

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

July 2, 2021

Flight Data Recorder

Specialist's Factual Report

By Kyle Garner

1. EVENT

Location: Sacramento, California
Date: February 15, 2020
Aircraft: Airbus A319
Registration: N521NK
Operator: Spirit Airlines
NTSB Number: ENG20LA016

2. FLIGHT DATA RECORDER GROUP

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

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N521NK, was manufactured in 2006 and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 88 parameters, as cited in Title 14 *Code of Federal Regulations* (CFR) Part 121.344(f).

4. DETAILS OF INVESTIGATION

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

Recorder Manufacturer/Model:	Honeywell 4700, 256 wps
Recorder Serial Number:	SSFDR-16580

4.1. Honeywell 4700, 256 wps Description

The Honeywell solid-state flight data recorder (SSFDR) records airplane flight information in a digital format using solid-state flash memory as the recording medium. The SSFDR 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 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 (for example, altitude, heading, and airspeed) has a specifically assigned word number within the subframe. The SSFDR 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.

4.1.2. Recording Description

The FDR recording contained approximately 27 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The parameters evaluated for this report appeared to be per federal FDR carriage requirements.

Two flight segments on the recording were of interest to the investigation: the last flight on the recording and the flight two segments before the last flight on the recording. An uneventful flight, flight number NK805, was performed between the two legs of interest. The details of each flight are shown in Table 1.

Table 1. Details of flights discussed in this report.

Report Designation	Flight Date	Flight Number	Origin	Destination	Summary
Flight 1	02/14/2020	NK806	KLAS	Hartsfield – Jackson Atlanta Int'l Airport (KATL)	Inflight dual generator failure. Aircraft landed without further incident at KATL
Flight 2	02/14/2020	NK805	KATL	KLAS	Uneventful flight
Flight 3	02/15/2020	NK1818	KLAS	KSMF	Inflight dual generator failure. Aircraft landed without further incident at KSMF

4.1.3. Engineering Unit Conversions

The engineering unit 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.

4.1.4. Pressure Altitude

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

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 = +. The only exception to this convention is that positive left aileron will be indicative of a left turn/roll.

4.1.5. Non-Computed Data

Some parameters record a non-computed data (NCD) pattern. An NCD pattern is indicative that the raw data is no longer reliable or not available. An NCD pattern is typically recorded when the aircraft is on the ground, an engine is not running, or a particular mode is not activated. For Flight 1 and Flight 3, the reviewed parameters that, at times, had NCD patterns in the recorded data were computed airspeed, engine 1/2 EPR limit, and engine 1/2 EPR command.

4.2. Time Correlation

For Flight 1, tabular data and plots are provided with reference to SRN.

For Flight 3, correlation of the FDR data from SRN to Coordinated Universal Time (UTC) was established by using the recorded parameters UTC hours, UTC minutes, and UTC seconds. Accordingly, the time offset for the Flight 3 data from SRN to UTC is the following:

$$\text{UTC} = \text{SRN} - 40043.$$

Therefore, for the rest of this report, all times for Flight 3 are referenced as UTC, not SRN.

4.3. FDR Plots and Tabular Data

Figures 1 to 8 contain FDR data recorded during Flight 1 on February 14, 2020. Figures 9 to 16 contain FDR data recorded during Flight 3 on February 15, 2020. For Flight 1 and 3, all the parameters listed in Table A-1 are plotted or provided in tabular format. Plots and tabular data are not provided for the uneventful Flight 2.

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 used to create figures 1 to 8 and figures 9 to 16 are provided in compressed electronic comma-separated value (*.csv) format as attachment 1 and attachment 2, respectively, to this report.

4.3.1. Flight 1 – NK806 (KLAS to KATL)

During the descent phase of the flight, at 69048 SRN, the FDR stopped recording. The FDR resumed recording approximately 77 seconds later, which was determined by calculating the difference in GPS time recorded before and after the event. Parameters for Flight 1 are plotted for two different time ranges:

- Full flight – the complete flight, takeoff to touchdown, from 57600 to 69900 SRN
- Before and after event – approximately 17 minutes before the FDR stopped recording during the event and 12 minutes after the FDR resumed recording, from 68000 to 69800 SRN

Figures 1 and 2 show a set of autopilot and autothrust parameters indicating which modes were engaged for Flight 1. Altitude, airspeed, and groundspeed are also shown for reference.

Figures 3 and 4 show a basic parameter set which includes aircraft accelerations, heading, attitude, air and ground speeds, engine N1, engine N2, and altitude.

Figures 5 and 6 show a set of parameters related to the electrical system, including bus and contactor status. Altitude, airspeed, and groundspeed are also shown for reference.

Figures 7 and 8 show a set of parameters related to engine operation, including engine N1/N2, fuel flow, throttle lever angle, modes, and EGT. Altitude, airspeed, and ground speed are also shown for reference.

4.3.2. Flight 3 – NK1818 (KLAS to KSMF)

During the approach to KSMF, at 1542:06 UTC, the FDR stopped recording. The FDR did not resume recording before landing at KSMF. Parameters for Flight 3 are plotted for two different time ranges:

- Full flight – all available data for Flight 3, takeoff to FDR recording loss, from 1438:00 to 1543:00 UTC
- Leading up to event – the 12 minutes before the FDR stopped recording, from 1530:00 to 1542:30 UTC

Figures 9 and 10 show a set of autopilot and autothrust parameters indicating which modes were engaged for Flight 3. Altitude, airspeed, and groundspeed are also shown for reference.

Figures 11 and 12 show a basic parameter set which includes aircraft accelerations, heading, attitude, air and ground speeds, engine N1, engine N2, and altitude.

Figures 13 and 14 show a set of parameters related to the electrical system, including bus and contactor status. Altitude, airspeed, and groundspeed are also shown for reference

Figures 15 and 16 show a set of parameters related to engine operation, including engine N1/N2, fuel flow, throttle lever angle, modes, and EGT. Altitude, airspeed, and ground speed are also shown for reference.

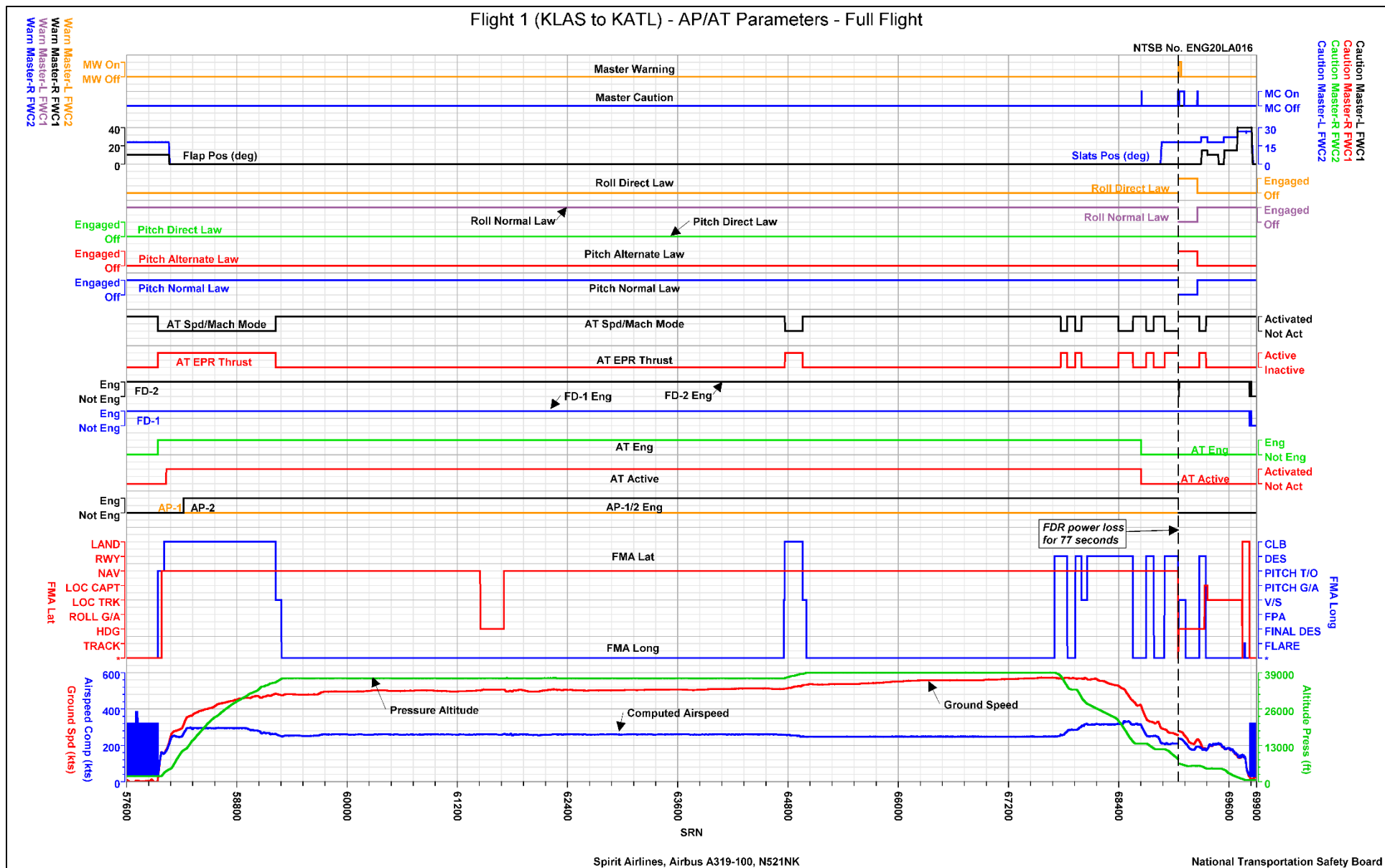


Figure 1. Autopilot and autothrust parameters – Flight 1 – Full flight

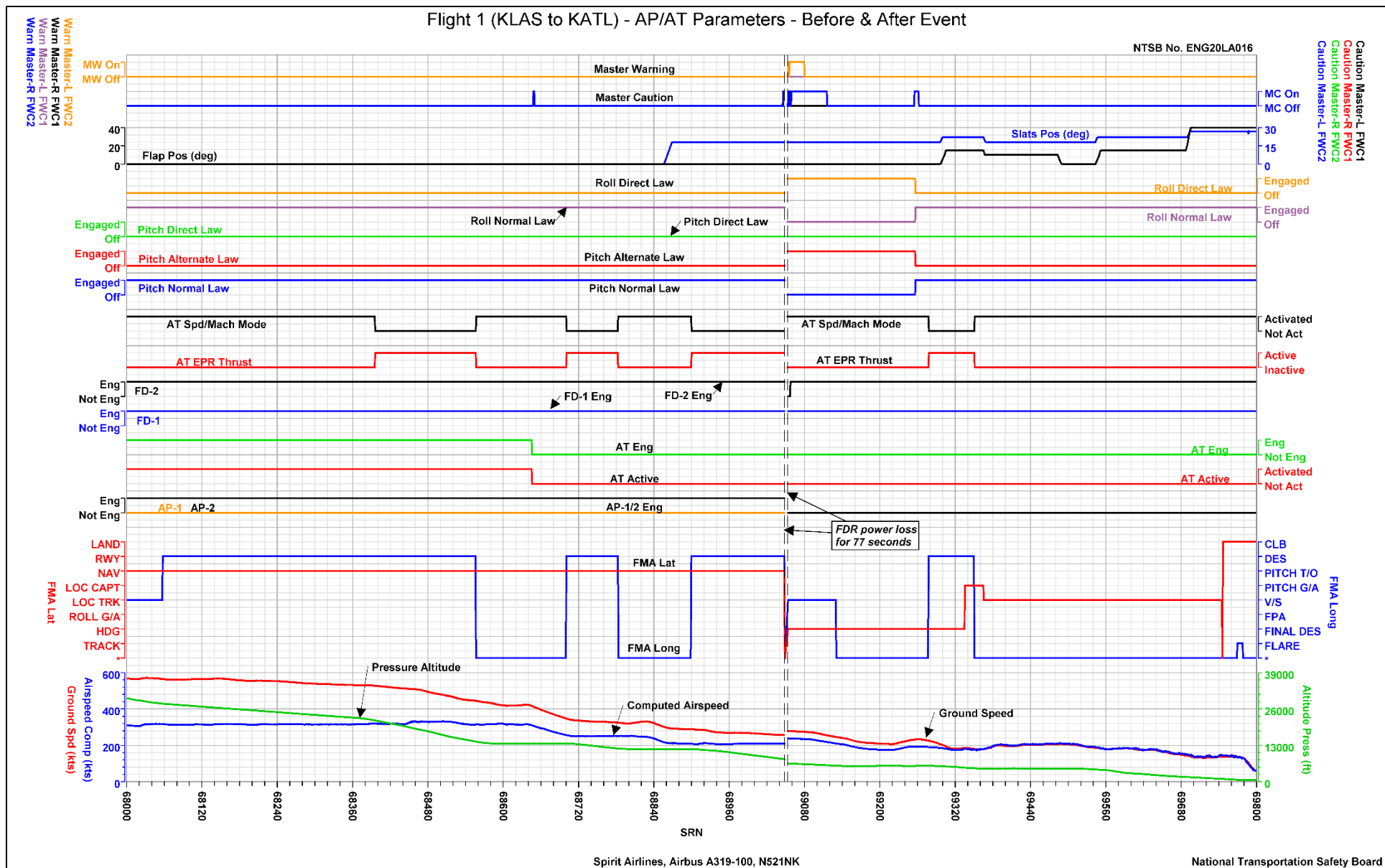


Figure 2. Autopilot and autothrust parameters – Flight 1 – Before and after event

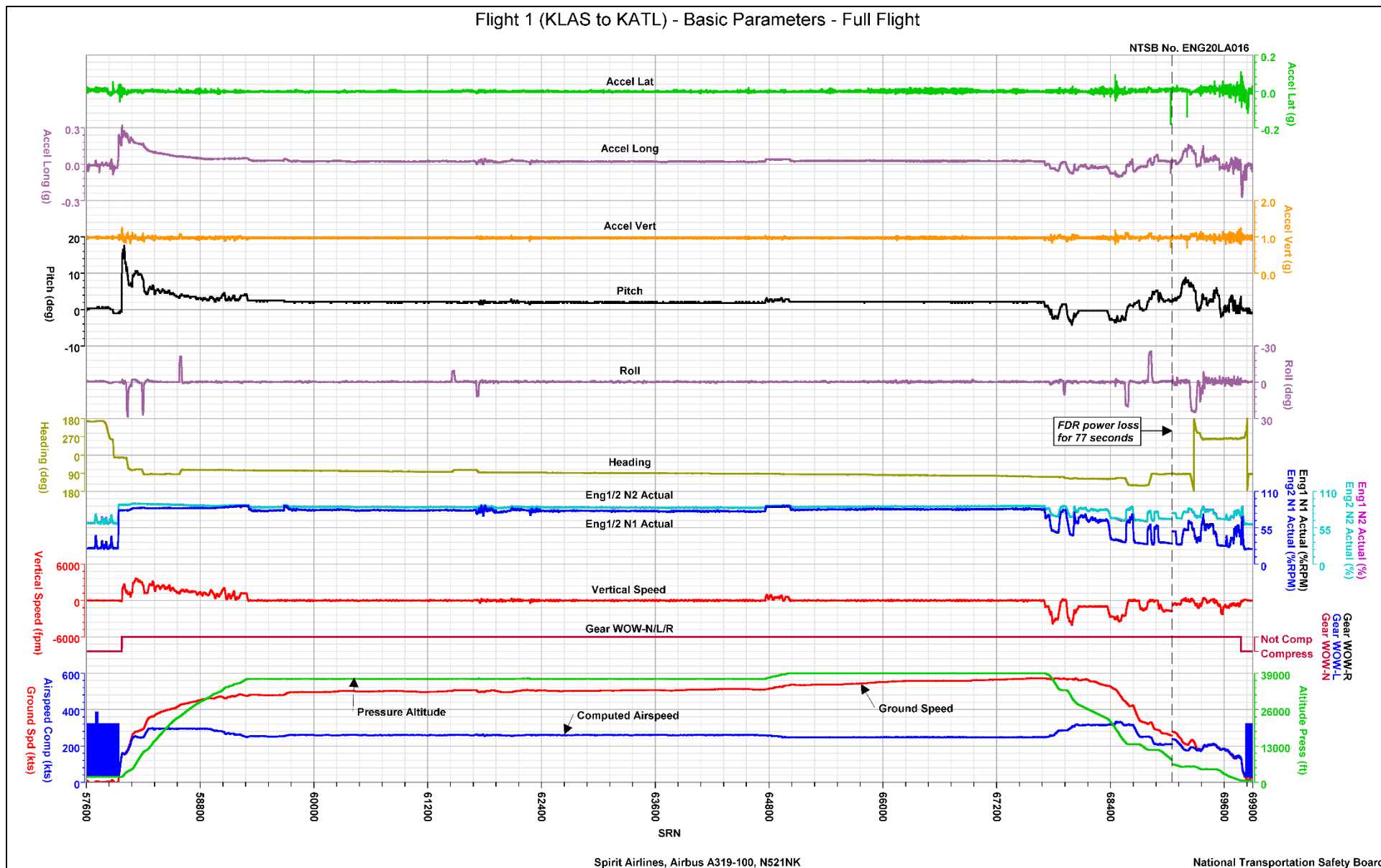


Figure 3. Basic parameters – Flight 1 – Full flight

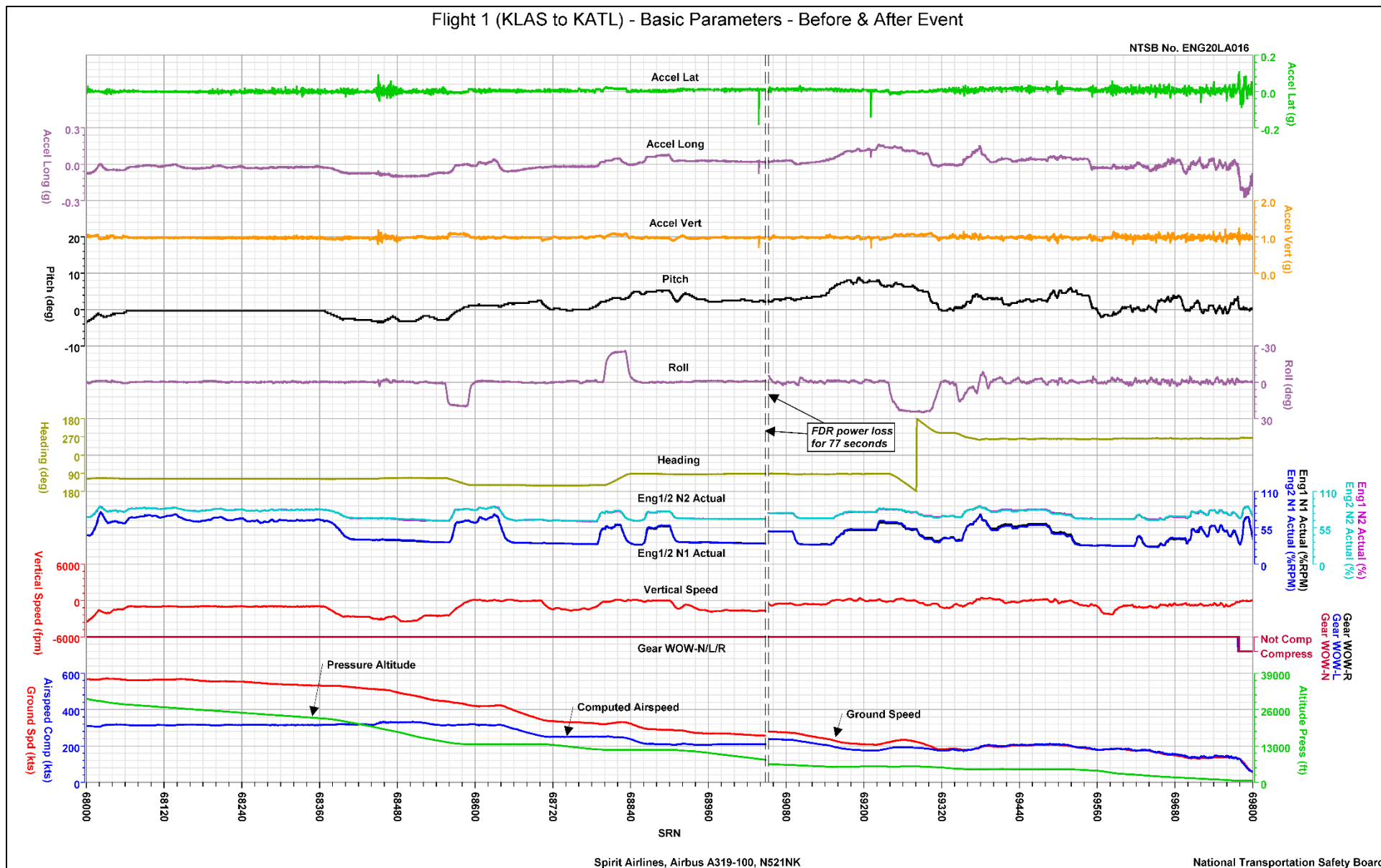


Figure 4. Basic parameters – Flight 1 – Before and after event

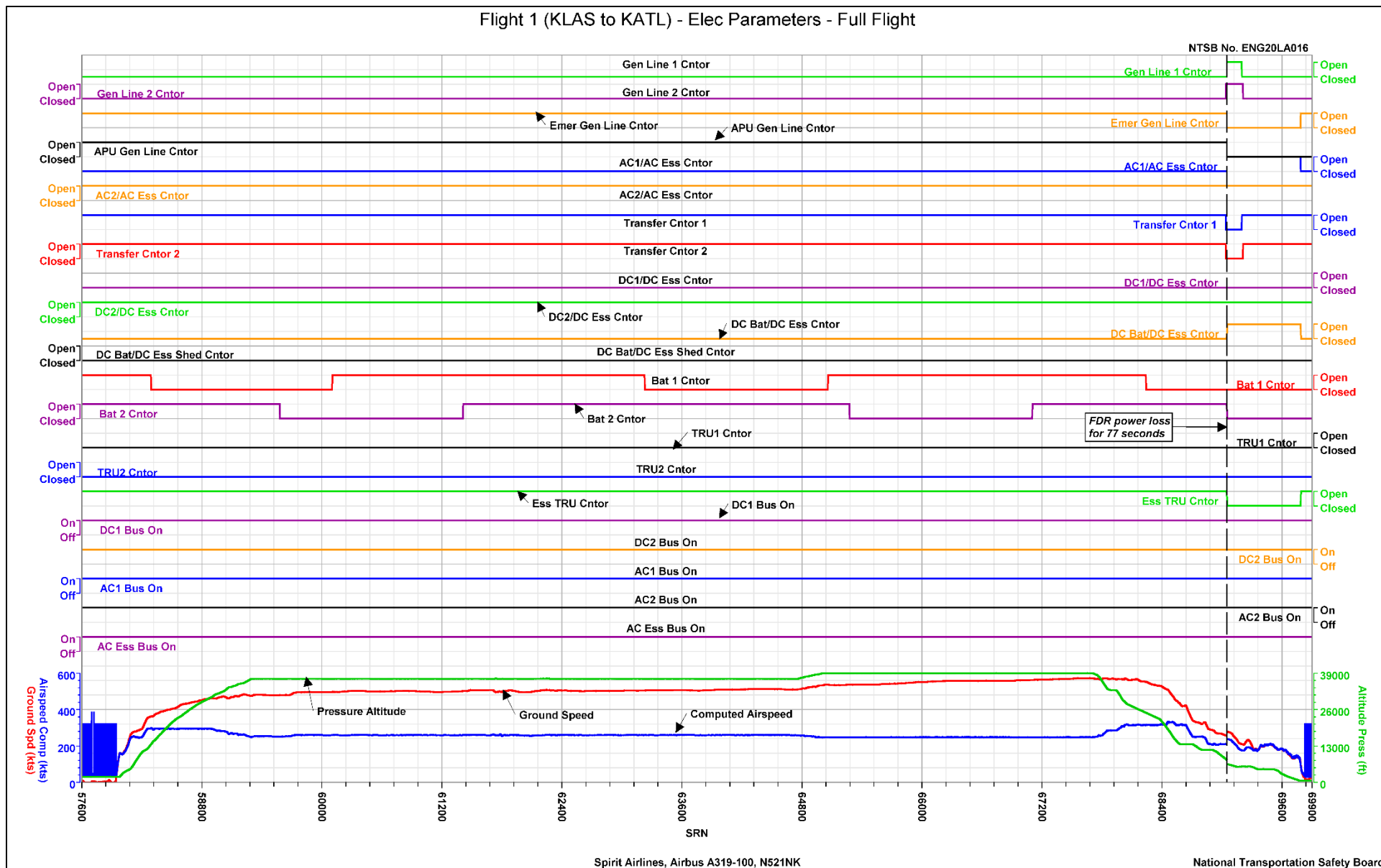


Figure 5. Electrical system parameters – Flight 1 – Full flight

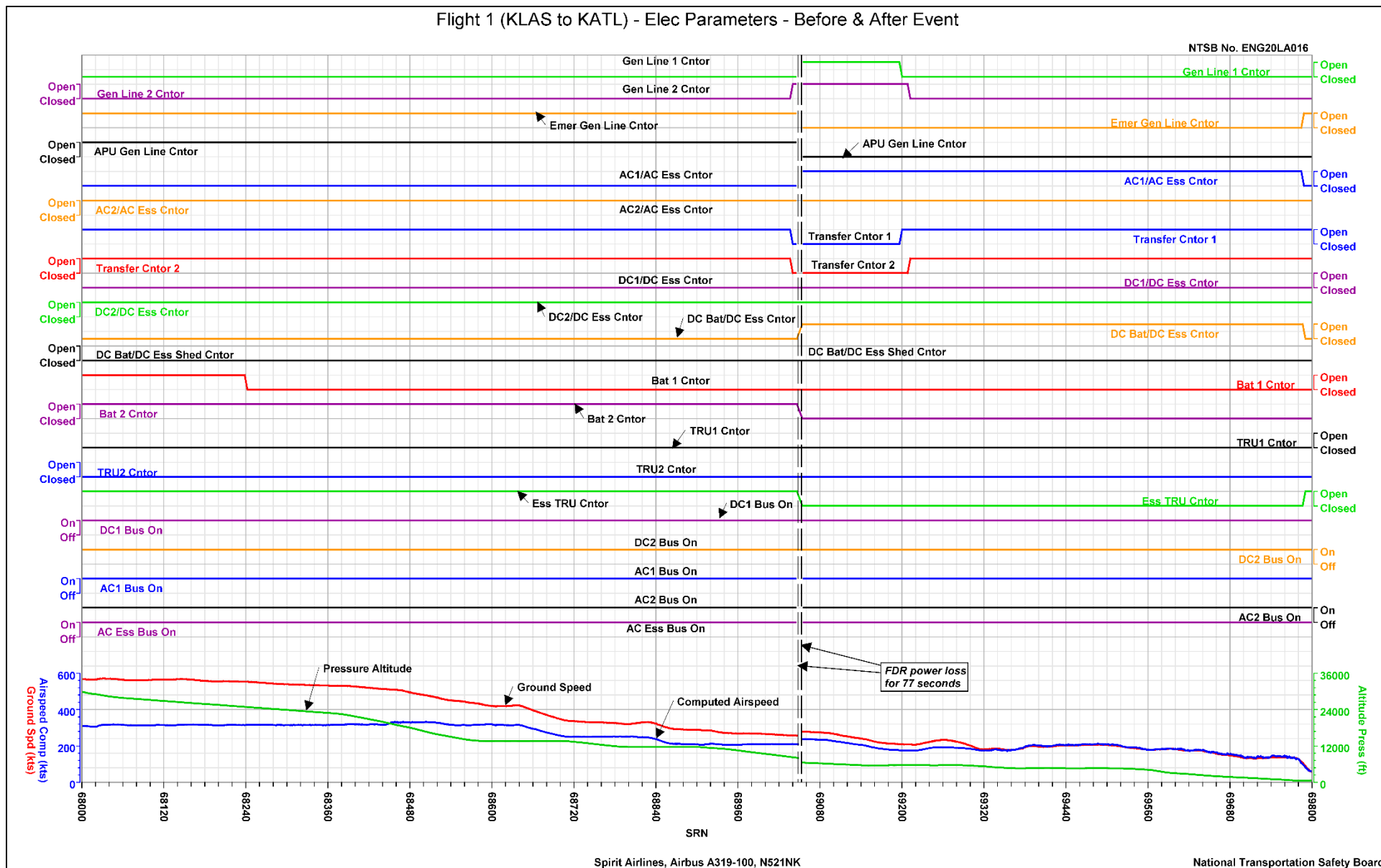


Figure 6. Electrical system parameters – Flight 1 – Before and after event

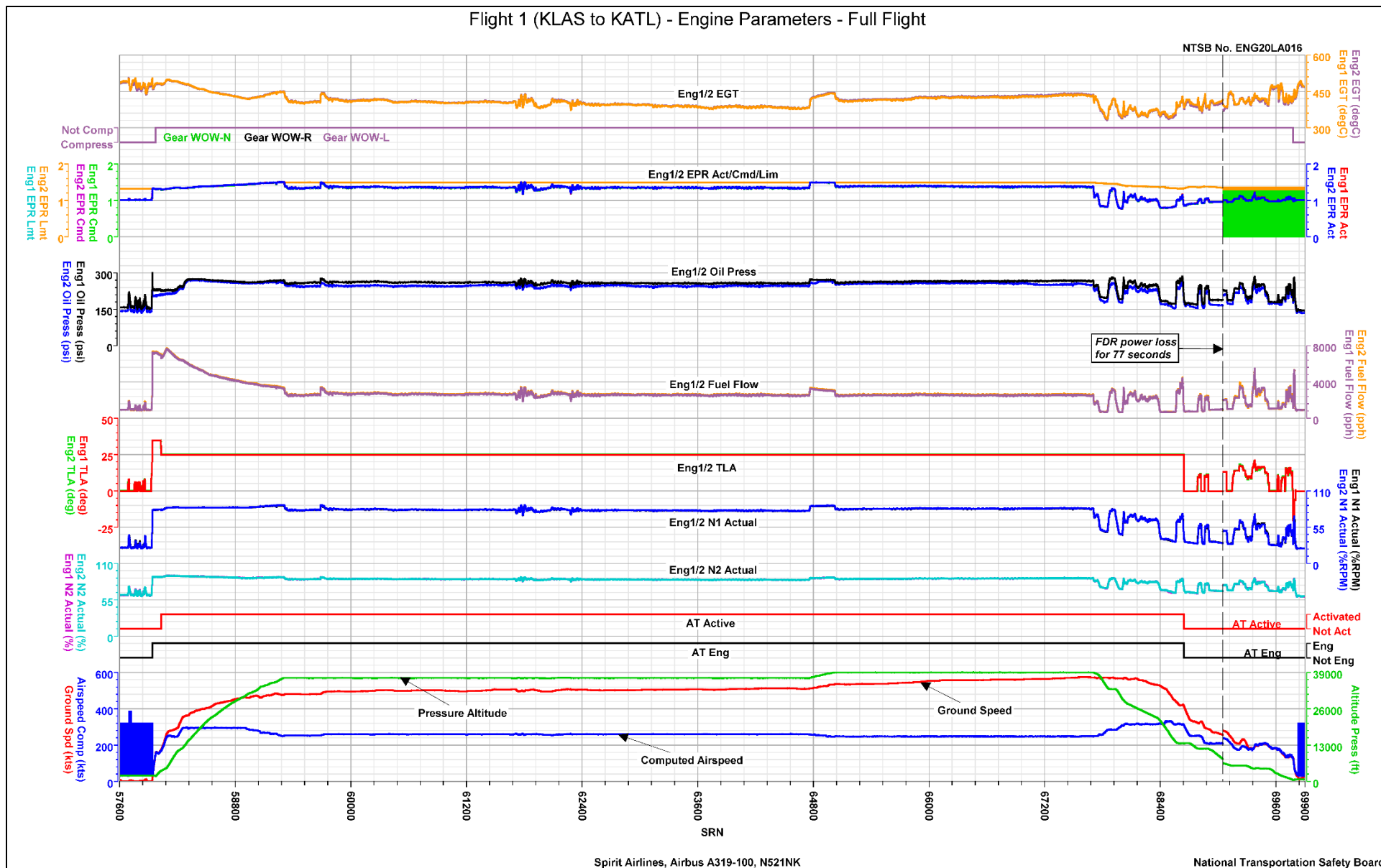


Figure 7. Engine parameters – Flight 1 – Full flight

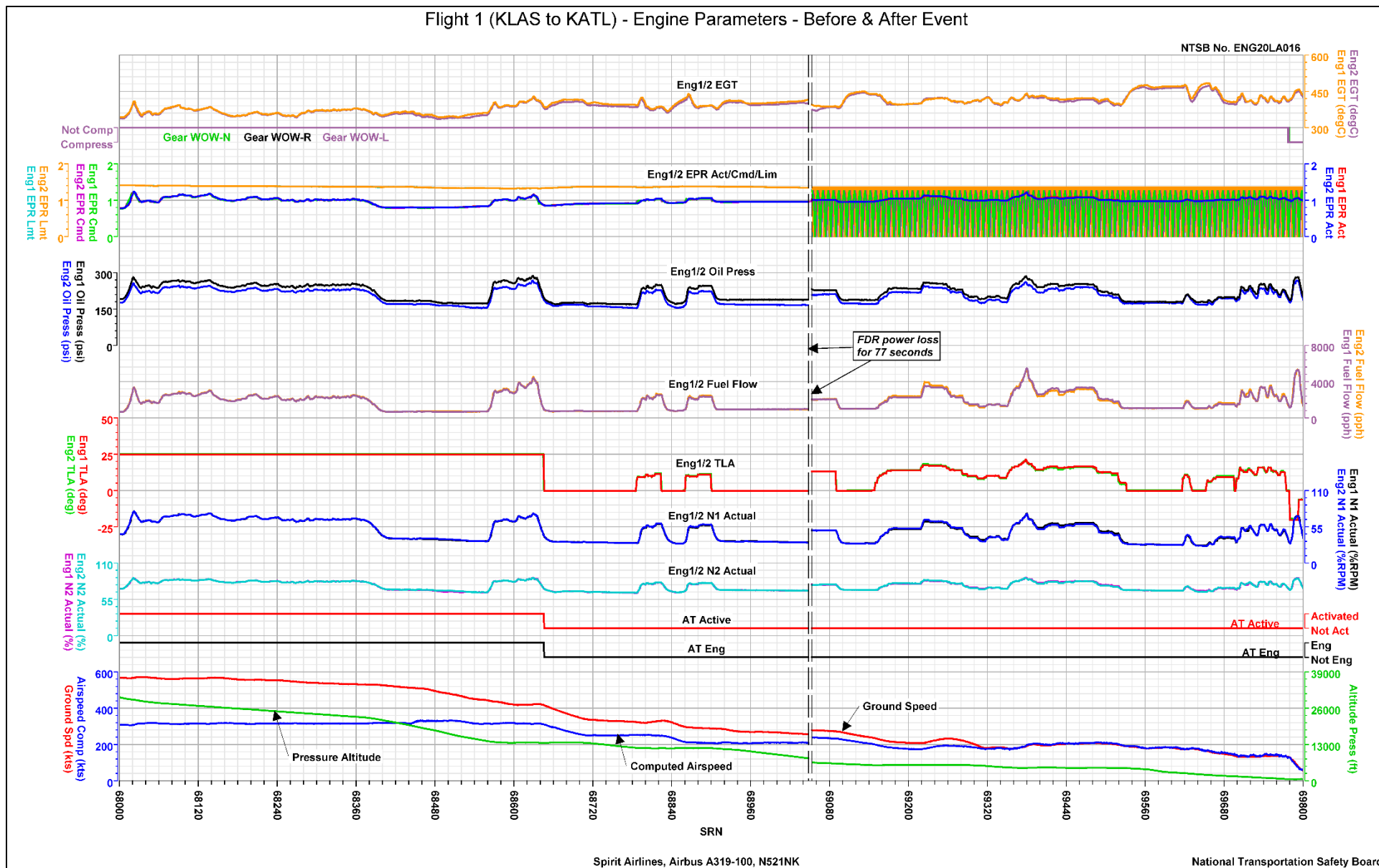


Figure 8. Engine parameters – Flight 1 – Before and after event

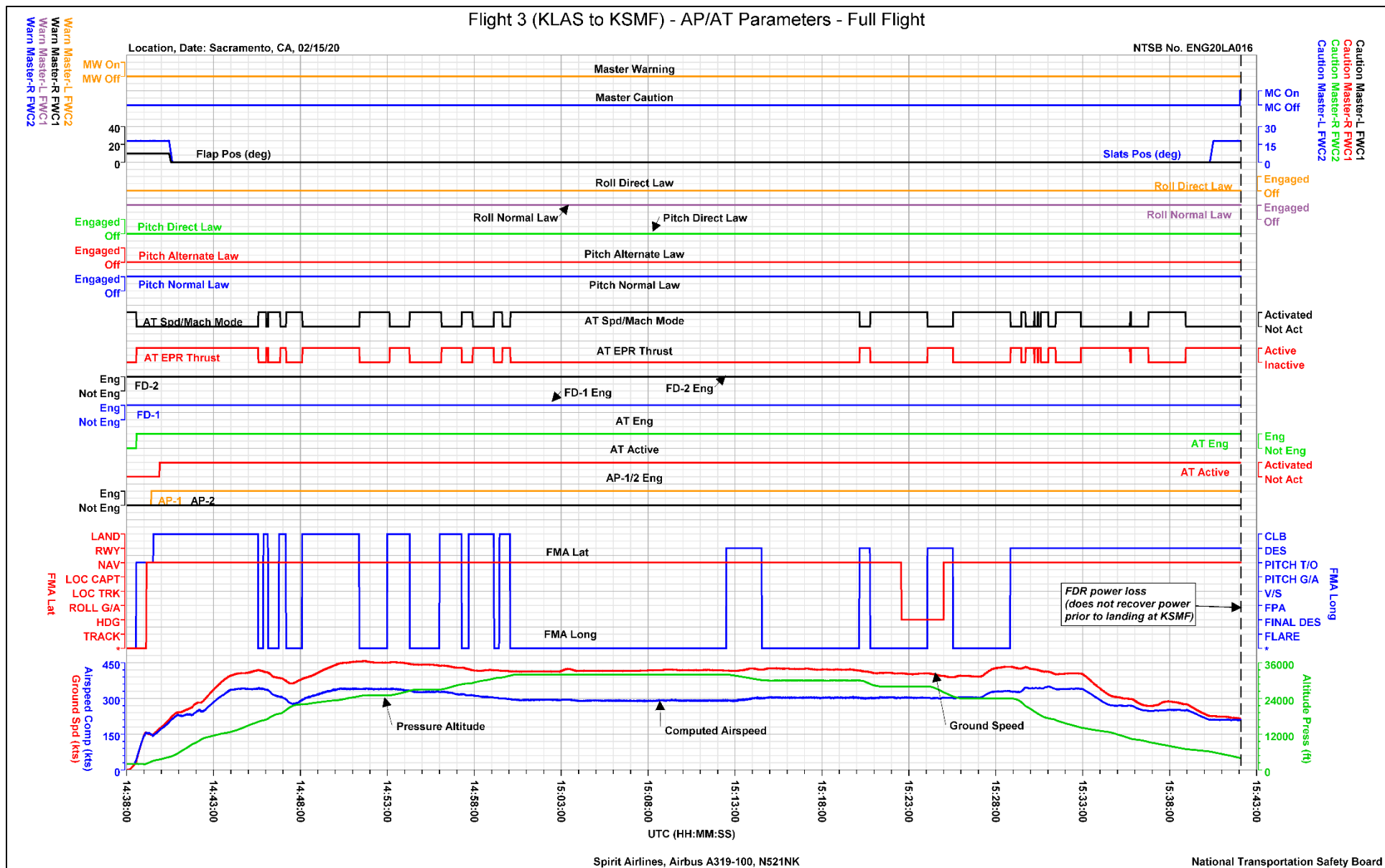


Figure 9. Autopilot and autothrust parameters – Flight 3 – Full flight

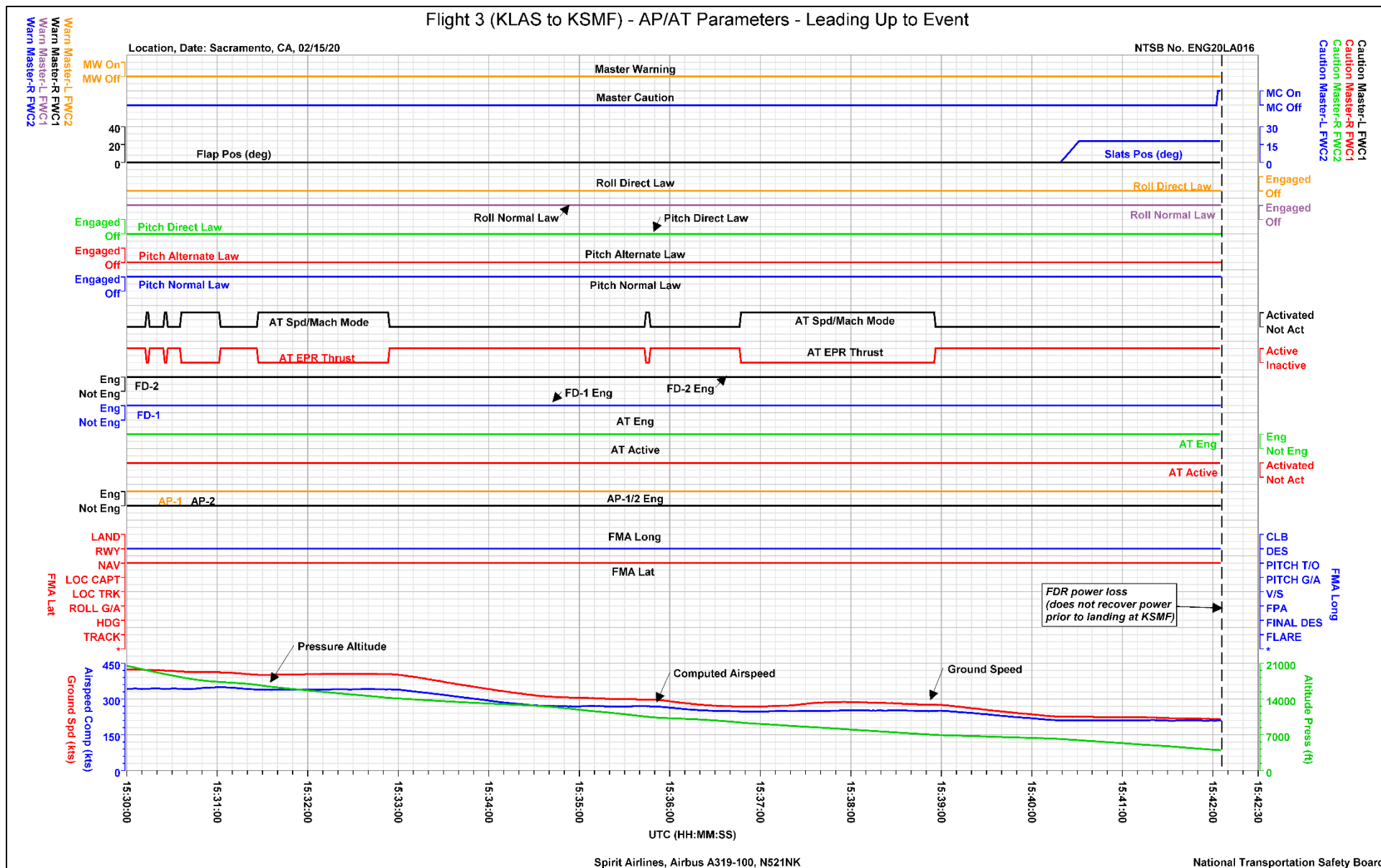


Figure 10. Autopilot and autothrust parameters – Flight 3 – Leading up to event

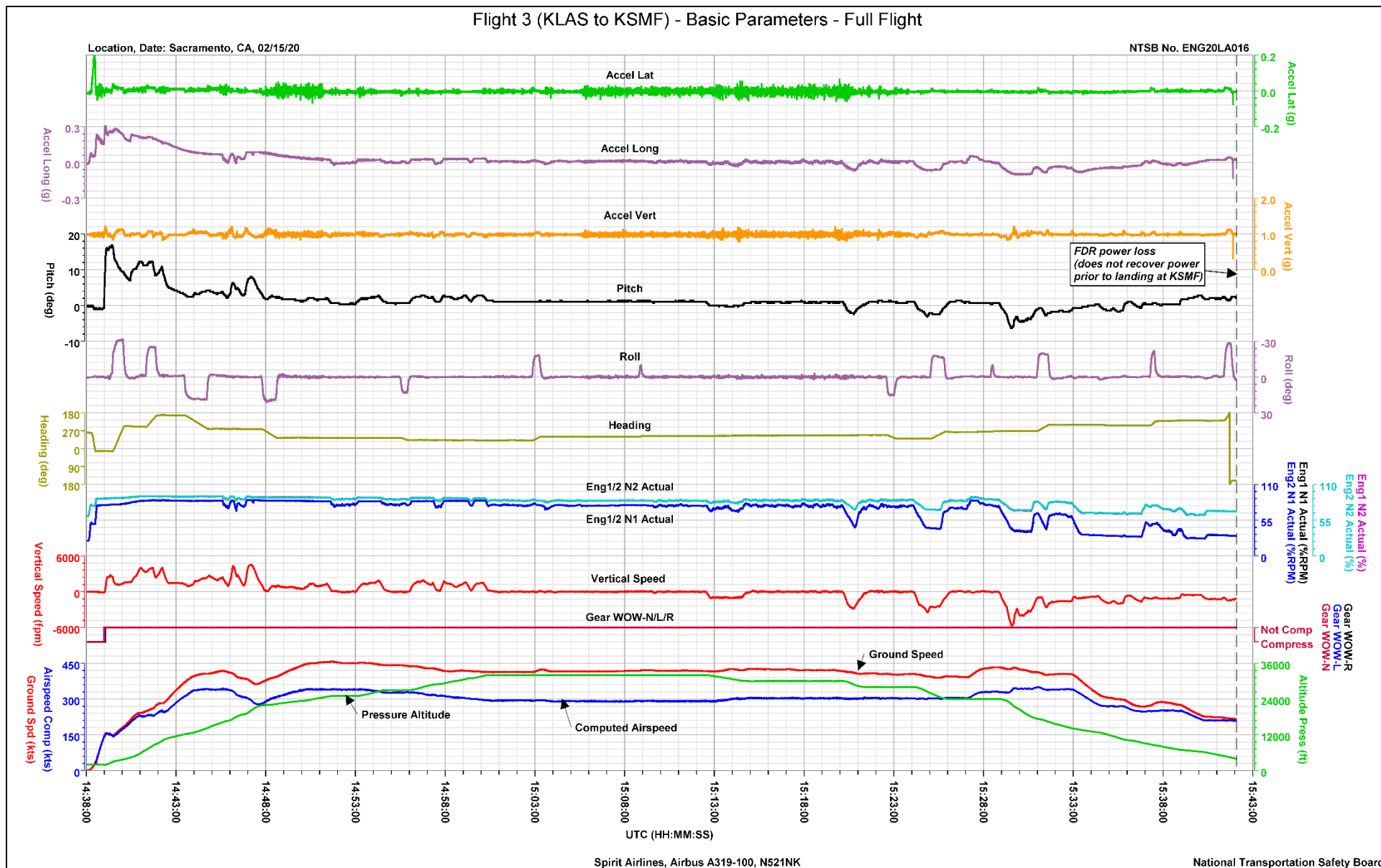


Figure 11. Basic parameters – Flight 3 – Full flight

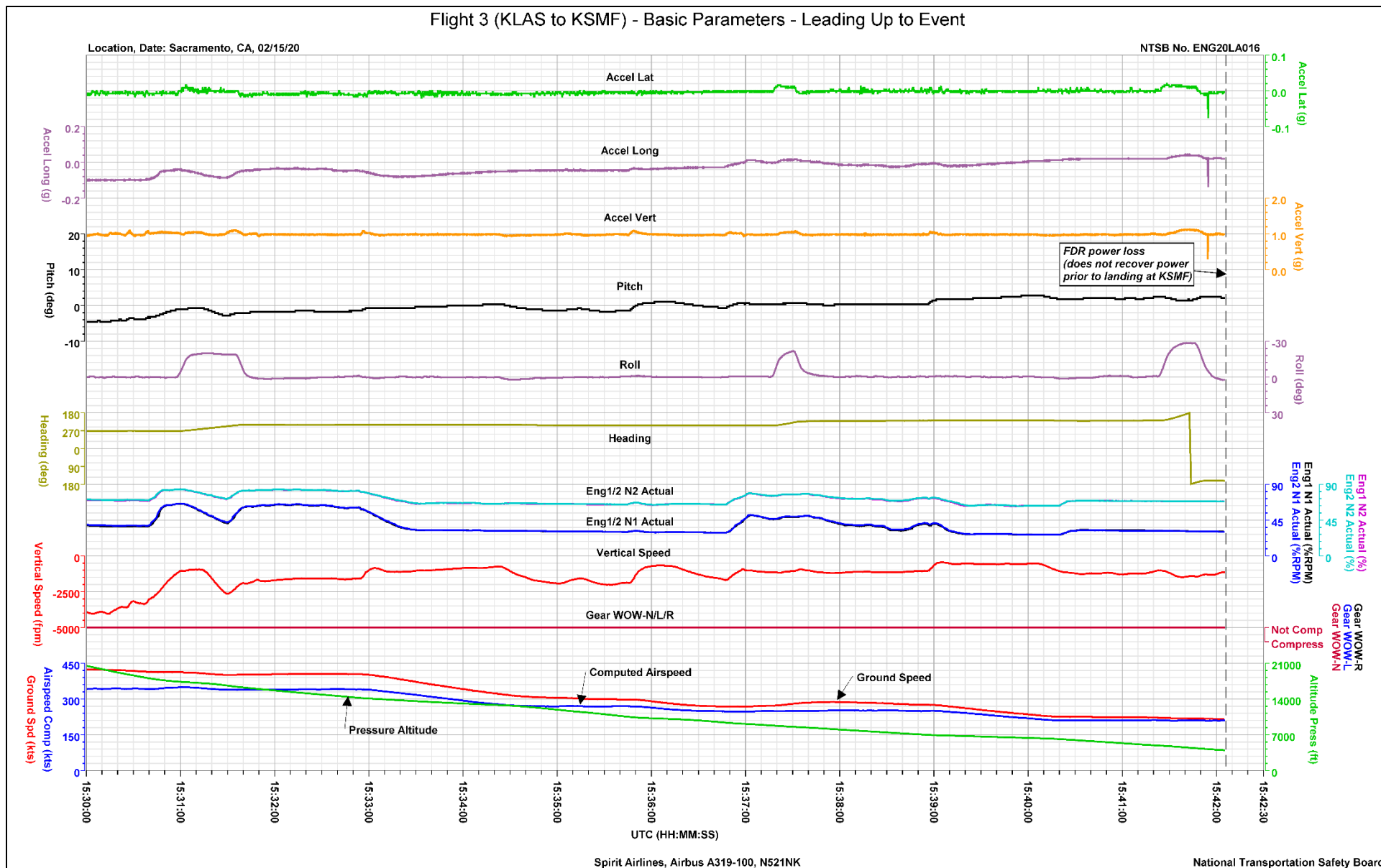


Figure 12. Basic parameters – Flight 3 – Leading up to event

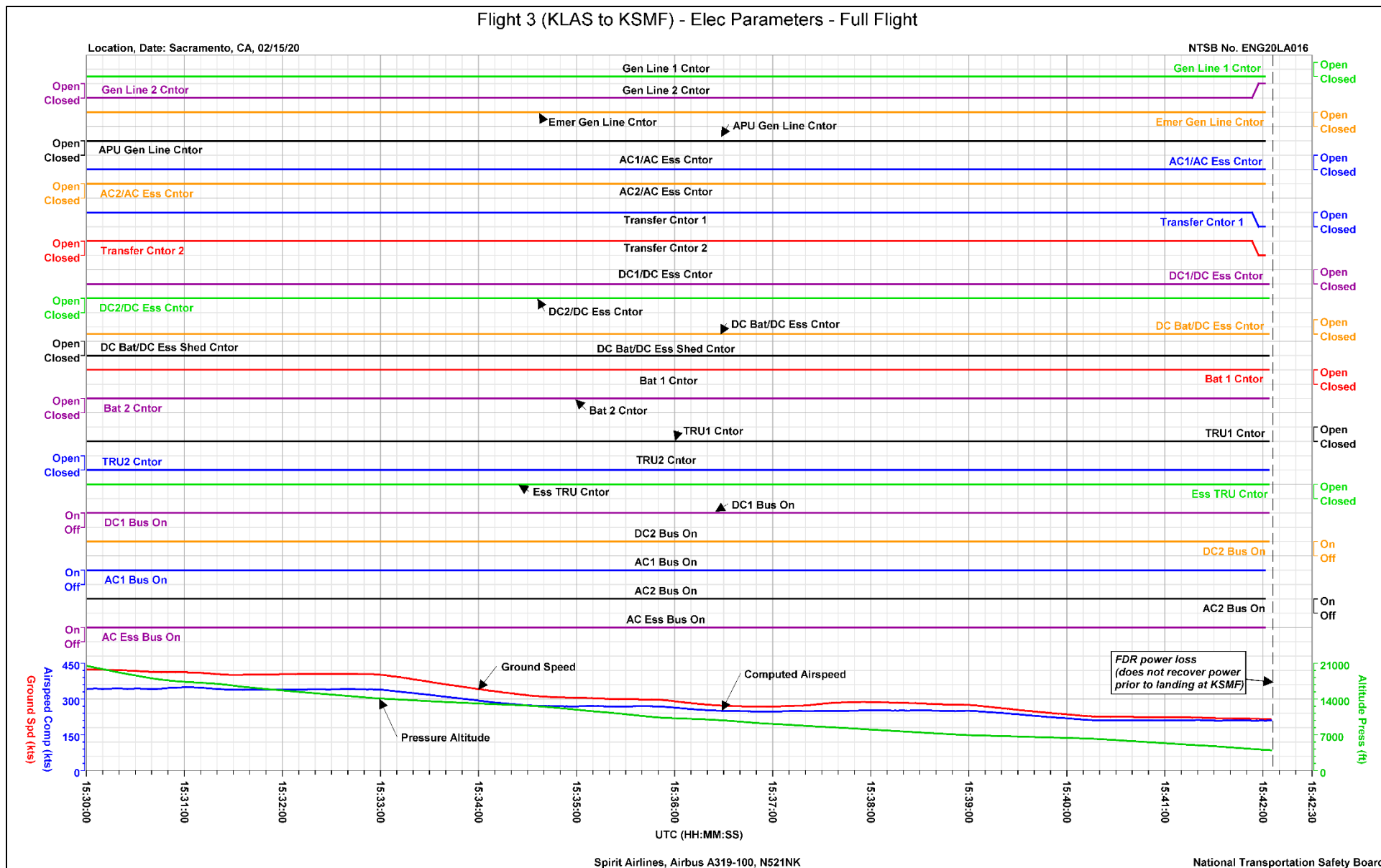


Figure 13. Electrical system parameters – Flight 3 – Full flight

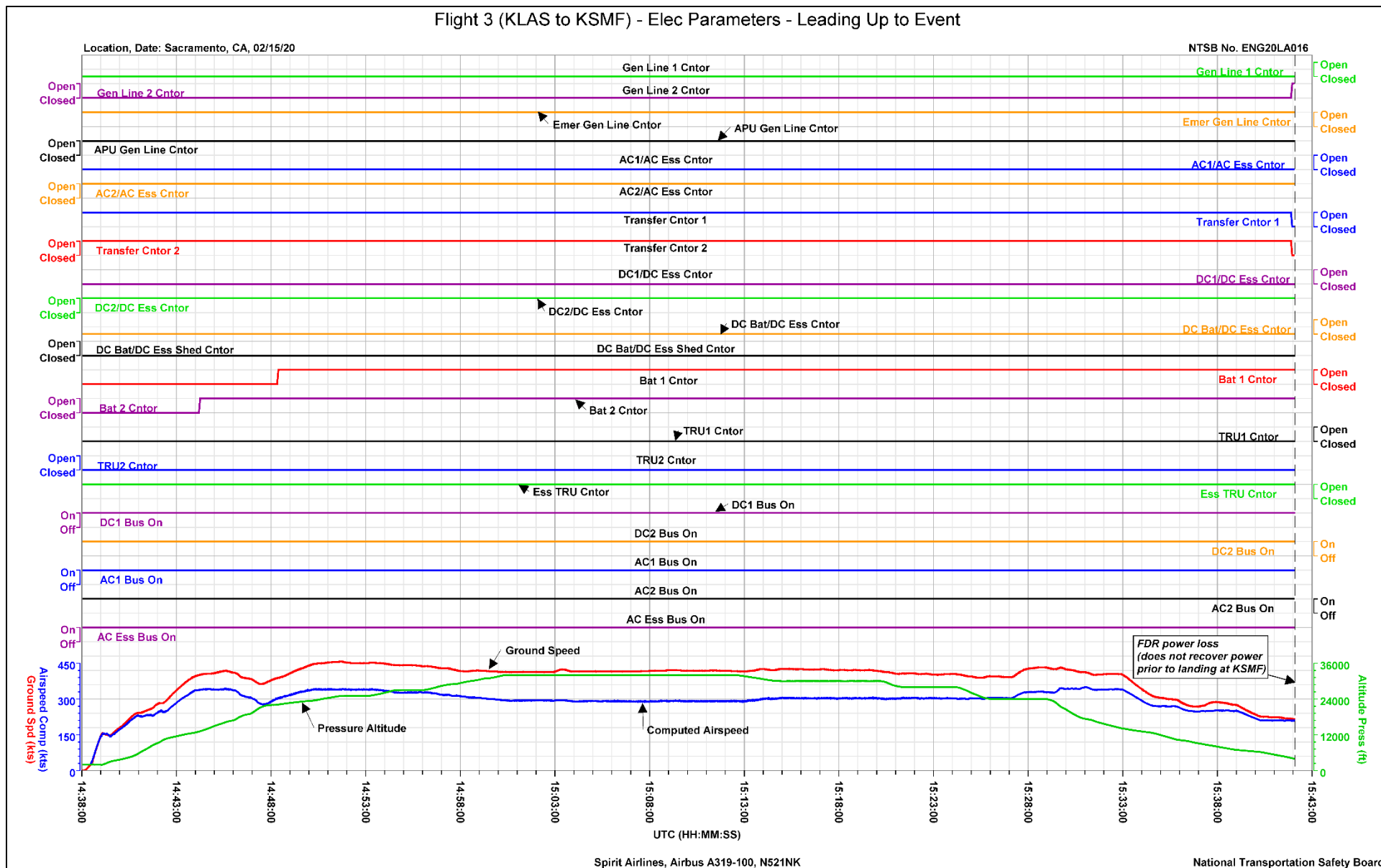


Figure 14. Electrical system parameters – Flight 3 – Leading up to event

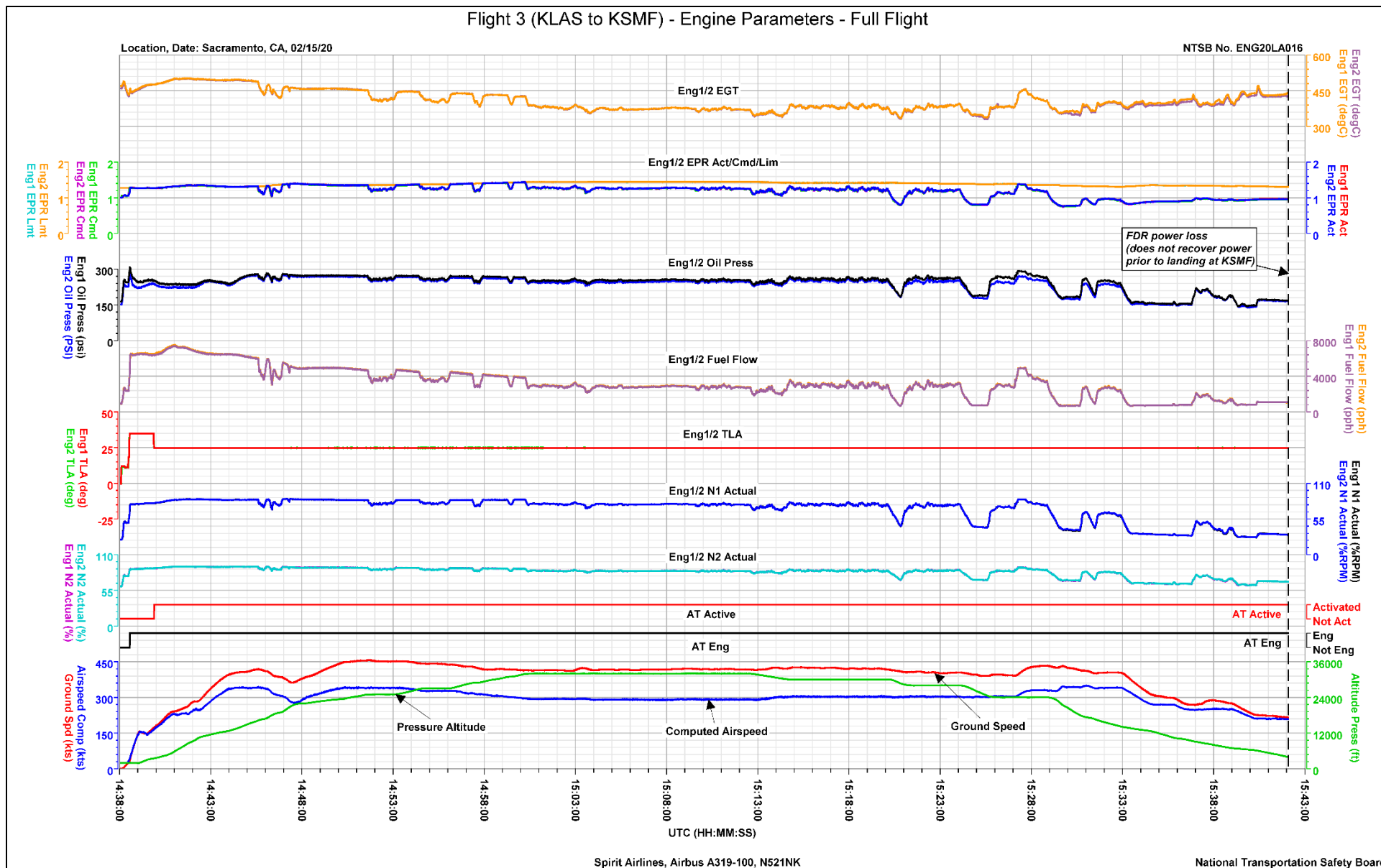


Figure 15. Engine parameters – Flight 3 – Full flight

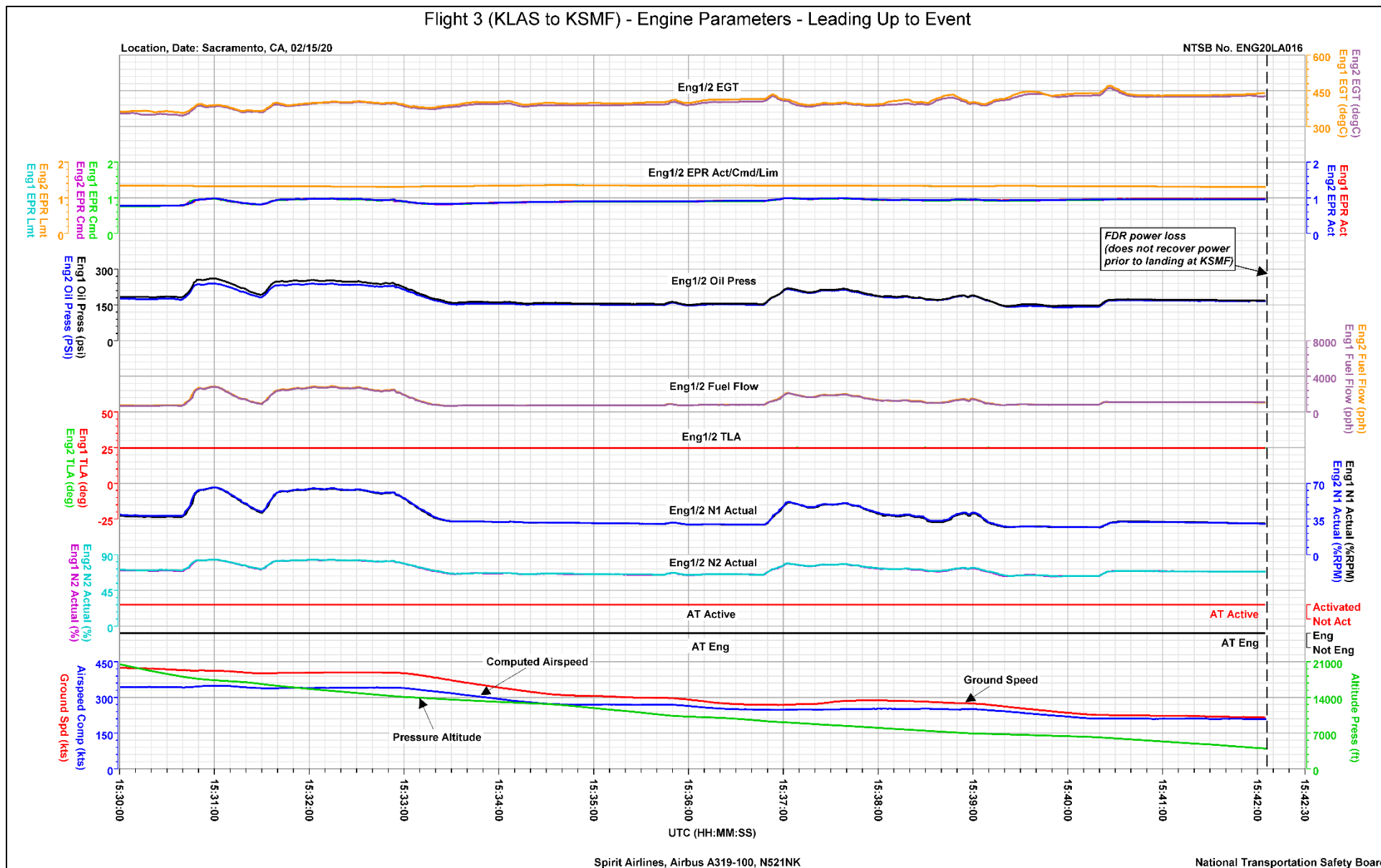


Figure 16. Engine parameters – Flight 3 – Leading up to event

APPENDIX A

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

Table A-2. Verified and provided FDR parameters.

Plot/Table Labels	Parameter Names	Units
AC Ess Bus On	AC Essential Bus On	-
AC/Ess TRU Cntor	AC Essential Transformer Rectifier Unit Contactor	-
AC1/2 Bus On	AC 1/2 Bus On	-
AC1/AC Ess Cntor	AC1/AC Essential Contactor	-
AC2/AC Ess Cntor	AC2/AC Essential Contactor	-
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Airspeed Comp	Computed Airspeed	kts
Altitude Press	Pressure Altitude	ft
AP-1/2	Autopilot 1/2 Engaged	-
APU Gen Line Cntor	Auxiliary Power Unit Generator Line Contactor	-
AT Active	Autothrust Active	-
AT Eng	Autothrust Engage	-
AT EPR Thrust	Autothrust EPR Thrust Mode Active	-
AT Spd/Mach Mode	Autothrust Speed/Mach Mode Active	-
Batt 1/2 Cntor	Battery 1/2 Contactor	-
Caution Master-L/R	Master Caution	-
DC Bat/DC Ess Cntor	DC Battery/DC Essential Contactor	-
DC Ess Bus On	DC Essential Bus On	-
DC1/2 Bus On	DC 1/2 Bus On	-
DC1/DC Ess Cntor	DC1/DC Essential Contactor	-
DC2/DC Ess Cntor	DC2/DC Essential Contactor	-
Emer Gen Line Cntor	Emergency Generator Line Contactor	-
Eng1/2 EGT	Engine 1/2 Exhaust Gas Temperature	degC
Eng1/2 EPR Act/Cmd/Lim	Engine 1/2 EPR Actual/Command/Limit	ratio
Eng1/2 Fuel Flow	Engine 1/2 Fuel Flow	pph
Eng1/2 N1 Actual	Engine 1/2 N1 Actual	%RPM
Eng1/2 N2 Actual	Engine 1/2 N2 Actual	%
Eng1/2 Oil Press	Engine 1/2 Oil Pressure	psi
Eng1/2 TLA	Engine 1/2 Throttle Lever Angle	deg
Ess TRU Cntor	Essential Transformer Rectifier Unit Contactor	-
F/D-1/2 Engaged	Flight Director 1/2 Engaged	-
Flap Pos	Flap Position	deg
FMA Lat	Flight Mode Annunciator – Lateral Mode	-
FMA Long	Flight Mode Annunciator – Longitudinal Mode	-
Gear WOW-L/R/N	Gear Weight-on-Wheels – Left/Right/Nose	-
Gen Line 1/2 Cntor	Generator Line 1/2 Contactor	-
Ground Spd	Groundspeed	kts
Heading	Magnetic Heading	deg
Pitch	Pitch	deg
Pitch Alternate/Direct/Normal Law	Pitch Alternate/Direct/Normal Law Engaged	-
Roll	Roll	deg
Roll Direct/Normal Law	Roll Direct Law Engaged	-
Slats Pos	Slats Position	deg
Time UTC Hours	Hours – UTC	hrs
Time UTC Min	Minutes – UTC	min

APPENDIX A

Plot/Table Labels	Parameter Names	Units
Time UTC Sec	Seconds – UTC	sec
Transfer Cntor 1/2	Transfer Contactor 1/2	-
TRU1/2 Cntor	Transformer Rectifier Unit 1/2 Contactor	-
Vertical Speed	Vertical Speed	fpm
Warn Master-L/R	Master Warning	-

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 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-3. Unit and discrete abbreviations.

Unit and discrete abbreviations	Descriptions
AC	alternating current
DC	direct current
deg	degrees
degC	degrees Celsius
EPR	engine pressure ratio
fpm	feet per minute
ft	feet
g	gravitational constant
hrs	hours
kts	knots
min	minutes
pph	pounds per hour
psi	pounds per square inch
RPM	revolutions per minute
sec	seconds