

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

July 22, 2020

Flight Data Recorder

Specialist's Factual Report
By Michael Portman

1. EVENT SUMMARY

Location: Atlanta, Georgia
Date: November 6, 2019
Aircraft: Embraer ERJ-170-200LR
Registration: N117HQ
Operator: Republic Airways
NTSB Number: DCA20IA014

On November 6, 2019, about 2115 eastern standard time (EST), Republic Airways flight 4439, an Embraer ERJ-170-200LR, N117HQ, experienced a pitch trim anomaly shortly after takeoff from Hartsfield-Jackson Atlanta International Airport (ATL), Atlanta, Georgia. The flight crew declared an emergency and returned to ATL. None of the 9 passengers and crew onboard were injured and the airplane was not damaged. The airplane was operating under the provisions of Title 14 *Code of Federal Regulations (CFR)* Part 121 as regularly scheduled passenger flight and was destined for LaGuardia Airport (LGA), New York, New York.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N117HQ, was manufactured in 2007, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 88 parameters, as cited in CFR Part 121.344(f).

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received an electronic file containing the FDR data from the N117HQ aircraft.

4.1. FDR Data File 256 wps Description

The FDR data in the electronic file was configured such that 256 12-bit words of digital information were recorded 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, pressure altitude, pitch angle, roll angle, and magnetic heading) has a specifically assigned word number within the subframe.

4.1.1. 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 event flight was the last flight of the recording and its duration was approximately 20 minutes. Additionally, the two flights preceding the event flight were determined to be pertinent to the investigation, and as such, plots and data are provided (LGA to ATL and Detroit [DTW] to LGA). The flight from LGA to ATL lasted approximately 2 hours, and the flight from DTW to LGA lasted 1 hour and 10 minutes. The parameters evaluated for the purpose of this report appeared to be in accordance with federal FDR carriage requirements, except Control Column Force - Right. This parameter is a calculated parameter derived from multiple sensed parameters, including control column position and load cell force. Examination of the data revealed the right control column position parameter appeared to be valid, however the right load cell force parameter appeared to be invalid. The operator was informed of this parameter deficiency.

4.1.2. Engineering Units 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.

4.1.2.1. Pitch Trim Control Parameters

The parameters Pitch Trim Ctrl BU, L, and R include the terms "FCM 1B-2B" and "FCM 3B-4B." These denote the flight control module (FCM) and databus through which the signal is processed. For example, "Pitch Trim Ctrl L FCM 1B-2B" indicates that a pitch trim change is being commanded by the captain and is being processed through either FCM 1 or 2 databus B.

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 = +.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, eastern standard time (EST), was established by using the recorded Time GMT hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional five hours offset to change GMT to EST.²

Accordingly, the time offset for the event flight data from SRN to local EST is the following: $EST = SRN - 20,193$. Therefore, for the rest of this report, times are referenced as EST, not SRN. However, previous flights are referenced as SRN, not local time.

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 through 8 contain FDR data recorded during the event on November 6, 2019. Figure 9 contains FDR data recorded during the preceding flight from LGA to ATL on November 6, 2019, and figure 10 contains FDR data recorded during the earlier preceding flight from DTW to LGA on November 6, 2019. All the parameters listed in table A-1 are plotted except Latitude, Longitude, Time GMT Hours, Time GMT Minutes, and Time GMT Seconds.

Figure 1 shows a plot of basic parameters for the entire incident flight. Of note in this and subsequent plots, the stabilizer parameter abruptly goes to zero degrees at 21:10:36. This is consistent with the manufacturer's description of trim cutout switch actuation behavior.

Figure 2 shows a plot of control related parameters for the entire incident flight, including the invalid Ctrl Col Force - R parameter. As can be seen in this plot, the parameter only registers force input during the very beginning and end portions of the flight.

Figure 3 shows a plot of the same basic parameters as figure 1, expanded to show detail of the pitching event.

Figure 4 shows a plot of the same control related parameters as figure 2, but without the invalid Ctrl Col Force - R parameter, expanded to show detail of the pitching event.

Figures 5, 6, and 7 show plots of autopilot and stabilizer functions for portions of the event flight where the autopilot quick disconnect switch (AP/TRIM disconnect button) is activated. Of note, any time the autopilot quick disconnect switch is active, there is no recorded stabilizer movement.

Figure 8 shows a plot of autopilot mode and control related parameters for the event flight.

Figure 9 shows a plot of the same autopilot mode and control related parameters as figure 8, but for the preceding flight from LGA to ATL. The captain's trim switch appears unused during this flight.

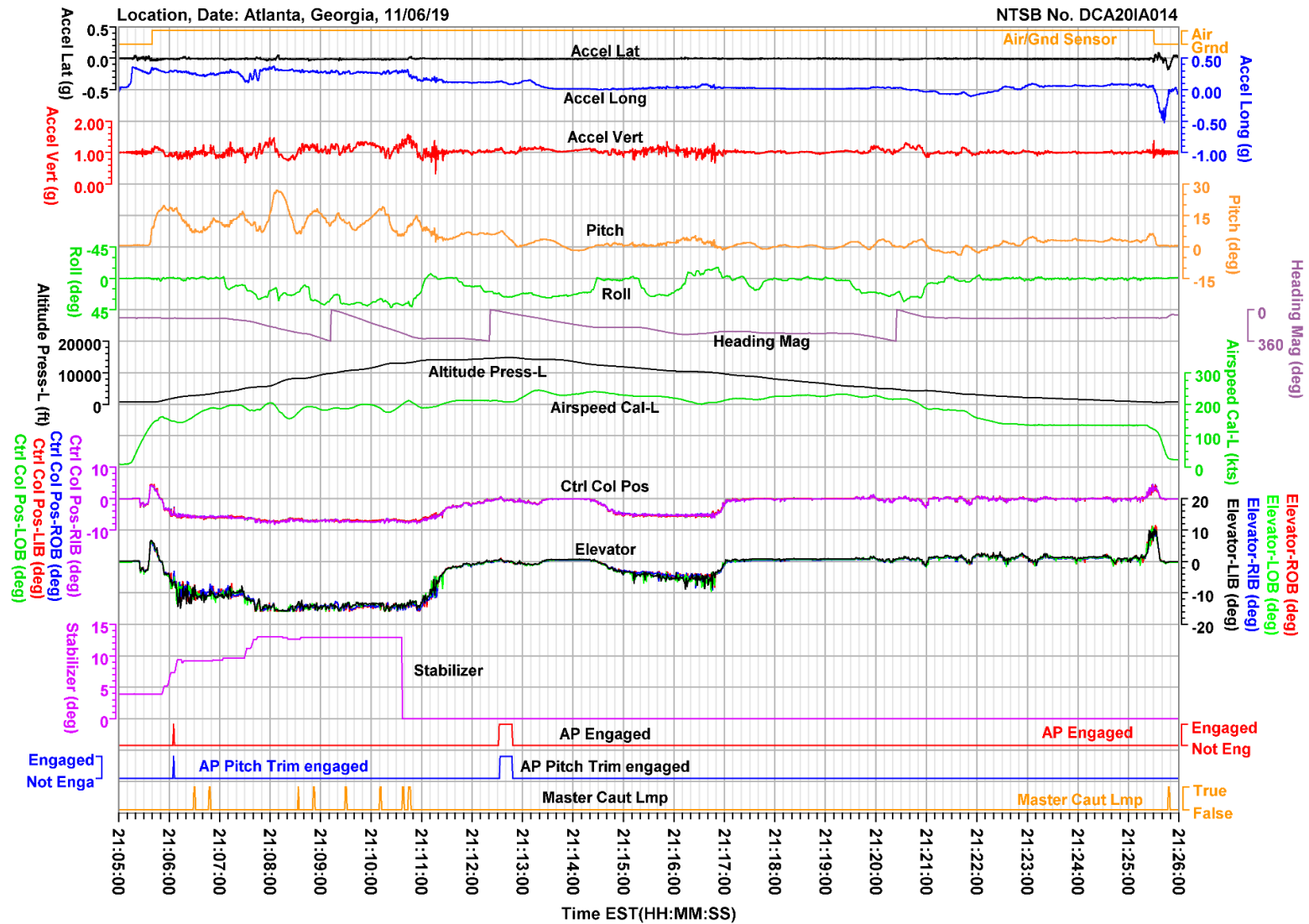
² GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

Figure 10 shows a plot of the same autopilot mode and control related parameters as figures 8 and 9, but for the second preceding flight from DTW to LGA. Of note, this flight includes several instances of "trim fail" inputs being recorded on the captain's side.

On the event flight, the aircraft began its takeoff roll at approximately 21:05:15, rotated at approximately 21:05:40, and became airborne shortly thereafter. The stabilizer, initially set at 3.88 degrees nose up, began transiting at approximately 21:05:50 toward a further nose up position. The stabilizer reached a maximum nose up position of 13 degrees at 21:07:45 and stayed at or near that position at least until 21:10:36 when the stabilizer parameter abruptly went to zero degrees, consistent with trim cutout switch actuation. During this time, the aircraft experienced several pitch oscillations, reaching a maximum pitch up attitude of 27.070 degrees at 21:08:08. After the stabilizer was cutout, the pitch oscillations subsided, and the aircraft continued to a landing at ATL at 21:25:32.

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.

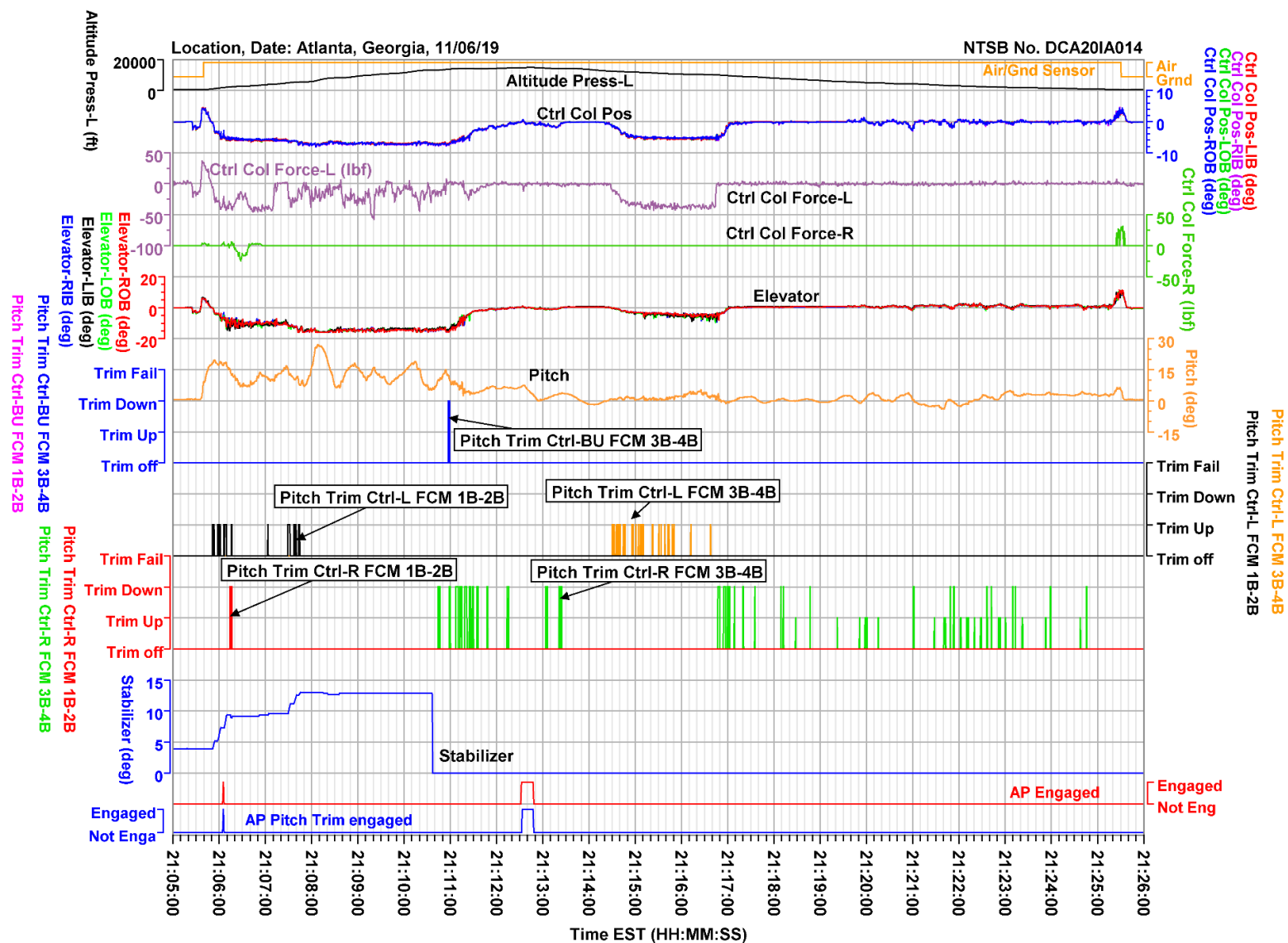
The corresponding tabular data used to create figures 1 through 8, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, as well as latitude and longitude, are provided in electronic comma separated value (*.csv) format as attachment 1 to this report. The corresponding tabular data used to create figure 9, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, are provided in electronic comma separated value (*.csv) format as attachment 2 to this report. The corresponding tabular data used to create figure 10, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, are provided in electronic comma separated value (*.csv) format as attachment 3 to this report.



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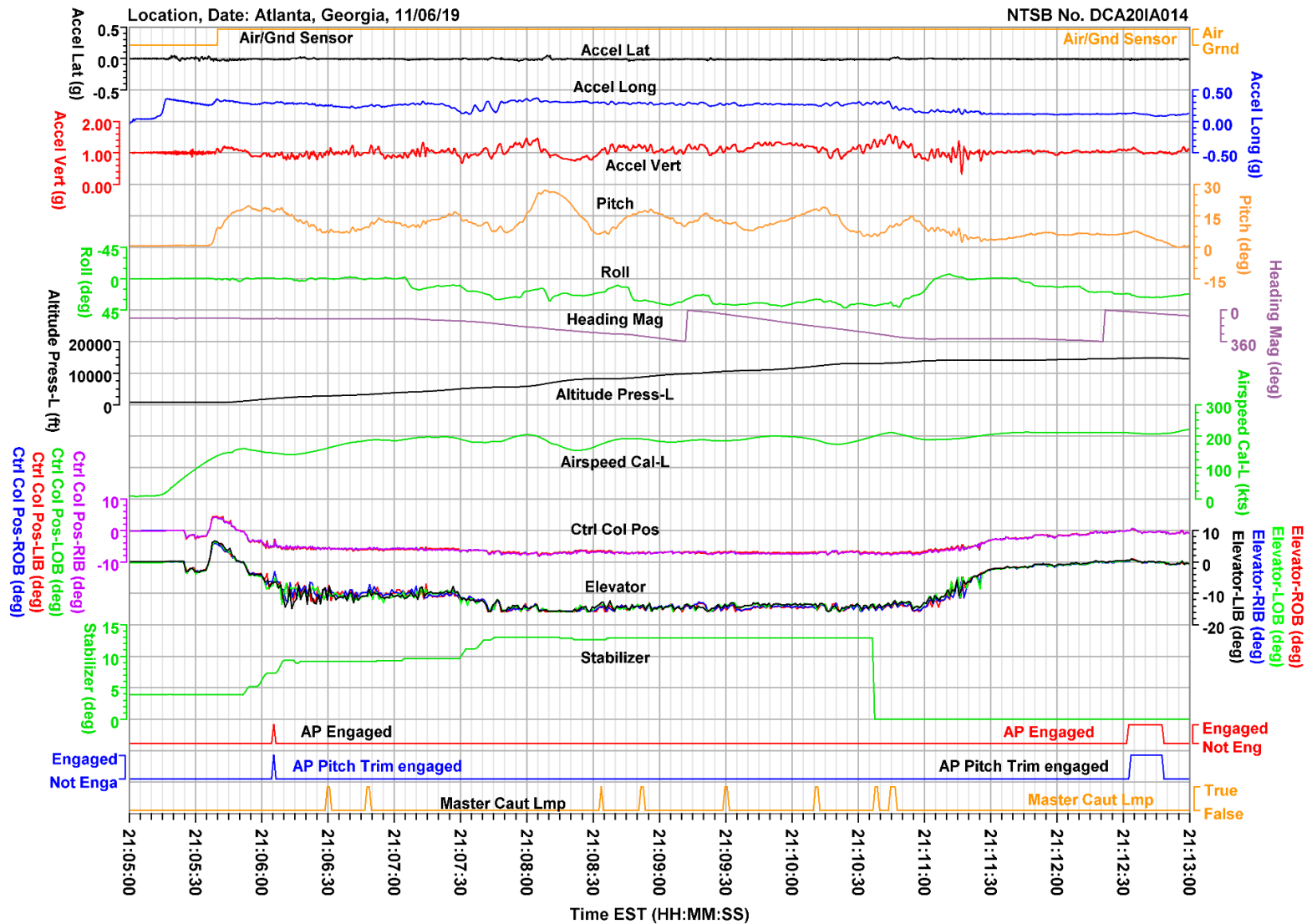
Figure 1. Plot of basic parameters for the incident flight.



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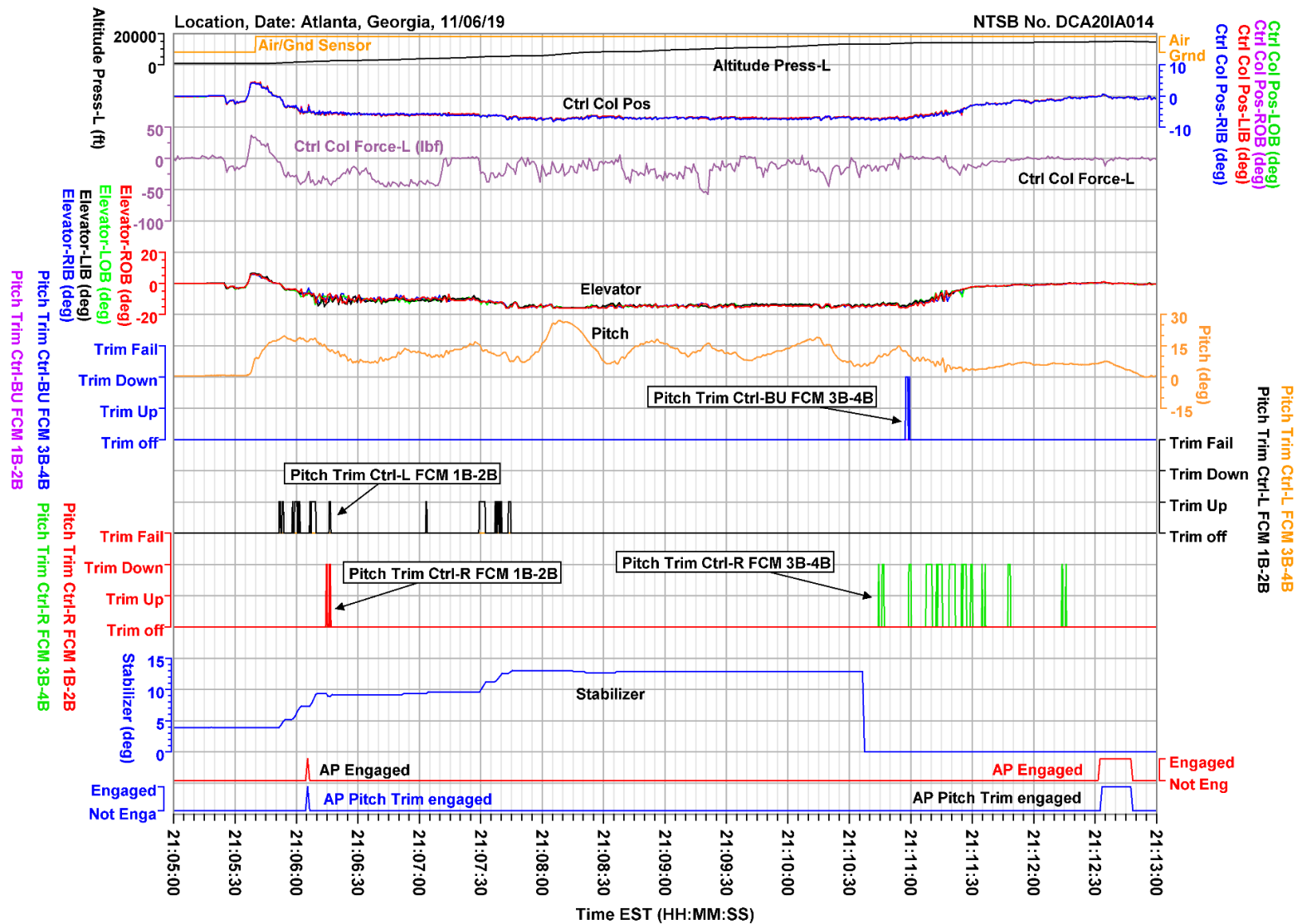
Figure 2. Plot of control parameters for the incident flight, including invalid Ctrl Col Force - R parameter.



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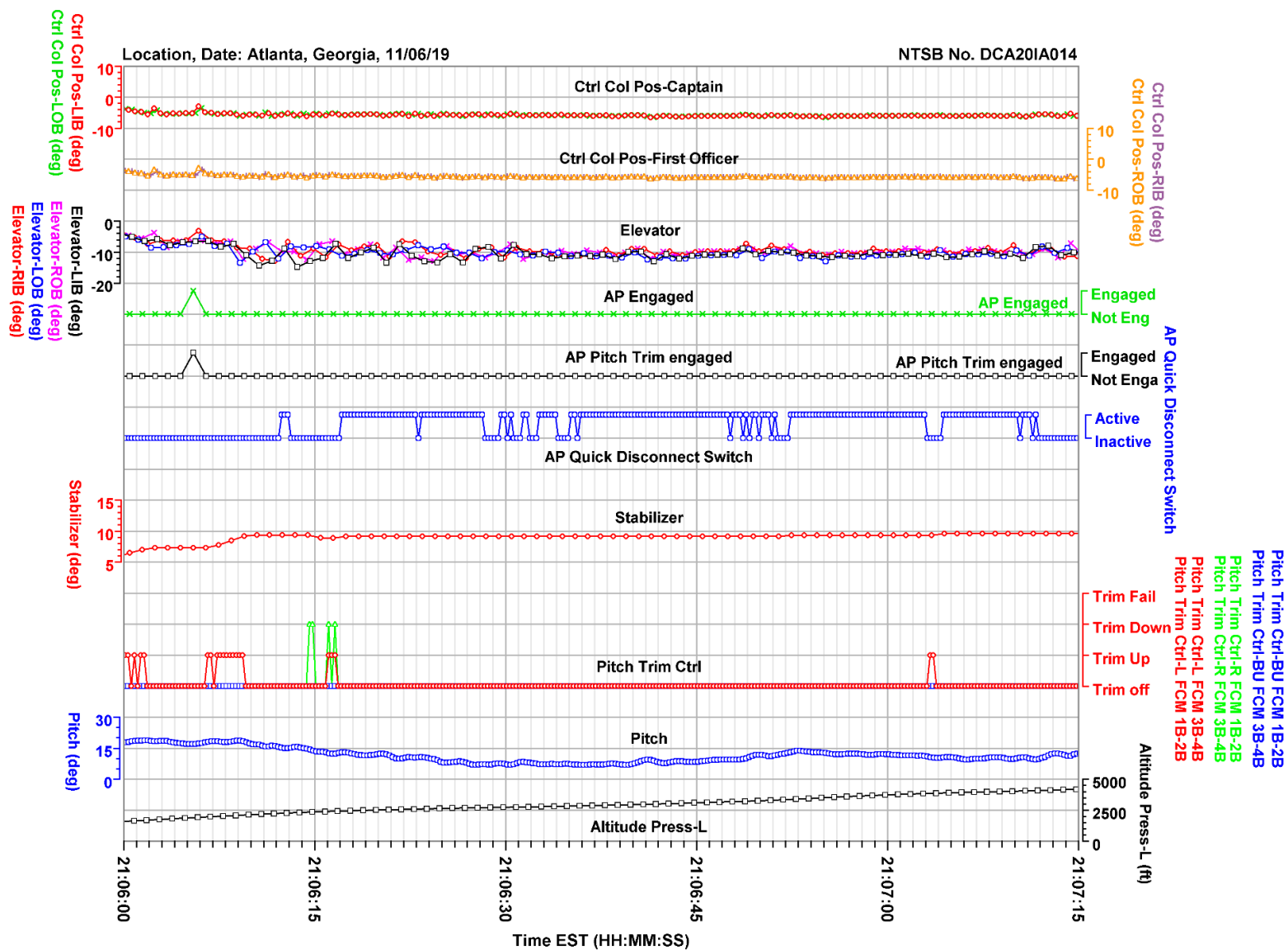
Figure 3. Plot of basic parameters expanded to show event detail.



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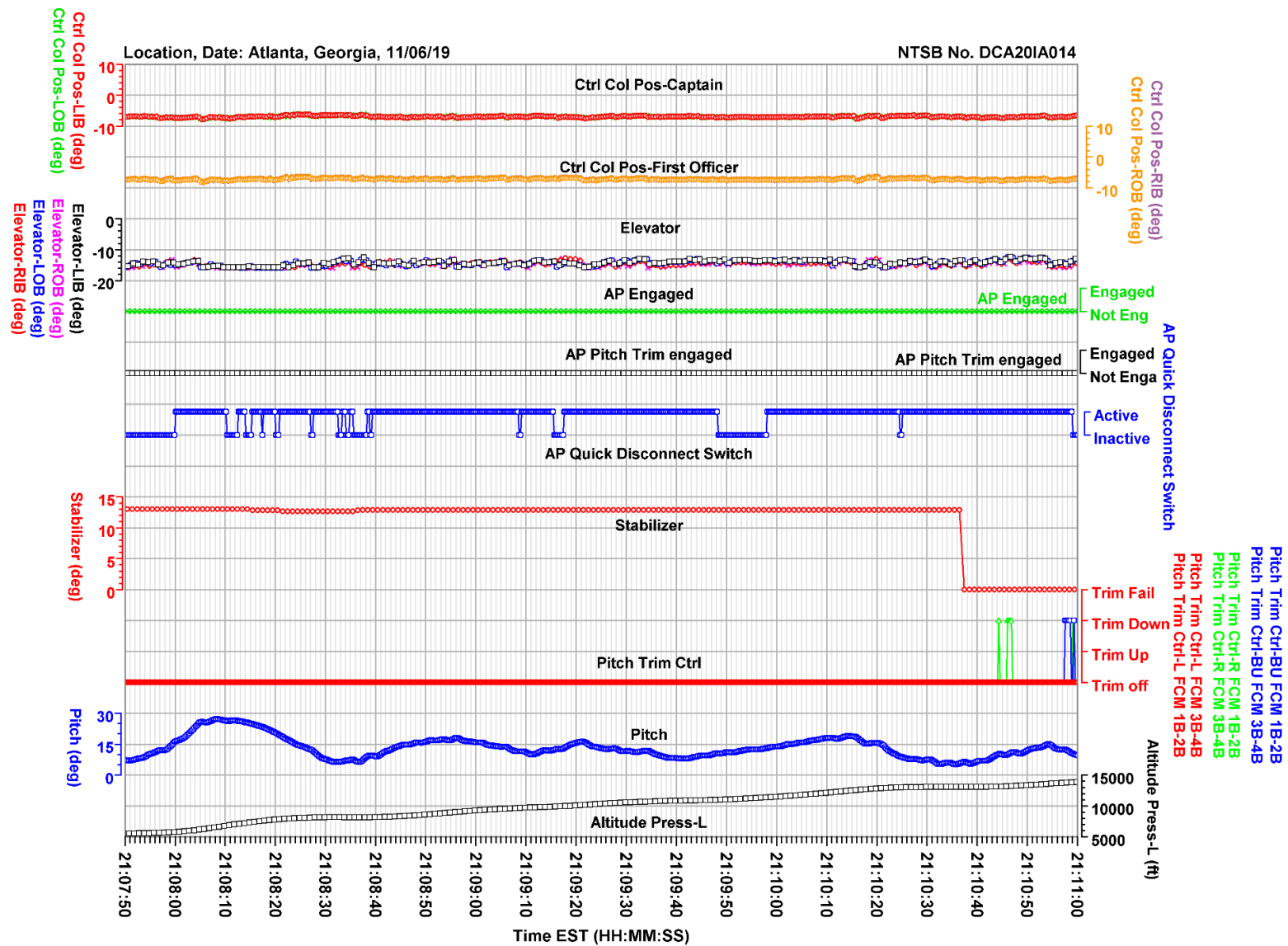
Figure 4. Plot of control parameters expanded to show event detail.



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Figure 5. Plot of autopilot and stabilizer functions for a portion of the event flight.



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Figure 6. Plot of autopilot and stabilizer functions for a following portion of the event flight.

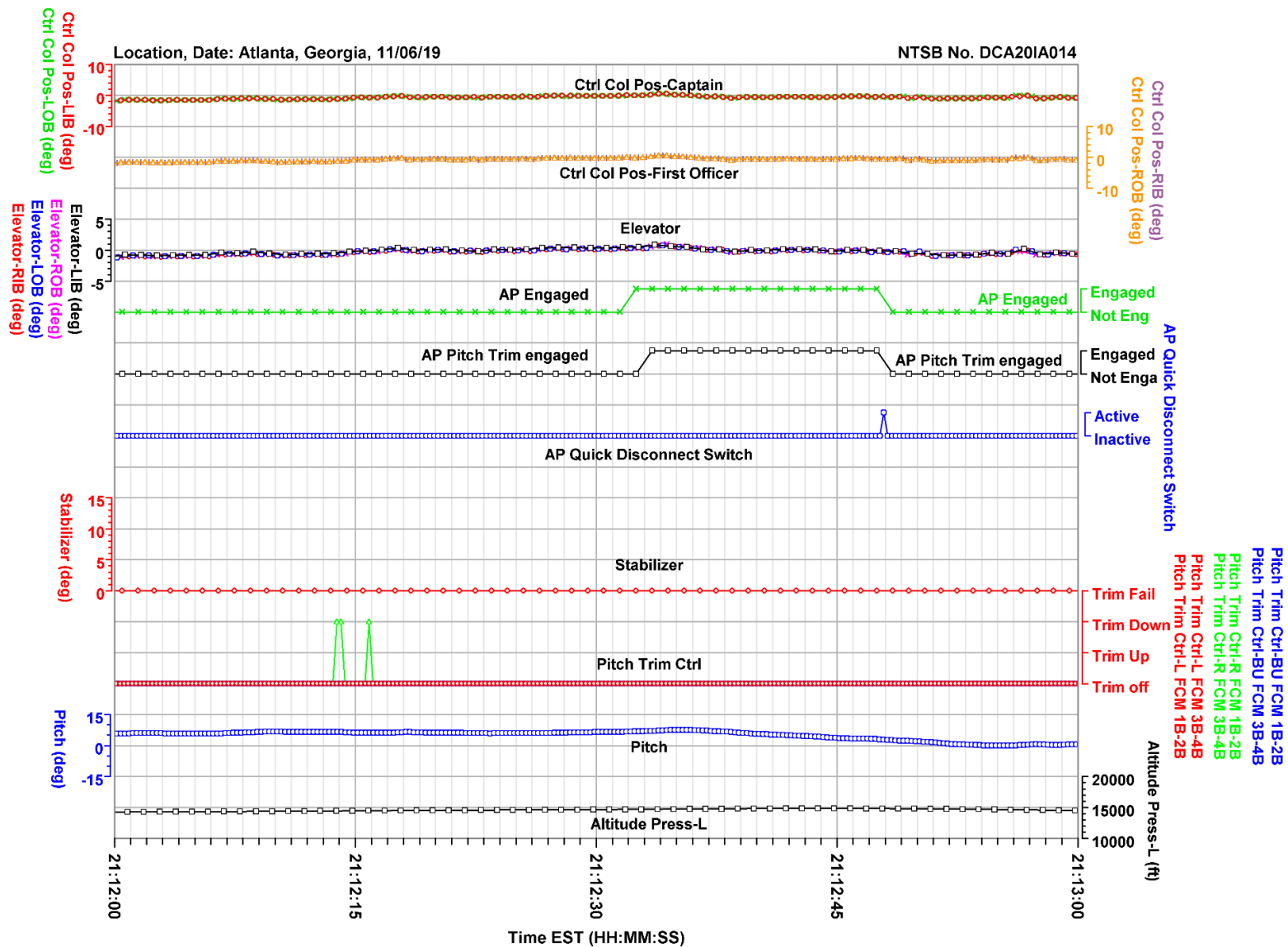


Figure 7. Plot of autopilot and stabilizer functions for a third portion of the event flight.

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-1. Verified and provided FDR parameters.

Plot/Table Labels	Parameter Names	Units
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Air/Gnd Sensor	Air/Ground Sensor	
Airspeed Cal	Calibrated Airspeed	kts
Altitude Press	Pressure Altitude	ft
AP Engaged	Autopilot Engaged	
AP Pitch Trim Engaged	Autopilot Pitch Trim Engaged	
AP Quick Disconnect Switch	Autopilot Quick Disconnect Switch	
AP/FD Lateral Mode Selected	Autopilot/Flight Director Lateral Mode Selected	
AP/FD Vertical Mode Selected	Autopilot/Flight Director Vertical Mode Selected	
Ctrl Col Force	Control Column Force	lbf
Ctrl Col Pos	Control Column Position	deg
Elevator	Elevator Position	deg
Heading Mag	Magnetic Heading	deg
Latitude	Latitude Position	deg
Longitude	Longitude Position	deg
Master Caution Lmp	Master Caution Lamp	
Pitch	Pitch Angle	deg
Pitch Trim Ctrl-BU	Pitch Trim Control Switch - Backup	
Pitch Trim Ctrl-L	Pitch Trim Control Switch - Captain	
Pitch Trim Ctrl-R	Pitch Trim Control Switch - First Officer	
Roll	Roll Angle	deg
Stabilizer	Stabilizer Position	deg
Time GMT Hrs	Greenwich Mean Time Hours	hrs
Time GMT Min	Greenwich Mean Time Minutes	min
Time GMT Sec	Greenwich Mean Time Seconds	sec

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 and discrete abbreviations.

Unit and discrete Abbreviations	Descriptions
deg	degrees
kts	knots
g	g
in	inches
FCM	Flight Control Module
ft	feet

Unit and discrete Abbreviations	Descriptions
hrs	hours
lbf	pounds force
LIB	left inboard
LOB	left outboard
min	minutes
RIB	right inboard
ROB	right outboard
sec	seconds