

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

November 8, 2019

## **Quick Access Recorder**

**Specialist's Factual Report**  
**By Cassandra Johnson**

### **1. EVENT SUMMARY**

Location: Waco, Texas  
Date: August 17, 2016  
Aircraft: Boeing 737-924  
Registration: N37408  
Operator: United Airlines  
NTSB Number: DCA16LA214

On August 17, 2016, about 1215 central daylight time (CDT), United Airlines flight 1945, a Boeing 737-924, registration N37408, encountered moderate turbulence at flight level 290 near Waco, Texas while on descent to land at George Bush Intercontinental Airport, Houston, Texas. One flight attendant received a serious injury. The scheduled domestic passenger flight operated under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121 was en route from Seattle-Tacoma International Airport, Seattle, Washington to Houston, Texas.

### **2. QUICK ACCESS RECORDER GROUP**

A quick access recorder (QAR) group was not convened.

### **3. FLIGHT DATA RECORDER CARRIAGE REQUIREMENTS**

The event aircraft, N37408, was manufactured in 2001, and was operating such that it was required to be equipped with a flight data recorder (FDR) that recorded, at a minimum, 57 parameters, as cited in 14 CFR Part 121.344.

### **4. DETAILS OF QAR INVESTIGATION**

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received an electronic file containing QAR data from the N37408 aircraft. The QAR contained the same data as recorded in the FDR.

#### **4.1. QAR File Description**

The QAR 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 QAR file only contained the event flight. Timing of the QAR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second.

#### **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=+).<sup>1</sup>

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

#### **4.2. Time Correlation**

Correlation of the QAR data from SRN to the event local time, CDT, was established by using the recorded Time GMT<sup>2</sup> 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 CDT is the following: CDT = SRN – 30,754. Therefore, for the rest of this report, all times are referenced as CDT, not SRN.

#### **4.3. QAR Plots and Corresponding Tabular Data**

Figures 1 to 4 contain QAR data recorded during the event on August 17, 2016. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, Time GMT Seconds, Latitude-IRU, and Longitude-IRU.

Figures 1 and 2 cover 1 hour and 3 minutes of the event flight from 11:40:00 CDT to 12:43:00 CDT. Figures 3 and 4 have an expanded scale from 12:11:00 CDT to 12:26:00 CDT focusing on the large vertical acceleration excursion.

Figures 1 and 3 contain basic parameters (lateral acceleration, longitudinal acceleration, vertical acceleration, pitch angle, roll angle, magnetic heading, computed airspeed, and pressure altitude), two autopilot command parameters, left and right control column positions, left and right microphone keying, and select weather parameters. Figures 2 and 4 contain select basic parameters and additional parameters.

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<sup>1</sup> 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 = +.

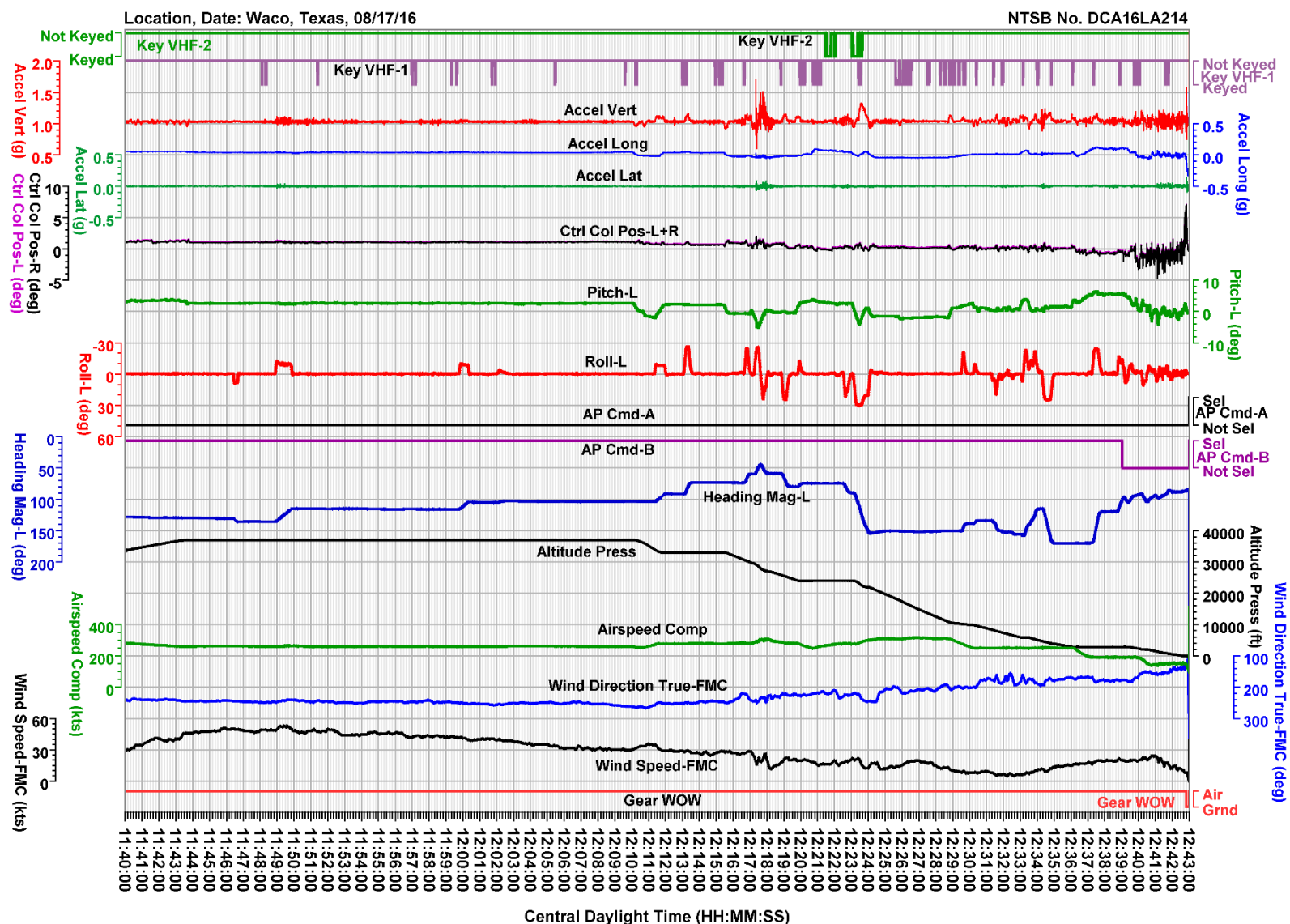
<sup>2</sup> GMT is Greenwich Mean Time which is also known as Coordinated Universal Time.

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.

In brief, the data indicated at approximately 12:17:21 CDT (about 28 minutes before touchdown) until about 12:18:19 CDT, there were vertical acceleration variations ranging between 1.70 g's and 0.60 g's before settling to about 1 g. During this time, the aircraft descended from a pressure altitude of about 29,100 feet (ft) to 26,710 ft while the autopilot command B (AP Cmd-B) was selected.

The corresponding tabular data used to create figures 1 to 4, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, Latitude-IRU, and Longitude-IRU, are provided in electronic comma separated value (\*.csv) format as attachment 1 to this report.

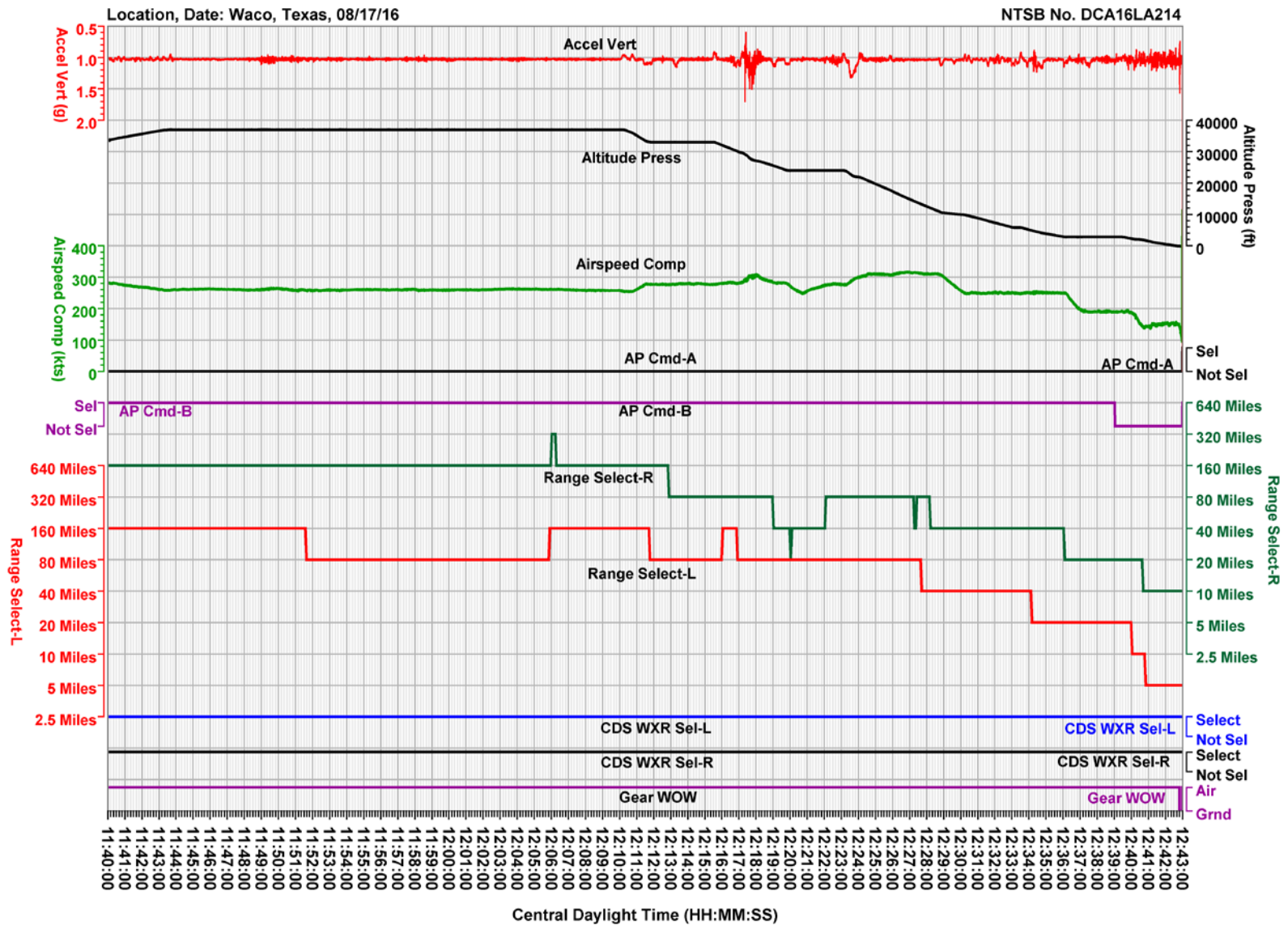
Figure 1. Plot of basic and select parameters from 11:40:00 CDT to 12:43:00 CDT.



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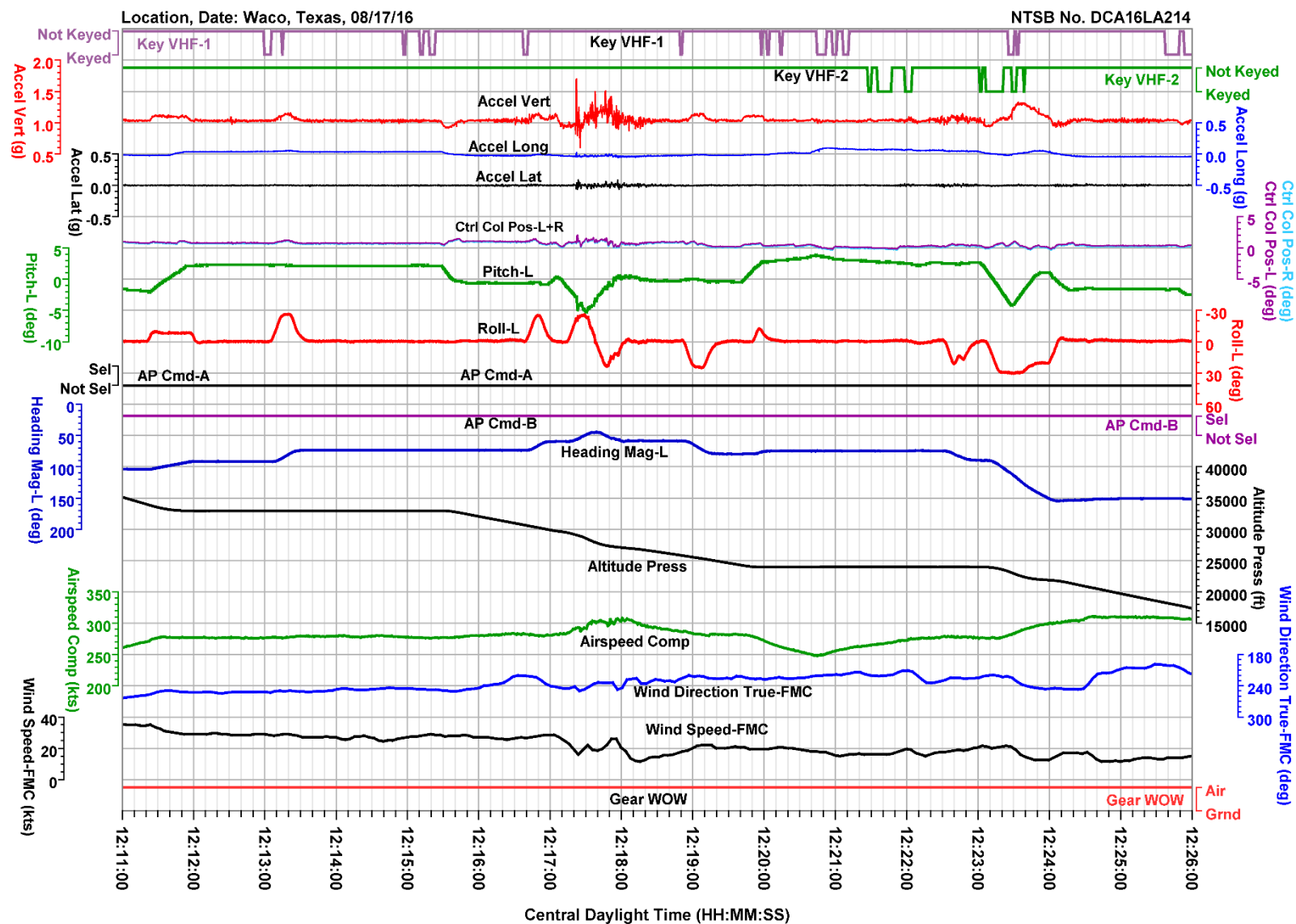
Figure 2. Plot of select basic parameters and additional parameters from 11:40:00 CDT to 12:43:00 CDT.



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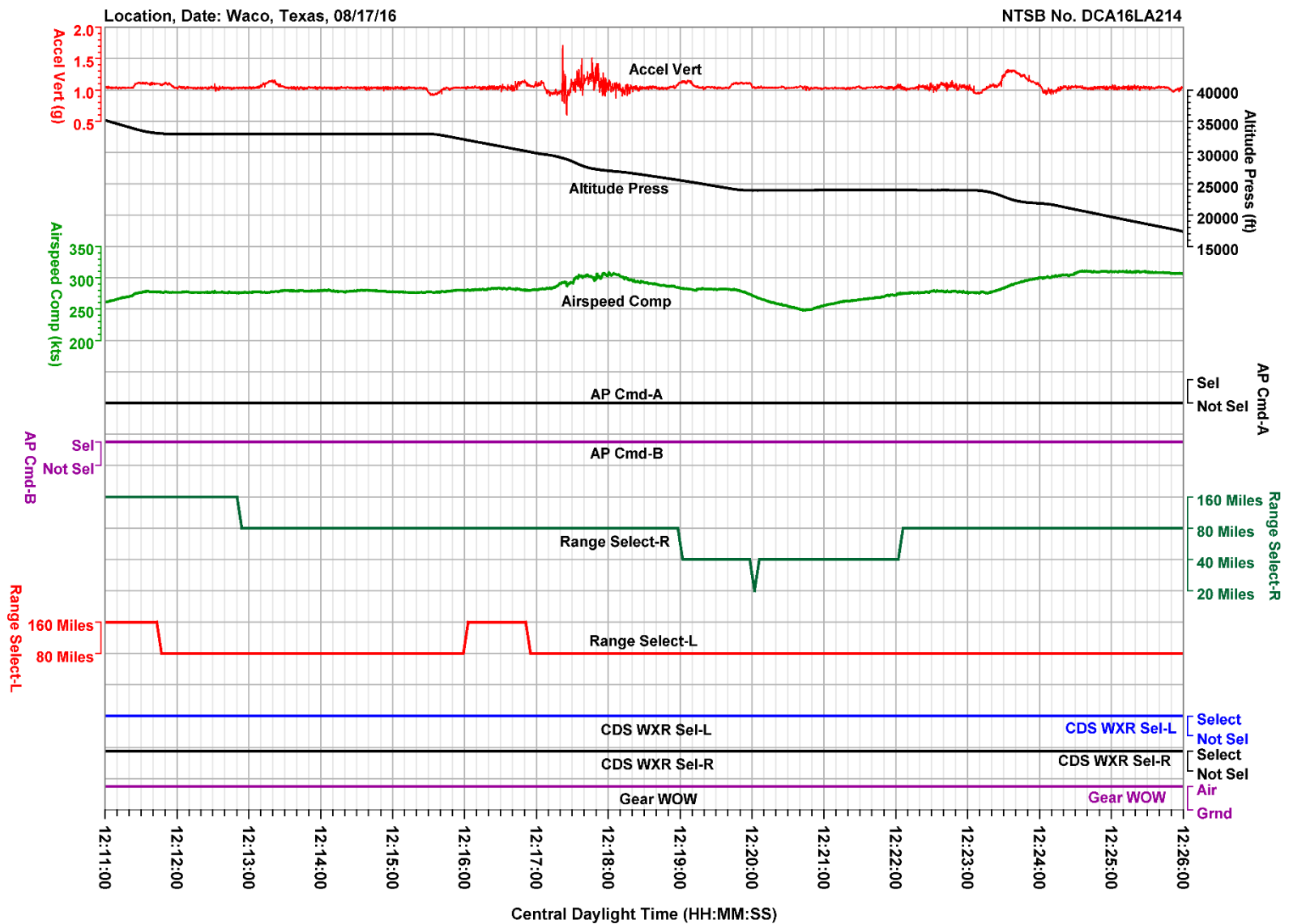
Figure 3. Plot of basic and select parameters from 12:11:00 CDT to 12:26:00 CDT.



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Figure 4. Plot of select basic parameters and additional parameters from 12:11:00 CDT to 12:26:00 CDT.



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## APPENDIX A

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

**Table A-1. Verified and provided QAR parameters.**

| Plot/Table Labels       | Parameter Names                                         | Units |
|-------------------------|---------------------------------------------------------|-------|
| 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 Cmd-A                | Autopilot Command-A                                     |       |
| AP Cmd-B                | Autopilot Command-B                                     |       |
| CDS WXR Sel-L           | Controls and Displays System Weather Select - Left      |       |
| CDS WXR Sel-R           | Controls and Displays System Weather Select - Right     |       |
| Ctrl Col Pos-L          | Left Control Column Position                            | deg   |
| Ctrl Col Pos-R          | Right Control Column Position                           | deg   |
| Gear WOW                | Weight on Wheels Gear                                   |       |
| Heading Mag-L           | Left Magnetic Heading                                   | deg   |
| Key VHF-1               | Microphone Keying-1                                     |       |
| Key VHF-2               | Microphone Keying-2                                     |       |
| Latitude-IRU            | Latitude Position - Source Inertial Reference Unit      | deg   |
| Longitude-IRU           | Longitude Position - Source Inertial Reference Unit     | deg   |
| Pitch-L                 | Pitch Angle                                             | deg   |
| Range Select-L          | Range Select - Left                                     |       |
| Range Select-R          | Range Select - Right                                    |       |
| Roll-L                  | Left Roll Angle                                         | deg   |
| Time Clock GMT Hrs      | Greenwich Mean Time Hours                               | hrs   |
| Time Clock GMT Min      | Greenwich Mean Time Minutes                             | min   |
| Time Clock GMT Sec      | Greenwich Mean Time Seconds                             | sec   |
| Wind Direction True-FMC | Wind Direction True - Source Flight Management Computer | deg   |
| Wind Speed-FMC          | Wind Speed - Source Flight Management Computer          | kts   |

NOTE: This QAR 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 QAR 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      |
| ft                              | feet         |
| g                               | acceleration |
| Grnd                            | Ground       |
| hrs                             | hours        |
| kts                             | knots        |
| min                             | minutes      |
| sec                             | seconds      |
| Sel                             | Select       |