

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

July 16, 2019

## **Locomotive Event Recorder**

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

### **1. EVENT SUMMARY**

Location: Granite Canyon, Wyoming  
Date: October 4, 2018  
Company: Union Pacific (UP)  
Train ID/Locomotive: MGRCY04 / UP 5412 (lead)  
NTSB Number: RRD19FR001  
Summary: Refer to the Accident Summary report, within this docket.

### **2. LOCOMOTIVE EVENT RECORDER GROUP**

A locomotive event recorder group was not convened.

### **3. DETAILS OF RECORDER INVESTIGATION**

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received UP 5412's locomotive event recorder: Wabtec Train Trax Locomotive Data Acquisition Recording System (LDARS) with the serial number 1215578.

#### **3.1. Locomotive Event Recorder Condition**

The locomotive event recorder suffered extensive impact damage as shown in figure 1.



Figure 1. UP 5412's locomotive event recorder as received

### 3.2. Downloading Locomotive Event Recorder

With the assistance of Wabtec, the locomotive event recorder manufacturer, UP 5412's certified crashworthy event recorder memory module was removed from the casing (see figure 2) and successfully downloaded (see figure 3).

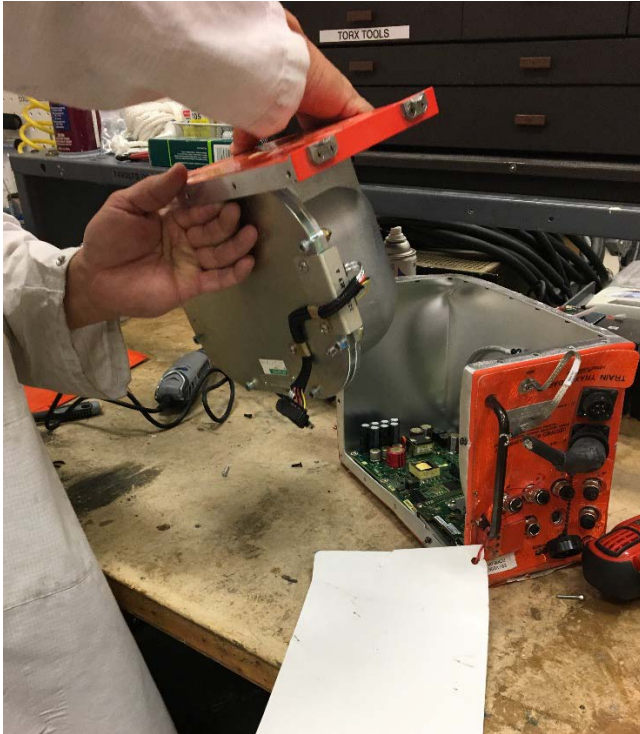


Figure 2. Removing the memory module



Figure 3. Downloading UP 5412 memory module

### 3.3. Locomotive Event Recorder Recording Description

Using the wheel size of 42.39 inches for UP 5412 as provided by investigators, the locomotive event recorder data were extracted using the Wabtec Railway Electronics Event Recorder – Data Analysis Software III (referred to as DAS III). This software outputted the locomotive event recorder parameters including distance and speed. The exported data have a sampling rate of one second; therefore, the data have an accuracy of +/- 1 second. Only the data relevant to this event are provided in this report.

### 3.4. Parameters

Table A-1 lists the parameters verified and provided in this report for UP 5412. Additionally, table A-2 contains the unit and discrete state abbreviations for the parameters.

#### 3.4.1. 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.

#### 3.4.2. IETMS Milepost

The Interoperable Electronic Train Management System (IETMS) Milepost data is the

interpolated distance, as computed by the positive train control (PTC) navigation function, between physical assets (for example, milepost marker or controlled signal) whose locations have been surveyed and validated to within 2.2 meter accuracy, and placed into the PTC track database, along with assigned milepost values.

### 3.4.3. EOT Comm Status

A loss of communication between the head of train device (located in the lead locomotive) and the end of train (EOT) device (located at the rear of the last car of the train consist) for a minimum of 16 minutes and 30 seconds will trigger the EOT Communication (Comm) Status parameter to record front to rear no communication (FR NC). Once the communication is reestablished, the EOT Comm Status will record communication okay (Comm Okay).

### 3.5. Time Correlation

The times exported were provided as Coordinated Universal Time (UTC). Therefore, UP 5412's times were adjusted to local time, mountain daylight time (MDT), by subtracting 6 hours (MDT = UTC – 6 hours).

No other time offset was applied to the event recorder data. Therefore, for the rest of the report, all times are referenced as MDT.

### 3.6. Plots and Corresponding Tabular Data

Figures 4 to 8 contain UP 5412's locomotive event recorder data recorded during the event on October 4, 2018. All the parameters listed in table A-1 were plotted except IETMS Milepost, feet traveled, and miles traveled.

Figure 4 covers 17 hours of data from 03:00:00 MDT<sup>1</sup> to 20:00:00 MDT. Figure 5 covers 4 hours of data from 15:45:00 MDT to 19:45:00 MDT. Figure 6 covers 3 hours of data from 16:50:00 MDT to 19:50:00 MDT. Figure 7 covers 1 hour of data from 18:40:00 MDT to 19:40:00 MDT. Lastly, figure 8 covers 19 minutes of data from 19:21:00 MDT to 19:40:00 MDT. In figures 4 to 8, the event recorder data ended at 19:39:59 MDT.

In summary, UP 5412's event recorder data indicated the following:

- For about the first 1 hour and 54 minutes (16:56:39 MDT to 18:50:37 MDT), the air flow remained above about 25 cubic feet per minute (cfm).
- At 18:47:49 MDT, the end of train communication status (EOT Comm Status) changed from communication okay (Comm OK) to front to rear no communication (FR NC) while at a speed of 14 miles per hour (mph).
- From 18:50:39 MDT to 18:53:53 MDT (duration of 3 minutes and 14 seconds), the air flow was 0 cfm. During this time speed increased from 24 mph to 29 mph. Also during this time, at 18:51:32 MDT, the EOT Comm Status returned to Comm OK.
- From 18:53:53 MDT to 19:09:51, the air flow remained mostly above 28 cfm and the speed had reduced to 18 mph. At 19:09:52 MDT, the air flow reduced to 20 cfm and

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<sup>1</sup> Times are presented from 0 to 23 hours. For example, 03 hours is the same as 3 a.m., 18 hours is the same as 6 p.m., and 20 hours is the same as 8 p.m.

then the next second reduced to 0 cfm and remained 0 cfm until the end of the data at 19:39:59 MDT.

- At 19:10:15 MDT, the Interoperable Electronic Train Management System (IETMS) Mandatory Directive transitioned from Work Zone to Speed Restriction while the speed remained at 18 mph.
- At 19:32:59 MDT, the IETMS Mandatory Directive transitioned back to Work Zone while the speed increased slightly to 22 mph. At this time, the IETMS Maximum (Max) Speed was 35 mph.
- At 19:34:55 MDT, the engineer initiated emergency (EIE) and the emergency brake both transitioned from Off to On and 1 second later, the IETMS emergency switch (Emerg Switch) changed from Cut-In (C/I) to Cut-Out (C/O). Additionally, the speed had increased to 29 mph.
- At 19:35:11 MDT, the EOT Comm Status changed to FR NC and the speed increased slightly to 30 mph.
- At 19:37:10 MDT, the IETMS Max Speed decreased to 30 mph while the speed increased to 43 mph.
- At 19:38:26 MDT, the IETMS Max Speed decreased to 0 mph while the speed increased to 51 mph.
- Approximately, 1 minute and 33 seconds later at 19:39:59 MDT, the data ended. At this time, the speed had increased to 56 mph.

The tabular data from 03:00:00 MDT to 19:39:59 MDT for all the parameters listed in table A-1 are provided in electronic comma separated value (.csv) format as attachment 1 to this factual report.

Figure 4: UP 5412's locomotive event recorder parameters (17 hours).

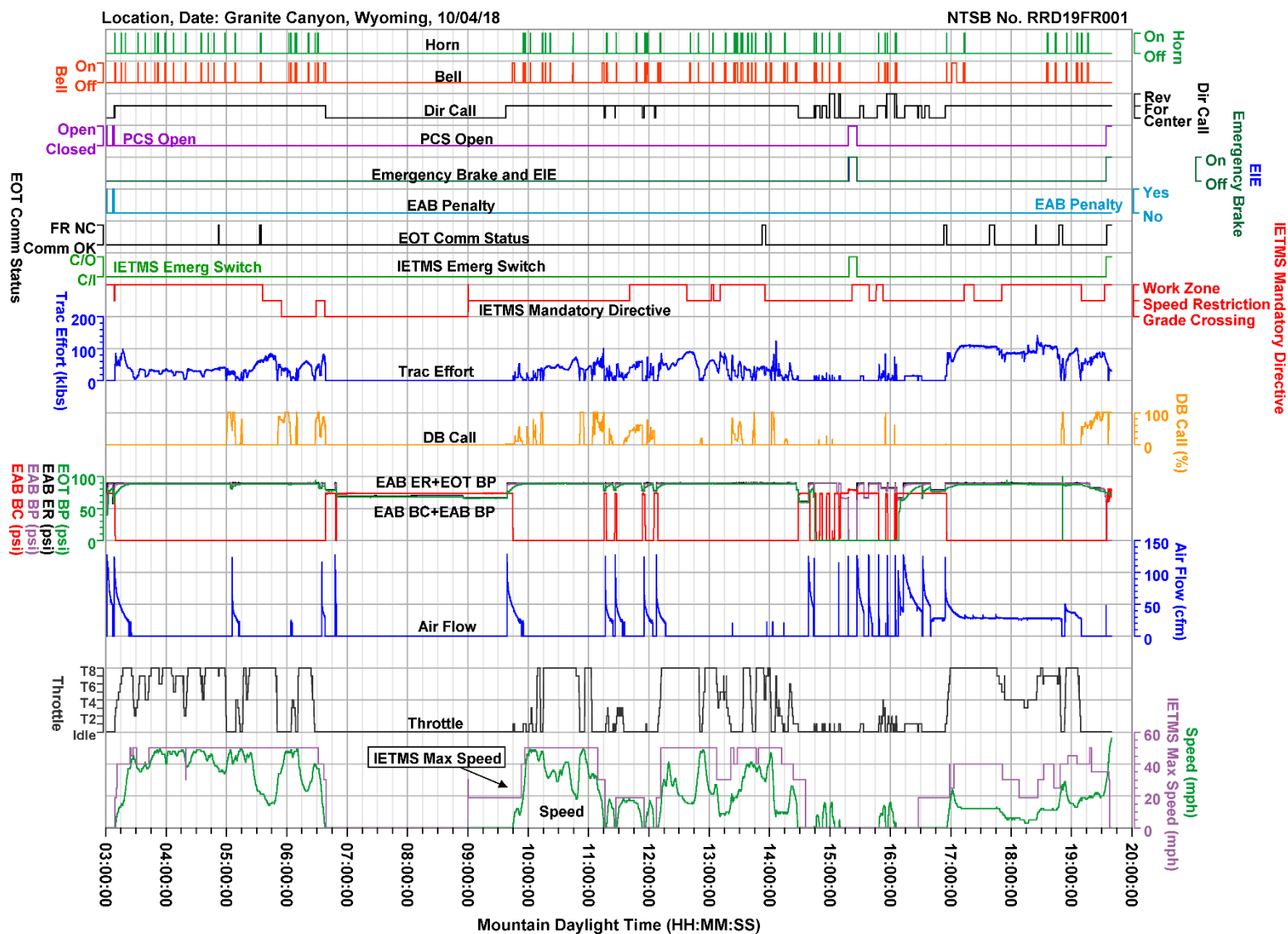
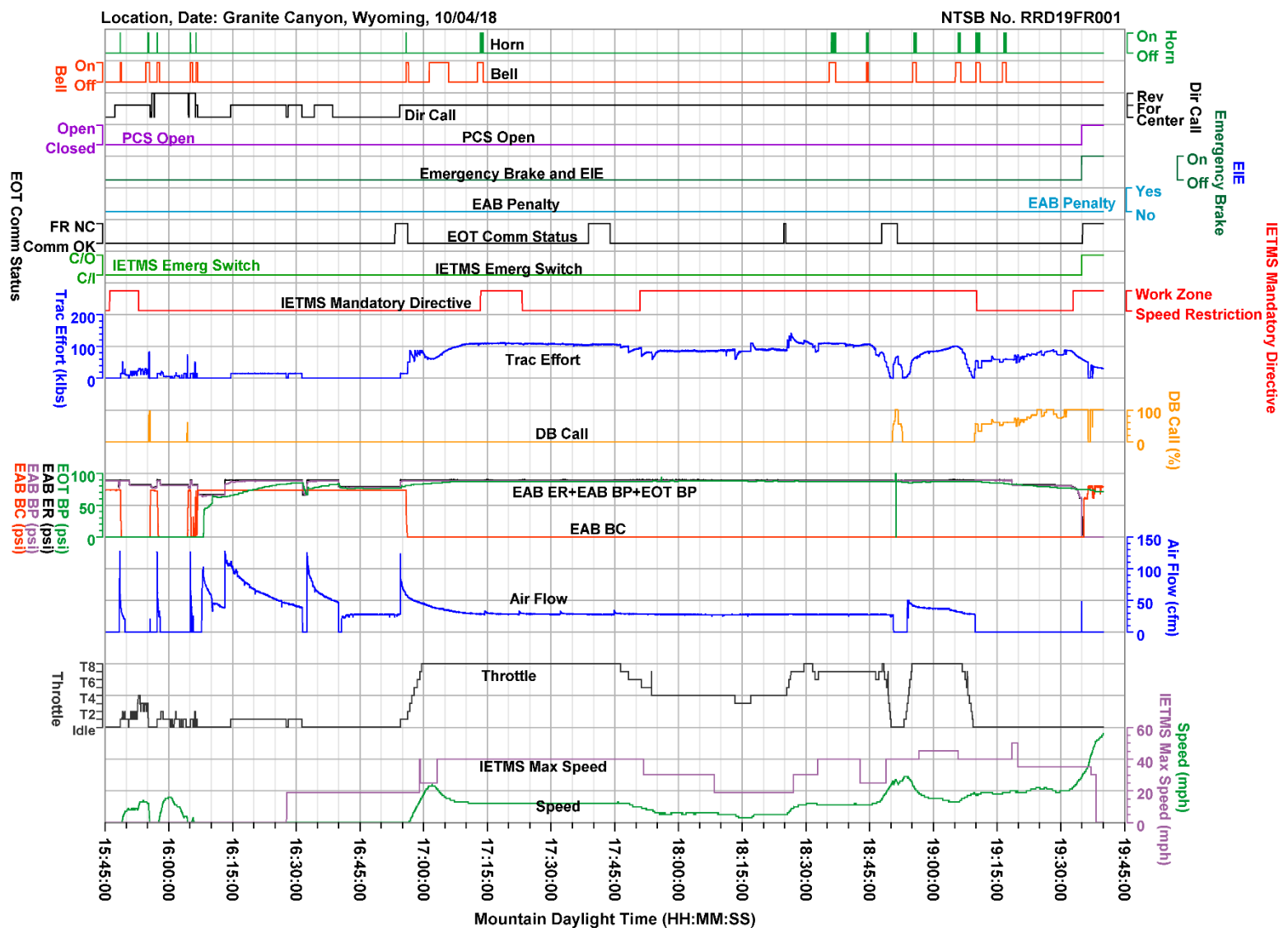


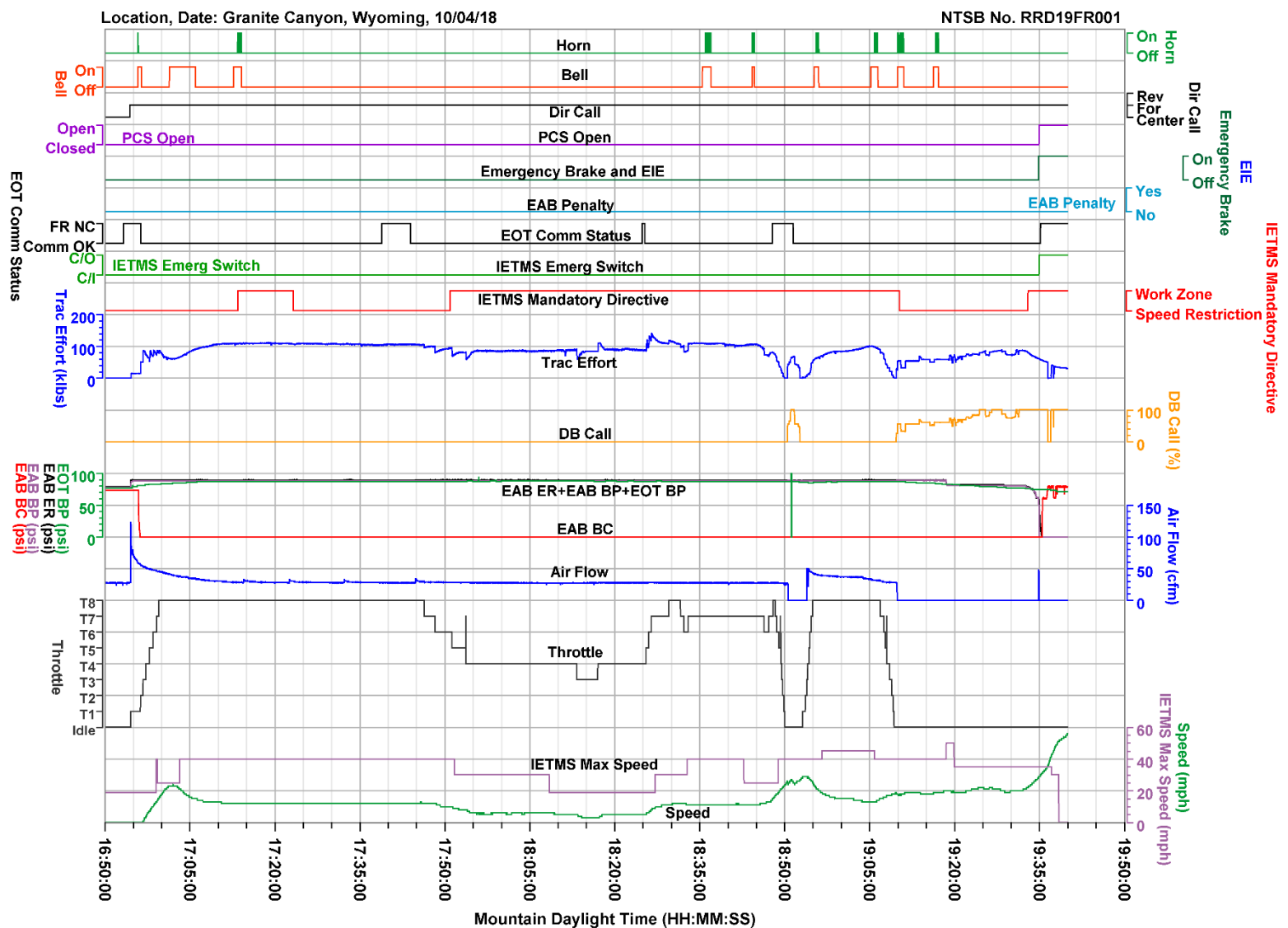
Figure 5: UP 5412's locomotive event recorder parameters (4 hours).



Plot covers 4 hours.

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Figure 6: UP 5412's locomotive event recorder parameters (3 hours).

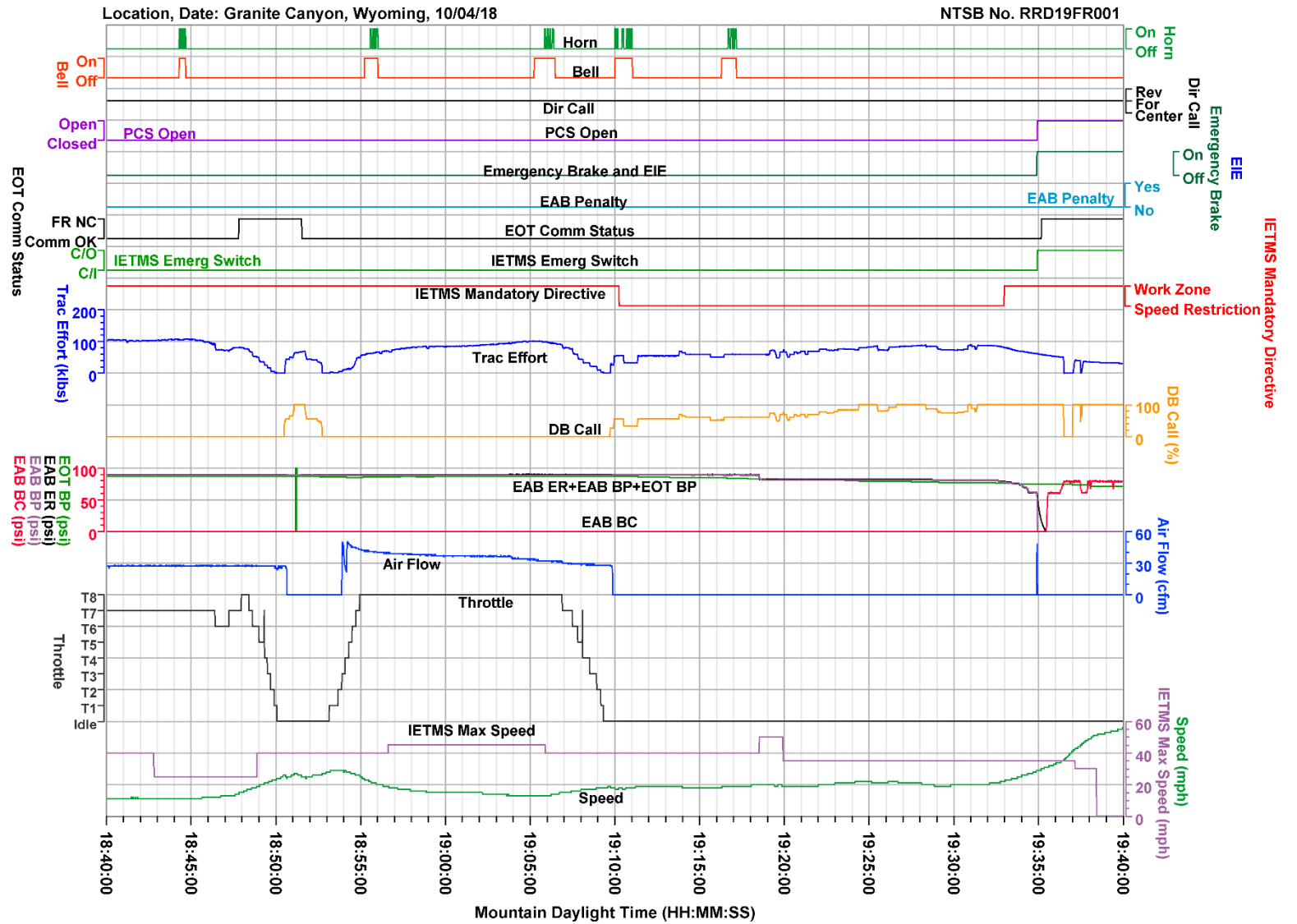


Plot covers 3 hours.

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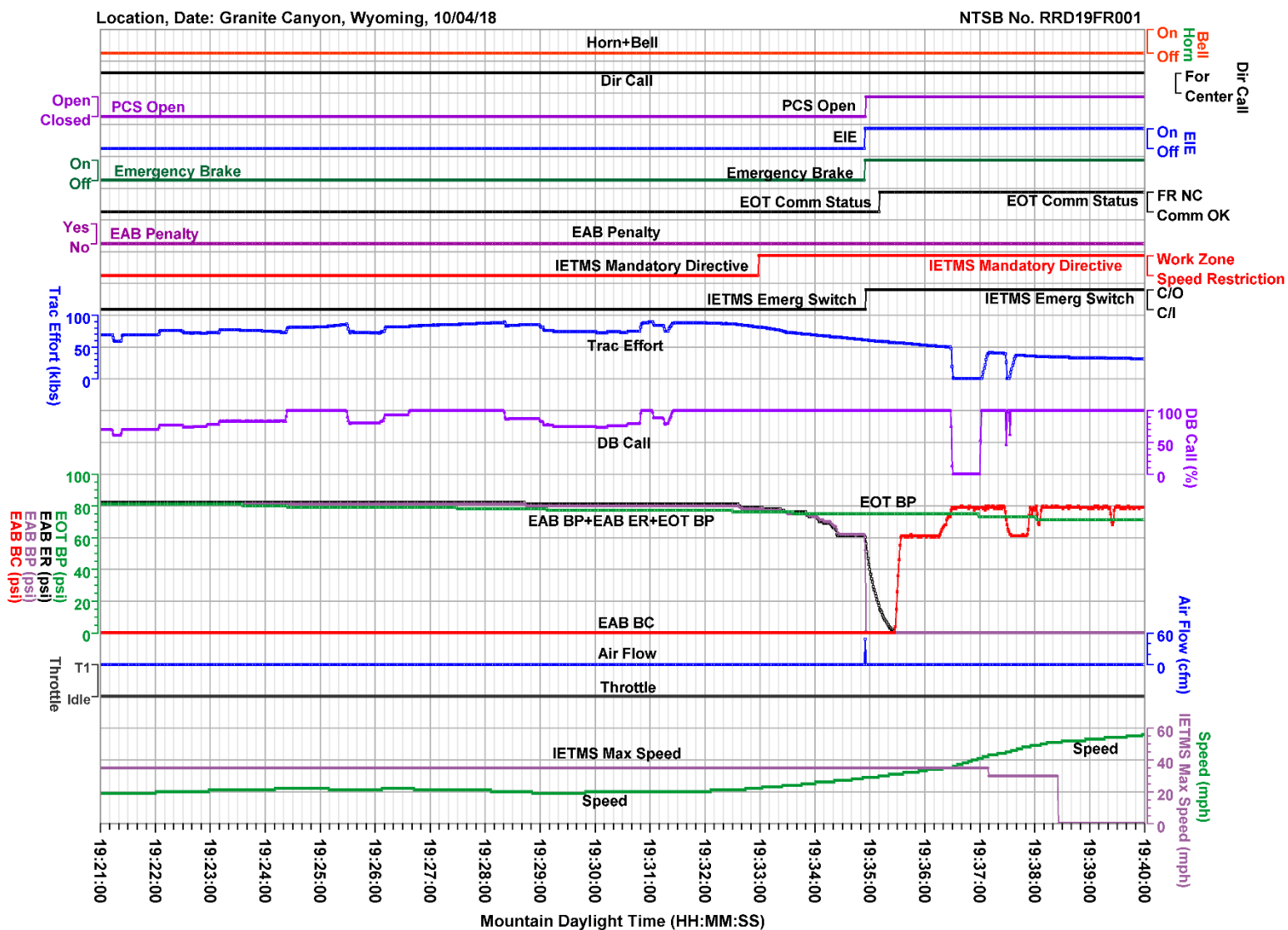
Figure 7: UP 5412's locomotive event recorder parameters (1 hour).



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Figure 8: UP 5412's locomotive event recorder parameters (19 minutes).



Revised: 15 April 2019

Plot covers 19 minutes.

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## APPENDIX A

This appendix describes the locomotive event recorder parameters provided and verified in this report for UP 5412. Table A-1 lists the plot labels, parameter descriptions, and units. Table A-2 contains the unit and discrete state abbreviations for the parameters.

**Table A-1. Verified and provided locomotive event recorder parameters for UP 5412.**

Plot Label	Parameter Description	Unit
Air Flow	Air Flow	cfm
Bell	Bell	
DB Call	Dynamic Braking Handle Position	%
Dir Call	Direction of Travel	
EAB BC	Electronic Air Brake – Brake Cylinder	psi
EAB BP	Electronic Air Brake – Brake Pressure	psi
EAB ER	Electronic Air Brake – Equalizing Reservoir Pressure	psi
EAB Penalty	Electronic Air Brake Penalty	
EIE	Engineer Initiated Emergency	
Emergency Brake	Emergency Brake	
EOT BP	End of Train Brake Pressure	psi
EOT Comm Status	End of Train Communication Status	
Horn	Horn	
Feet Traveled	Feet Traveled	ft
IETMS Emerg Switch	Interoperable Electronic Train Management System Emergency Switch	
IETMS Mandatory Directive	Interoperable Electronic Train Management System Mandatory Directive	
IETMS Max Speed	Interoperable Electronic Train Management System Maximum Speed	mph
IETMS Milepost	Interoperable Electronic Train Management System Milepost	
Miles Traveled	Miles Traveled	miles
PCS Open	Pneumatic Control Switch Open	
Speed	Speed	mph
Throttle	Throttle Position	
Trac Effort	Tractive Effort	klbs

NOTE: Parameters with a blank unit description in table A-1 are discrettes. 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 state abbreviations.**

Unit and Discrete Abbreviation	Description
C/I	Cut In
C/O	Cut Out
cfm	cubic feet per minute
COMM ok	Communication Okay
For	Forward
FR NC	Front to Rear No Communication

## APPENDIX A

<b>Unit and Discrete Abbreviation</b>	<b>Description</b>
ft	feet
klbs	kilo pounds
mph	miles per hour
psi	pounds per square inch
Rev	Reverse
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