

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

December 12, 2016

Locomotive Event Recorders

Specialist's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: Panhandle, Texas
Date: June 28, 2016
Operator: BNSF Railway

Eastbound Train S-LACLPC1-26K

Locomotive ID/Location: 3967/ 3rd locomotive
DPU¹ ID/Location: 8234/ Rear of train
DPU ID/Location: 3970/ End of train

Westbound Train Q-CHISBD6-27L

Locomotive ID/Location: 7553/ 2nd locomotive
Locomotive ID/Location: 7907/ 3rd locomotive
Locomotive ID/Location: 8191/ 4th locomotive
Locomotive ID/Location: 5212/ 5th locomotive

NTSB Number: DCA16FR008
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

3.1. Summary of Locomotive Event Recorders from Eastbound Train S-LACLPC1-26K

Due to the severity of the collision and the post-accident fire, the locomotive event recorders from the first locomotive, BNSF 5162, and the second locomotive, BNSF 7838, were not located in the wreckage.

The Wabtec Train Trax locomotive event recorder from the third locomotive, BNSF 3967, suffered severe thermal damage (see figure 1). The manufacturer's part number and serial

¹ DPU stands for distributed power unit.

number were unreadable. The recorder was sent to the National Transportation Safety Board (NTSB) Vehicle Recorder Division for readout and evaluation.



Figure 1. BNSF 3967's locomotive event recorder as received

The locomotive event recorders from the two DPU units, BNSF 8234 and BNSF 3970, were undamaged and the download files were provided to the NTSB Vehicle Recorder Division for readout and evaluation.

3.1.1. BNSF 3967's Locomotive Event Recorder

BNSF 3967's certified crashworthy event recorder memory module was removed from the outer casing (see figure 2). Next the certified crashworthy event recorder memory module was opened and the memory module was removed (see figures 3 and 4). With the assistance of Wabtec, the locomotive event recorder manufacturer, the memory chips were removed and placed onto a surrogate board (see figure 5). Then BNSF 3967's memory module was successfully downloaded (see figure 6).



Figure 2. BNSF 3967's certified crashworthy event recorder memory module



Figure 3. BNSF 3967's certified crashworthy event recorder memory module opened



Figure 4. BNSF 3967's memory module



Figure 5. BNSF 3967's memory chips removed and placed on surrogate board

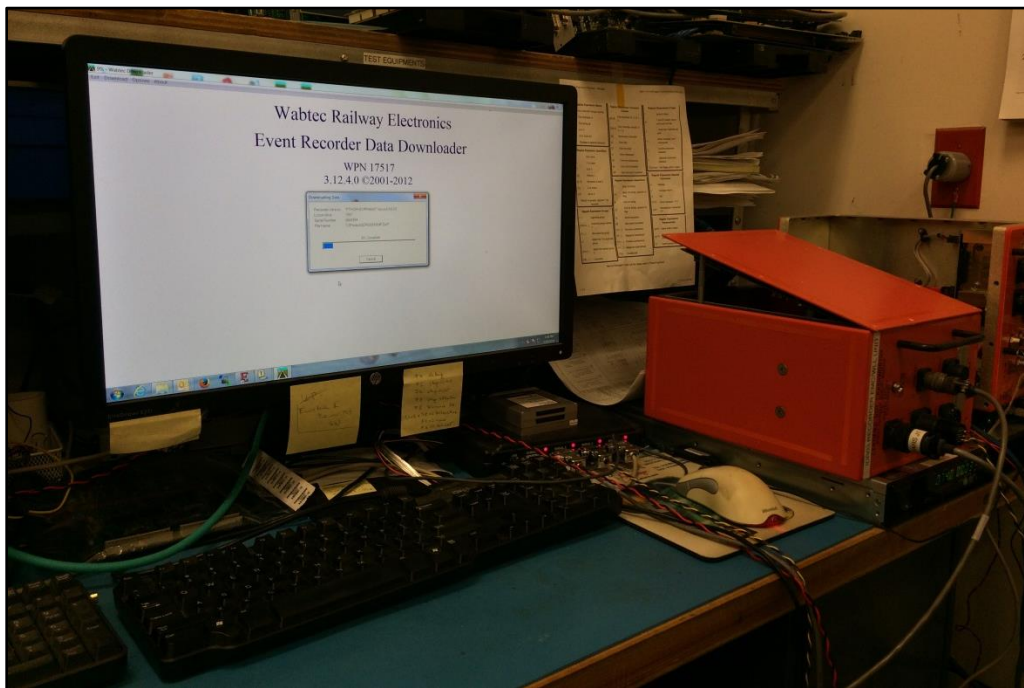


Figure 6. Downloading BNSF 3967's memory module

3.2. Summary Locomotive Event Recorders from Westbound Train Q-CHISBD6-27L

Due to the severity of the collision and the post-accident fire, the locomotive event recorder from the first locomotive, BNSF 5416, was not located in the wreckage.

The Wabtec Train Trax locomotive event recorder from the second locomotive, BNSF 7553, suffered severe thermal damage (see figure 7). The manufacturer's part number and serial number were unreadable. The recorder was sent to the NTSB Vehicle Recorder Division for readout and evaluation.



Figure 7. BNSF 7553's locomotive event recorder as received

The locomotive event recorder from the third locomotive, BNSF 7907, was undamaged and the download file was provided to the NTSB Vehicle Recorder Division for readout and evaluation.

The locomotive event recorders from the fourth and fifth locomotives, BNSF 8191 and BNSF 5212, were undamaged; however, investigators were unable to download either recorder during the on-scene aspect of the investigation. Therefore, these recorders were sent to the NTSB Vehicle Recorder Division for readout and evaluation (see figures 8 and 9). BNSF 8191's recorder was a Wabtec Train Trax recorder with part number 26432-9 Y and serial number 0852357. BNSF 5212's recorder was a Wabtec Permanent Core Memory Module with part number 17853P and serial number 0364712. Both recorders were successfully downloaded.



Figure 8. BNSF 8191's locomotive event recorder as received



Figure 9. BNSF 5212's locomotive event recorder as received

3.2.1. BNSF 7553's Locomotive Event Recorder

BNSF 7553's certified crashworthy event recorder memory module was removed from the outer casing (see figure 10). Next the certified crashworthy event recorder memory module was opened and the memory module was removed (see figures 11 and 12). With the assistance of Wabtec, the ribbon cable was removed and a new one attached (see figure 13). Then BNSF 7553's memory module was successfully downloaded (see figure 14).



Figure 10. BNSF 7553's certified crashworthy event recorder memory module

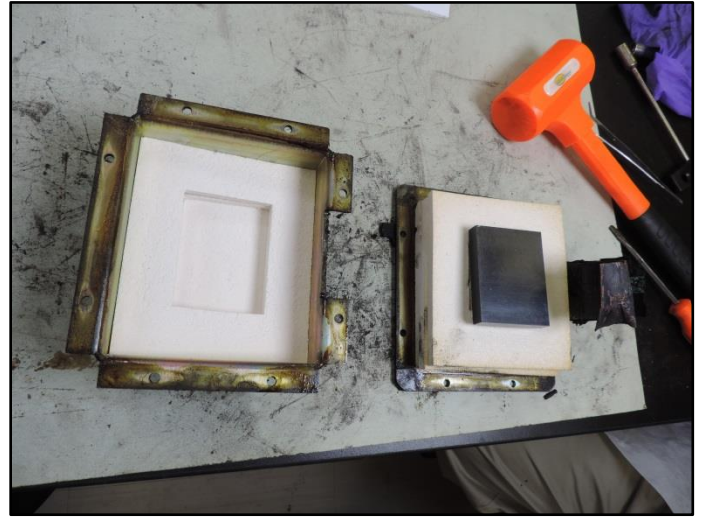


Figure 11. BNSF 7553's certified crashworthy event recorder memory module opened

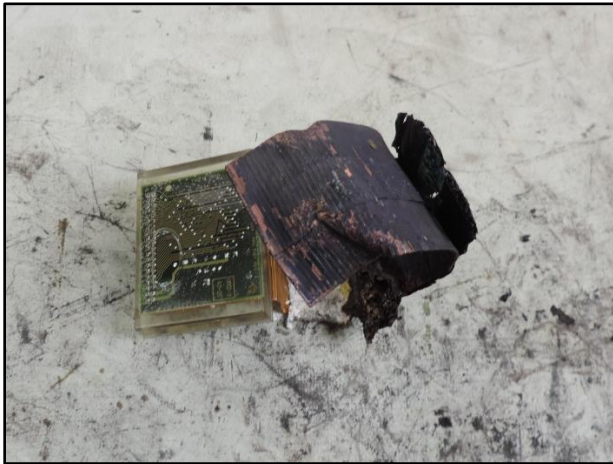


Figure 12. BNSF 7553's memory module

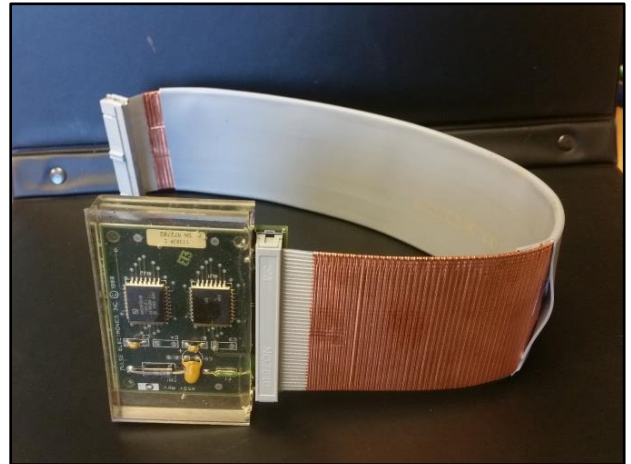


Figure 13. BNSF 7553's memory module with new ribbon attached

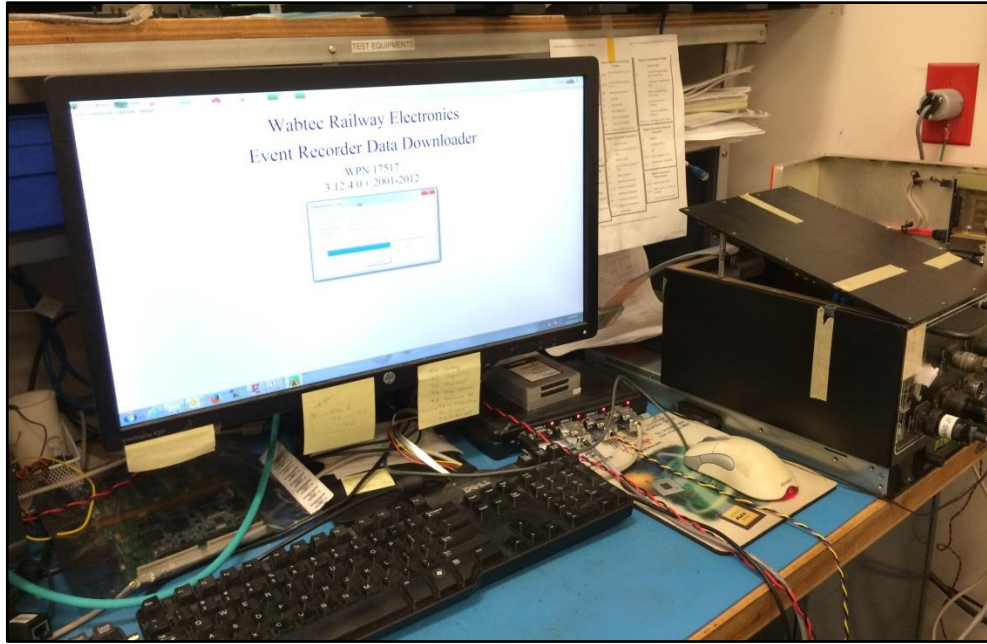


Figure 14. Downloading BNSF 7553's memory module

3.3. Locomotive Event Recorder Recording Description

Using the wheel sizes as provided by on-scene investigators (see table 1), the locomotive event recorder data for BNSF 3967, BNSF 8234, BNSF 3970, BNSF 7553, BNSF 7907, BNSF 8191, and BNSF 5212 were extracted using the Wabtec Railway Electronics Event Recorder Data Analysis software. 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 sets have an accuracy of +/- 1 second. Only pertinent data from BNSF 3967, BNSF 8234, BNSF 7553, and BNSF 7907 are provided in this report.

Table 1. Wheel Sizes as provided by on-scene investigators

ID	Wheel Size
BNSF 3967	41.0 inches
BNSF 8234	41.9 inches
BNSF 3970	42.6 inches
BNSF 7553	40.125 inches
BNSF 7907	39.375 inches
BNSF 8191	40.5 inches
BNSF 5212	37.75 inches

3.4. Parameters

Table A-1 lists the parameters verified and provided in this report for BNSF 3967, BNSF 8234, BNSF 7553, and BNSF 7907. Specifically, table A-1 lists the plot labels, parameter descriptions, and units. 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 decrease.

3.4.2. Parameters Not Available

There are critical parameters that help determine the activities of the crew. Some of these parameters are bell, horn, alerter, and engineer induced emergency (EIE). These parameters were only recorded in the lead locomotive's event recorder. As previously mentioned, neither lead locomotive event recorders (BNSF 5162 or BNSF 5416) were located in the wreckage.

3.5. Time Correlation

Each set of locomotive event recorder data and on-board forward facing video recorder data² are independently time stamped and, consequently, the times may not reflect the actual time of day. According to the video recorder timing correlation, BNSF 7907's on-board forward facing video data was correlated to local time, central daylight time (CDT), by adding 8 seconds to its time. Additionally, the collision time was determined to be 8:20:55 CDT.

3.5.1. Time Correlation for BNSF 3967 and BNSF 8234 locomotive event recorders

BNSF 3967's locomotive event recorder data ended abruptly at 9:20:53. Therefore, 3,598 seconds was subtracted from BNSF 3967's locomotive event recorder time so that the data ended at the collision time of 8:20:55 CDT.

To correlate the locomotive event recorder data between BNSF 3967 and BNSF 8234, select parameters (trainline emergency (TLEM), emergency brake, pneumatic control switch (PCS), throttle position, and speed) from both recorders were plotted together. In order to align BNSF 8234's locomotive event recorder data to BNSF 3967's locomotive event recorder data, 1 second was added to BNSF 8234's locomotive event recorder time (see figure 15).

² Refer to the National Transportation Safety Board's Onboard Image Recorder Factual Report.

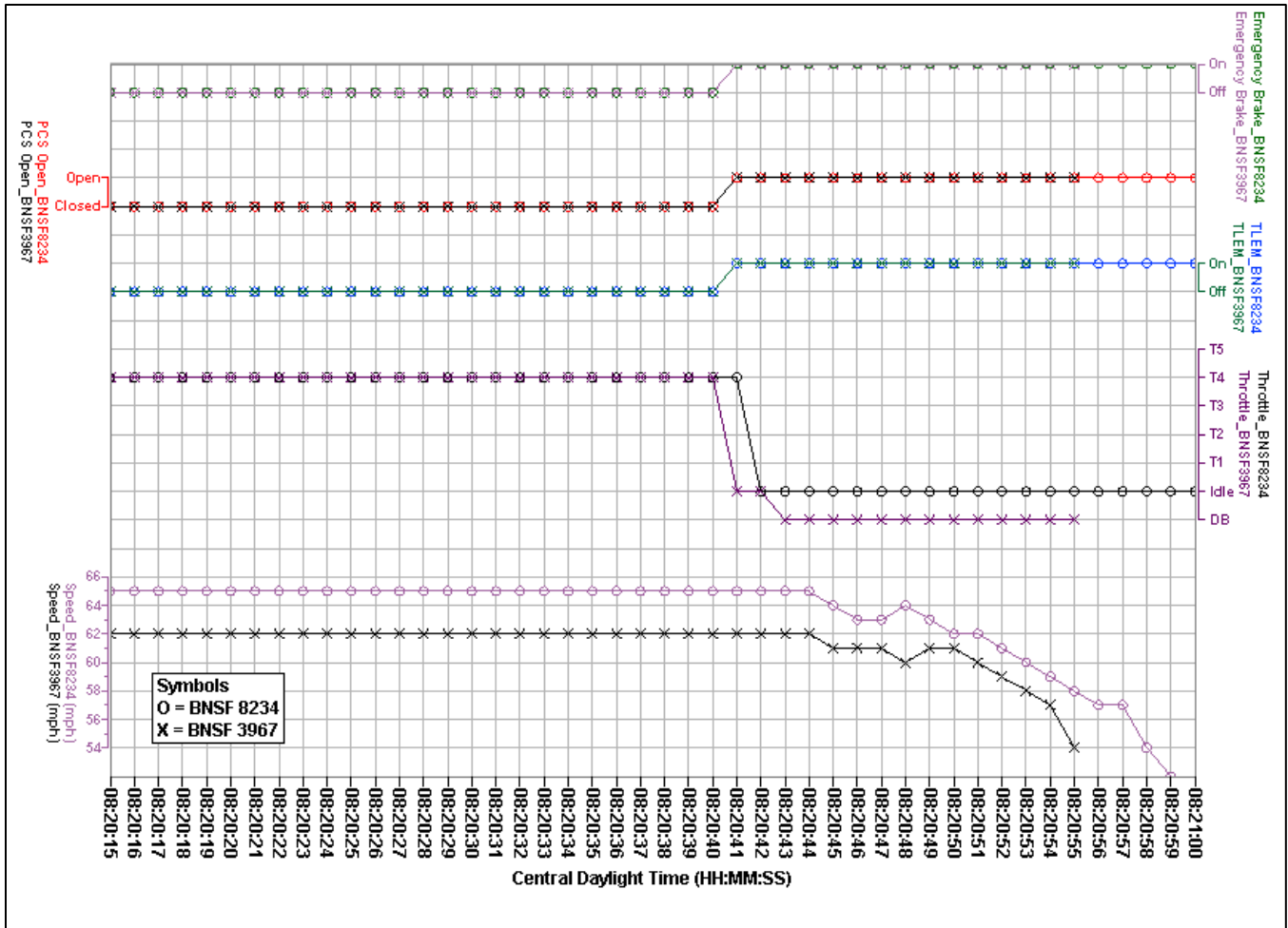


Figure 15. Time correlation between BNSF 8234 and BNSF 3967

Therefore, for the rest of this report, all times for BNSF 3967 and BNSF 8234 are referenced as CDT.

3.5.2. Time Correlation for BNSF 7553 and BNSF 7907 locomotive event recorders

BNSF 7907's video data recorded the PCS discrete thus providing a common parameter between BNSF 7907's locomotive event recorder and BNSF 7907's video recorder data. The PCS discrete from both sets of data transitioned to "Open" at the same time; thus, BNSF 7907's video recorder data and BNSF 7907's locomotive recorder data are time aligned. Therefore, 8 seconds was added to BNSF 7907's locomotive event recorder time to correlate to the local time, CDT.

To correlate the locomotive event recorder data between BNSF 7553 and BNSF 7907, select parameters (TLEM, emergency brake, PCS, throttle position, sanding mode, and speed) from both recorders were plotted together. In order to align BNSF 7553's locomotive event recorder data to BNSF 7907's locomotive event recorder data, 3,597 seconds was subtracted from BNSF 7553's locomotive event recorder time (see figure 16).

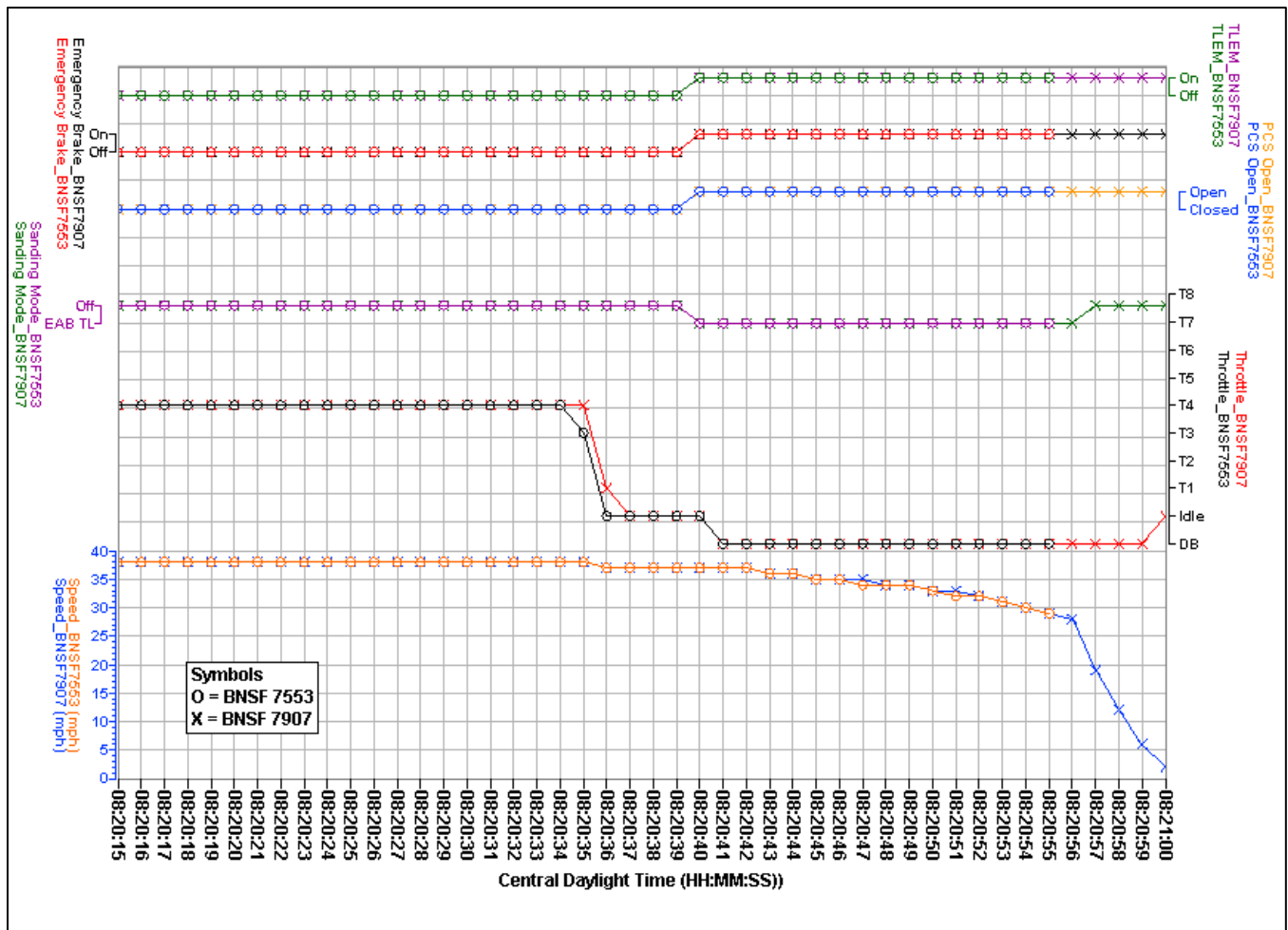


Figure 16. Time correlation between BNSF 7907 and BNSF 7553

Therefore, for the rest of this report, all times for BNSF 7553 and BNSF 7907 are referenced as CDT.

3.6. Plots and Corresponding Tabular Data

Figures 17 to 24 contain locomotive event recorder data from BNSF 3967, BNSF 8234, BNSF 7553, and BNSF 7907 recorded during the July 28, 2016 event. All the parameters listed in table A-1 were plotted.

Figures 17 and 18 contain BNSF 3967's locomotive event recorder data. Figures 19 and 20 contain BNSF 8234's locomotive event recorder data. Figures 17 and 19 cover about 50 minutes of data from 07:35:00 CDT to 08:25:00 CDT (BNSF 3967's data ends at 8:20:55 CDT). Figure 18 has an expanded scale focusing on 10 minutes of data from 08:11:00 CDT to 08:21:00 CDT. Figure 20 also has an expanded scale focusing on 10 minutes of data from 08:12:00 CDT to 08:22:00 CDT.

Figures 21 and 22 contain BNSF 7553's locomotive event recorder data. Figures 23 and 24 contain BNSF 7907's locomotive event recorder data. Figures 21 and 23 cover 6 hours of data from 02:25:00 CDT to 08:25:00 CDT (BNSF 7553's data ends at 8:20:55 CDT). Figure 22 has

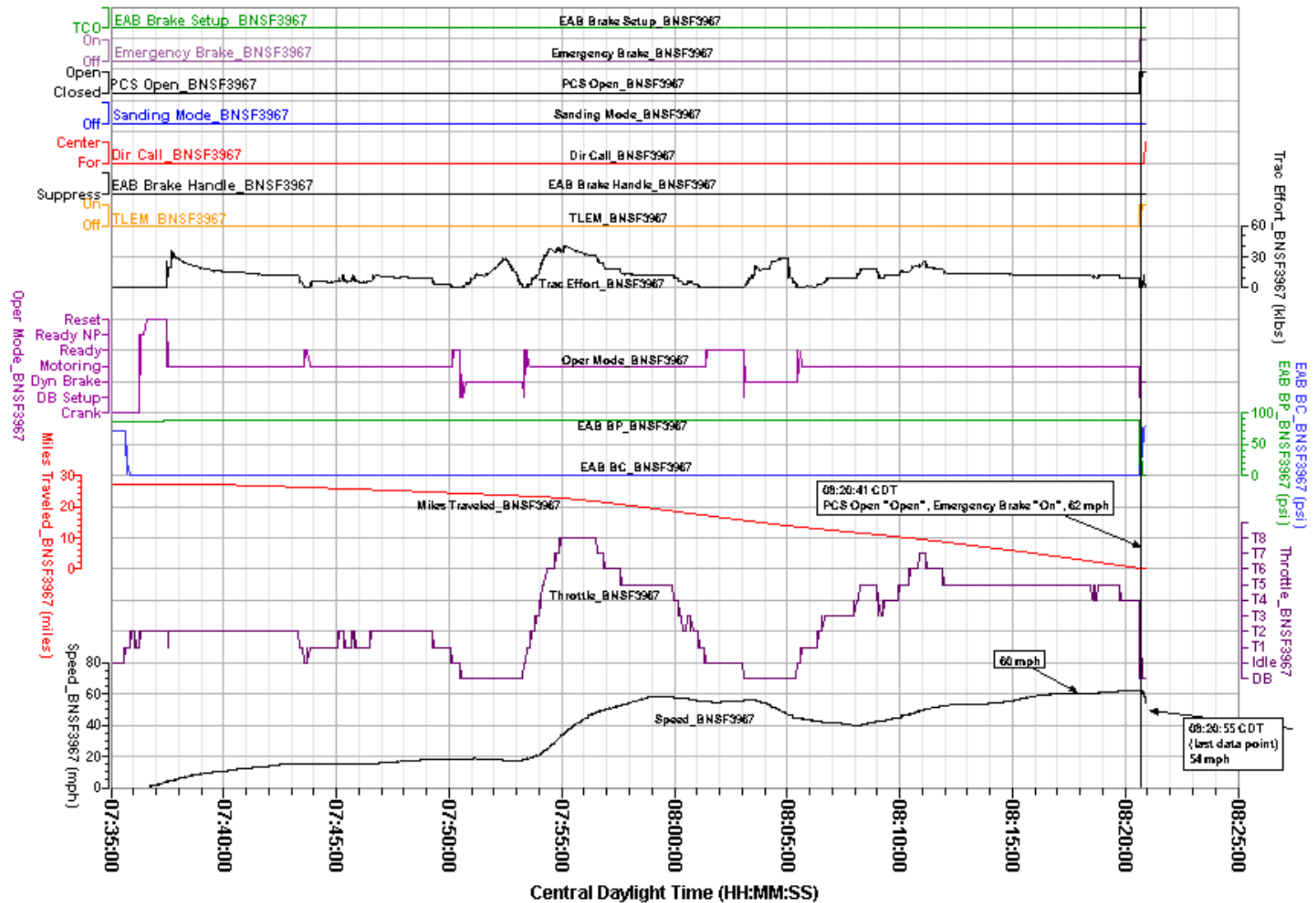
an expanded scale focusing on 10 minutes of data from 08:11:00 CDT to 08:21:00 CDT. Figure 24 also has an expanded scale focusing on 10 minutes of data from 08:12:00 CDT to 08:22:00 CDT.

In brief, the locomotive event recorder data from BNSF 3967 indicated at 8:20:41 CDT while at a speed of 62 miles per hour (mph), the PCS transitioned from “Closed” to “Open”, the Emergency Brake transitioned from “Off” to “On”, the throttle position changed from throttle position 4 (T4) to Idle, and the electronic air brake – brake pipe pressure (EAB BP) reduced from 89 pound per square inch (psi) to 33 psi. One second later at 8:20:42 CDT, the EAB BP reduced to 0 psi and remained at 0 psi for the rest of the data. At 8:20:43 CDT, the throttle position changed to dynamic brake (DB) and remained at DB for the rest of the data. Two seconds later at 8:20:45 CDT, the speed reduced to 61 mph. Then 10 seconds later at 8:20:55 CDT, the data ended while at speed of 54 mph.

The locomotive event recorder data from BNSF 7553 indicated at 8:20:40 CDT while at a speed of 37 mph and a throttle position of Idle, the PCS transitioned from “Closed” to “Open”, the Emergency Brake transitioned from “Off” to “On”, and the EAB BP reduced from 79 psi to 8 psi. One second later at 8:20:41 CDT, the throttle position transitioned to DB and EAB BP reduced to 0 psi. Both throttle position and EAB BP remained unchanged for the rest of the data. Two seconds later at 8:20:43 CDT the speed decreased to 36 mph and continued to decrease. Twelve seconds later at 8:20:55 CDT, the data ended while at speed of 29 mph.

All of the corresponding tabular data used to create figures 15, 17, 18, 19, and 20 (BNSF 3967 and BNSF 8234 data) are provided in electronic comma separated value (*.csv) format as attachment 1 to this factual report. Additionally, all of the corresponding tabular data used to create figures 16, 21, 22, 23, and 24 (BNSF 7553 and BNSF 7907 data) are provided in electronic comma separated value (*.csv) format as attachment 2 to this factual report.

Figure 17: BNSF 3967's locomotive event recorder parameters (50 minutes)

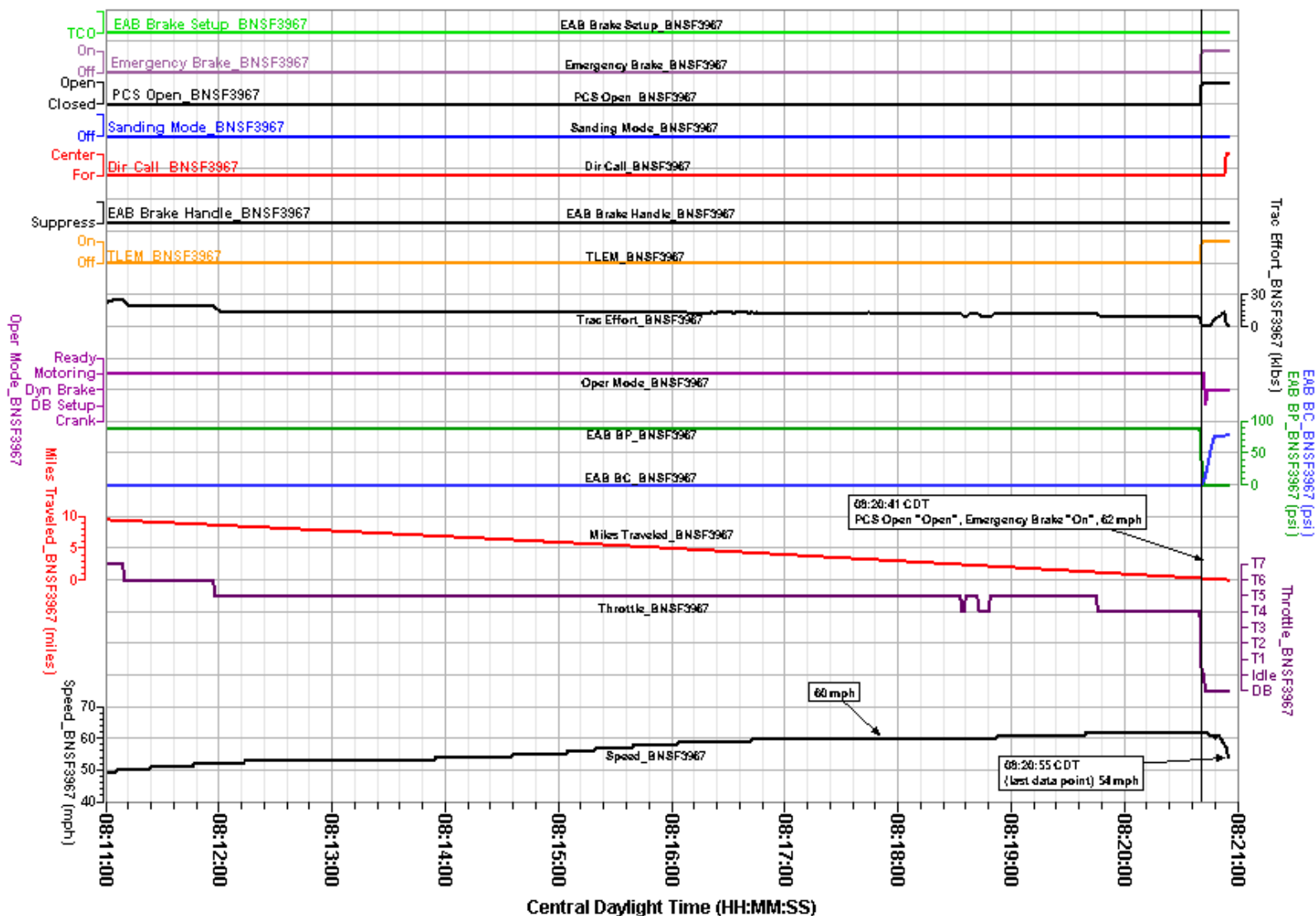


Revised: 23 September 2016

BNSF 3967: 50 Minutes (07:35:00 to 08:25:00)

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Figure 18: BNSF 3967's locomotive event recorder parameters (10 minutes)

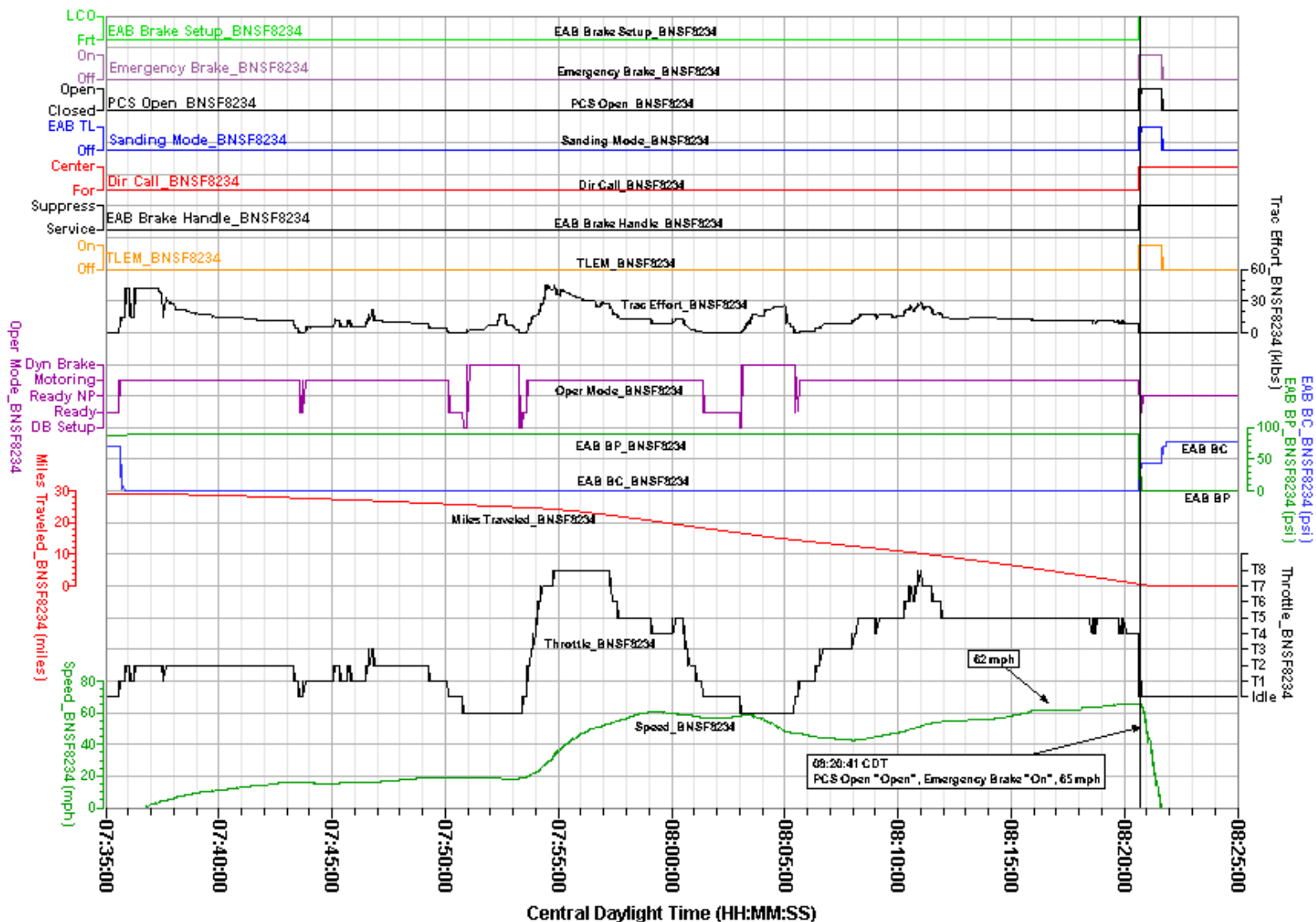


Revised: 23 September 2016

BNSF 3967: 10 Minutes (08:11:00 to 08:21:00)

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Figure 19: BNSF 8234's locomotive event recorder parameters (50 minutes)

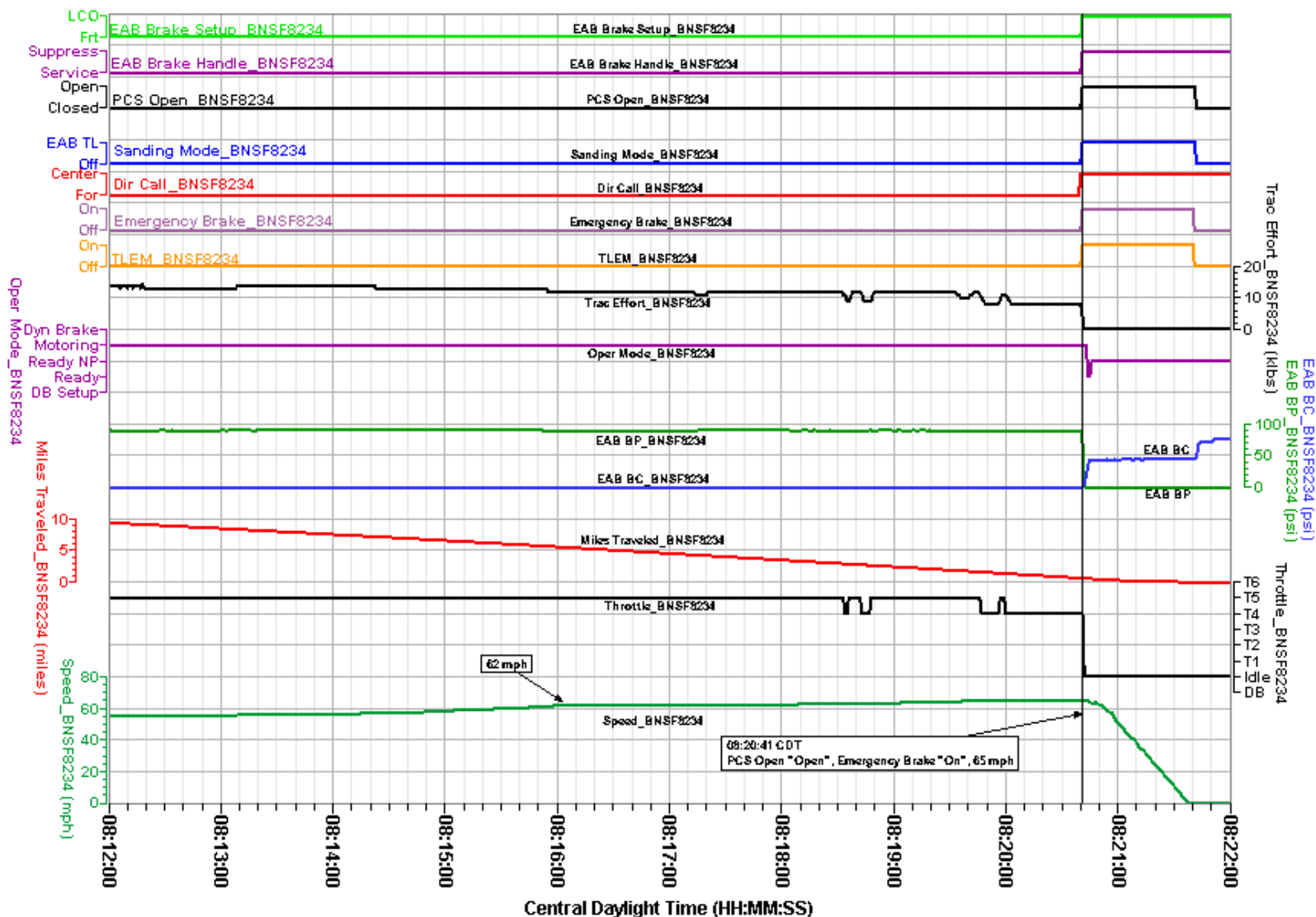


Revised: 23 September 2016

BNSF 8234: 50 Minutes (07:35:00 to 08:25:00)

National Transportation Safety Board

Figure 20: BNSF 8234's locomotive event recorder parameters (10 minutes)

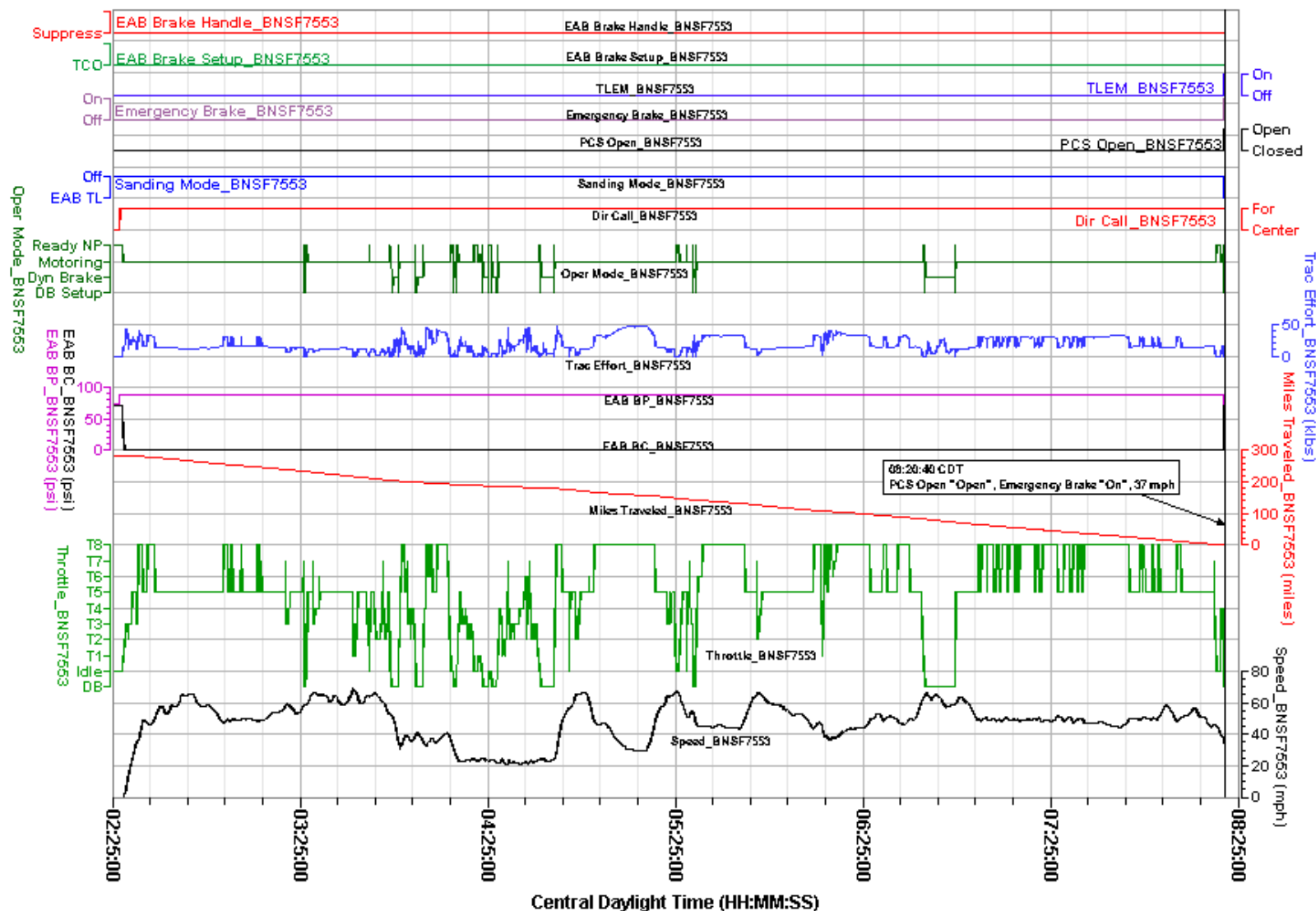


Revised: 23 September 2016

BNSF 8234: 10 Minutes (08:12:00 to 08:22:00)

National Transportation Safety Board

Figure 21: BNSF 7553's locomotive event recorder parameters (6 hours)

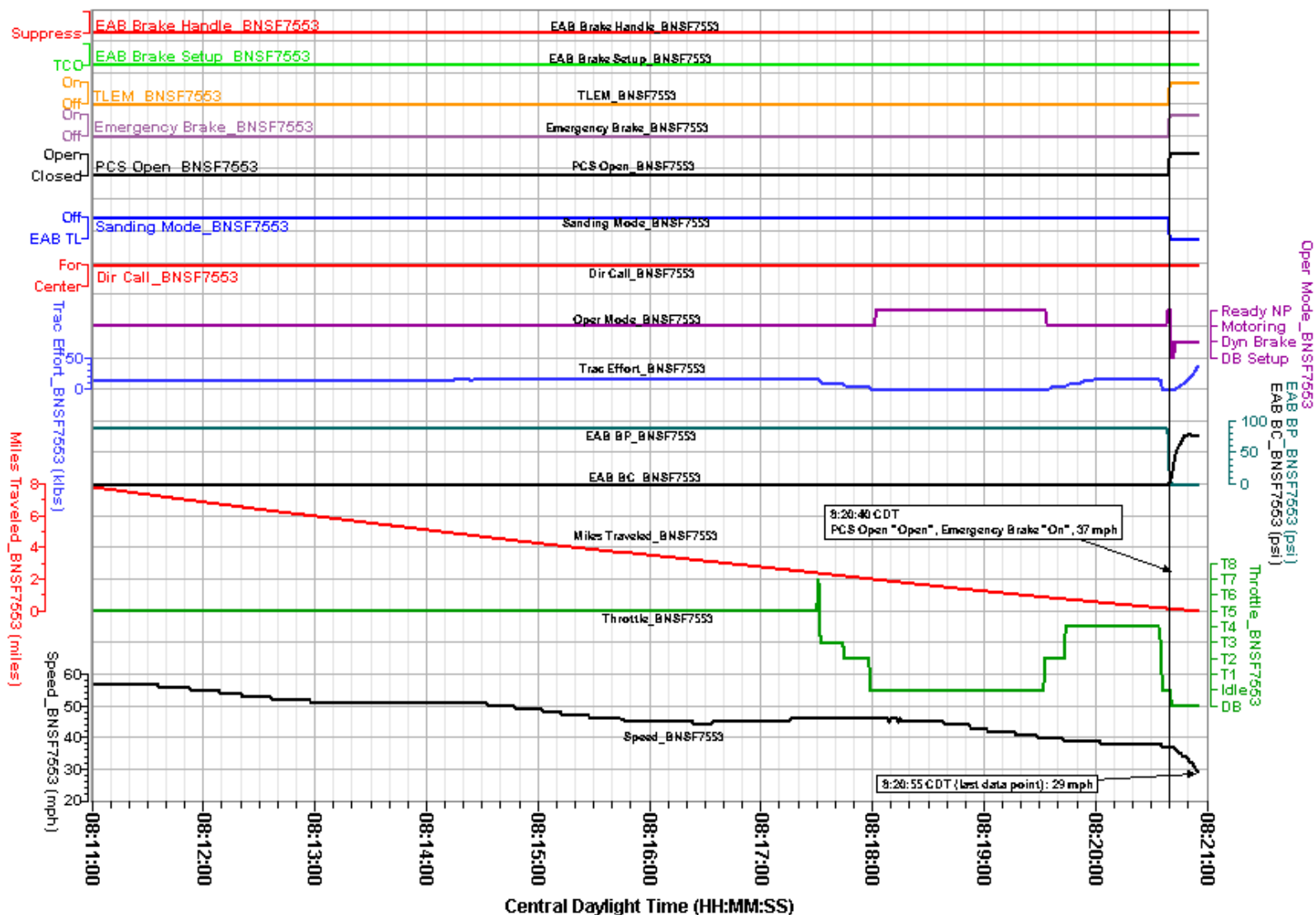


Revised: 23 September 2016

BNSF 7553: 6 Hours (02:25:00 to 08:25:00)

National Transportation Safety Board

Figure 22: BNSF 7553's locomotive event recorder parameters (10 minutes)

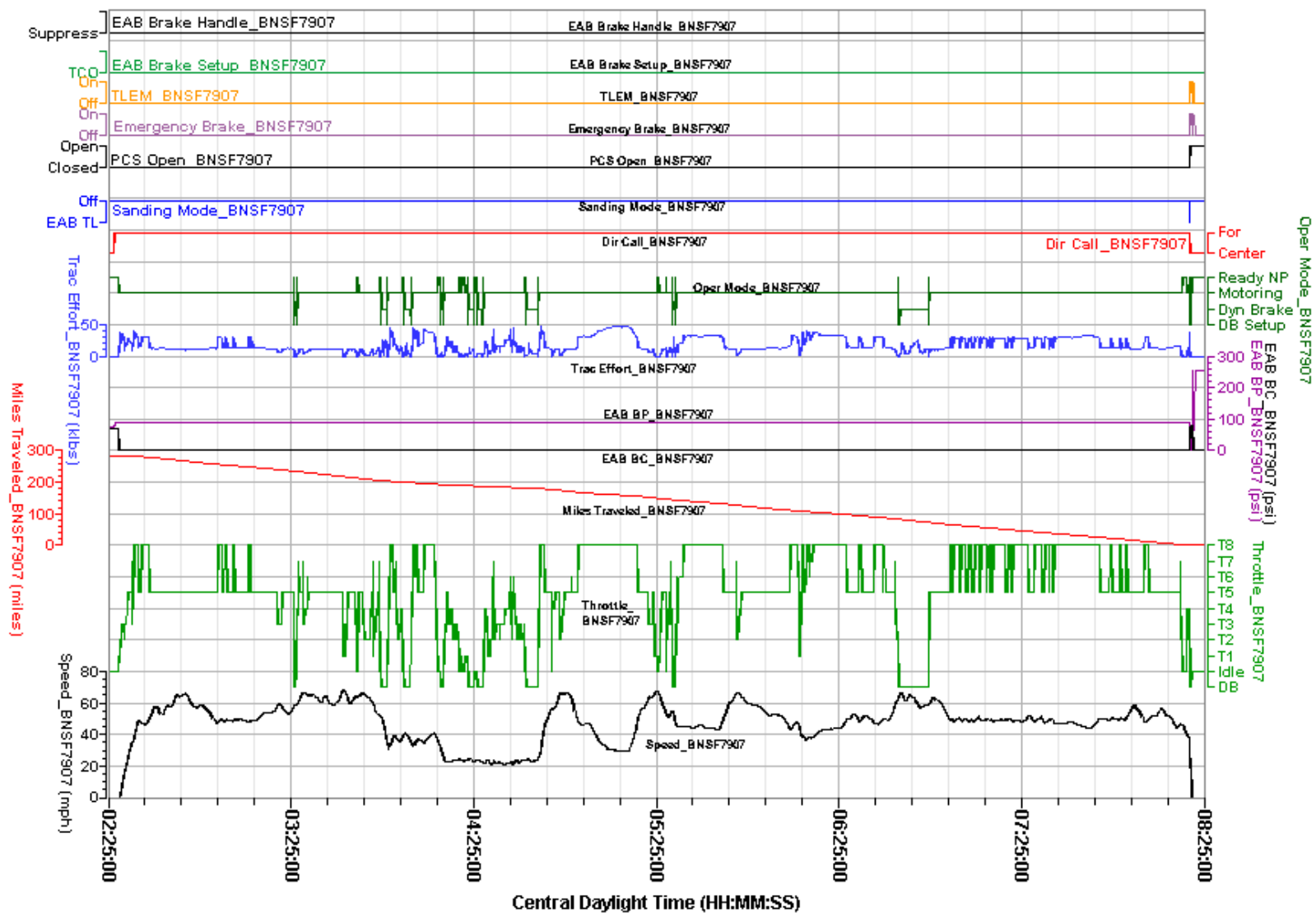


Revised: 23 September 2016

BNSF 7553: 10 Minutes (08:11:00 to 08:21:00)

National Transportation Safety Board

Figure 23: BNSF 7907's locomotive event recorder parameters (6 hours)

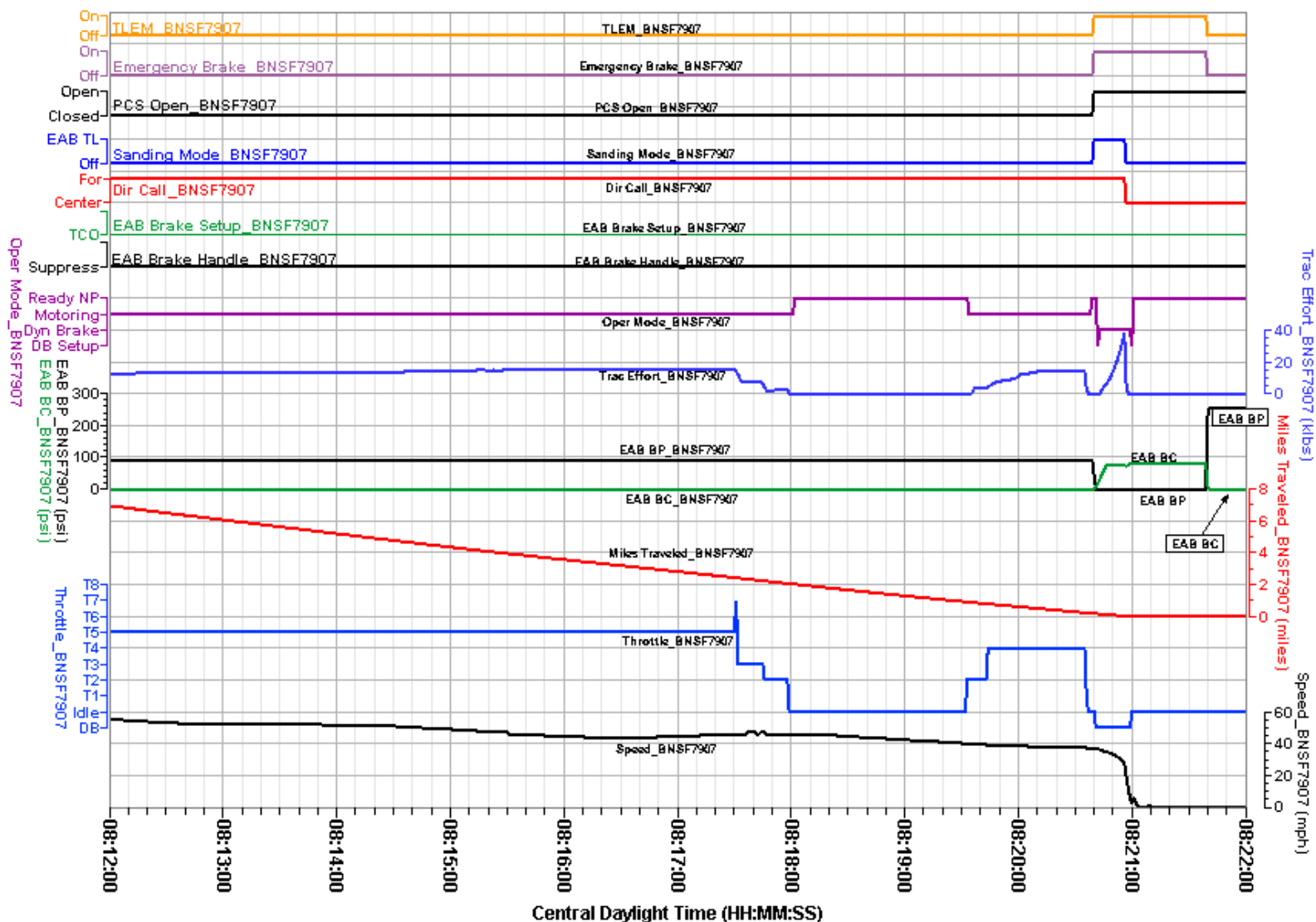


Revised: 14 October 2016

BNSF 7907: 6 Hours (02:25:00 to 08:25:00)

National Transportation Safety Board

Figure 24: BNSF 7907's locomotive event recorder parameters (10 minutes)



Revised: 23 September 2016

BNSF 7907 - 10 Minutes (08:12:00 to 08:22:00)

National Transportation Safety Board

APPENDIX A

This appendix describes the locomotive event recorder parameters provided and verified in this report for BNSF 3967, BNSF 8234, BNSF 7553, and BNSF 7907. 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.

Plot Label	Parameter Description	Unit
1. Dir Call_BNSF ID	Direction of Travel	
2. EAB BC_BNSF ID	Electronic Air Brake – Brake Cylinder Pressure	psi
3. EAB BP_BNSF ID	Electronic Air Brake – Brake Pipe Pressure	psi
4. EAB Brake Handle_BNSF ID	Electronic Air Brake – Brake Handle Position	
5. EAB Brake Setup_BNSF ID	Electronic Air Brake – Setup	
6. Emergency Brake _BNSF ID	Emergency Brake	
7. Miles Traveled_BNSF ID	Miles Traveled	miles
8. Oper Mode_BNSF ID	Operating Mode	
9. PCS Open_BNSF ID	Pneumatic Control Switch	
10. Sanding Mode_BNSF ID	Sanding Mode	
11. Speed_BNSF ID	Speed	mph
12. Throttle_BNSF ID	Throttle Position	
13. TLEM_BNSF ID	Trainline Emergency	
14. Trac Effort	Traction 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.

NOTE: ID stands for all four locomotives: 3967, 8234, 7553, and 7907.

Table A-2. Unit and discrete state abbreviations.

Units and Discrete Abbreviation	Description
DB	Dynamic Brake
Dyn	Dynamic
EAB TL	Electronic Air Brake Trainline
For	Forward
Frt	Freight
klbs	kilo pounds
LCO	Lead Cutout
mph	miles per hour
psi	pounds per square inch
Ready NP	Ready No-Power
T1	Throttle Position 1
T2	Throttle Position 2
T3	Throttle Position 3
T4	Throttle Position 4

Units and Discrete Abbreviation	Description
T5	Throttle Position 5
T6	Throttle Position 6
T7	Throttle Position 7
T8	Throttle Position 8
TCO	Trail Cutout