SM FEW030	30/17 A3008 RMK T03000170
KMIA 212125Z AUTO 04011G17KT	10SM FEW030	31/14 A3008 RMK T03100140
KMIA 212130Z AUTO 04011KT	10SM FEW030	30/14 A3008 RMK T03000140
KMIA 212135Z AUTO 04011G17KT	10SM FEW030	30/15 A3008 RMK T03000150
KMIA 212140Z AUTO 03011G16KT	10SM FEW030	30/16 A3008 RMK T03000160
KMIA 212145Z AUTO 04009KT	10SM FEW030	29/17 A3008 RMK T02900170
KMIA 212150Z AUTO 05010KT	10SM FEW030	29/17 A3008 RMK T02900170
KMIA 212155Z AUTO 05013KT	10SM FEW030 FEW045	30/16 A3008 RMK T03000160
KMIA 212200Z AUTO 05010KT	10SM FEW030 FEW045	29/18 A3009 RMK T02900180

5. Video Evidence

Eight (8) external video surveillance cameras and one (1) passenger handheld cellular telephone recorded a portion of the accident flight. The video footage from each camera was separated into individual image frames and chronologically ordered. Image content pertinent to the investigation is documented in this study. The consecutive sequence of images from each camera was cropped, enlarged, and packaged in .pdf file format to simplify factual content reference and distribution. When image content was cropped or scaled, the original image aspect ratio was preserved. The resulting image sequence from each camera is provided in Attachments 3–11. Image content in the attachments is most easily viewed in full screen mode, using the arrow keys or mouse wheel to page forward or backward. A pictorial summary of the video evidence (camera view, aircraft position, time stamp) follows in Figures 1 through 9. Camera times shown have not been altered or aligned.

Ground level visibility conditions appear to be clear in the relevant video evidence. The taxiway and runway pavement surface condition in the foreground of applicable images appears to be bare and dry.

"SW GATE AOA TRK PTZ Site 11" Camera, Attachment 3

Figure 1: Excerpt of cropped and enlarged image sequence extracted from "SW GATE AOA TRK PTZ Site 11" surveillance camera recording. Airplane is moving right to left on short final approach.

"SW Gate CAM01" Camera, Attachment 4

Figure 2: Excerpt of cropped and enlarged image sequence extracted from "SW Gate CAM01" surveillance camera recording. Airplane is moving right to left toward main gear touchdown point.

"Tunnel Airside South" Camera, Attachment 5

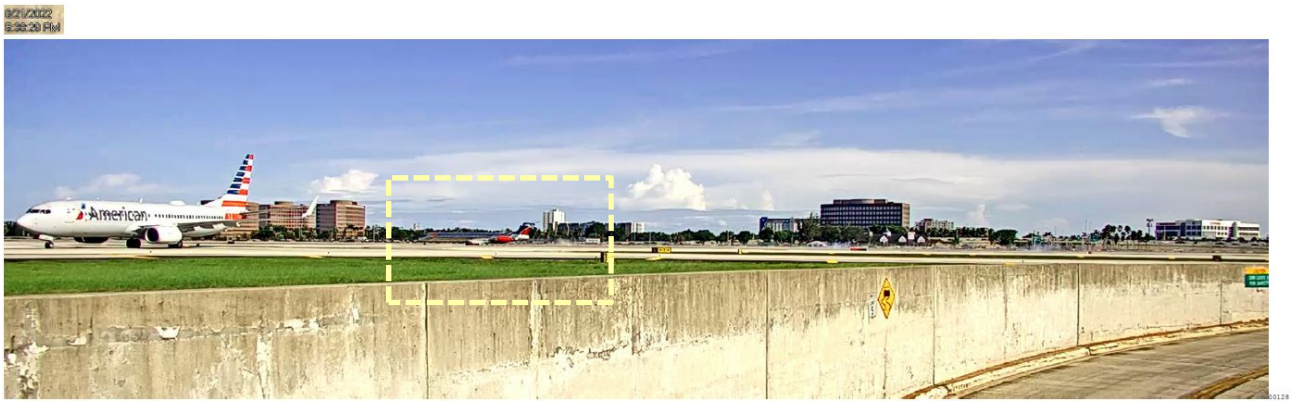

Figure 3: Excerpt of cropped and enlarged image sequence extracted from "Tunnel Airside South" surveillance camera recording. Airplane is moving right to left.

"Taxiway T3" Camera, Attachment 6

Figure 4: Excerpt of cropped and enlarged image sequence extracted from "Taxiway T3" surveillance camera recording. Airplane is moving left to right.

"E Sat Train Guideway" Camera, Attachment 7

Figure 5: Excerpt of cropped and enlarged image sequence extracted from "E Sat Train Guideway" surveillance camera recording. Airplane is moving right to left.

"FAA Tower AOA TRK PTZ 3 W" Camera, Attachment 8

Figure 6: Excerpt of cropped and enlarged image sequence extracted from "FAA Tower AOA TRK PTZ 3 W" surveillance camera recording. Airplane is moving right to left.

"FAA Tower AOA TRK PTZ 2 S" Camera, Attachment 9

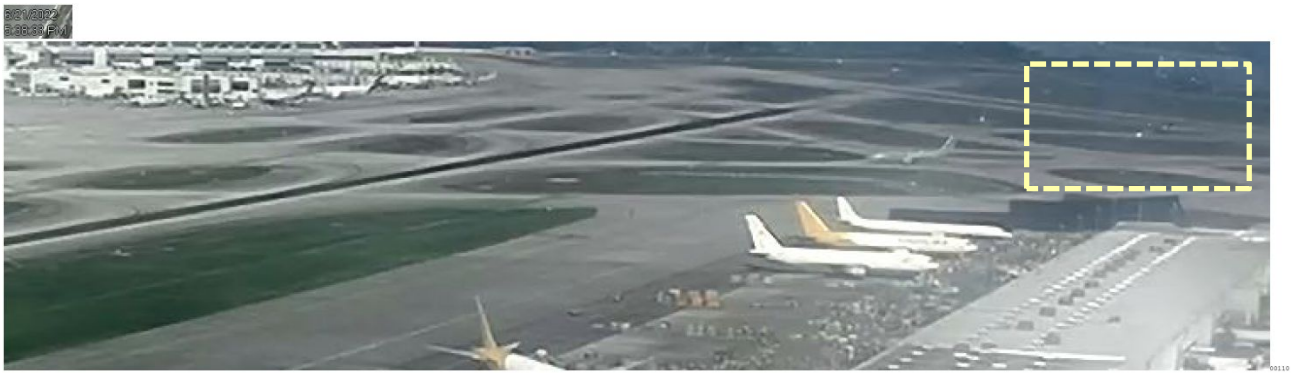

Figure 7: Excerpt of cropped and enlarged image sequence extracted from "FAA Tower AOA TRK PTZ 2 S" surveillance camera recording. Airplane is moving right to left, approaching position of final rest.

"Spot 13" Camera, Attachment 10

Figure 8: Excerpt of cropped and enlarged image sequence extracted from "Spot 13" surveillance camera recording. Airplane is moving right to left, approaching position of final rest.

"Passenger" Camera, Attachment 11

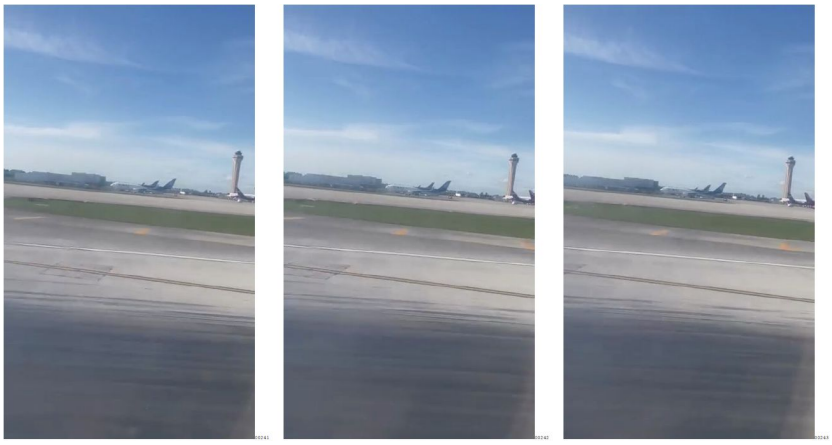

Figure 9: Image sequence (3 images) extracted from "Passenger" cellular telephone recording. Airplane is moving left to right. The air traffic control tower is visible in the background, right-hand side of each frame.

6. Flight Data Recorder Parametric Data

The available FDR data are documented in the NTSB Flight Data Recorder Specialist's Factual Report. The HI1064 accident flight time history plots in Attachment 12 present the following subset of available FDR parameters for the full flight, the descent and approach segment below 10,000 feet, and the final approach and landing segment: pressure altitude, computed airspeed, longitudinal acceleration, left and right engine pressure ratio, left and right engine N1 (fan speed in percent), right gear down discrete, right gear up discrete, air/ground discrete, left and right brake pedal position, left and right brake pressure, vertical acceleration, pitch attitude, left and right elevator surface position, left flap surface position, roll attitude, left aileron surface position, lateral acceleration, heading, and rudder surface position. The available FDR data indicate that HI1064 was configured for a flaps 28 landing with evidence of increased wheel brake pressure subsequent to airplane main and nose gear touchdown.

Please refer to the NTSB FDR Factual Report and the NTSB Systems Factual Report for information regarding the 16-second gap in recorded FDR parameters and the validity of brake pedal position and brake pressure parameters.

7. Paraphrased Cockpit Voice Recorder Events

The paraphrased CVR events incorporated in this study are documented in Table 1. Paraphrased CVR events generally represent machine-generated annunciations or flight deck, outbound, or inbound communications. The columns in Table 1 correspond to Coordinated Universal Time (UTC), local time, FDR elapsed time in seconds, and the corresponding paraphrased CVR event. Time alignment between the CVR and FDR was established using the sequence of common FDR VHF key down events and the beginning of CVR RDO key events. Local time was established by correlating the FDR vertical acceleration signature and CVR paraphrased MECH. SOUND event to main gear touchdown and then looking up the FAA ADS-B data HH:MM:SS value that corresponded to a main gear touchdown position 2,750 feet beyond the displaced threshold of runway 9.

Table 1: Paraphrased CVR Events

HH:MM:SS UTC	HH:MM:SS Local	FDR Time Seconds	Description Paraphrased CVR Event
21:08:08.87	17:08:08.87	171564.625	START RECORDING
21:33:06.97	17:33:06.97	173062.725	RDO KEY
21:33:11.17	17:33:11.17	173066.925	APP
21:33:13.67	17:33:13.67	173069.425	RDO KEY
21:34:46.47	17:34:46.47	173162.225	2500 FT CALL
21:35:07.07	17:35:07.07	173182.825	APP
21:35:09.07	17:35:09.07	173184.825	RDO KEY
21:35:45.57	17:35:45.57	173221.325	TWR
21:36:29.57	17:36:29.57	173265.325	1000 FT CALL
21:37:12.37	17:37:12.37	173308.125	500 FT CALL
21:37:44.07	17:37:44.07	173339.825	100 FT CALL
21:37:49.97	17:37:49.97	173345.725	50 FT CALL
21:37:51.17	17:37:51.17	173346.925	40 FT CALL
21:37:52.27	17:37:52.27	173348.025	30 FT CALL
21:37:53.57	17:37:53.57	173349.325	20 FT CALL
21:37:56.07	17:37:56.07	173351.825	10 FT CALL
21:38:00.97	17:38:00.97	173356.725	MECH. SOUND
21:38:01.77	17:38:01.77	173357.525	THUNK SOUND
21:38:04.87	17:38:04.87	173360.625	2ND THUNK SOUND
21:38:06.87	17:38:06.87	173362.625	SHIMMY & SLIDE SOUND
21:38:11.17	17:38:11.17	173366.925	LANDING GEAR AUTOVOICE
21:38:36.87	17:38:36.87	173392.625	LOUD THUD SOUNDS
21:38:43.17	17:38:43.17	173398.925	END SLIDING SOUND
21:39:12.47	17:39:12.47	173428.225	END RECORDING

The paraphrased CVR events in Table 1 were overlaid on the series of zoomed-in FDR time history plots in Attachment 13, providing a high resolution comparison of recorded FDR parameters and CVR events.

8. Weight & Balance

The accident flight weight and balance data are documented in the Operational Factors/Human Performance Group Chairmen's Field Notes. For convenient aircraft performance reference, the HI1064 itemized weight and balance data are reproduced in Table 2.

Table 2: HI1064 Weight and Balance Buildup

Description	Weight (lb.)	%MAC
Aircraft Empty Weight	84,234	
Payload	24,500	
Zero Fuel Weight	108,734	
Fuel	27,500	
Ramp weight	136,234	
Taxi fuel	600	
Takeoff weight	135,634	
Enroute fuel burn	15,184	
Projected landing weight	120,450	16.92

9. HI1064 Flight Path Reconstruction

The NTSB drone aerial survey of runway 9 documented HI1064 witness mark evidence and the aircraft position at rest. An NTSB flight path model of the HI1064 landing event was constructed in Google Earth from drone survey data, the NTSB Systems Group aircraft component survey, FAA ADS-B data, FDR data, paraphrased CVR events, integrated FDR accelerometer data, and calculated distance markers relative to the runway 9 displaced threshold. Exemplar flight path overview plots are shown in Figures 10 and 11. The sequence of plots in Attachment 14 illustrate the HI1064 ground track reconstruction from short final approach to aircraft position at rest.

10. Landing Performance Data

The MD-82 landing performance data in Attachment 15 can be used to calculate the expected aircraft landing performance for dry runway surface conditions as a function of weight, landing flap, pressure altitude, temperature, wind, speed, runway slope, engine reverse thrust configuration, and spoiler deployment technique. The Boeing Flight Crew Operations Manual (FCOM) simplified tabular presentation of variables that affect landing performance may yield more conservative distance values than landing performance calculated using first principles-based methods.

3.0 SUMMARY

A review of the available ADS-B, FDR, CVR, video and survey factual evidence indicated that HI1064 main landing gear touchdown occurred about 2,750 ± 50 feet beyond the runway 9 displaced threshold, which was within the first third of the landing distance available. Image sequence summaries extracted from eight (8) external surveillance cameras and one (1) passenger cellular telephone that documented the airplane flight path during the final approach and landing rollout are included in the attachments to this study.

Figure 10: Example of HI1064 accident flight path reconstruction looking toward the runway 9 displaced threshold, showing 0 to 2,400 feet along the runway. Ground track reconstruction is based on ADS-B, FDR, paraphrased CVR, video, and runway witness mark evidence. Aircraft direction of travel is toward the top of the page. FAA ADS-B data recorded for HI1064 are identified by blue symbols. Green symbols depict NTSB flightpath calculated by integrating FDR accelerometer data. Distance beyond the runway 9 displaced threshold is annotated in feet. This image is a duplicate of Attachment 14, Figure A14.3.

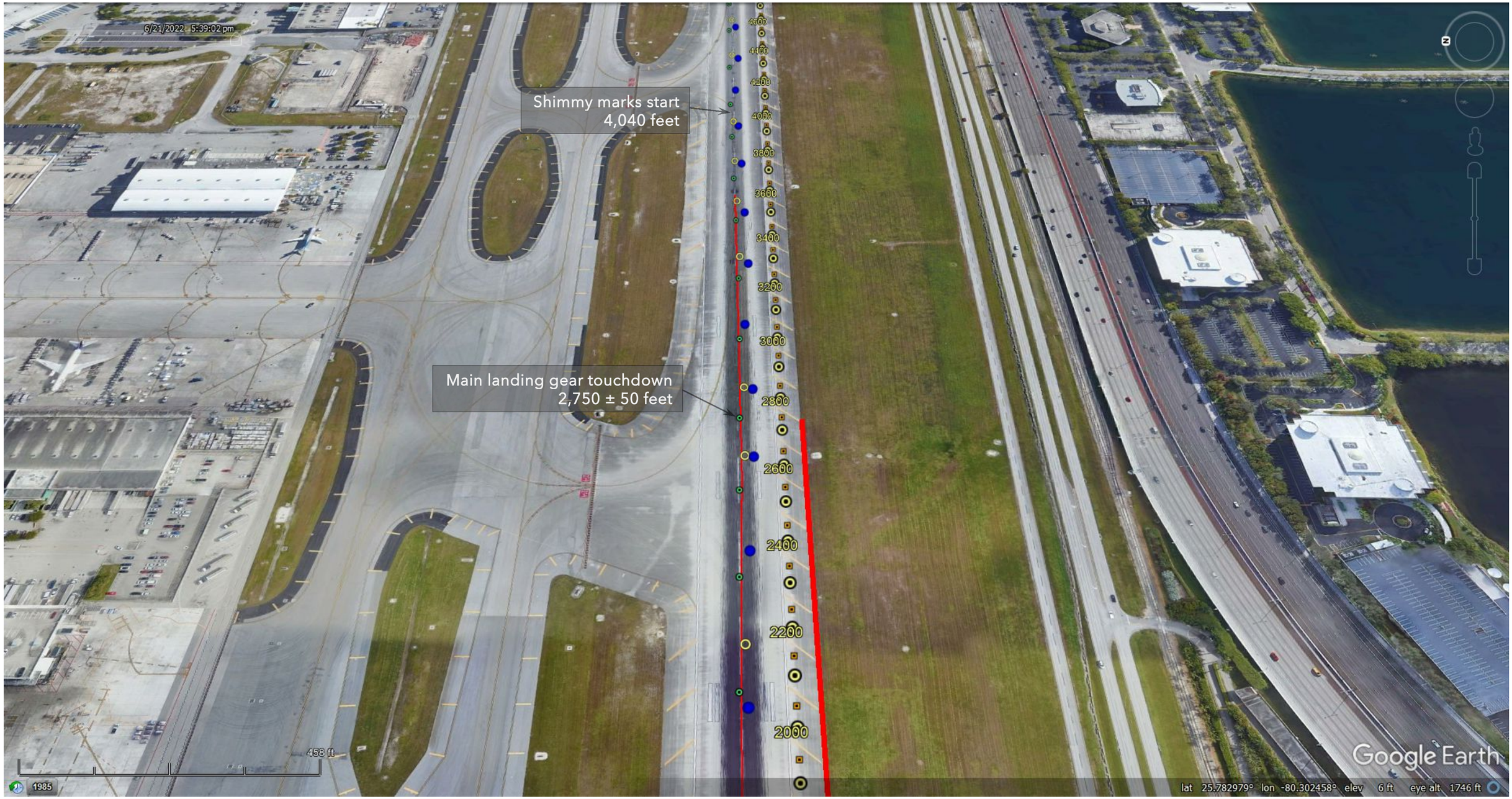

Figure 11: HI1064 accident flight reconstruction 2,000 to 4,600 feet beyond the runway 9 displaced threshold. Ground track reconstruction is based on FAA ADS-B, paraphrased CVR, FDR, video, and runway witness mark evidence. Aircraft direction of travel is toward the top of the page. FAA ADS-B data recorded for HI1064 are identified by blue symbols. Green symbols depict NTSB flightpath calculated by integrating FDR accelerometer data. Distance beyond the runway 9 displaced threshold is annotated in feet. Additional text annotations indicate location of main landing gear touchdown and start of left main landing gear shimmy marks. This image is a duplicate of Attachment 14, Figure A14.5.

4.0 ATTACHMENTS

Attachment 1: MD-80 three-view drawing
Attachment 2: Miami International Airport (MIA)
Attachment 3: "SW GATE AOA TRK PTZ Site 11" camera image sequence
Attachment 4: "SW Gate CAM01" camera image sequence
Attachment 5: "Tunnel Airside South" camera image sequence
Attachment 6: "Taxiway T3" camera image sequence
Attachment 7: "E Sat Train Guideway" camera image sequence
Attachment 8: "FAA Tower AOA TRK PTZ 3 W" camera image sequence
Attachment 9: "FAA Tower AOA TRK PTZ 2 S" camera image sequence
Attachment 10: "Spot 13" camera image sequence
Attachment 11: "Passenger" camera image sequence
Attachment 12: Flight Data Recorder (FDR) data
Attachment 13: Paraphrased CVR events overlaid on FDR data
Attachment 14: Accident flight path reconstruction (HI1064)
Attachment 15: Landing performance data (HI1064)