

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

June 22, 2017

Flight Data Recorder

Specialist's Factual Report

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1. EVENT SUMMARY

Location: Minneapolis, Minnesota
Date: February 14, 2016
Aircraft: Airbus A319
Registration: N827AW
Operator: American Airlines
NTSB Number: DCA16CA089

On February 14, 2016, about 04:35 central standard time (CST), American Airlines flight 476, an Airbus A319, N827AW, encountered turbulence while descending to land. Because of the turbulence, one passenger who had gotten out of her seat to use the bathroom fell and received a fractured ankle. The remaining 99 passengers and crew were not injured. The airplane was not damaged. The regularly scheduled passenger flight was operating under the provisions of Title 14 *Code of Federal Regulations* Part 121 from Phoenix Sky Harbor International Airport (PHX), Phoenix, Arizona, to Minneapolis International Airport (MSP), Minneapolis, Minnesota.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR Carriage Requirements

The event aircraft, N827AW, was manufactured in 2001 and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 57 parameters as cited 14 CFR Part 121.344(e).

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received an electronic file containing the FDR data from the N827AW aircraft.

4.1. FDR Data File Description

The FDR data in the electronic file was configured such that 128 12-bit words of digital information were recorded every second. Each grouping of 128 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 128-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 only the event flight. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event flight was 3 hours and 25 minutes in duration. The parameters evaluated for the purpose of this report appeared to be in accordance with federal FDR carriage requirements.

4.1.2. Engineering Units Conversions

The engineering unit's 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.

4.1.2.1. 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. The following three parameters had NCD pattern: indicated airspeed, wind direction, and wind speed.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, CST, was established by using the recorded Time GMT² hours, Time GMT Minutes, and Time GMT Seconds and then subtracting an additional 6 hours to change GMT to CST.

Accordingly, the time offset for the event flight data from SRN to CST is the following: CST = SRN + 8,127. Therefore, for the rest of this report, all times are referenced as CST, not SRN.

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 to 6 contain FDR data recorded during the February 14, 2016 event. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, and Time GMT Seconds.

Figures 1 and 2 are an overlay of the aircraft's position using Google Earth. Figure 1 shows the entire flight. Figure 2 shows the aircraft's position for the entire flight including the aircraft's position at 04:25:21 CST while the aircraft was at a pressure altitude of 34,992 feet

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).

(ft). The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figures 3 and 5 contain the basic parameters (for example, vertical acceleration, lateral acceleration, longitudinal acceleration, pressure altitude, pitch, roll, magnetic heading, indicated airspeed), wind speed, wind direction,³ total air temperature (TAT), two autopilot parameters, and master warning. Figures 4 and 6 contain the flight control parameters.

Figures 3 and 4 cover the entire flight from 02:25:00 MDT to 05:00:00 MDT. Figures 5 and 6 have an expanded scale from 04:34:20 CST to 04:36:20 CST 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.

In brief, the data indicated at approximately 04:35:21 CST (about 2 hours and 36 minutes after takeoff) until 04:35:54 CST, there were vertical acceleration variations ranging between 1.69 g's and -0.05 g's before settling to about 0.9 g. During this time, the pressure altitude started at 32,464 ft and decreased to 31,508 ft. The autopilot 2 (AP-2) status transitioned from Engaged to Not Engaged at 04:35:23 CST and at 04:36:04 CST. At 04:35:24 CST the master warning transitioned from No Warn to Warn before it transitioned back to No Warn 6 seconds later at about 04:35:30. About 25 minutes later, the aircraft landed.

The corresponding tabular data used to create figures 1 to 6, 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.

³ Wind direction and wind speed are most likely inaccurate during the upset because wind algorithms assume steady-state conditions.

Figure 1. Google Earth overlay showing aircraft's position for entire flight.

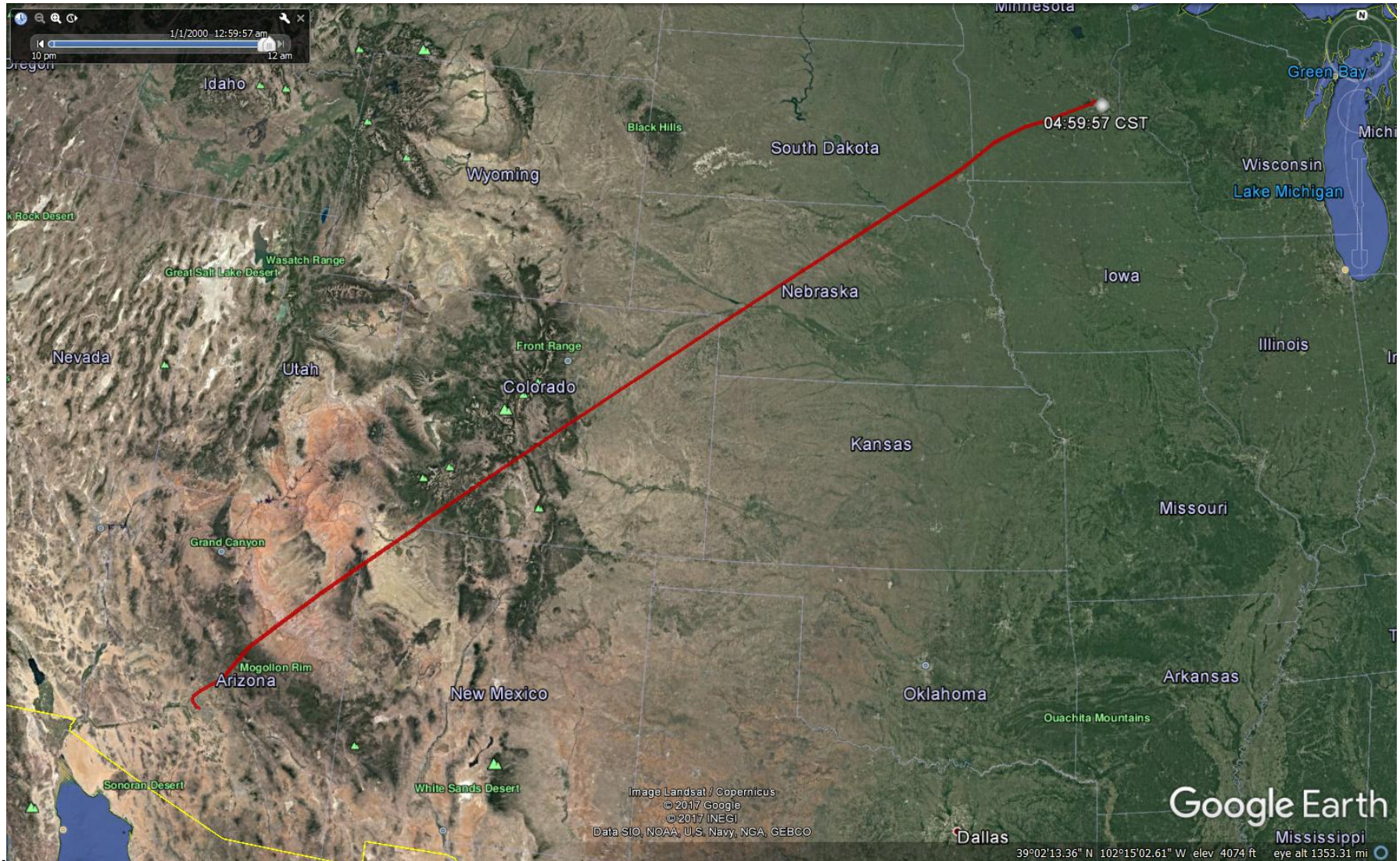


Figure 2. Google Earth overlay showing aircraft's position for the entire flight including the position at 04:25:21 CST.

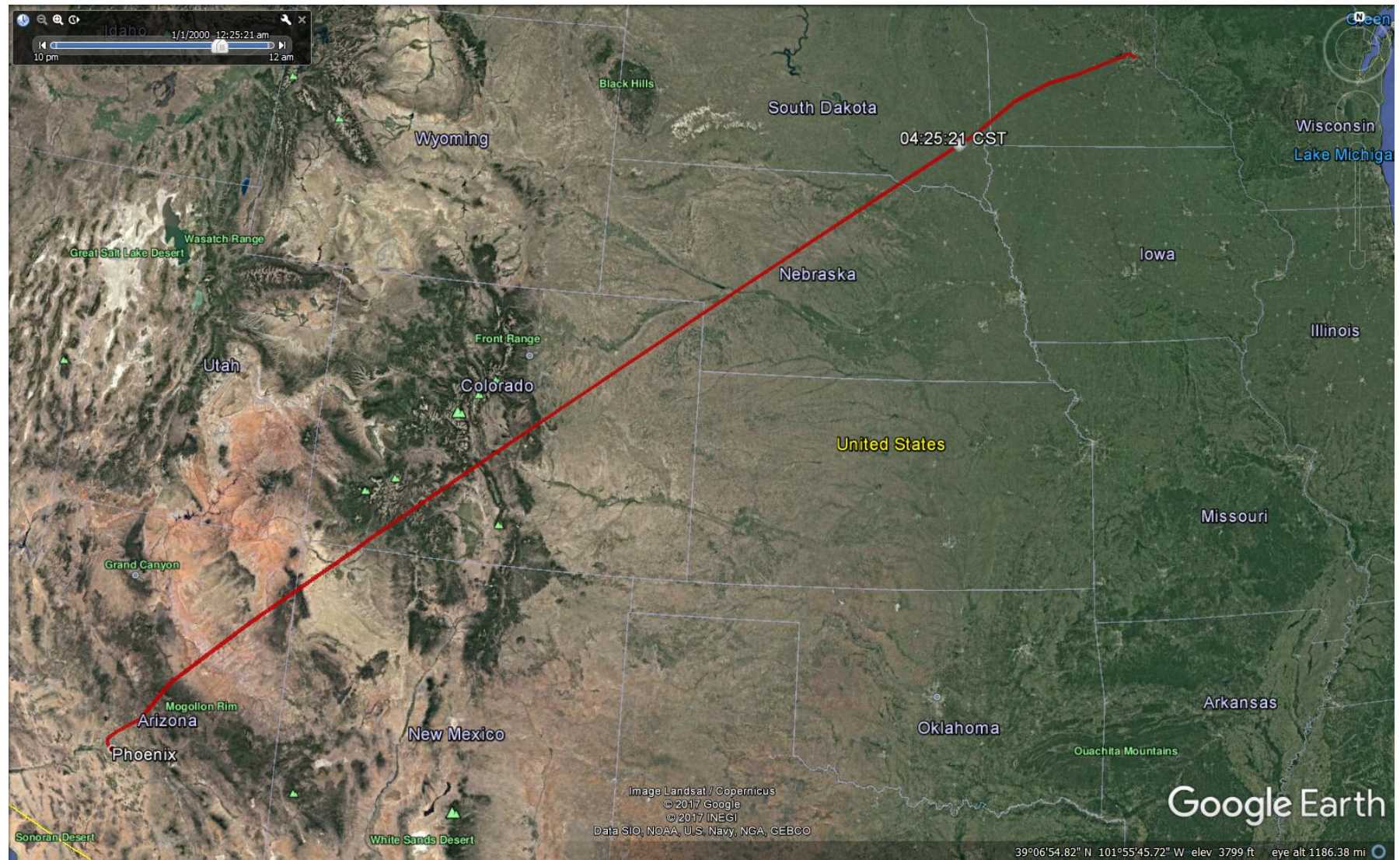
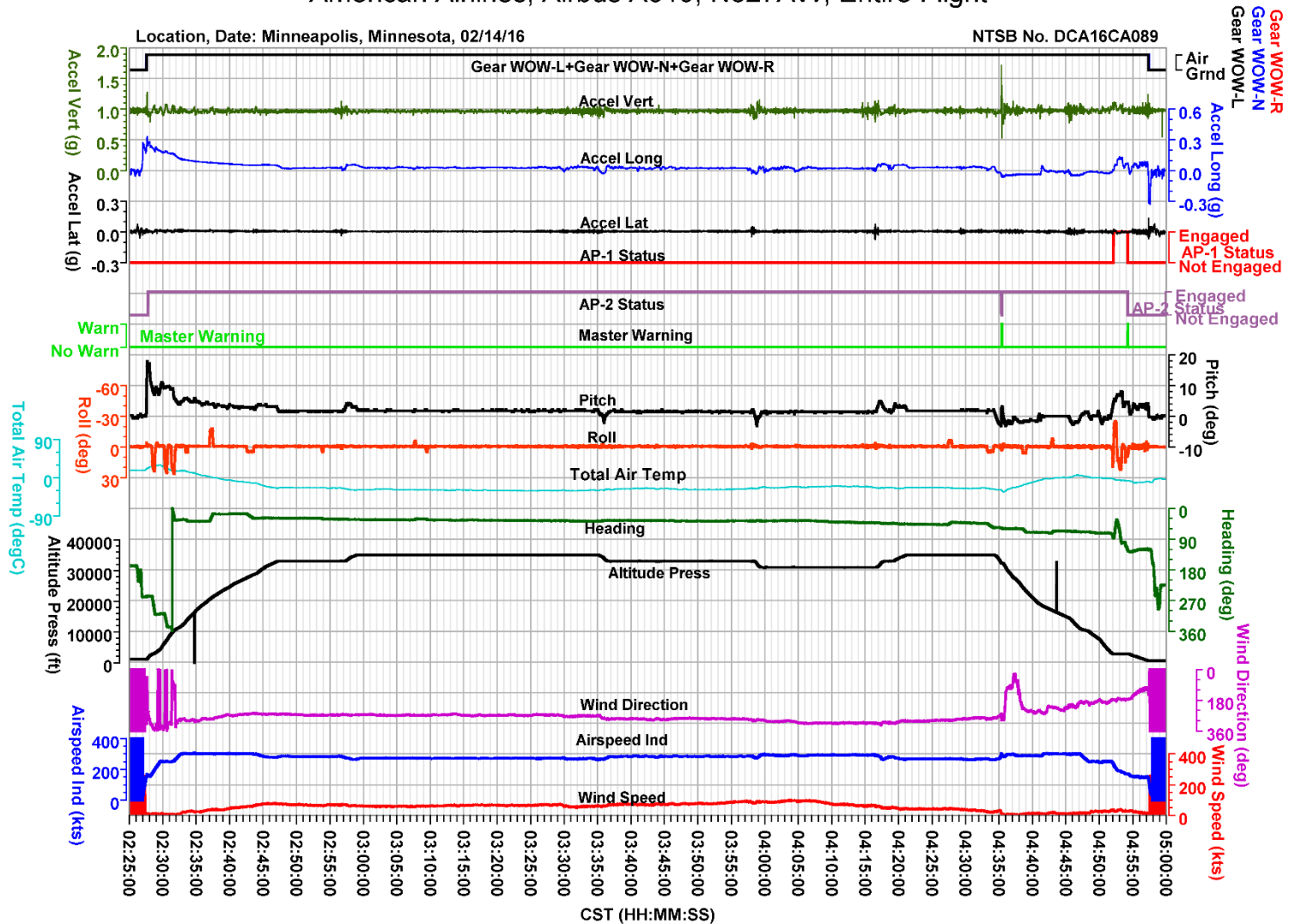


Figure 3. Plot of basic parameters during entire flight.
American Airlines, Airbus A319, N827AW, Entire Flight

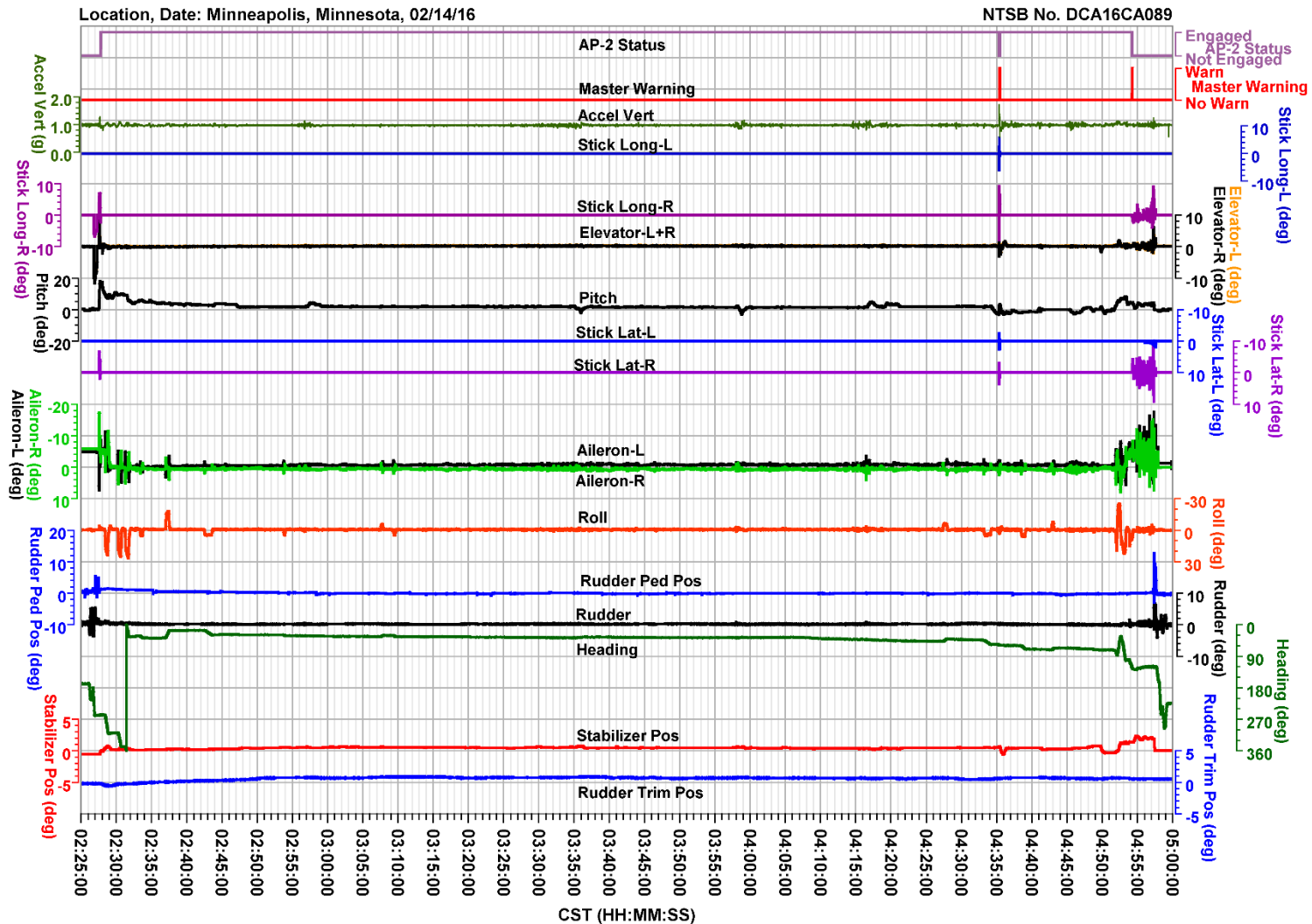


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Basic Parameters - Entire Flight

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Figure 4. Plot of flight control parameters during entire flight.
American Airlines, Airbus A319, N827AW, Entire Flight

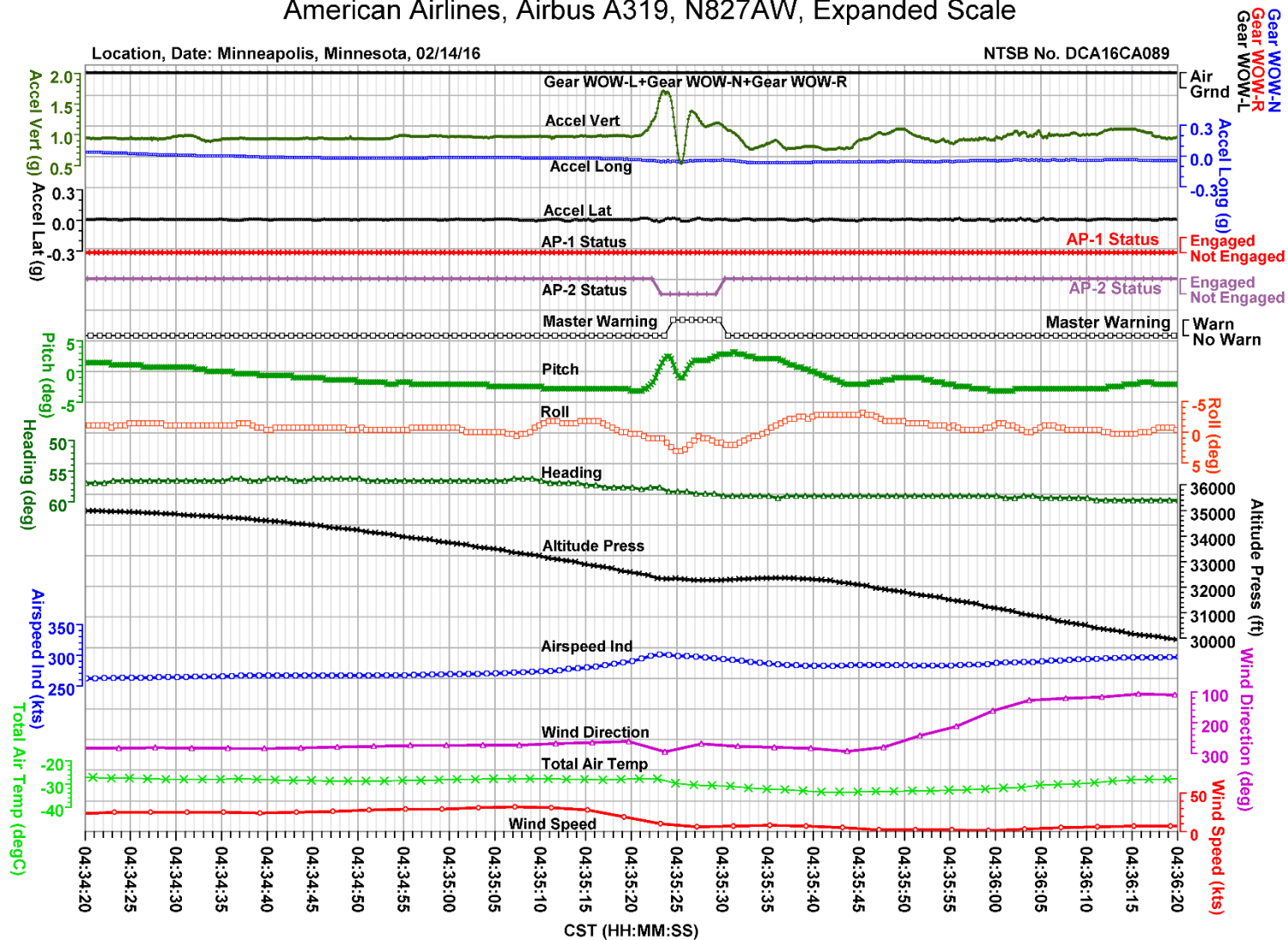


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Flight Control Parameters - Entire Flight

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Figure 5. Plot of basic parameters with expanded scale at event.
American Airlines, Airbus A319, N827AW, Expanded Scale



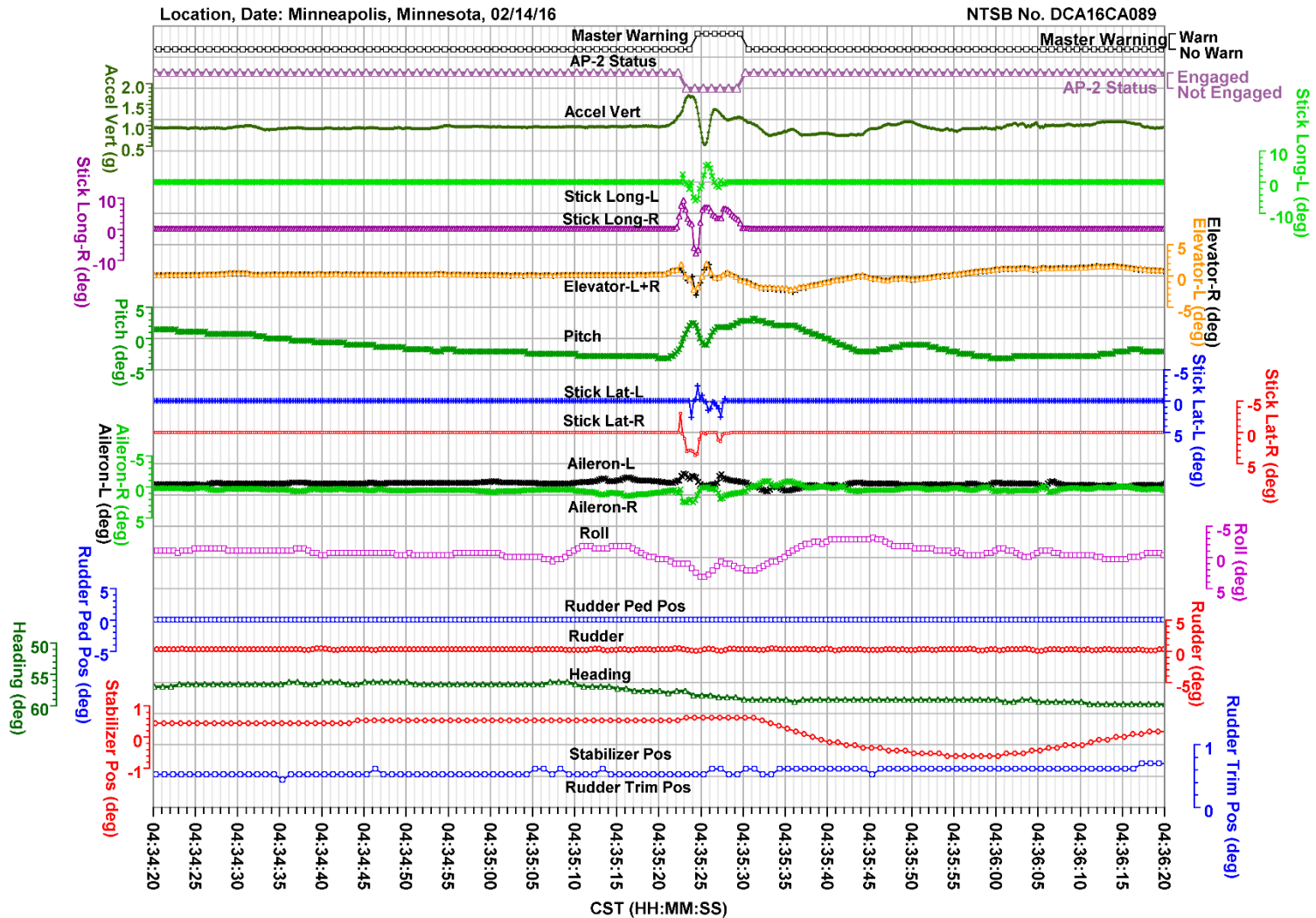
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Basic Parameters - Expanded Scale

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Figure 6. Plot of flight control parameters with expanded scale at event.

American Airlines, Airbus A319, N827AW, Expanded Scale



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Flight Control Parameters - Expanded Scale

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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. Table A-2 contains the unit abbreviations for the parameters.

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-L	Left Aileron Position	deg
Aileron-R	Right Aileron Position	deg
Airspeed Ind	Indicated Airspeed	kts
Altitude Press	Pressure Altitude	ft
AP-1 Status	Autopilot 1 Status	
AP-2 Status	Autopilot 2 Status	
Elevator-L	Left Elevator Position	deg
Elevator-R	Right Elevator Position	deg
Gear WOW-L	Left Main Landing Gear Weight on Wheels	
Gear WOW-N	Nose Gear Weight on Wheels	
Gear WOW-R	Right Main Landing Gear Weight on Wheels	
Heading	Magnetic Heading	deg
Latitude	Latitude Position	deg
Longitude	Longitude Position	deg
Master Warning	Master Warning	
Pitch	Pitch Angle	deg
Roll	Roll Angle	deg
Rudder	Rudder Position	deg
Rudder Ped Pos	Rudder Pedal Position	deg
Rudder Trim Pos	Rudder Trim Position	deg
Stabilizer Pos	Stabilizer Pos	deg
Stick Lat-L	Left Lateral Stick Position	deg
Stick Lat-R	Right Lateral Stick Position	deg
Stick Long-L	Left Longitudinal Stick Position	deg
Stick Long-R	Right Longitudinal Stick Position	deg
Time GMT Hrs	Greenwich Mean Time Hours	hrs
Time GMT Min	Greenwich Mean Time Minuets	min
Time GMT Sec	Greenwich Mean Time Seconds	Sec
Total Air Temp	Total Air Temperature	degC
Wind Direction	Wind Direction	deg
Wind Speed	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 abbreviations.

Unit Abbreviations	Descriptions
deg	degrees
degC	degrees Celsius
ft	feet
g	g
hrs	hours
kts	knots
min	minutes
sec	seconds