

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

July 31, 2018

Flight Data Recorder

Specialist's Factual Report
By Christopher Babcock

1. EVENT SUMMARY

Location: Atlanta, Georgia
Date: June 23, 2017
Aircraft: Airbus A321
Registration: N315DN
Operator: Delta Airlines
NTSB Number: DCA17LA145

On June 23, 2017, about 1338 eastern daylight time (EDT), Delta Airlines flight 800, an Airbus 321-200, registration N315DN, experienced a tail strike while landing on runway 26R at Hartsfield International Airport (ATL), Atlanta, Georgia. There were no injuries to the passengers or crew and the airplane received substantial damage. The flight was operating under 14 *Code of Federal Regulations (CFR)* Part 121 as a scheduled domestic passenger flight from Boston International Airport (BOS), Boston, Massachusetts. Visual meteorological conditions prevailed at the time of the landing. A flight data recorder was recovered from the aircraft for evaluation.

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was not convened.

3. FDR Carriage Requirements

The accident aircraft, N315DN, was manufactured in 2016, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, the first 88 parameters listed in 14 CFR Part 121 Appendix M.

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: **L-3/Fairchild FA2100**
Recorder Serial Number: **001186125**

4.1. L-3 Communications FA2100 Description

This model FDR records airplane flight information in a digital format using solid-state flash memory as the recording medium. The FA2100 can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. It is configured to record

1024 12-bit words of digital information every second. Each grouping of 1024 words (each second) is called a subframe. Each subframe has a unique 12-bit synchronization (sync) word identifying it as either subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The data stream is "in sync" when successive sync words appear at proper 1024-word intervals. Each data parameter (e.g. altitude, heading, airspeed) has a specifically assigned word number within the subframe. The FA2100 is designed to meet the crash-survivability requirements of TSO-C124b.

4.1.1. Recorder Condition

The recorder was in good condition and the data were extracted normally from the recorder.

4.1.2. Recording Description

The FDR recording contained approximately 113 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event flight was the last flight of the recording and its duration was approximately 2 hours and 15 minutes. The parameters evaluated for this report appeared to be in accordance with federal FDR carriage requirements.

4.1.3. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the aircraft manufacturer. Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).¹

Table A-1 lists the FDR parameters verified and provided in this report. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

4.1.3.1. Aircraft Attitude Parameters

There are two parameters for aircraft pitch recorded on the FDR: "Pitch Angle (ISIS)" and "Pitch Attitude." There are also two parameters for aircraft roll recorded on the FDR: "Roll Angle (ISIS)" and "Roll Attitude." According to Airbus, the source of the "Pitch Attitude" and "Roll Attitude" parameters is the air data inertial reference unit (ADIRU). The source of the "Pitch Angle (ISIS)" and "Roll Angle (ISIS)" parameters is the standby attitude instrument.

4.2. Time Correlation

Correlation of the FDR data from SRN to the local eastern daylight time was established by using the recorded Time Hrs, Time Min, and Time Sec parameters which recorded Universal Coordinated Time (UTC) time and then applying an -4 hour offset to change to EDT.

Accordingly, the time offset for the event flight data from SRN to EDT is the following:

¹ CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

$$\text{EDT} = \text{SRN} - 351,267 \text{ seconds}$$

In this report, all times are referenced as EDT.

4.3. FDR Plots and Corresponding Tabular Data

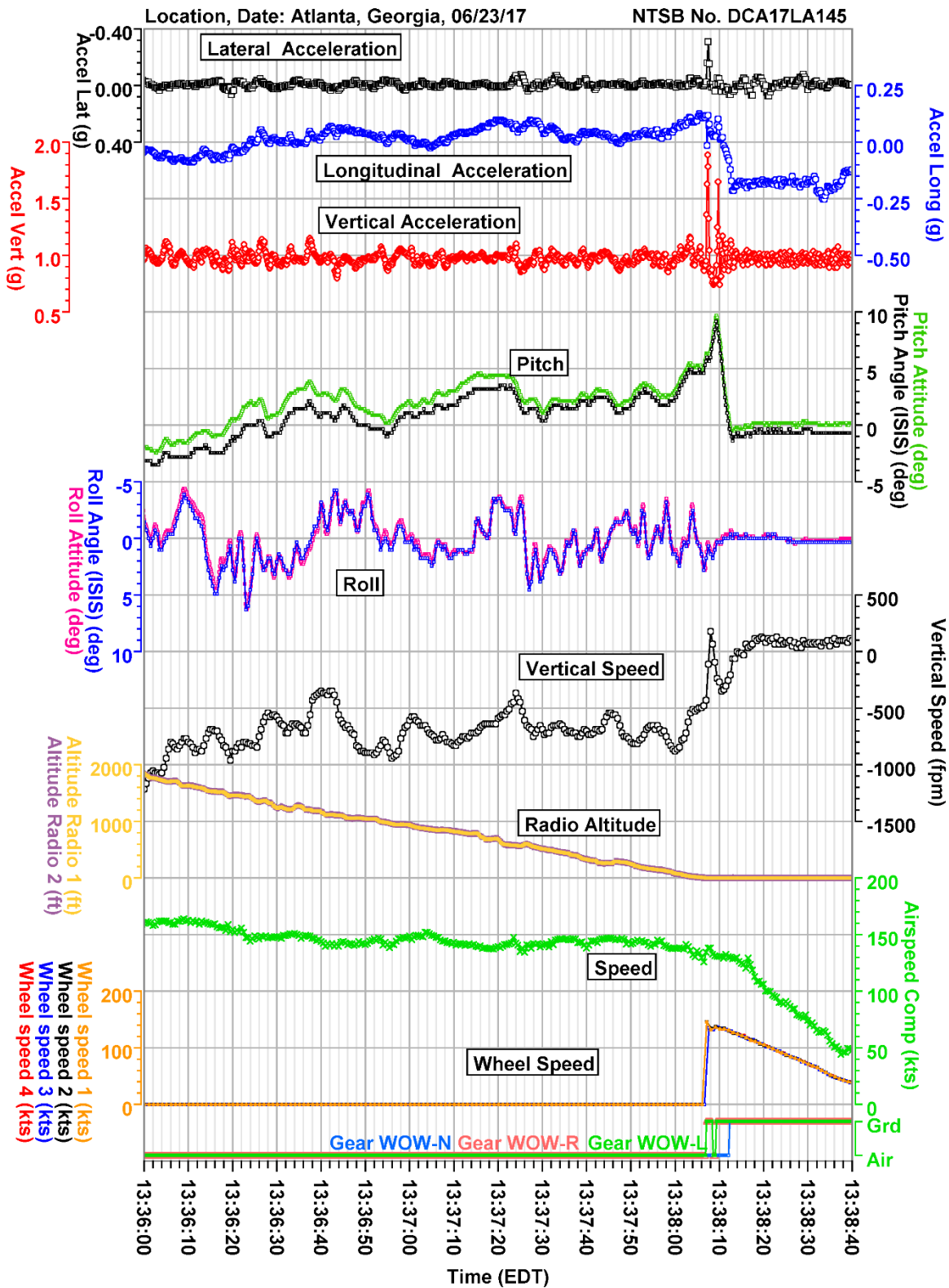
The aircraft descended below 2000 feet above ground level (AGL) at 13:35:55 EDT. The aircraft's airspeed was about 160 knots and the vertical speed varied between 500 and 1000 feet per minute descent with the landing gear selected down. The autopilot was not engaged and the autothrottle was engaged. At 13:37:58 EDT, the pitch began increasing from 2 degrees. At 13:38:03 EDT, the flare law mode activated. The autothrottle disengaged at 13:38:06 EDT. At 13:38:07 EDT, both main gear weight on wheels (WOW) status switched from air to ground. At this time, the aircraft's airspeed was approximately 130 knots and primary pitch angle was about 6.2 degrees nose up and the wings were level. The aircraft also experienced its maximum vertical acceleration of 1.89 g. At 13:38:08 EDT, both main gear WOW status switched briefly back to air. At 13:38:09 EDT, both main gear WOW status switched back to ground. At this time the aircraft experienced its maximum primary pitch angle of 9.7 degrees nose up and maximum standby pitch angle of 9.8 degrees nose up. The aircraft also experienced a spike in vertical acceleration of 1.65 g. The nose gear WOW status transitioned to ground at 13:38:12 EDT and the aircraft decelerated using brakes, spoilers, and thrust reversers.

Figures 1-4 contain FDR data recorded during the June 23, 2017, event. Figure 1 shows basic aircraft parameters during the last 2,000 feet of descent. Figure 2 shows flight control parameters during the last 2,000 feet of descent. Figure 3 shows engine related parameters during the last 2,000 feet of descent. Figure 4 shows discrete parameters during the last 2,000 feet of descent.

These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The tabular data for the entire flight for all parameters listed in Table A-1 are provided in electronic comma separated value (*.csv) format as attachment 1 to this report.

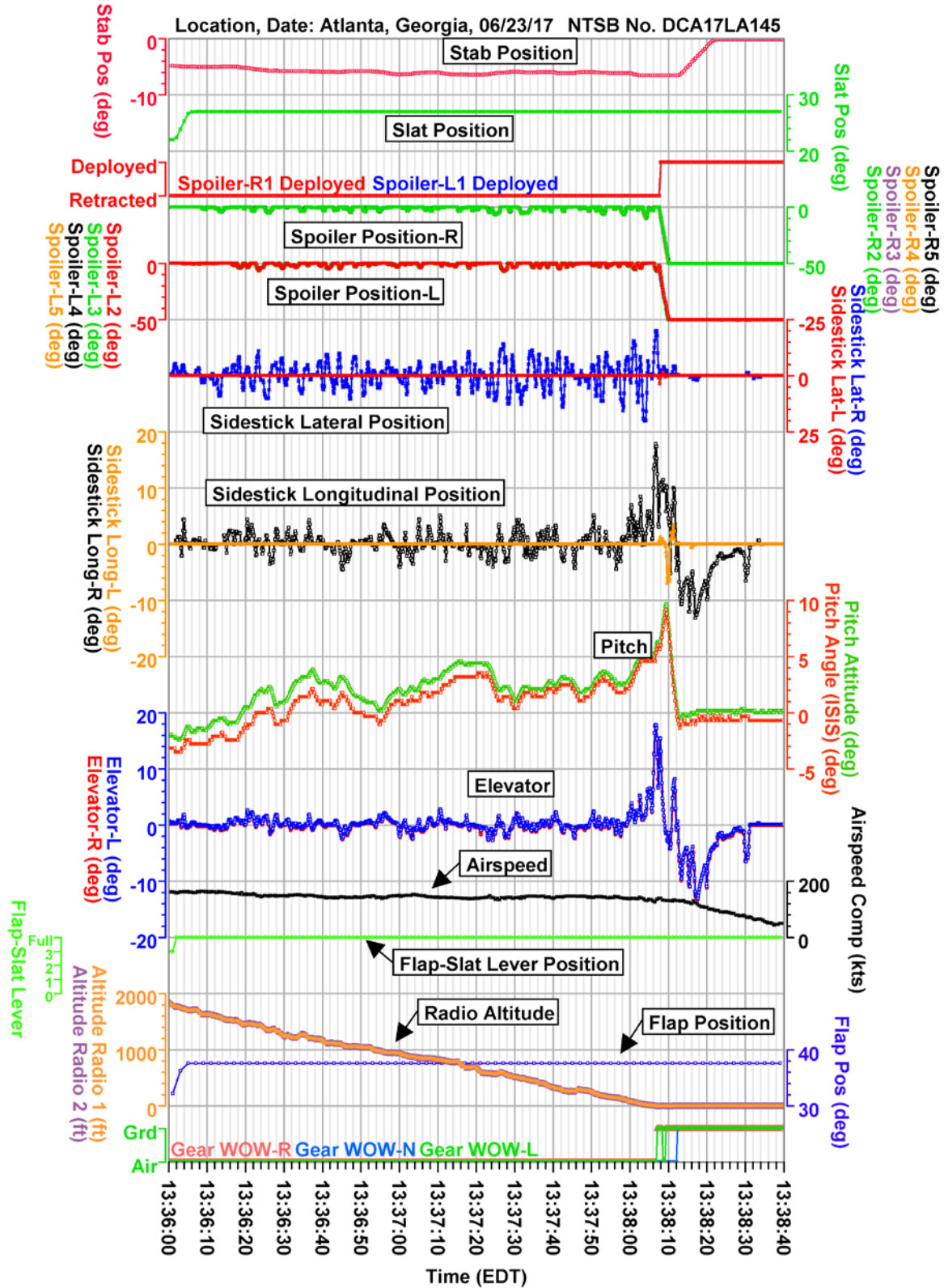
Delta Airlines, Airbus A321, Flight 800, N315DN



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Figure 1. Basic parameters for accident approach.

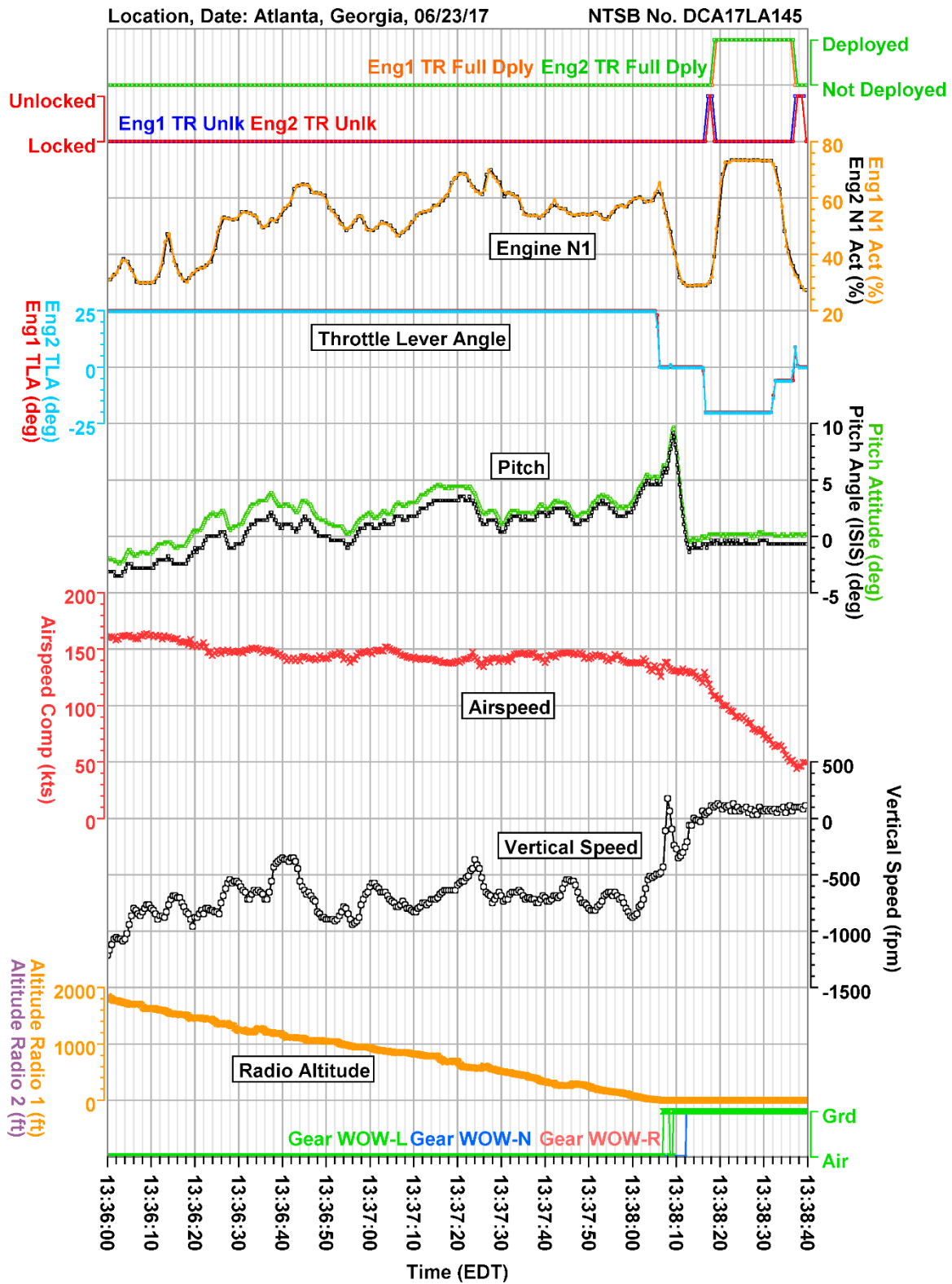
Delta Airlines, Airbus A321, Flight 800, N315DN



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Figure 2. Flight control parameters for accident approach.

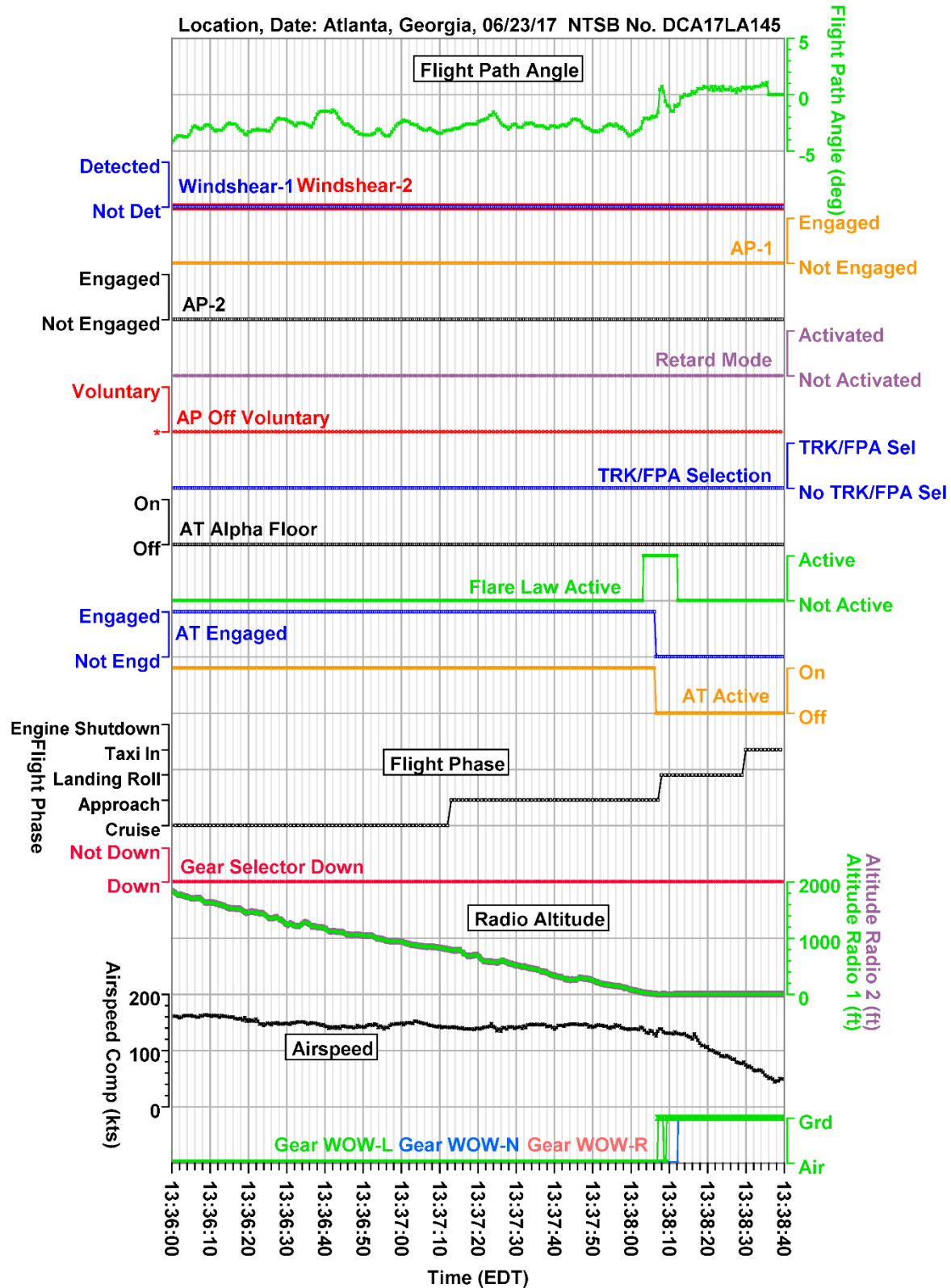
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Figure 3. Engine parameters for accident approach.

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Figure 4. Discrete parameters for accident approach.

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameter names, description, and units and Table A-2 describes the unit abbreviations used in this report.

Table A-1. Verified and provided FDR parameters.

Parameter Name	Parameter Description
1. Accel Lat (g)	Lateral Acceleration
2. Accel Long (g)	Longitudinal Acceleration
3. Accel Vert (g)	Vertical Acceleration
4. Airspeed Comp (kts)	Computed Airspeed
5. Altitude Radio 1 (ft)	Radio Altitude #1
6. Altitude Radio 2 (ft)	Radio Altitude #2
7. AP Off Voluntary (discrete)	Pilot Activated Autopilot Disconnect
8. AP-1 (discrete)	Autopilot #1 Engaged Discrete
9. AP-2 (discrete)	Autopilot #2 Engaged Discrete
10. AT Active (discrete)	Autothrottle Active Discrete
11. AT Alpha Floor (discrete)	Autothrottle Alpha Floor Mode Discrete
12. AT Engaged (discrete)	Autothrottle Engaged Discrete
13. Elevator-L (deg)	Left Elevator Position
14. Elevator-R (deg)	Right Elevator Position
15. Eng1 N1 Act (%rpm)	Engine 1 N1 Speed
16. Eng1 TLA (deg)	Engine 1 Thrust Lever Angle
17. Eng1 TR Full Dply (discrete)	Engine 1 Thrust Reverser Fully Deployed Discrete
18. Eng1 TR Unlk (discrete)	Engine 1 Thrust Reverser Unlocked Discrete
19. Eng2 N1 Act (%rpm)	Engine 2 N1 Speed
20. Eng2 TLA (deg)	Engine 2 Thrust Lever Angle
21. Eng2 TR Full Dply (discrete)	Engine 2 Thrust Reverser Fully Deployed Discrete
22. Eng2 TR Unlk (discrete)	Engine 2 Thrust Reverser Unlocked Discrete
23. Flap Pos (deg)	Flap Position
24. Flap-Slat Lever (discrete)	Flap-Slate Handle Position Discrete
25. Flare Law Active (discrete)	Flare Law Active Discrete
26. Flight Path Angle (deg)	Flight Path Angle
27. Flight Phase (discrete)	Phase of Flight Discrete
28. Gear Selector Down (discrete)	Landing Gear Handle Position Discrete
29. Gear WOW-L (discrete)	Left Main Landing Gear Weight on Wheels Discrete
30. Gear WOW-N (discrete)	Nose Landing Gear Weight on Wheels Discrete
31. Gear WOW-R (discrete)	Right Main Landing Gear Weight on Wheels Discrete
32. Key VHF-1 (discrete) ^A	VHF Radio #1 Keyed Discrete
33. Key VHF-2 (discrete) ^A	VHF Radio #2 Keyed Discrete
34. Key VHF-3 (discrete) ^A	VHF Radio #3 Keyed Discrete
35. Pitch Angle (ISIS) (deg)	Standby Pitch Attitude
36. Pitch Attitude (deg)	ADIRU Pitch Attitude
37. Retard Mode (discrete)	Autothrottle Retard Mode Discrete
38. Roll Angle (ISIS) (deg)	Standby Roll Attitude

Parameter Name	Parameter Description
39. Roll Attitude (deg)	ADIRU Roll Attitude
40. Sidestick Lat-L (deg)	Captain Sidestick Lateral Roll Control Position
41. Sidestick Lat-R (deg)	First Officer Sidestick Lateral Roll Control Position
42. Sidestick Long-L (deg)	Captain Sidestick Longitudinal Pitch Control Position
43. Sidestick Long-R (deg)	First Officer Sidestick Longitudinal Pitch Control Position
44. Slat Pos (deg)	Leading Edge Slats Position
45. Spoiler-L1 Deployed (discrete)	Left #1 Spoiler Deployed Discrete
46. Spoiler-L2 (deg)	Left #2 Spoiler Position
47. Spoiler-L3 (deg)	Left #3 Spoiler Position
48. Spoiler-L4 (deg)	Left #4 Spoiler Position
49. Spoiler-L5 (deg)	Left #5 Spoiler Position
50. Spoiler-R1 Deployed (discrete)	Right #1 Spoiler Deployed Discrete
51. Spoiler-R2 (deg)	Right #2 Spoiler Position
52. Spoiler-R3 (deg)	Right #3 Spoiler Position
53. Spoiler-R4 (deg)	Right #4 Spoiler Position
54. Spoiler-R5 (deg)	Right #5 Spoiler Position
55. Time Hrs (hrs) ^A	UTC Hours
56. Time Min (min) ^A	UTC Minutes
57. Time Sec (sec) ^A	UTC Seconds
58. TRK/FPA selection (discrete)	Track/Flight Path Angle Selection Discrete
59. Vertical Speed (fpm)	Vertical Speed
60. Wheel speed 1 (kts)	#1 Wheel Speed
61. Wheel speed 2 (kts)	#2 Wheel Speed
62. Wheel speed 3 (kts)	#3 Wheel Speed
63. Wheel speed 4 (kts)	#4 Wheel Speed
64. Windshear-1 (discrete)	#1 Windshear Detected Discrete
65. Windshear-2 (discrete)	#2 Windshear Detected Discrete

^A Parameter available in tabular data only

Table A-2. Unit and discrete abbreviations.

Unit Abbreviation	Descriptions
deg	degrees
kts	knots
g	g
discrete	discrete
fpm	feet per minute
ft	feet
Gnd	ground
hrs	hours
min	minutes
Not Det	not detected
Not Engd	not engaged
sec	seconds
TRK/FPA	track/flight path angle
%rpm	percent revolutions per minute

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.