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

June 5, 2017

Flight Data Recorder

Specialist's Factual Report
By Charles Cates

1. EVENT SUMMARY

Location:	Chicago, Illinois
Date:	October 28, 2016
Aircraft:	Boeing 767-300
Registration:	N345AN
Operator:	American Airlines
NTSB Number:	DCA17FA021

On October 28, 2016, at about 2:32 PM CDT, American Airlines flight number 383, a Boeing 767-300, N345AN, powered by two General Electric CF6-80C2B6 turbofan engines, experienced a right engine uncontained failure and subsequent fire during the takeoff ground roll on runway 28R at the Chicago O'Hare International Airport (ORD), Chicago, Illinois. The flight crew aborted the takeoff and stopped the aircraft on runway 28R and an emergency evacuation was conducted. Of the 161 passengers and 9 crew members onboard, one passenger received serious injuries during the evacuation and the airplane was substantially damaged as a result of the fire. The flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 as a domestic scheduled passenger flight to Miami International Airport (MIA), Miami, Florida.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR Carriage Requirements

The event aircraft, N345AN, was manufactured in 2003, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 88 parameters, as cited in 14 CFR Part 121.344.

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 256 wps**
Recorder Serial Number:	**00753**

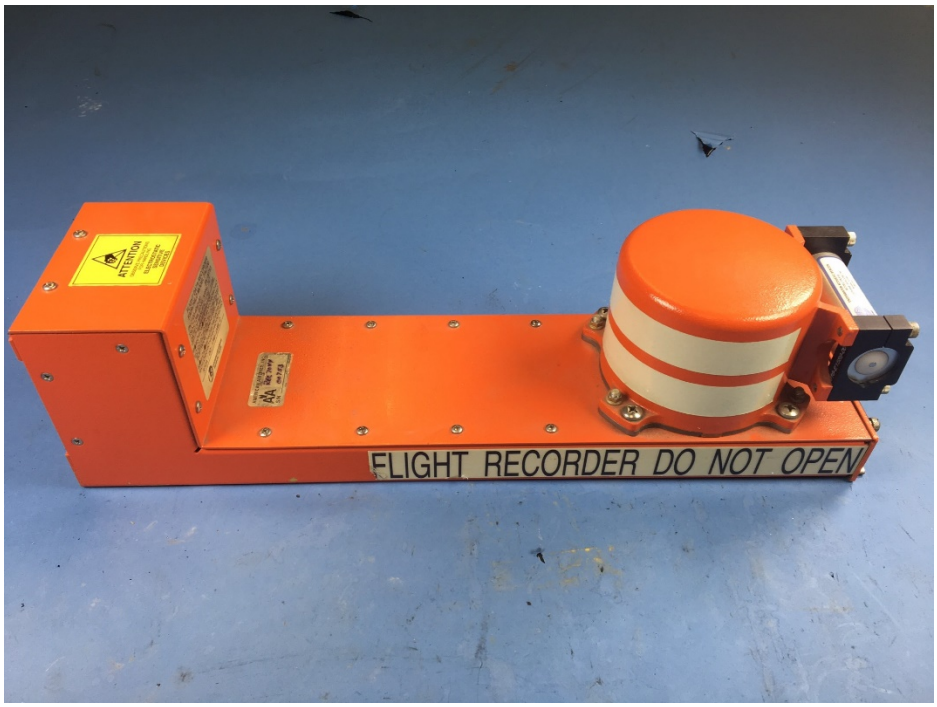
4.1. L-3/Fairchild FA2100 256 wps Description

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 256 12-bit words of digital information every second. Each grouping of 256 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 256-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-C124a.

4.1.1. Recorder Condition

The recorder was in good condition and the data were extracted normally from the recorder using the manufacturer's recommended procedures.

Figure 1. As-received condition of the flight data recorder.



4.1.2. Recording Description

The FDR recording contained approximately 55.5 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event was the last portion of the recording and its duration was approximately 7 minutes. The parameters evaluated for the purpose of 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. Specifically, table A-1 lists the parameter names, plot/table labels, and units. Additionally, table A-2 describes the unit abbreviations used in this report.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, central daylight time (CDT), was established by using the recorded Time GMT[2] hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional -5 hours offset to change GMT to CDT.

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

CDT = SRN – 147,469.

Therefore, for the rest of this report, all times are referenced as CDT, not SRN.

4.3. FDR Plots and Corresponding Tabular Data

Figures 2 to 9 contain FDR data recorded during the October 28, 2016 event. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, and Time GMT Seconds.

When airspeed is less than 30 knots, it is recorded as non-computed data (NCD). Engine throttle resolver angle (TLA) is also recorded as NCD when the engine is shut down. The NCD pattern is indicative that the raw data is not available.

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 recording began at 14:22:15 with the APU and left engine running, figure 2. The right engine start sequence began at 14:22:20 with N2 rotation and the fuel switch was moved from the cutoff position at 14:22:45. Both engines idled for about 90 seconds before the aircraft began to taxi. Autobrakes were selected in the 'RTO' (rejected takeoff) position at about 14:23:20 and the APU was shut down at about 14:23:20, figure 8. The APU remained off for the remainder of the recording. The aircraft taxied for about 6.5 minutes before beginning the takeoff attempt.

The takeoff attempt began at about 14:31:20, figure 3. The throttles were advanced and engines accelerated to high power, figures 4 and 5, with the aircraft attaining a steady longitudinal acceleration rate of about 0.25-0.3g. At 14:31:43.4, the longitudinal acceleration suddenly decreased to about 0.125g and vertical acceleration variations increased in

[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 = +.

[2] GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

magnitude, consistent with the failure of the #2 engine. See Table 1 for a timeline of events following the failure of the engine.

The throttles were reduced to idle, autobrakes and auto speedbrakes deployed, and the aircraft began to decelerate. During the deceleration, ENG FIRE R was annunciated and the #2 engine fuel cutoff switch was moved to the cutoff position. Shortly after coming to a stop the engine fire switch was pulled.

Figure 6 shows a timeline of the rejected takeoff. Table 1 shows the speeds at which the events described occurred as well as a timeline of events following the airplane coming to a stop. Events that do not report tenths of a second are +/- 1 second due to the fidelity of those parameters in the recording. See figure 8 for data regarding the aircraft doors. The aft right door's wiring was likely damaged by the fire and resultant heat as the aircraft decelerated, and the data is not included for this reason. The aft right door was not opened during the event or the aircraft evacuation.

Table 1. Timeline of rejected takeoff and evacuation events.

Time (CDT)	Event	Airspeed (kts)	Ground Speed (kts)	Time since engine failure	Time since coming to a stop
14:31:43.4	Accel changes indicative of #2 engine failure	128	127	0:00.0	0:00.0
14:31:44.7	Throttles reduced to idle	130	131	0:01.3	0:00.0
14:31:45.7	RTO autobrakes activated	134	133	0:02.3	0:00.0
14:31:45.9	Peak recorded speeds	135	133	0:02.5	0:00.0
14:31:47.5	Auto speedbrakes activated	124.5	127	0:04.1	0:00.0
14:31:48.6	Peak deceleration achieved	119.5	123	0:05.2	0:00.0
14:32:00	ENG FIRE R message activated	35	36	0:16.6	0:00.0
14:32:00.5	Manual braking initiated	35	36	0:17.1	0:00.0
14:32:08	#2 engine fuel control moved to Cutoff	N/A	5	0:24.6	0:00.0
14:32:09.8	Aircraft came to a stop	N/A	0	0:26.4	0:00.0
14:32:12	#2 engine fire extinguisher activated	N/A	0	0:28.6	0:02.2
14:32:16	Parking brake set	N/A	0	0:32.6	0:06.2
14:32:20	Left overwing exit door opened	N/A	0	0:36.6	0:10.2
14:32:38	Forward left entry door opened	N/A	0	0:54.6	0:28.2
14:32:42	Forward right entry door opened	N/A	0	0:58.6	0:32.2
14:32:48	Aft left entry door opened	N/A	0	1:04.6	0:38.2
14:33:08.9	End of recording, #1 engine shut down	N/A	0	1:25.5	0:59.1

Figure 5 shows parameters from the right engine. Following the failure, EGT and fuel flow both became invalid due to damage caused by the failure. Despite the failure, the engine continued to run on at idle power with high vibration levels until the fuel switch was moved to the cutoff position.

The recording ended at 14:33:08.9. According to the manufacturer, the recording ended because the #1 engine fuel control was moved into the cutoff position.

The corresponding tabular data used to create figures 2 to 9, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, are provided in electronic comma separated value (*.csv) format as attachment 1 to this report.

Figure 2. Plot of basic parameters during entire flight.

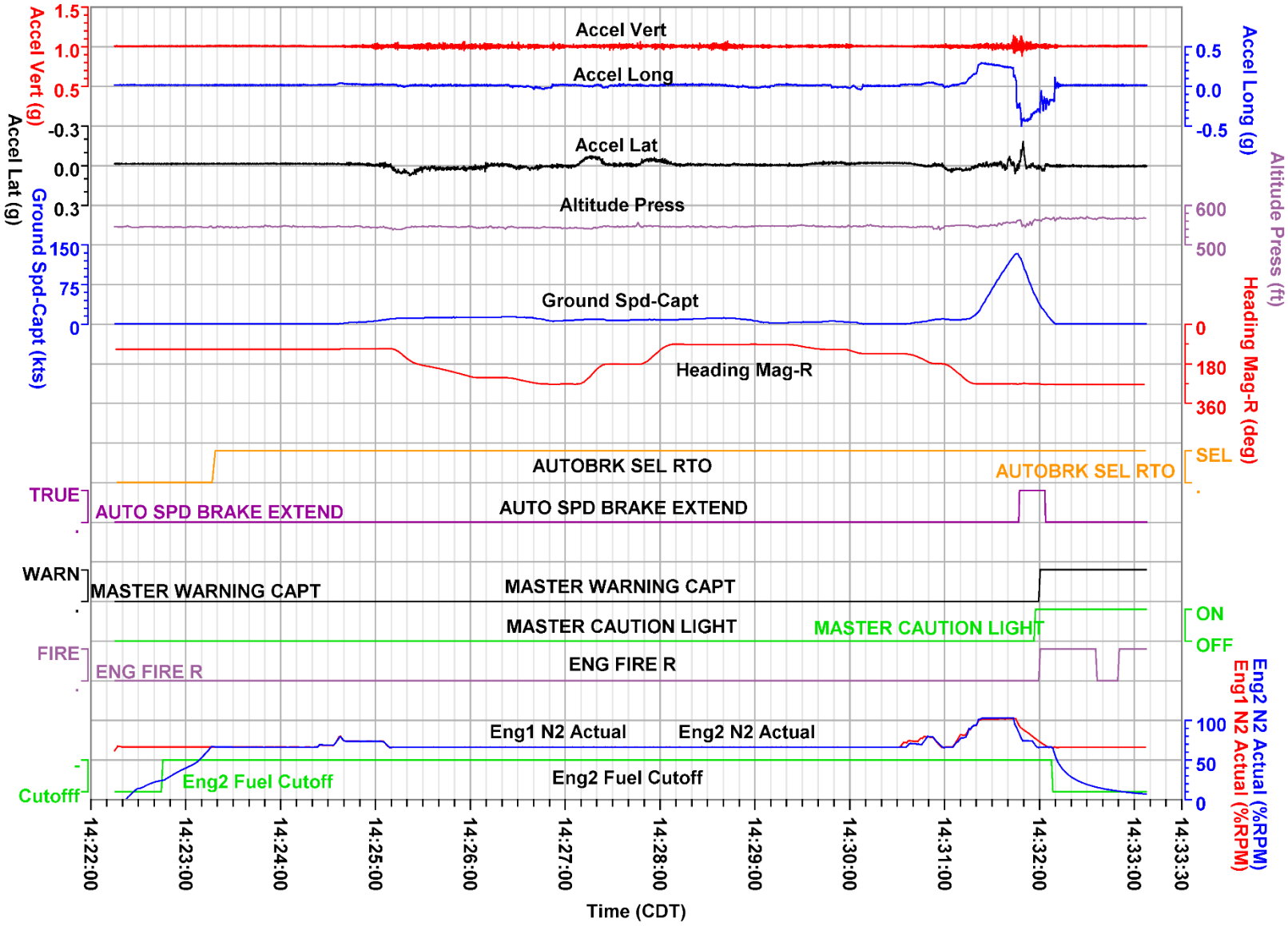


Figure 3. Basic parameters from start of takeoff roll to end of the recording.

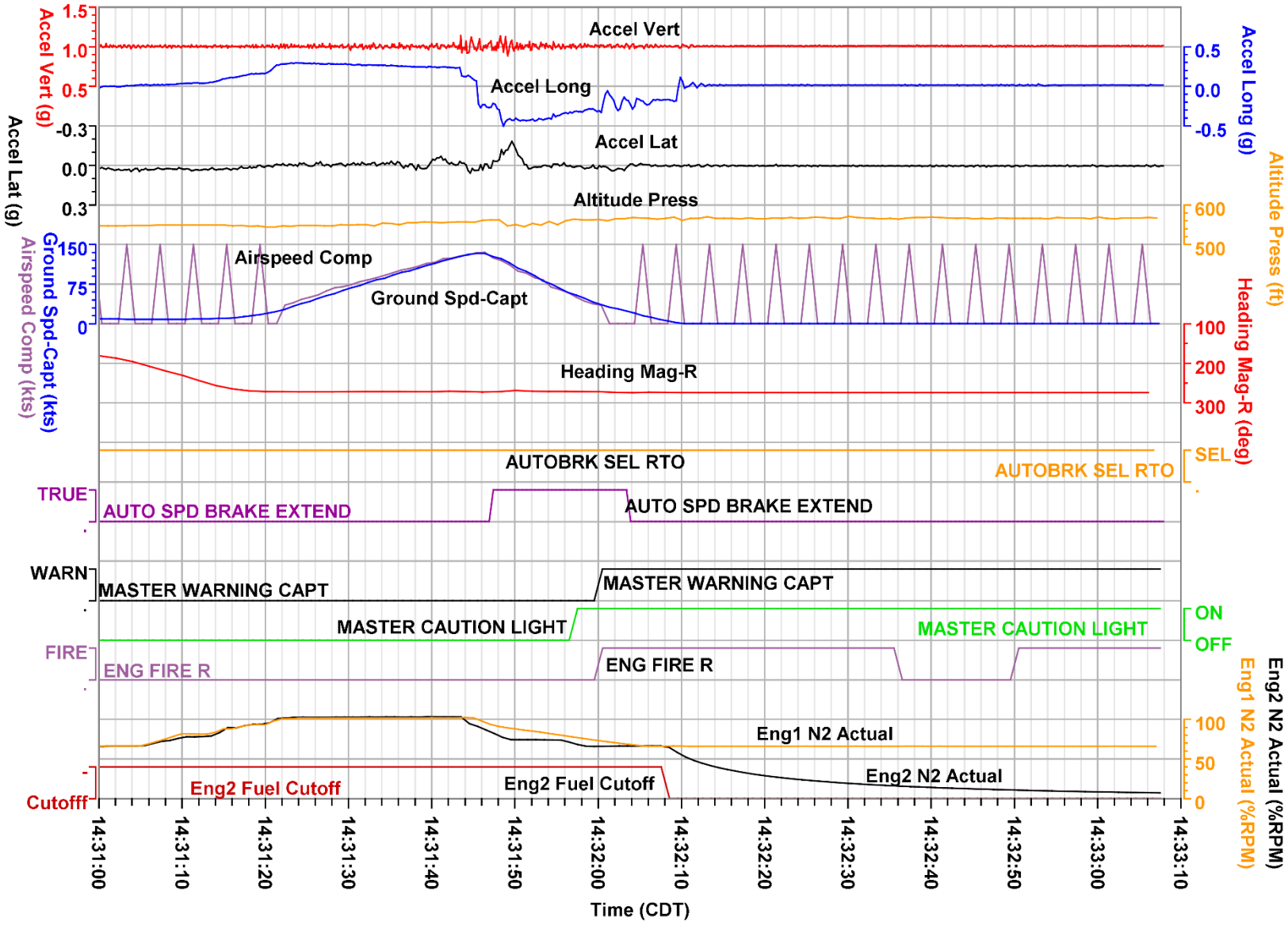


Figure 4. Engine 1 parameters from start of takeoff roll to end of the recording.

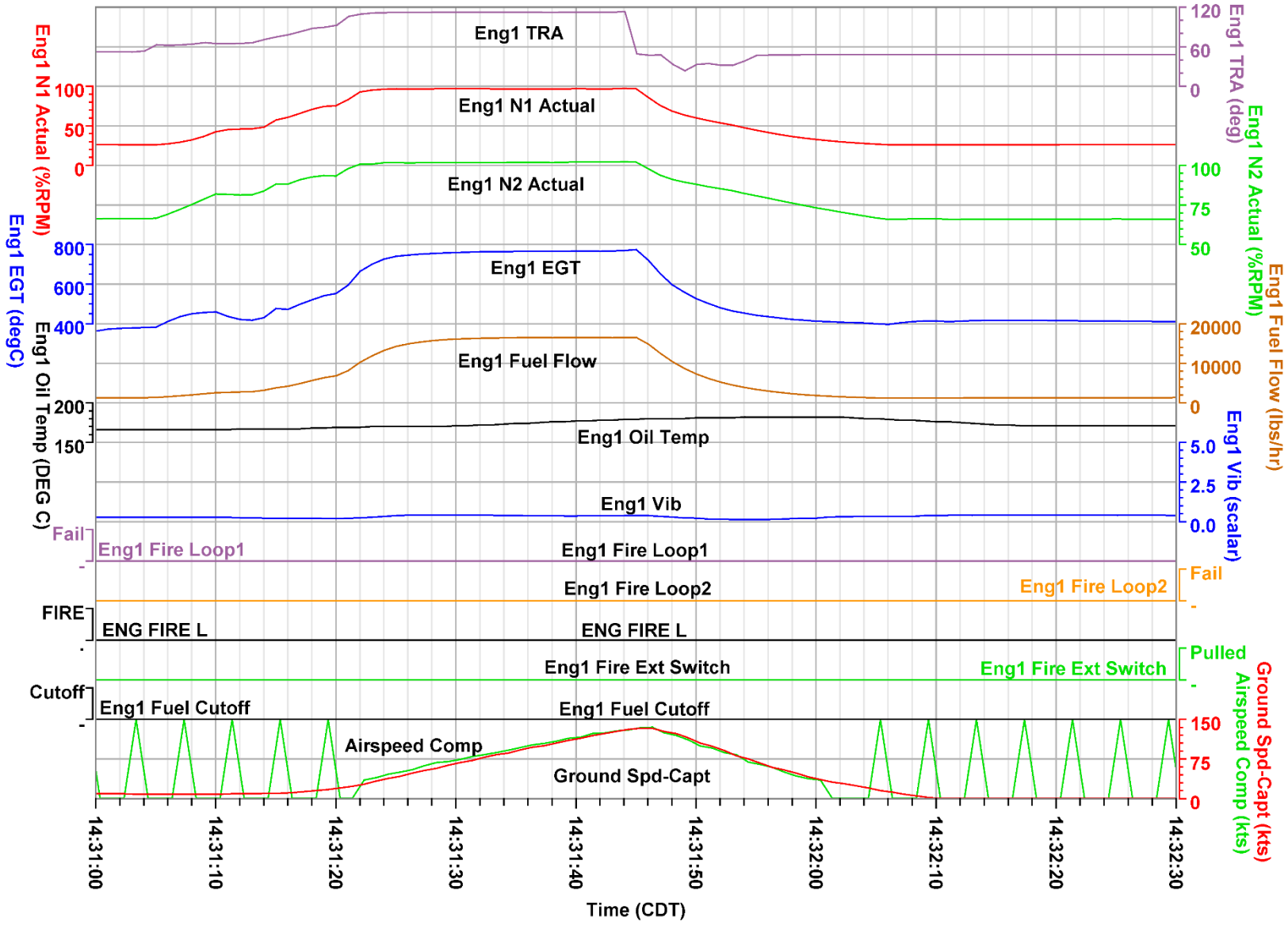


Figure 5. Engine 2 parameters from start of takeoff roll to end of the recording.

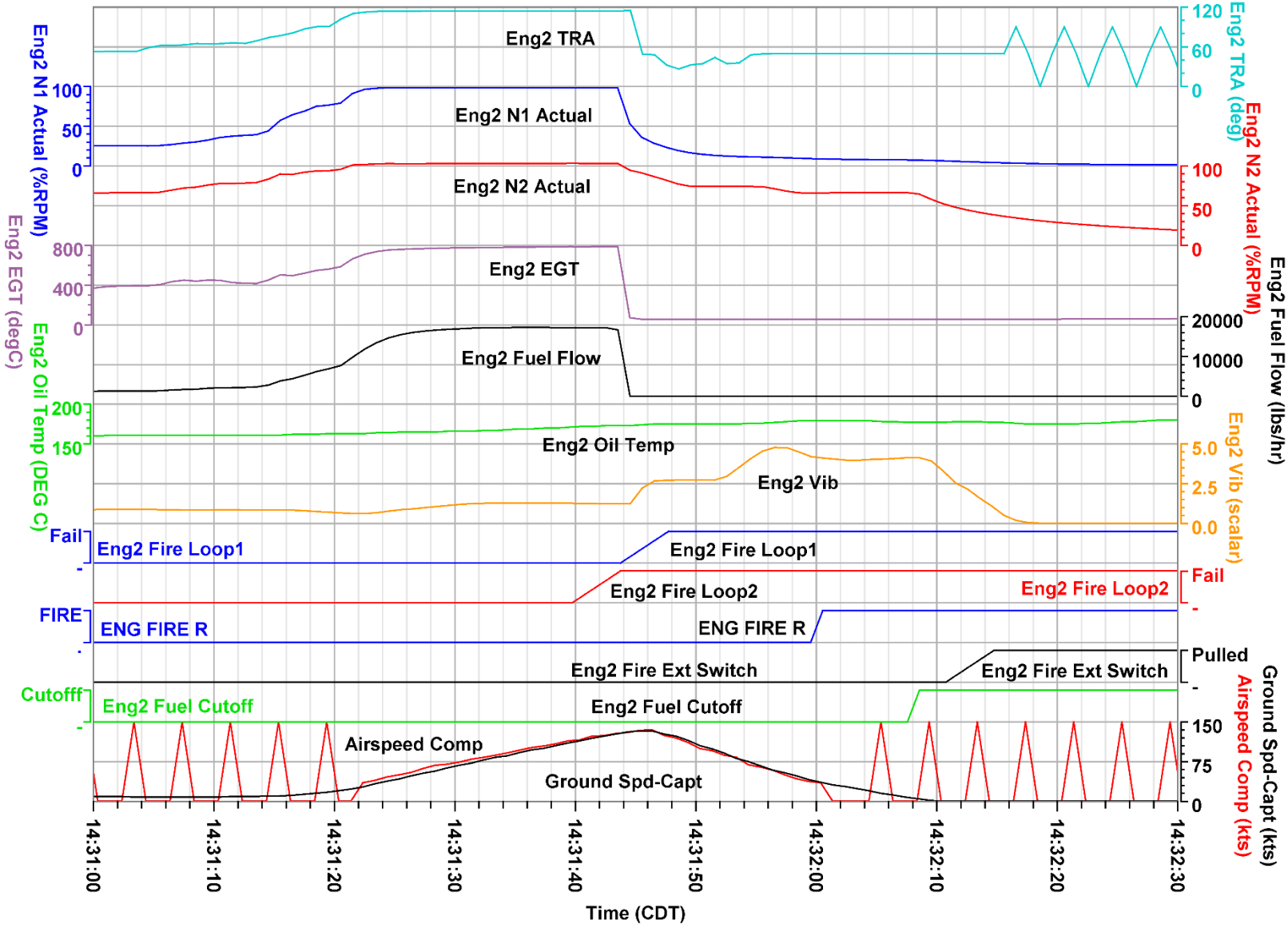


Figure 6. Timeline of takeoff rejection.

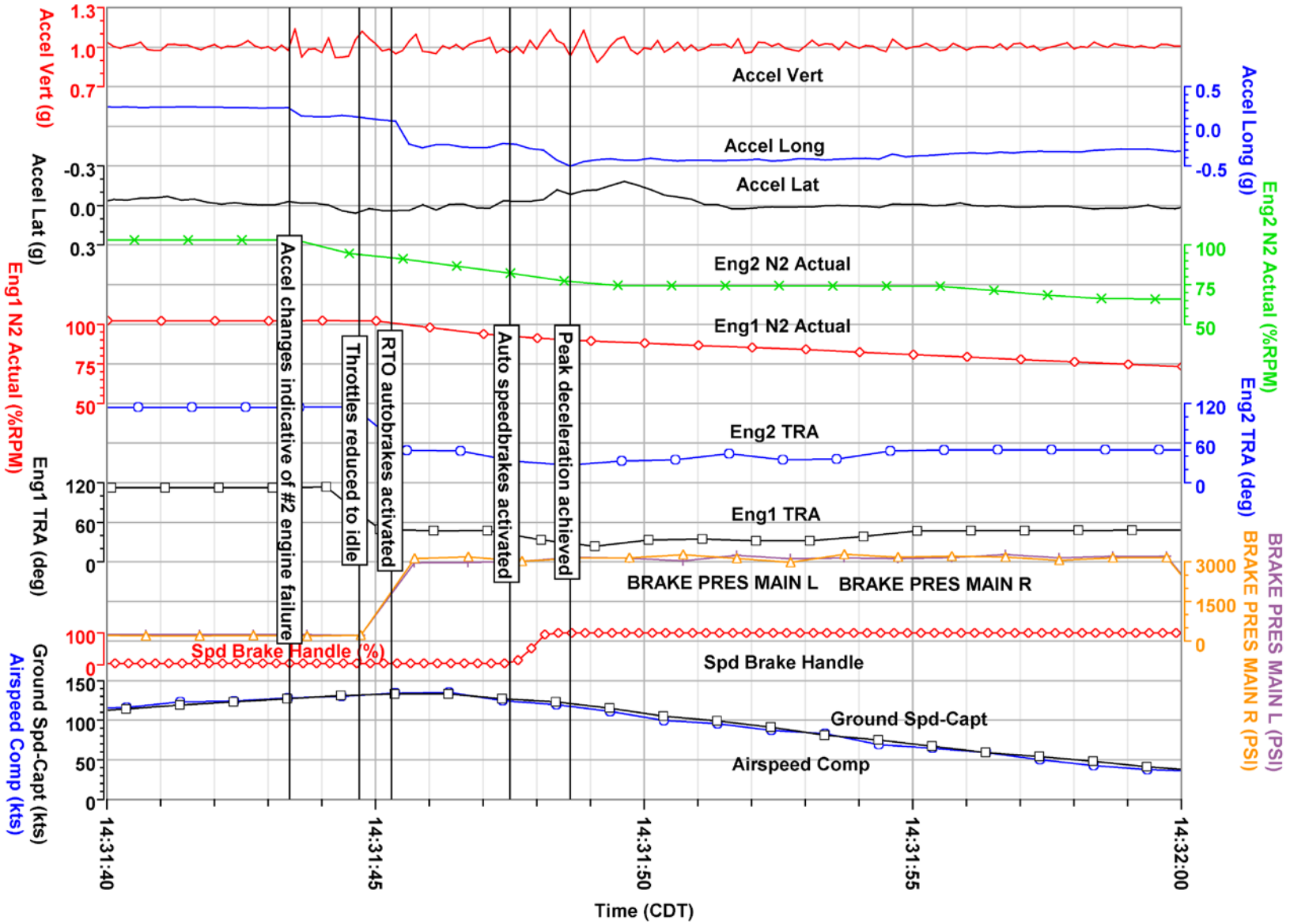


Figure 7. Hydraulics and brake parameters from start of takeoff roll to end of the recording.

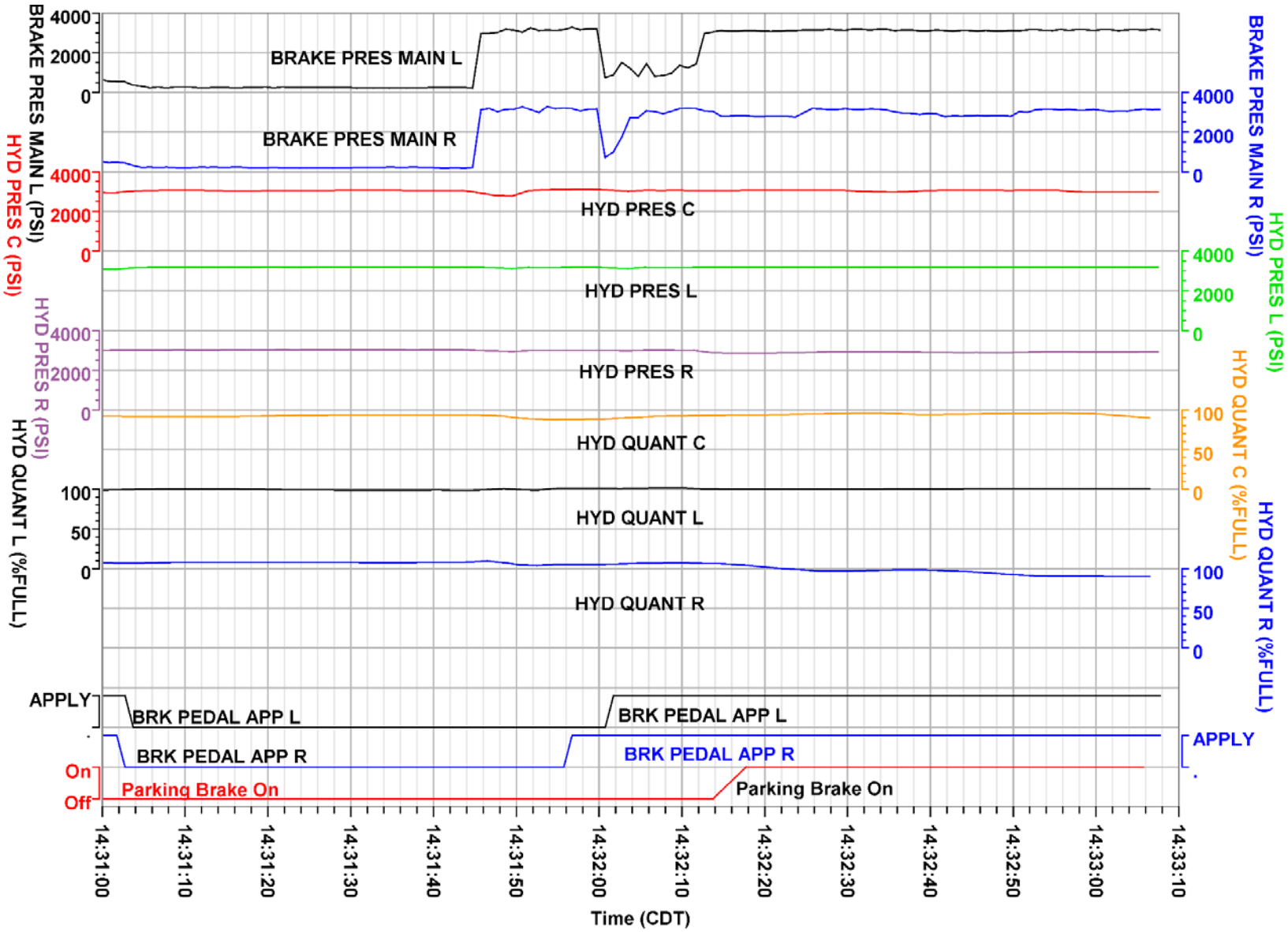


Figure 8. Door parameters from start of takeoff roll to end of the recording.

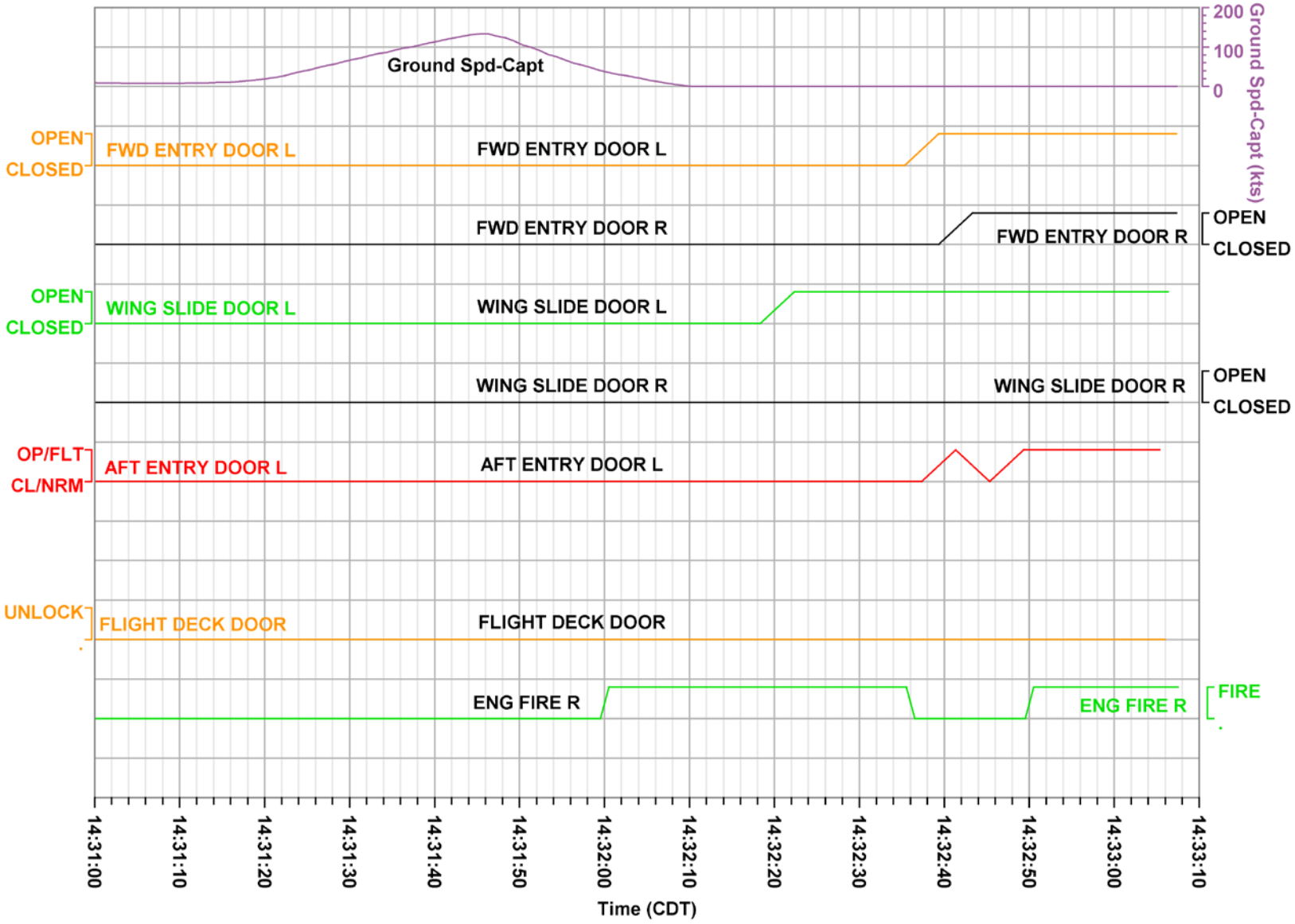
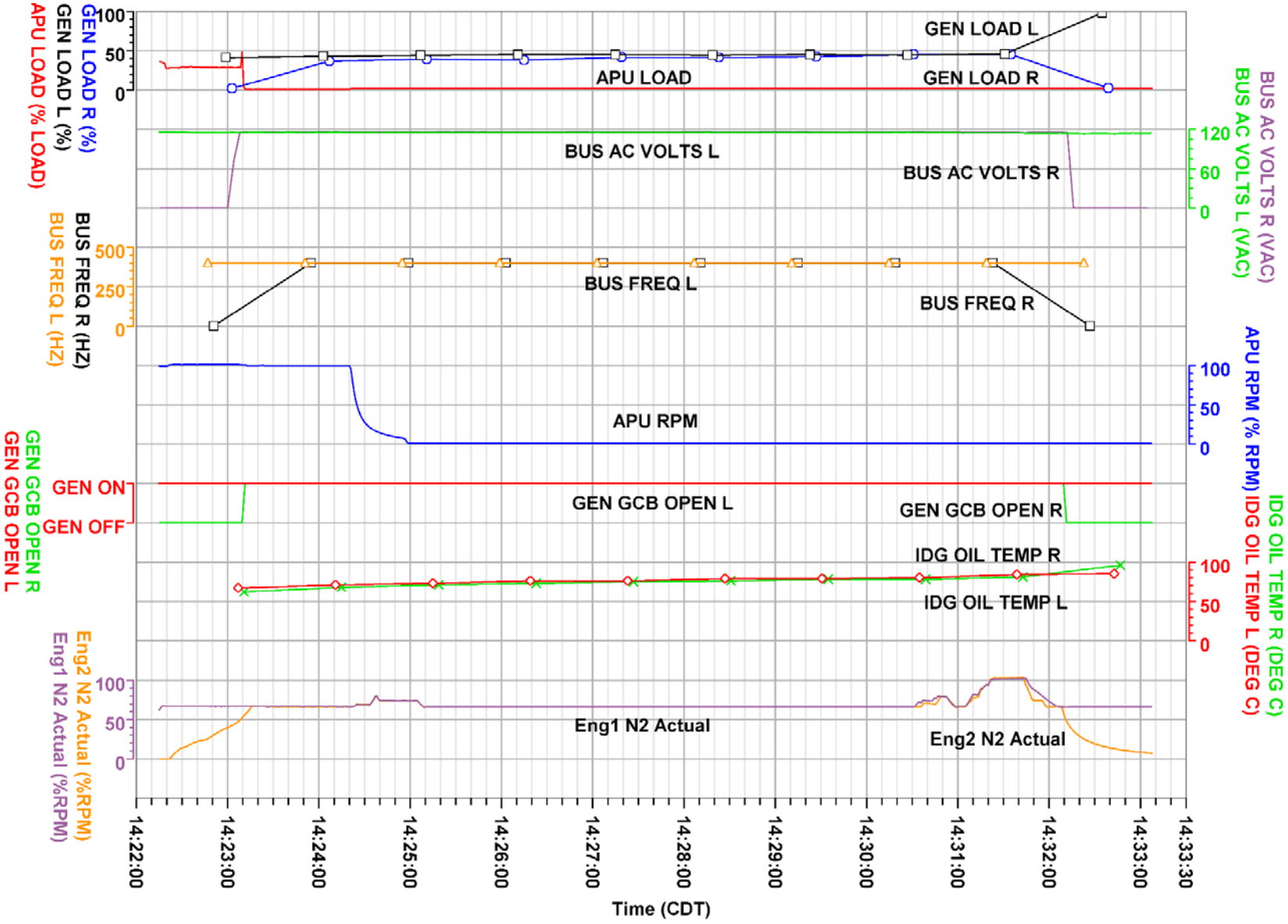


Figure 9. Electrical system parameters during entire flight.



APPENDIX A

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

Table A-1. Verified and provided FDR parameters.

Parameter Name	Units	Description
1. Accel Lat	g	Lateral Acceleration
2. Accel Long	g	Longitudinal acceleration
3. Accel Vert	g	Vertical acceleration
4. Aft Entry Door L		Aft left entry door status
5. Aft Entry Door R		Aft right entry door status
6. Airspeed Comp	kts	Computed airspeed
7. Altitude Press	ft	Pressure altitude
8. APU Load	%	APU load
9. APU RPM	%	APU speed
10. Auto Spd Brake Extend		Auto speedbrakes extended
11. Autobrk Sel RTO		Rejected takeoff autobrakes selected
12. Brake Pres Main L	psi	Left main gear brake pressure
13. Brake Pres Main R	psi	Right main gear brake pressure
14. Brk Pedal App L		Left brake pedal applied
15. Brk Pedal App R		Right brake pedal applied
16. Bus AC Volts L	VAC	Left electrical bus voltage
17. Bus AC Volts R	VAC	Right electrical bus voltage
18. Bus Freq L	Hz	Left electrical bus frequency
19. Bus Freq R	Hz	Right electrical bus frequency
20. ENG FIRE L		ENG FIRE L message annunciated
21. ENG FIRE R		ENG FIRE R message annunciated
22. Eng# EGT	deg C	Engine # exhaust gas temperature
23. Eng# Fire Ext Switch		Engine # fire extinguisher switch status
24. Eng# Fire Loop 1		Engine # fire detector 1 status
25. Eng# Fuel Cutoff		Engine # fuel cutoff switch position
26. Eng# Fuel Flow	lbs/hr	Engine # fuel flow
27. Eng# N1 Actual	%	Engine # fan speed
28. Eng# N2 Actual	%	Engine # core speed
29. Eng# Oil Temp	deg C	Engine # oil temperature
30. Eng# TRA	deg	Engine # throttle resolver angle

Parameter Name	Units	Description
31. Eng# Vib	scalar	Engine # vibration magnitude
32. Eng2 Fire Loop #		Engine 2 fire detector # status
33. Flight Deck Door		Flight deck door status
34. FWD Entry Door L		Forward left entry door status
35. FWD Entry Door R		Forward right entry door status
36. Gen GCB Open L		Left generator circuit breaker open
37. Gen GCB Open R		Right generator circuit breaker open
38. Gen Load L	%	Left generator load
39. Gen Load R	%	Right generator load
40. Ground Spd - Capt	kts	Ground Speed
41. Heading Mag-R	deg	Magnetic Heading
42. Hyd Pres C	psi	Center hydraulic system pressure
43. Hyd Pres L	psi	Left hydraulic system pressure
44. Hyd Pres R	psi	Right hydraulic system pressure
45. Hyd Quant C	%	Center hydraulic system quantity
46. Hyd Quant L	%	Left hydraulic system quantity
47. Hyd Quant R	%	Right hydraulic system quantity
48. IDG Oil Temp L	deg C	Left integrated drive generator oil temperature
49. IDG Oil Temp R	deg C	Right integrated drive generator oil temperature
50. Master Caution Light		Master caution light illuminated
51. Master Warning Capt		Captain master warning annunciated
52. Parking Brake On		Parking brake set
53. Time GMT Hrs	Hr	GMT Hours
54. Time GMT Min	Min	GMT Minutes
55. Time GMT Sec	Sec	GMT Seconds
56. Wing Slide Door L		Left overwing exit door status
57. Wing Slide Door R		Right overwing exit door status

NOTE: This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the FDR plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

NOTE: Parameters with a blank unit description in table A-1 are discretes. 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.

Table A-2. Unit abbreviations.

Unit Abbreviation	Description
kts	knots
ft	feet
psi	pounds per square inch
VAC	volts alternating current
Hz	Hertz
deg C	degrees Celsius
lbs/hr	pounds per hour
deg	degrees
Hr	hour
Min	minute
Sec	second