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

July 26, 2018

Locomotive Event Recorders

Group Chairman's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location:	Crozet, Virginia
Date:	January 31, 2018
Company:	Amtrak
Train ID:	923
Locomotive:	Amtrak 145 (lead)
Locomotive:	Amtrak 4 (trailing locomotive located at the end of the train consist)
NTSB Number:	HWY18MH005
Summary:	Refer to the Accident Summary report, within this docket.

2. LOCOMOTIVE EVENT RECORDER GROUP

A locomotive event recorder group was convened on February 1, 2018.

Chairman: Cassandra Johnson
Mechanical Engineer
National Transportation Safety Board

Member: Jeremy Gaatz
Assistant Superintendent East Road Operations
Amtrak

3. DETAILS OF RECORDER INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received and downloaded Amtrak 145's locomotive event recorder, a Wabtec Pulse Permanent Core Memory (PCM) with the serial number 0308409. Additionally, the NTSB Vehicle Recorder Division received the locomotive event recorder data file from Amtrak 4.

3.1. Amtrak 145 Locomotive Event Recorder

On January 31, 2018, the NTSB Office of Railroad, Pipeline & Hazardous removed Amtrak 145's locomotive event recorder and on the next day, February 1, 2018, handed it over to the NTSB Vehicle Recorder division for download and evaluation.

Amtrak 145's locomotive event recorder was undamaged as shown in figure 1. On February 1, 2018, the locomotive event recorder was reinstalled into Amtrak 145 and using Amtrak's download cables and software, was successfully downloaded as shown in figure 2.

Figure 1. Photo of Amtrak 145's locomotive event recorder.

Figure 2. Downloading Amtrak 145's locomotive event recorder.

3.2. Locomotive Event Recorders Recording Description

Using the wheel sizes of 38.75 inches for Amtrak 145 and 37.25 inches for Amtrak 4, both sets of locomotive event recorder data were extracted using the Wabtec Railway Electronics Event Recorder Data Analysis software. Wheel size, number of rotations, and time are used by the software program to calculate distance traveled and speed; however, the calculations do not account for any wheel skidding or slipping that could have occurred.

The exported data have a sampling rate of one second; therefore, both sets of data have an accuracy of +/- 1 second. Only the data relevant to this event are provided in this report.

3.3. Parameters

Tables A-1 and A-2 list the locomotive event recorder parameters verified and provided in this report for Amtrak 145 and Amtrak 4, respectively. Additionally, table A-3 contains the unit and discrete state abbreviations for the parameters.

3.3.1. Distance Traveled

The default output for the distance traveled is the distance decreasing in time. Therefore, the distance traveled began with a very large value and continually decreased to 0 feet.

3.3.2. Speed Accuracy

In brief, Title 49 *Code of Federal Regulations* (CFR) Part 229.135(b) states that event recorders shall record data with at least the accuracy required of the indicators being displayed to the engineer. Additionally, 49 CFR 229.117(a)(1) states that speed indicators shall be accurate within +/- 3 miles per hour (mph) of actual speed at speeds of 10 to 30 mph and accurate within +/- 5 mph at speeds above 30 mph.

3.4. Time Correlation and Speed Validation

During the initial download, the time for Amtrak 145's locomotive event recorder data was verified to be accurate to +/- 1 minute relative to eastern standard time (EST) as reported by a cell phone network. Therefore, Amtrak 145's locomotive event recorder times are referenced as EST.

The speed, throttle, and pneumatic control switch (PCS) data from both locomotive event recorders were compared and no time offset was needed to align both sets of data. (See figures 3 and 4.) Therefore, Amtrak 4's locomotive event recorder times are referenced as EST. Additionally, the speed data from both event recorders were validated within the accuracy of the measurement.

Figure 3. Locomotive event recorder data overlay from 11:15:00 EST to 11:17:00 EST.

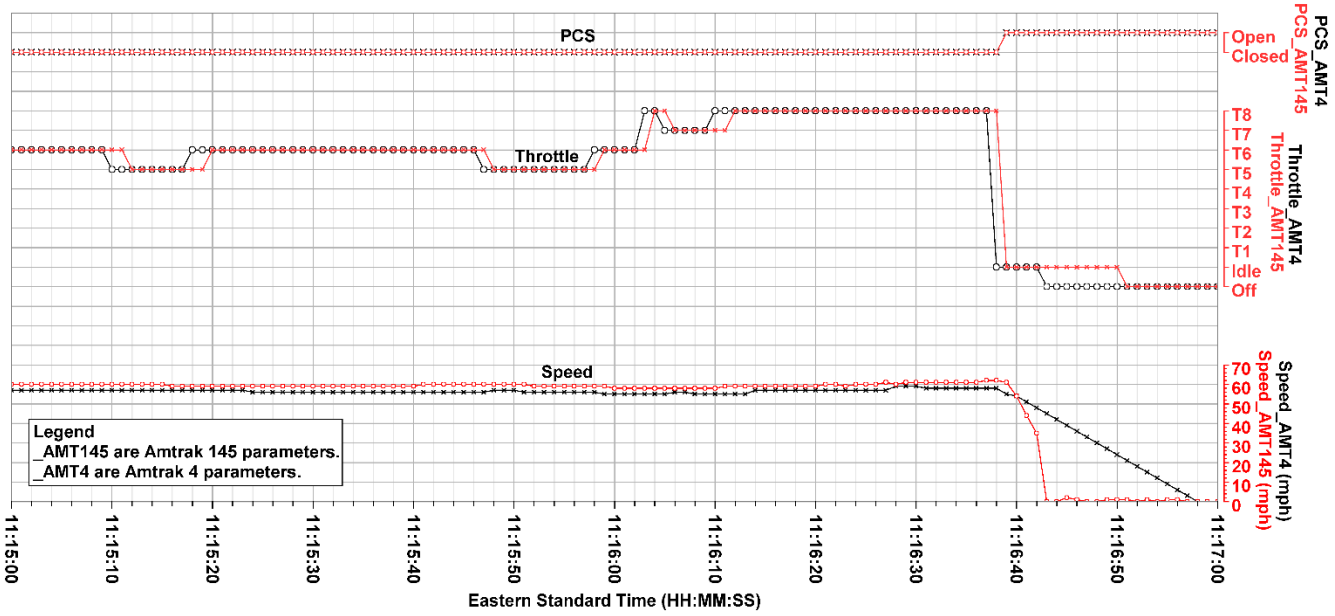
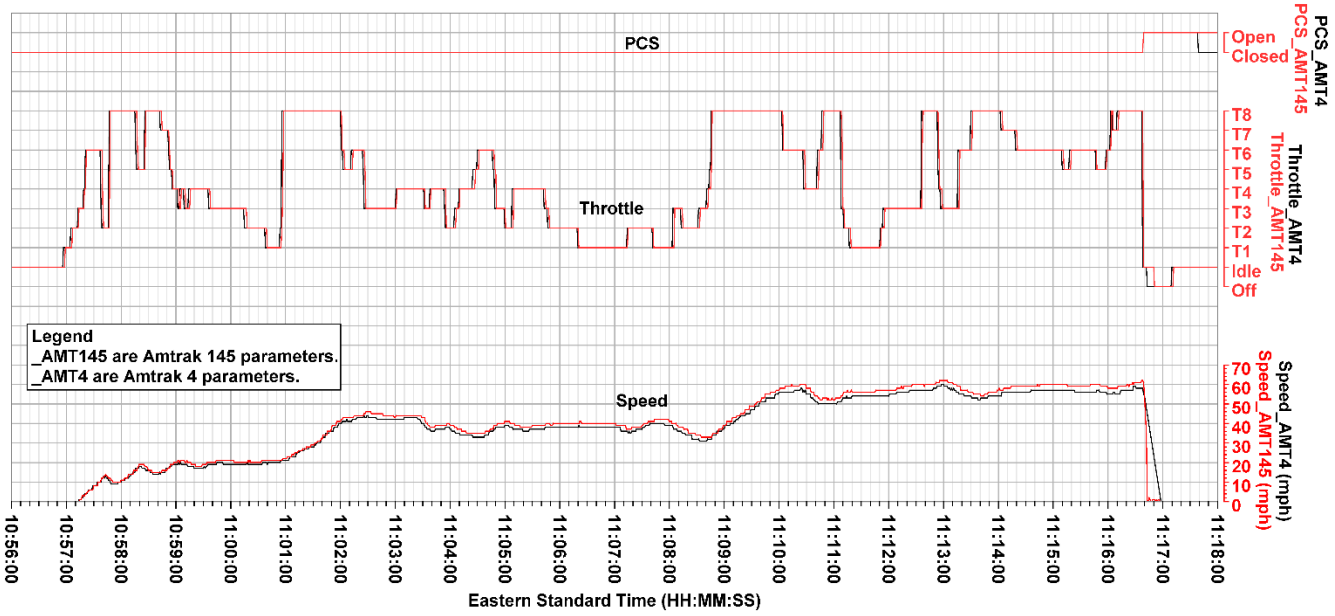


Figure 4. Locomotive event recorder data overlay from 10:56:00 EST to 11:18:00 EST.



3.5. Plots and Corresponding Tabular Data

Figures 5 and 6 contain locomotive event recorder data from Amtrak 145 recorded during the event on January 31, 2018. All the parameters listed in table A-1 were plotted.

Specifically, figure 5 covers the trip starting at Charlottesville, Virginia to the event, from 10:56:00 EST to 11:18:00 EST. Figure 6 focuses on the event and covers 1 minute and 35 seconds of data from 11:15:30 EST to 11:17:05 EST.

In summary, Amtrak 145's locomotive event recorder data indicated the following:

- At 11:16:19 EST, while at a speed of approximately 59 mph[1] and throttle position at throttle 8 (T8), both the bell and horn transitioned from Off to On. Bell and horn remained mostly On throughout the event. At this time, the Electronic Air Brake – Brake Pipe Pressure (EAB BP) was 110 pounds per square inch (psi) and the Electronic Brake – Brake Handle (EAB Brake Handle) status was Release.
- At 11:16:36 EST, the EAB Brake Handle changed to Minimum and the speed increased slightly to 61 mph.
- At 11:16:39 EST, while at a speed of about 61 mph, the Electronic Air Brake Emergency Type (EAB Emer Type) transitioned from None to Engineer Initiated Emergency (EIE), the PCS changed from Closed to Open, the EAB Brake Handle transitioned to Emergency, the throttle position changed to Idle, and the EAB BP decreased to 78 psi. At this time, the horn transitioned to Off for 1 second.
- At 11:16:41 EST, the EAB BP decreased to 0 psi and the speed decreased to about 44 mph.
- At 11:16:43 EST, the speed was 0 mph.
- Afterward until 11:16:57 EST, the speed fluctuated between 0 and 1 mph. This is consistent with the derailment of Amtrak 145 since speed is a calculation of wheel rotation.

All of the corresponding tabular data used to create figures 3 to 6 are provided in electronic separated value (.csv) format as attachment 1 to this factual report.

[1] Per 49 CFR 229.117(a)(1), speed indicators shall be accurate within +/- 5 mph at speeds above 30 mph.

Figure 5: Amtrak 145's locomotive event recorder parameters from 10:56:00 EST to 11:18:00 EST.

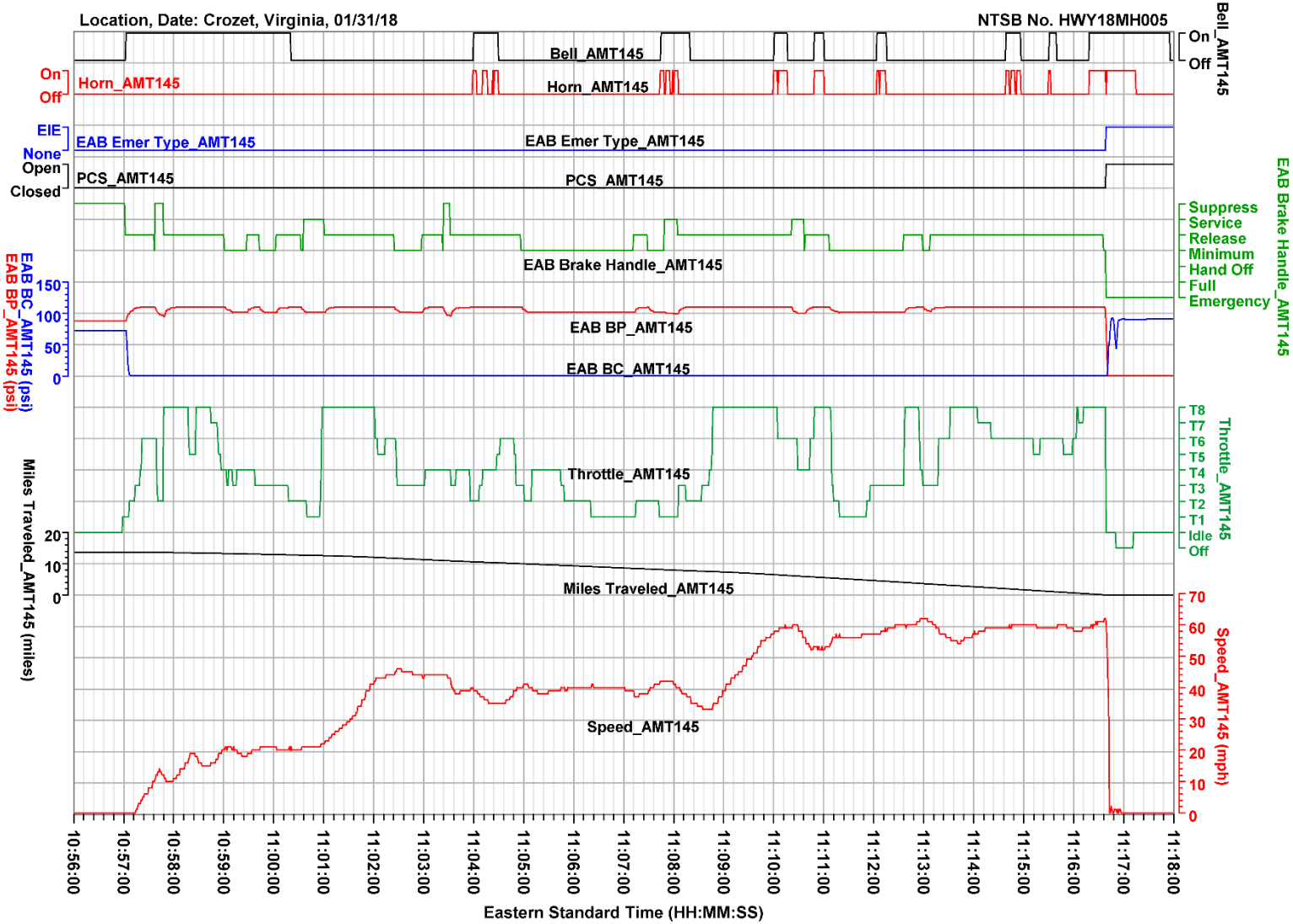
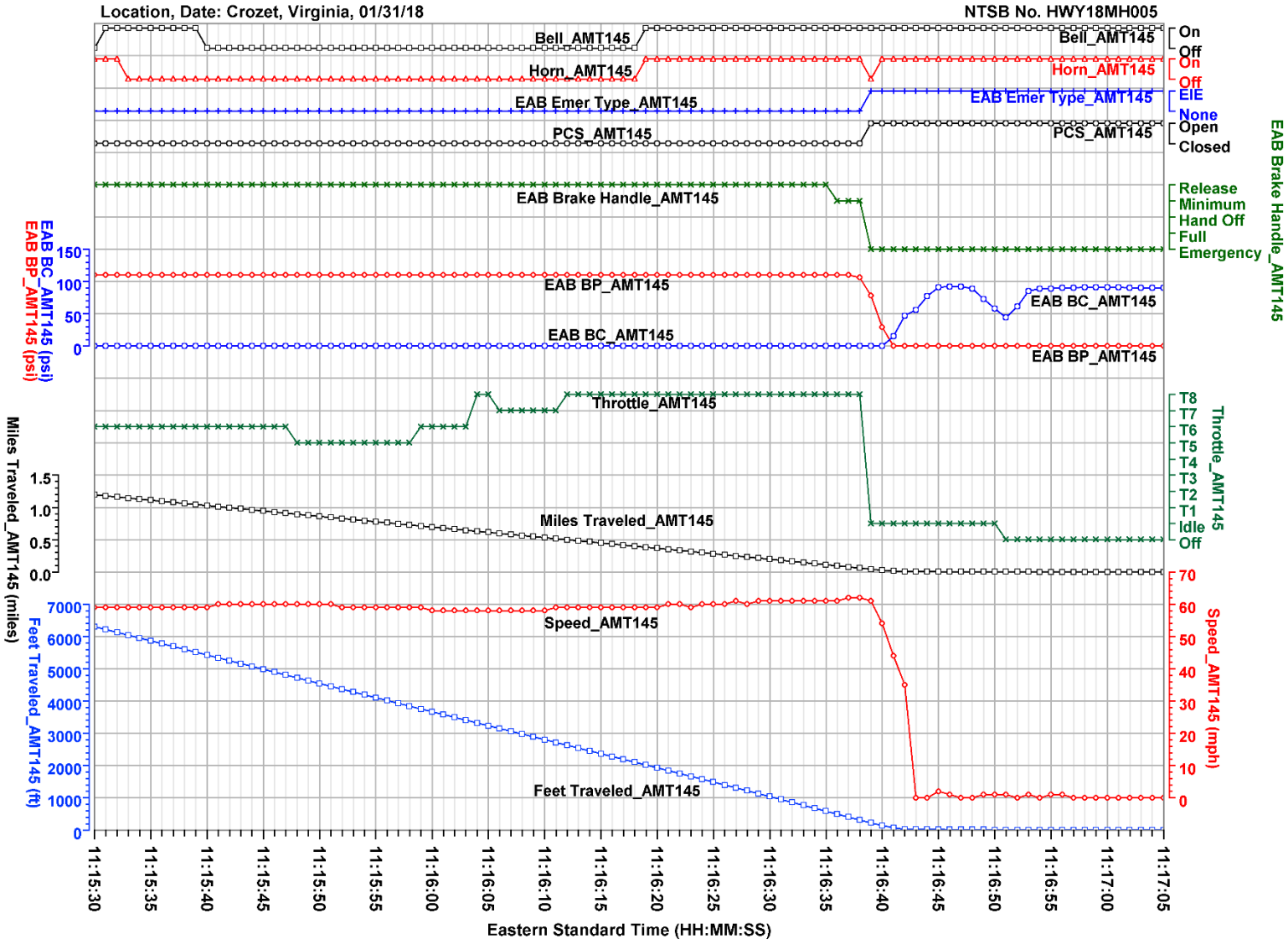


Figure 6: Amtrak 145's locomotive event recorder parameters from 11:15:30 EST to 11:17:05 EST.



APPENDIX A

In this appendix, tables A-1 and A-2 describe the locomotive event recorder parameters provided and verified in this report for Amtrak 145 and Amtrak 4, respectively. Parameters with a blank unit description in tables A-1 and A-2 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 contains the unit and discrete state abbreviations for the parameters.

Table A-1. Verified and provided locomotive event recorder parameters for Amtrak 145

Plot/Table Label	Unit	Parameter Description
Bell_AMT145		Bell
EAB BC_AMT145	psi	Electronic Air Brake – Brake Cylinder Pressure
EAB BP_AMT145	psi	Electronic Air Brake – Brake Pipe Pressure
EAB Brake Handle_AMT145		Electronic Air Brake – Brake Handle Position
EAB Emer Type_AMT145		Electronic Air Brake – Emergency Type
Feet Traveled_AMT145	ft	Feet Traveled
Horn_AMT145		Horn
Miles Traveled_AMT145	miles	Miles Traveled
PCS_AMT145		Pneumatic Control Switch
Speed_AMT145	mph	Speed
Throttle_AMT145		Throttle Position

Table A-2. Verified and provided locomotive event recorder parameters for Amtrak 4

Plot/Table Label	Unit	Parameter Description
PCS_AMT4		Pneumatic Control Switch
Speed_AMT4	mph	Speed
Throttle_AMT4		Throttle Position

Table A-3. Unit and discrete state abbreviations.

Unit and Discrete State Abbreviation	Description
EIE	Engineer Initiated Emergency
ft	feet
mph	miles per hour
psi	pounds per square inch
T1	Throttle Position 1
T2	Throttle Position 2
T3	Throttle Position 3
T4	Throttle Position 4
T5	Throttle Position 5
T6	Throttle Position 6
T7	Throttle Position 7
T8	Throttle Position 8