NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division Washington, D.C. 20594

February 14, 2013

Locomotive Event Recorder

Specialist's Factual Report By Cassandra Johnson

1. EVENT SUMMARY

Location: Midland, Texas
Date: November 15, 2012

Company: Union Pacific (UP) Railroad

Train ID: ZLCAI-14

Lead Locomotive #: 7877 Trailing Locomotive #: 7653

NTSB Number: HWY13MH003

2. LOCOMOTIVE EVENT RECORDER GROUP

A locomotive event recorder group was not convened.

3. DETAILS OF RECORDER INVESTIGATION

The locomotive event recorders from both the UP train ZLCAI-14's lead locomotive 7877 and UP train ZLCAI-14's trailing distributed power (DP) locomotive 7653 were downloaded on scene¹. The files were readout and evaluated by the National Transportation Safety Board's Vehicle Recorder Division.

3.1. Locomotive Event Recorder Recording Description and Wheel Size

For most locomotive event recorders, the actual speed and distance values are not recorded but rather the number of drive wheel rotations (or fraction thereof) are stored in memory. At the time the data is extracted, a wheel size (diameter) is manually entered into the readout station or computer. Wheel size, number of rotations, and time are then used by the program to calculate distance traveled, where the derived distance traveled does not account for any wheel skidding or slipping that could have occurred. Then the calculated distance traveled and time data are used to calculate speed. The wheel sizes measured were 43 inches and 42.75 inches for UP 7877 and UP 7653, respectively.

Using the wheel sizes measured, the locomotive event recorder data from both UP 7877 and UP 7653 were extracted using the Wabtec Railway Electronics Event Recorder Data Analysis

¹ For the rest of this report, UP train ZLCAI-14's lead locomotive 7877 and UP train ZLCAI-14's trailing DP locomotive 7653 will be referred as UP 7877 and UP 7653, respectively.

Software. The data exported has a sampling rate of one second. Therefore, the data has an accuracy of +/- 1 second.

3.2. Parameters

Table A-1 lists the parameters from both UP 7877's and UP 7653's locomotive event recorders that were verified and provided in this report. Additionally, table A-2 contains the unit and discrete state abbreviations for the parameters.

3.2.1. 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.

3.2.2. Derived Milepost

Milepost was not a recorded parameter but was derived by using miles traveled, milepost location of where the locomotive event recorder was downloaded, and the locomotive direction of travel. UP 7877's locomotive event recorder was downloaded at milepost 554 and UP 7653's locomotive event recorder was downloaded at milepost 555.35. Additionally, milepost was decreasing in value for both locomotives since the train was traveling east.

3.3. Event Recorder Timing

Each set of locomotive event recorder data from UP 7877 and UP 7653 are independently time stamped. As a consequence of the independent time stamping, recorded times may not reflect the actual time of the day. Therefore, common events on each locomotive event recorder may not be sampled by both recorders at precisely the same time. To provide a common time base, the locomotive event recorder data was correlated to UP 7877's video recorder data², which was referenced to GPS time and reports as local time in central standard time (CST).

3.3.1. Lead Locomotive Timing Correlation Details

The video recorder data from UP 7877 recorded the horn, providing a common parameter between UP 7877's locomotive event recorder data and video recorder data. The video from UP 7877 recorded the horn starting at 16:35:23 CST and stopping at 1635:27 CST. The locomotive event recorder data recorded the horn "On" at 16:35:28 event recorder time and then transitioned to "Off" at 16:35:32 event recorder time. Therefore, an offset of 5 seconds was subtracted from UP 7877's event recorder data to align the UP 7877 event and video recordings.

3.3.2. UP 7877 and UP 7653 Timing Correlation Details

UP 7653's locomotive event recorder data was correlated to UP 7877's locomotive event recorder data by aligning the following parameters: TLEM, speed, PCS, Emergency Brake, and Throttle. To align the two sets of data, a 1 second offset was added to UP 7653's locomotive event recorder data as shown in figure 1.

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² Refer to the National Transportation Safety Board's On Board Video Recorder Factual Report.

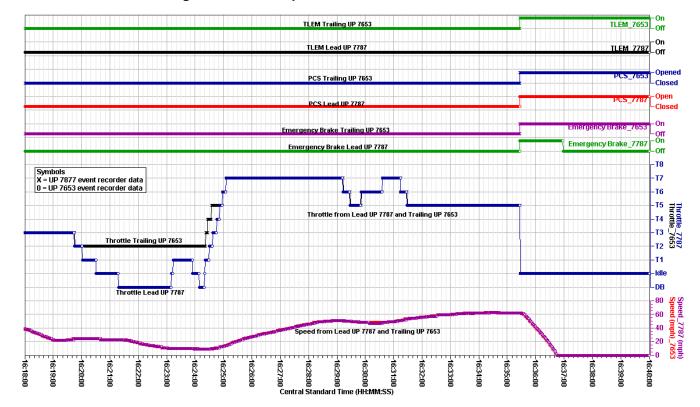


Figure 1. Time comparison between UP 7877 and UP 7653.

Therefore, for the rest of this report, all times are referenced as CST.

3.4. Plots and Corresponding Tabular Data

Figures 2 to 4 and figures 5 to 7 contain UP 7877's and UP 7653's locomotive event recorder data, respectively, during the November 15, 2012 event. All the parameters listed in table A-1 are plotted except feet traveled. Figures 2 and 5 cover the entire last two movements including the event (the scale is from 14:00:00 CST to 16:45:00 CST). Figures 3 and 6 cover the last movement including the event (the scale is from 15:35:00 CST to 16:43:00 CST). Lastly, figures 4 and 7 have an expanded time scale from 16:32:00 CST to 16:38:30 CST.

In summary, the locomotive event recorder data from UP 7877's indicated the following:

- At about 14:11:24 CST, the train departed. At this time the derived milepost was 647.12 and there were 93.12 miles until download.
- About 1 hour and 8 minutes later at 15:19:47 CST, the train stopped. At this time, the derived milepost was 595.97 and there were 41.97 miles until download.
- About 19 minutes later at 15:38:14 CST, the train started moving.
- About 57 minutes later at 16:35:23 CST, the horn transitioned to "On". At this time, the
 derived milepost was 554.85, the throttle was "T5", and there were 0.85 miles until
 download.
- About 4 seconds later at 16:35:27 CST, the horn transitioned to "Off". At this time, the derived milepost was 554.78 and there were 0.78 miles until download. Also at this

time, the EIE transitioned to "On", PCS transitioned to "Opened", and Emergency Brake transitioned to "On".

- One second later at 16:35:27 CST, the throttle transitioned from "T5" to "Idle".
- About 1 minute and 18 seconds later at 16:36:46 CST, the train came to a complete stop. At this time, the milepost was 554.

All of the corresponding tabular data from UP 7877's event recorder used to create figures 2 through 4 including feet traveled are provided in electronic comma separated value (*.csv) format as attachment 1 to this factual report. Additionally, the corresponding tabular data from UP 7653's event recorder used to create figures 5 to 7 including feet traveled are provided in electronic comma separated value (*.csv) format as attachment 2 to this factual report.

EAB Pen Alerter EAB Penalty
Off EAB Penalty TLEM TLEM CVE CVE -Off -Center Dir Call Dir Cal PCS EIE Emergency Brake
Off
On
Bell **Emergency Brake** Bell Trac Effort (klbs) Horn -Off 554 Milepost Location of UP 7877 at event recorder download. Total Miles (miles) Milepost Derived Total Miles EAB ER Pressure ()
EAB BP (psi)
EAB BC (psi)
50 c EAB BP and EAB ER Pressure EAB BC On DB Setup -100 🗣 Off On DB Start DB Start nic Brake (%) Off Dynamic Brake T8 T7 Т6 T5 Throttle T3 T2 Throttle DB. -80 -40 Speed -16:15:00 16:00:00 16:45:00 Revised: 11 February 2013 Lead UP 7877 - Last Two Movements Including Event National Transportation Safety Board

Figure 2: UP 7877's locomotive event recorder parameters during last two movements.

EAB Pen Alerter **EAB Penalty** EAB Penalty -Off -On TLEM TLEM -<mark>Off</mark> -On CVE Off Dir Call PCS EIE EIE Off On Page Off On Bell Emergency Brake Trac Effort (klbs) Horn -Off Trac Effort 554 Milepost Location of UP 7877 at event recorder download. 60 Total Miles (miles) Milepost Derived 20 EAB ER Pressure (psi)

EAB BP (psi)

EAB BC (psi)

50 0 EAB BP and EAB ER Pressure EAB BC DB Setup DB Setup mic Brake (%) DB Start **DB Start** Off --50 T8 **T7** T6 T5 Throttle Throttle T3 T2 Idle DB -80 Speed 40 -16:15:00 -16:17:00 -16:01:00 -16:03:00 -16:11:00 -15:37:00 15:41:00 -15:43:00 -15:45:00 -15:47:00 -15:51:00 -16:07:00 -16:21:00 -16:33:00 -16:37:00 16:31:00 16:39:00 16:43:00 16:35:00 Revised: 11 February 2013 Lead UP 7877 - Last Movement Including Event National Transportation Safety Board

Figure 3: UP 7877's locomotive event recorder parameters during last movement.

EAB Pen Alerter **EAB Penalty** EAB Penalty -Off -On TLEM TLEM CVE Off Dir Call PCS PCS EIE Off On **Emergency Brake** Emergency Brake Off Horn Horn Trac Effort -559 -558 -557 Total Miles (miles) 554 Milepost Location -555 (miles) of UP 7877 at event recorder download. Milepost Derived -554 EAB ER Pressure (psi)
EAB BP (psi)
EAB BC (psi)
100
EAB BC (psi)
100
EAB BC (psi) EAB BP and EAB ER Pressure EAB BP and EAB ER Pressure Dynamic Brake (%) Off **T5** T4 Throttle T2 T1 -80 -60 Speed (mph) -40 -20 16:36:10 16:34:30 16:34:20 16:34:10 -16:35:30 16:34:00 16:34:40 16:35:00 16:35:10 16:35:20 ±16:32:50 £16:33:00 E16:33:50 -16:33:30 16:33:10 16:33:20 16:33:40 16:34:50 16:36:20 16:36:30 16:36:40 16:36:50 16:37:00 16:37:10 16:37:20 16:37:40 16:38:00

Figure 4: UP 7877's locomotive event recorder parameters expanded scale.

EAB Pen Alerter EAB Penalty
Off
On
TIEM EAB Penalty TLEM TLEM CVE CVE -Off Dir Call Dir Call PCS EIE Off
On
Emergency Brake Emergency Brake Trac Effort (klbs) Horn 555.35 Milepost Location of Up 7653 at event recorder download. Total Miles (miles) Milepost Derived EAB ER Pressure (psi)
(psi)
(psi)
(psi)
(psi)
(psi)
(psi)
(psi) EAB BP and EAB ER Pressure DB Setup DB Setup Off mic Brake (%) DB Start DB Start Off -50 Dynamic Brake T8 **T7** T6 **T5** Throttle T3 T2 Throttle DB -80 Speed (mph) 40 -16:00:00 -16:15:00 16:30:00 14:30:00 14:45:00 16:45:00 Central Standard Time (HH:MM:SS) Revised: 11 February 2013 Trailing UP 7653 - Last Two Movements Including Event National Transportation Safety Board

Figure 5: UP 7653's locomotive event recorder parameters during last two movements.

EAB Pen Alerter EAB Penalty EAB Penalty -Off -On TLEM TLEM -<mark>Off</mark> -On CVE CVE -Off -Center Dir Cal PCS EIE EIE Off On Emergency Brake Off On Bell Emergency Brake Bell Trac Effort (klbs) Horn -Off Trac Effort 555.35 Milepost Location of Up 7653 at event recorder download. 60 Milepost Derived s (miles) EAB ER Pressure (psi)

EAB BP (psi)

EAB BC (psi)

50

0 0 EAB BP and EAB ER Pressure EAB BC DB Setup DB Setup Off On mic Brake (%) DB Start DB Start Off -50 Dynamic Brake T8 **T7** T6 **T5** Throttle Throttle T3 T2 DB -80 Speed 40 -16:15:00 -16:01:00 -16:03:00 -16:09:00 -16:11:00 -16:17:00 -16:21:00 -15:37:00 -15:41:00 -15:45:00 -15:47:00 -15:51:00 -15:53:00 -16:07:00 -16:27:00 -16:29:00 -16:31:00 -16:33:00 -16:37:00 -16:41:00 15:59:00 16:39:00 16:43:00 15:39:00 16:35:00 Revised: 11 February 2013 Trailing UP 7653 - Last Movement Including Event National Transportation Safety Board

Figure 6. UP 7653's locomotive event recorder data during last movement.

EAB Pen Alerter EAB Penalty EAB Penalty -Off -On TLEM TLEM -<mark>Off</mark> -On CVE Off Dir Call Dir Call PCS EIE **Emergency Brake** Off Horn Horn Trac Effort -560 5 -559 -558 555.35 Milepost Location of Up 7653 at event recorder download. Total Miles (miles) Milenost Derived .556 g -555 EAB ER Pressure (psi)

EAB BP (psi)

EAB BC (psi)

6 6 0 EAB BP and EAB ER Pres EAB BC EAB BP and EAB ER Pressure Dynamic Brake (%) DB Setup and DB Star Off **T5** Throttle T4 Throttle T2 T1 -80 -60 40 -20 16:36:10 16:34:30 16:34:20 16:34:10 16:34:00 16:34:40 16:35:10 16:35:20 £16:33:00 E16:33:50 -16:32:50 -16:33:30 16:33:10 16:33:20 16:33:40 16:34:50 16:35:00 16:36:20 16:36:30 16:36:40 16:36:50 16:37:00 16:37:10 16:37:20 16:37:40 16:38:00

Figure 7. UP 7653's locomotive event recorder parameters expanded scale.

APPENDIX A

This appendix describes the locomotive event recorder parameters provided and verified in this report. Table A-1 lists the parameters for both UP 7877 and UP 7653. Table A-2 describes the unit abbreviations.

Table A-1. UP 7877 and UP 7653 verified and provided locomotive event recorder parameters.

Parameter Name	Parameter Description
1. Bell (discrete)	Bell
2. CVE (discrete)	Conductor Valve Emergency
3. DB Setup (discrete)	Dynamic Brake Setup
4. DB Start (discrete)	Dynamic Brake Start
5. Dir Call (discrete)	Direction of Travel
6. Dynamic Brake (%)	Dynamic Brake
7. EAB BC (psi)	Electronic Air Brake Brake Cylinder Pressure
8. EAB BP (psi)	Electronic Air Brake Brake Pressure
9. EAB ER Pressure (psi)	Electronic Air Brake Equalizing Reservoir Pressure
10. EAB Pen Alerter (discrete)	Electronic Air Brake Penalty Alerter
11. EAB Penalty (discrete)	Electronic Air Brake Penalty
12. EIE (discrete)	Engineer Induced Emergency
13. Emergency Brake (discrete)	Emergency Brake
14. Horn (discrete)	Horn
15. Milepost Derived (miles)	Derived Milepost Location
16. PCS (discrete)	Pneumatic Control Switch
17. Speed (mph)	Speed
18. Throttle (discrete)	Throttle Position
19. TLEM (discrete)	Train Line Emergency
20. Total Feet (ft)	Feet Traveled
21. Total Miles (miles)	Total Miles Traveled
22. Trac Effort (klbs)	Traction Effort

Table A-2. Unit and discrete state abbreviations.

Unit and Discrete State Abbreviations	Description
%	percent
DB	Dynamic Brake
discrete	discrete
For	Forward
ft	feet
klbs	kilo pounds
miles	miles
mph	miles per hour
psi	pounds per square inch

Unit and Discrete State Abbreviations	Description
T1	Throttle 1
T2	Throttle 2
T3	Throttle 3
T4	Throttle 4
T5	Throttle 5
T6	Throttle 6
T7	Throttle 7
T8	Throttle 8

NOTE: For parameters with a unit description of discrete, 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.