

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

May 8, 2018

Flight Data Recorder

Specialist's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: International Waters
Date: August 31, 2016
Aircraft: Boeing 767-322
Registration: N657UA
Operator: United Airlines
NTSB Number: DCA16CA220

On August 31, 2016, at 0210 Universal Coordinated Time (UTC) a Boeing 767-322, registration N657UA, operated by United Airlines as flight 880, encountered turbulence during cruise that resulted in one flight attendant sustaining a serious injury. Another flight attendant and 10 passengers, including one infant, received minor injuries. There were no injuries to the other passengers and crew aboard and the airplane was not damaged. The flight was operating under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 121 as a regularly scheduled passenger flight from the George Bush Intercontinental Airport (KIAH), Houston, Texas to the London-Heathrow Airport (EGLL), United Kingdom. The flight diverted to the Shannon Airport, Ireland (EINN) and landed safely.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR Carriage Requirements

The event aircraft, N657UA, was manufactured in 1993, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 34 parameters, as cited in 14 CFR Part 121.344(d).

4. DETAILS OF FDR INVESTIGATION

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

Recorder Manufacturer/Model: **Honeywell 4700**
Recorder Serial Number: **6539**

4.1. Honeywell 4700 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 event flight was the last flight of the recording and its duration was approximately 8 hours and 24 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 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.

4.1.3.1. Non-Computed Data Pattern

A non-computed data (NCD) pattern is indicative that the raw data for a given parameter is no longer reliable or not available. When the aircraft is on the ground, computed airspeed and wind direction true recorded a NCD pattern.

4.2. Time Correlation

Correlation of the FDR data from SRN to Coordinated Universal Time (UTC) was established by using the recorded Time GMT² hours, Time GMT Minutes, and Time GMT Seconds. Accordingly, the time offset for the event flight data from SRN to UTC is the following: UTC = SRN – 6,176. Therefore, for the rest of this report, all times are referenced as UTC, not SRN.

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 UTC.

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 to 6 contain FDR data recorded during the event on August 31, 2016. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, Time GMT Seconds, Latitude and Longitude.

Figures 1 and 4 contain the basic parameters. Figures 2 and 5 contain flight control parameters and select weather parameters. Lastly, figures 3 and 6 contain select autopilot parameters.

Figures 1 to 3 cover the entire flight from 20:15:00 UTC on August 30, 2016 to the end of the recording at 04:55:11 UTC on August 31, 2016 (the x-axis ends at 05:00:00 UTC). Figures 4 to 6 have an expanded scale from 02:07:00 UTC to 02:15:00 UTC focusing on the large vertical acceleration excursion.

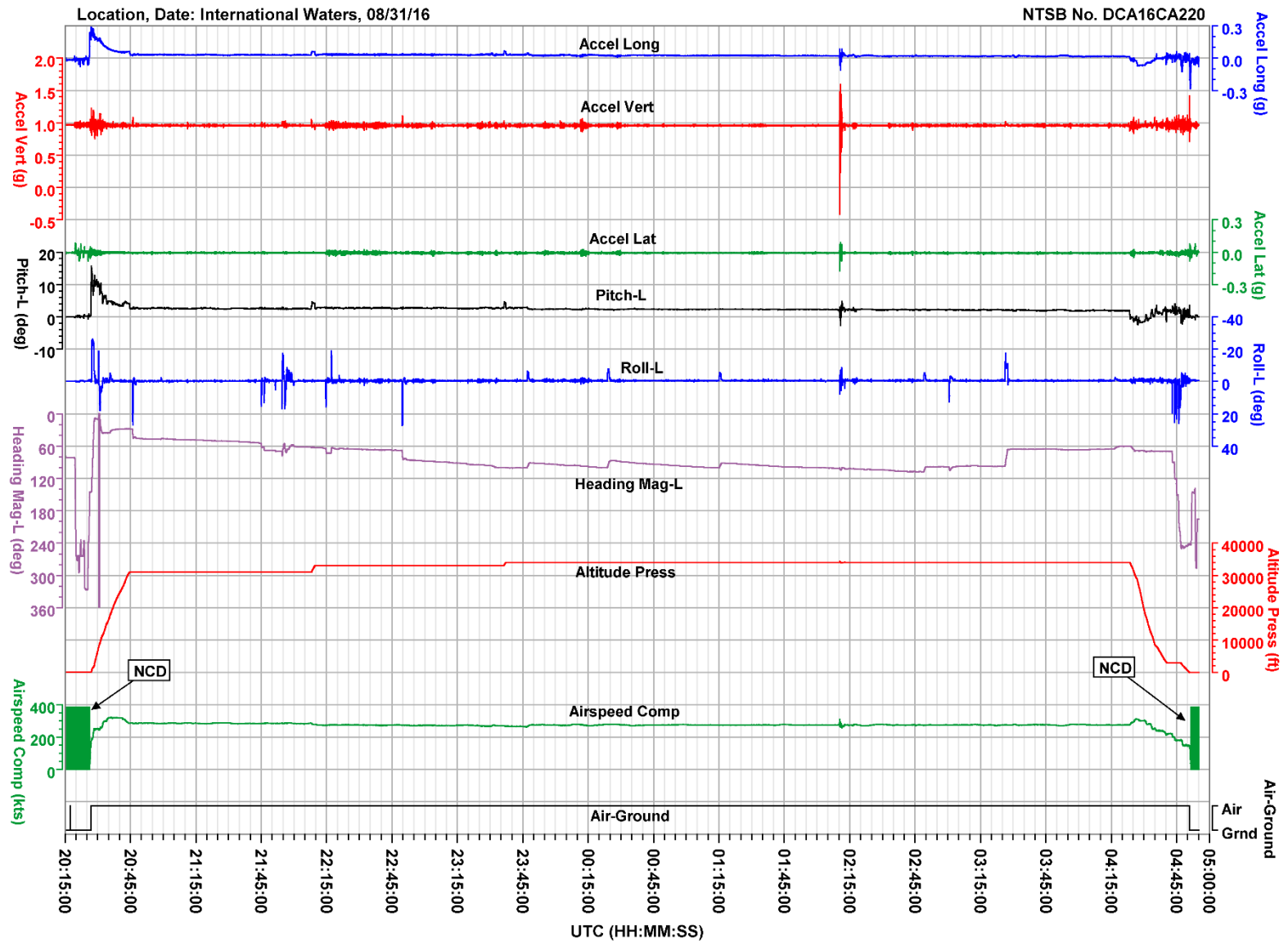
These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The FDR data indicated at 02:10:28 UTC³ (about 5 hours and 43 minutes after takeoff) until 02:11:50 UTC, there were vertical acceleration variations ranging between 1.60 g's and -0.41 g's before settling to about 1 g. During this time, the pressure altitude started at approximately 34,000 feet (ft) and varied between a maximum value of 34,302 ft and a minimum value of 33,805 ft before returning to approximately 34,000 ft. At 04:23:40 UTC, about 2 hours and 13 minutes after the start of the vertical acceleration variations, the aircraft began its descent from 34,000 ft. Approximately 27 minutes later at 04:51:01 UTC, the aircraft landed.

The corresponding tabular data used to create figures 1 to 6, including Time GMT Hours, Time GMT Minutes, Time GMT Seconds, Latitude, and Longitude, are provided in electronic comma separated value (*.csv) format as attachment 1 to this report.

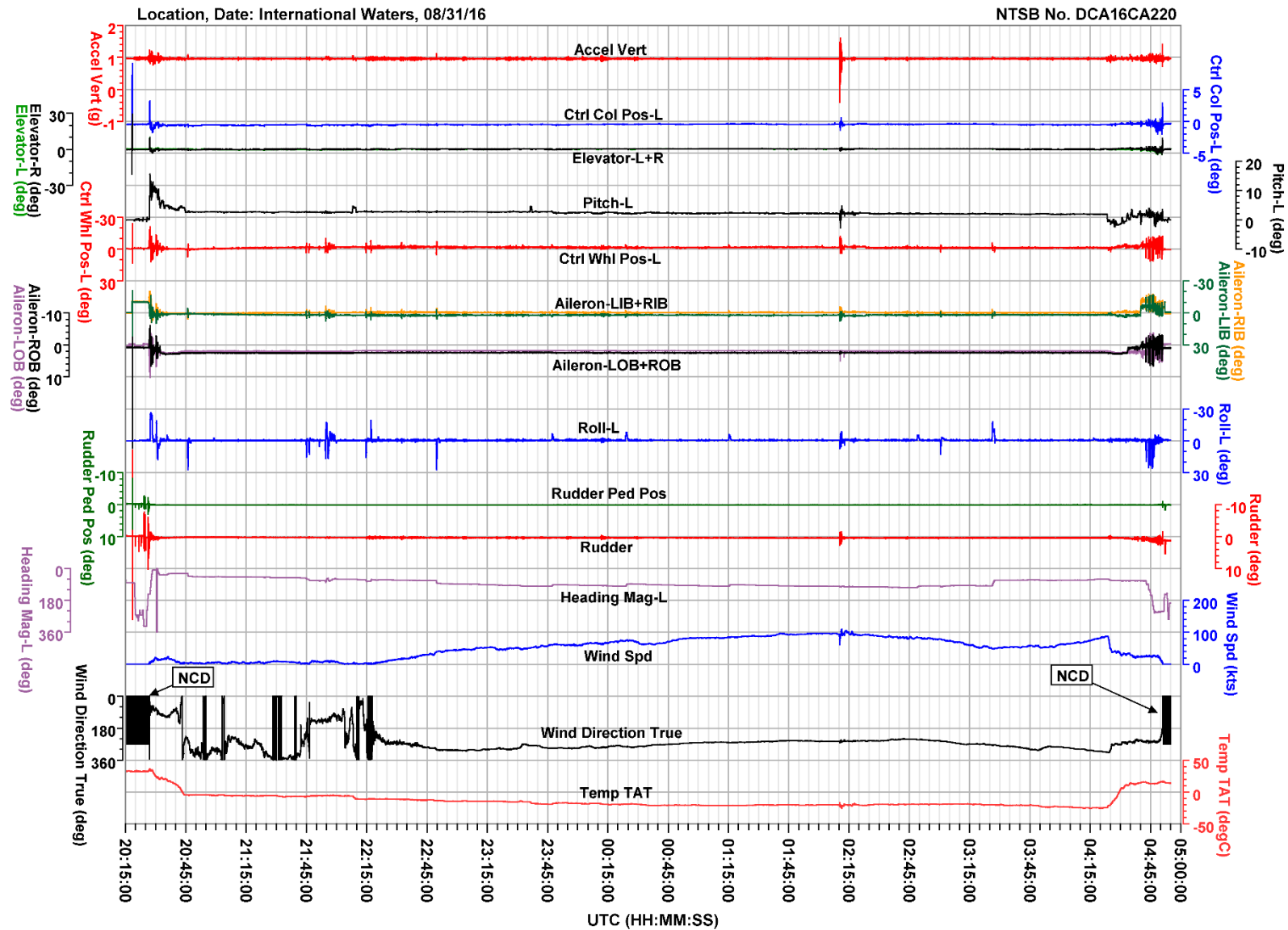
³ At 02:10:28 UTC, the recorded latitude and longitude positions were 46° 12' 18.84" North and 38° 31' 33.47" West.

Figure 1. Plot of basic parameters during entire flight.



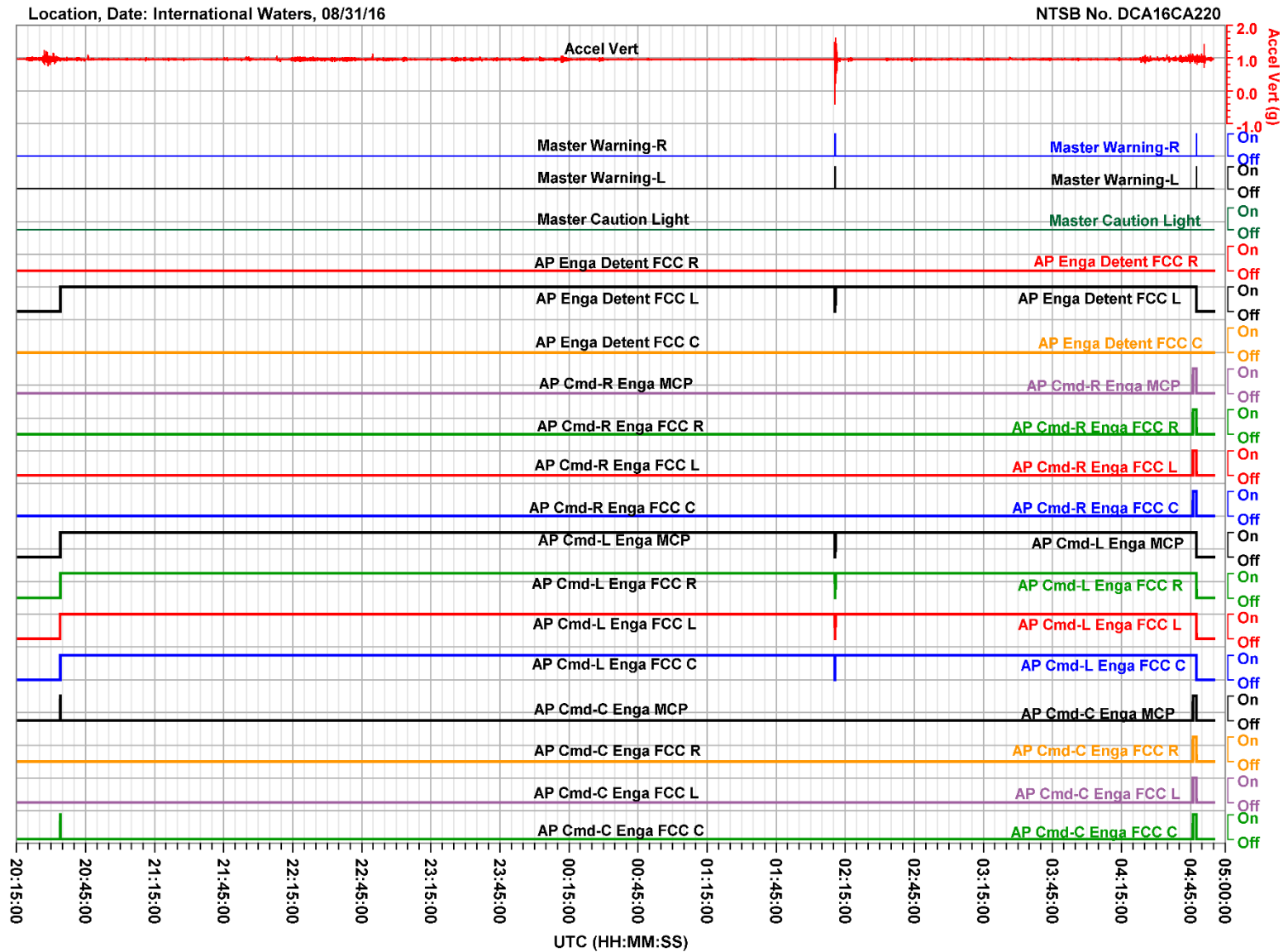
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Figure 2. Plot of flight control parameters and select weather parameters during entire flight.



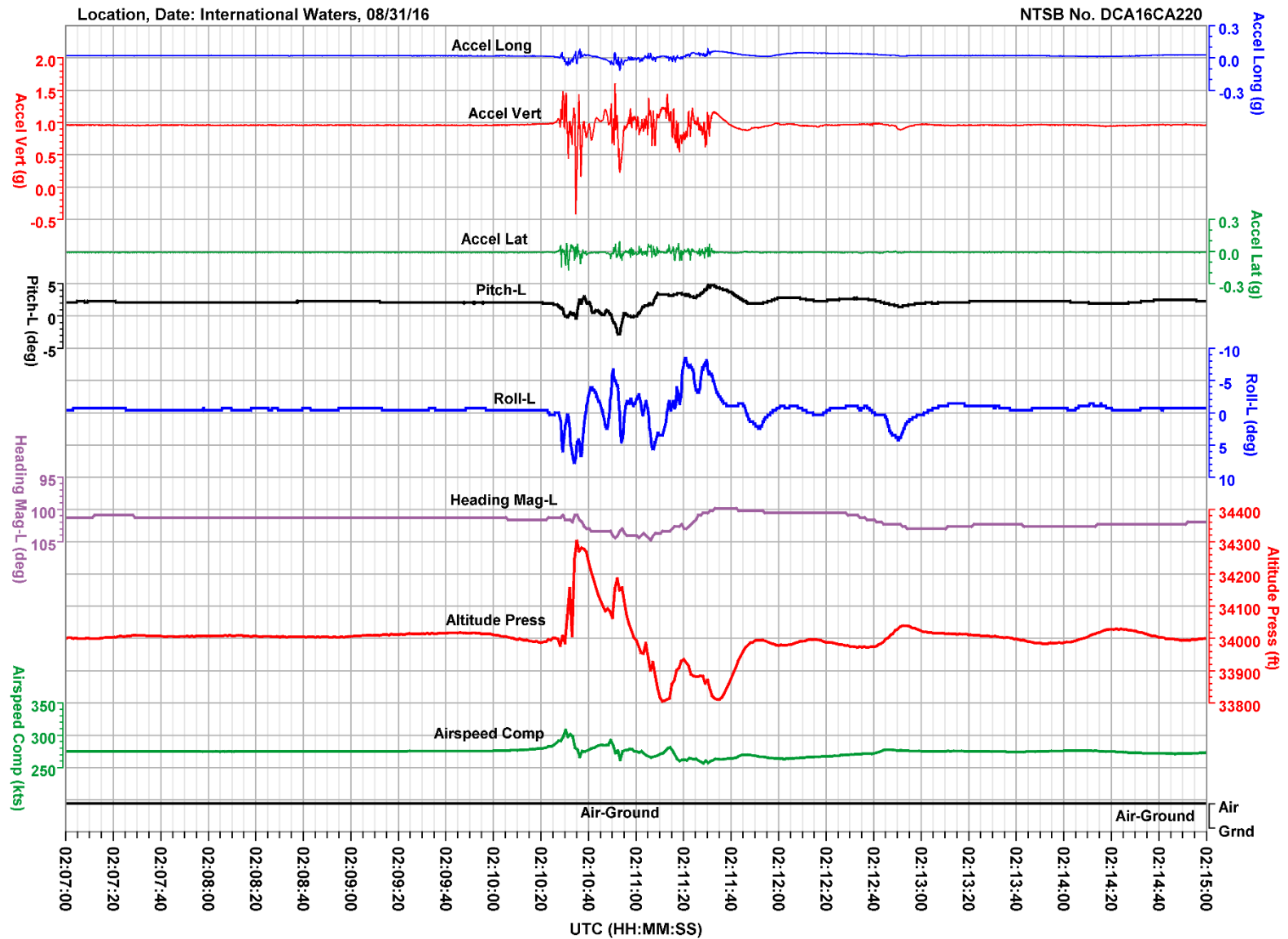
National Transportation Safety Board

Figure 3. Plot of select autopilot parameters during entire flight.



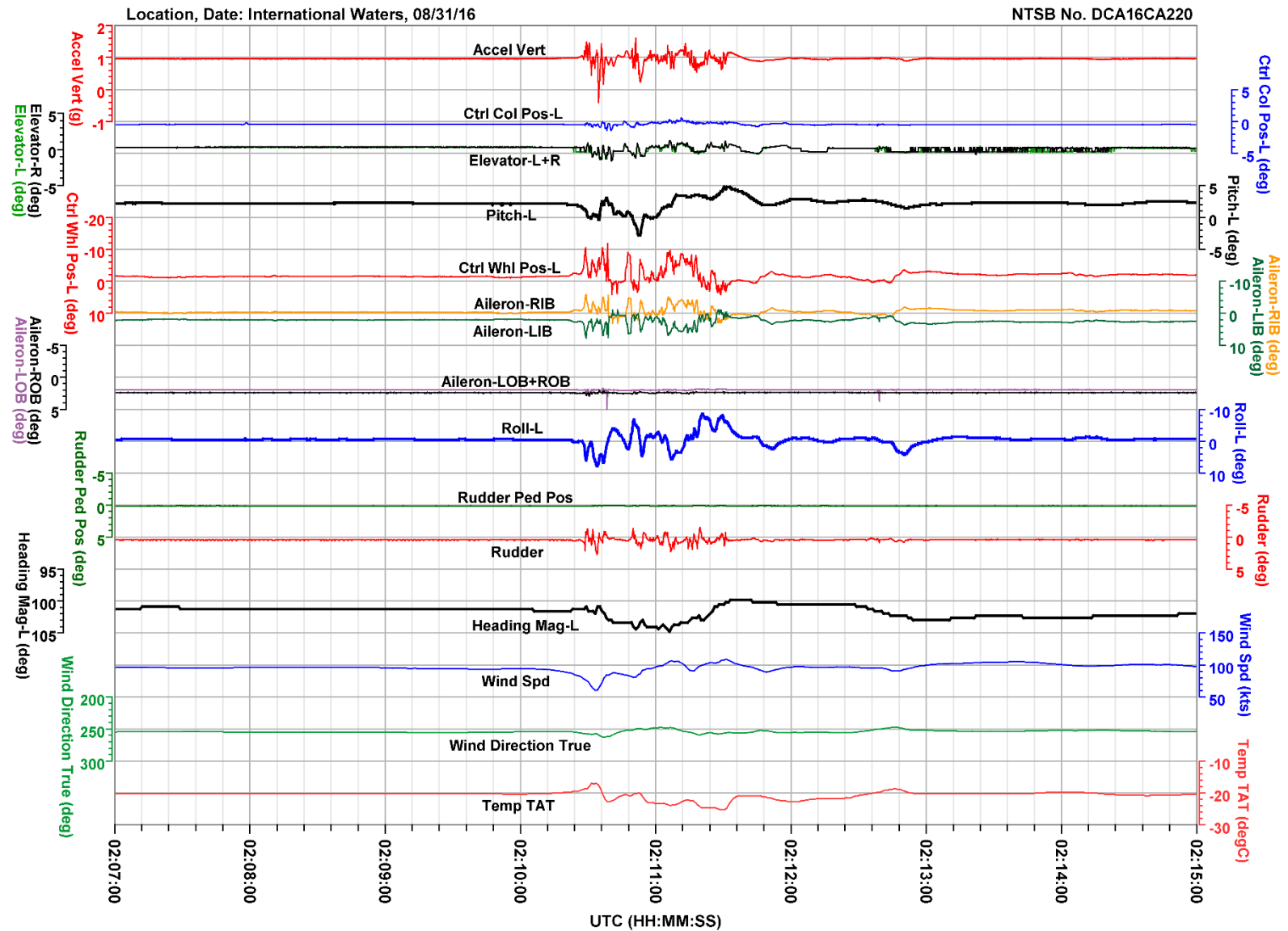
National Transportation Safety Board

Figure 4. Plot of basic parameters with expanded scale at event.



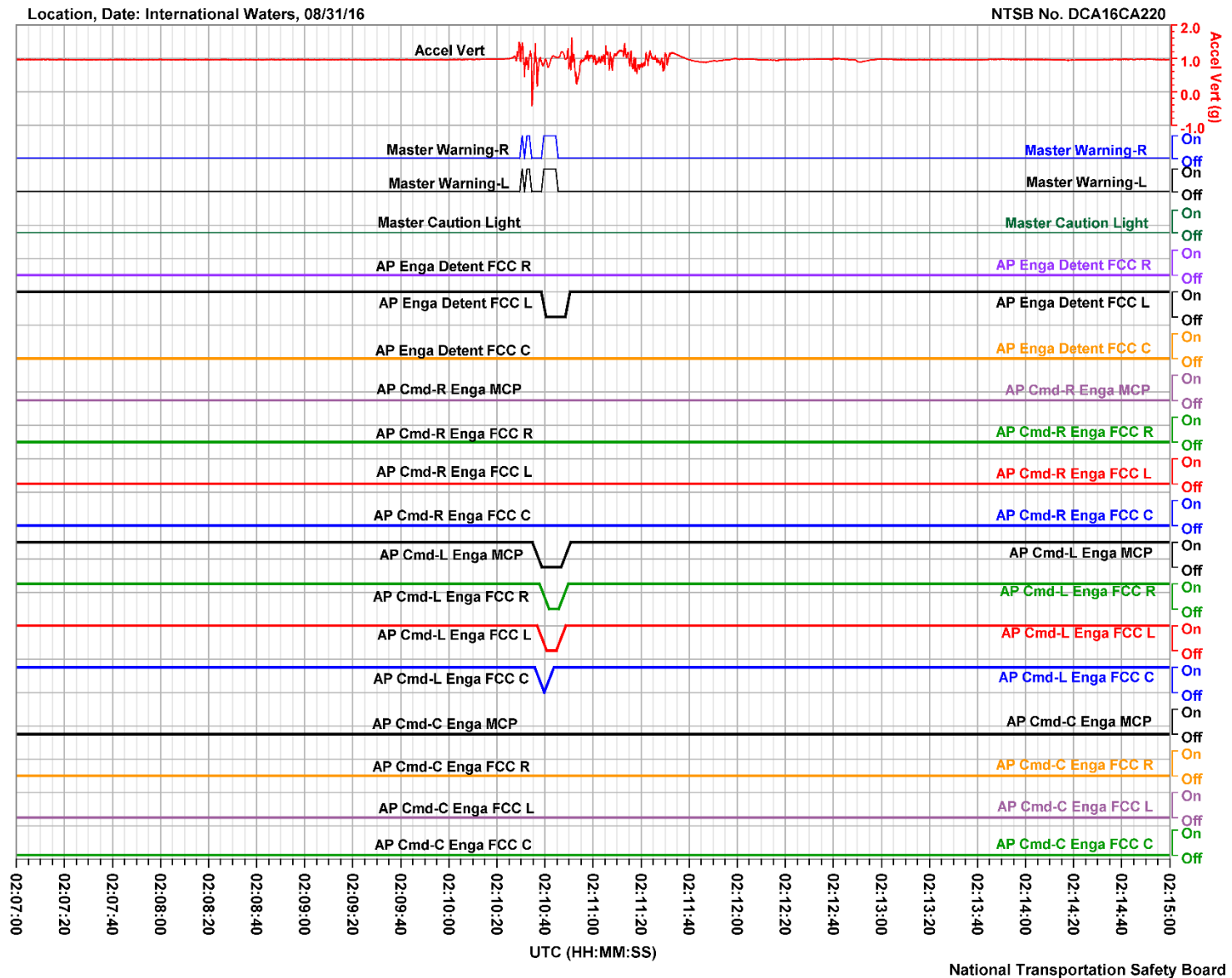
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Figure 5. Plot of flight control parameters and select weather parameters with expanded scale at event.



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Figure 6. Plot of select autopilot parameters with expanded scale at 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-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
Aileron-LIB	Aileron Position - Left Inboard	deg
Aileron-LOB	Aileron Position - Left Outboard	deg
Aileron-RIB	Aileron Position - Right Inboard	deg
Aileron-ROB	Aileron Position - Right Outboard	deg
Air-Ground	Air to Ground	
Airspeed Comp	Computed Airspeed	kts
Altitude Press	Pressure Altitude	ft
AP Cmd-C Enga FCC C	Autopilot Command - Center Engaged Flight Control Computer Center	
AP Cmd-C Enga FCC L	Autopilot Command - Center Engaged Flight Control Computer Left	
AP Cmd-C Enga FCC R	Autopilot Command - Center Engaged Flight Control Computer Right	
AP Cmd-C Enga MCP	Autopilot Command - Center Engaged Mode Control Panel	
AP Cmd-L Enga FCC C	Autopilot Command - Left Engaged Flight Control Computer Center	
AP Cmd-L Enga FCC L	Autopilot Command - Left Engaged Flight Control Computer Left	
AP Cmd-L Enga FCC R	Autopilot Command - Left Engaged Flight Control Computer Right	
AP Cmd-L Enga MCP	Autopilot Command - Left Engaged Mode Control Panel	
AP Cmd-R Enga FCC C	Autopilot Command - Right Engaged Flight Control Computer Center	
AP Cmd-R Enga FCC L	Autopilot Command - Right Engaged Flight Control Computer Left	
AP Cmd-R Enga FCC R	Autopilot Command - Right Engaged Flight Control Computer Right	
AP Cmd-R Enga MCP	Autopilot Command - Right Engaged Mode Control Panel	
AP Enga Detent FCC C	Autopilot Engaged Detent Flight Control Computer Center	
AP Enga Detent FCC L	Autopilot Engaged Detent Flight Control Computer Left	
AP Enga Detent FCC R	Autopilot Engaged Detent Flight Control Computer Right	
Ctrl Col Pos-L	Control Column Position - Left	deg
Ctrl Whl Pos-L	Control Wheel Position - Left	deg
Elevator-L	Elevator Position - Left	deg
Elevator-R	Elevator Position - Right	deg
Heading Mag-L	Magnetic Heading - Left	deg
Latitude	Latitude Position	deg
Longitude	Longitude Position	deg
Master Caution Light	Master Caution Light	
Master Warning-L	Master Warning - Left	
Master Warning-R	Master Warning - Right	
Pitch-L	Pitch Angle - Left	deg
Roll-L	Roll Angle - Left	deg
Rudder	Rudder Position	deg
Rudder Ped Pos	Rudder Pedal Position	deg
Temp TAT	Total Air Temperature	degC
Time GMT Hrs	Greenwich Mean Time Hours	hrs
Time GMT Min	Greenwich Mean Time Minutes	min

Plot/Table Labels	Parameter Names	Units
Time GMT Sec	Greenwich Mean Time Seconds	sec
Wind Direction True	Wind Direction True	deg
Wind Spd	Wind Speed	kts

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
degC	degrees Celsius
ft	feet
Grnd	Ground
hrs	hours
kts	knots
min	minutes
sec	seconds