**TRAIN RECORDERS
GROUP CHAIRMAN'S FACTUAL REPORT**

Oxnard, California

HWY15MH006

(09 pages)

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

March 23, 2016

Lead Car and Locomotive Event Recorders

Group Chairman's Factual Report
By George Haralampopoulos

1. EVENT SUMMARY

Location:	Oxnard, California
Date:	February 24, 2015
Operator:	Metrolink
Train #:	102
Lead Car #:	645
Locomotive #:	870
NTSB Number:	HWY15MH006

For a summary of the accident, see the Accident Summary Report, which is available in the docket for the investigation.

2. RECORDER GROUP

On February 25, 2015 a recorder group was established. The group convened on February 26, 2015 in Oxnard, California.

Chairman: George Haralampopoulos
Aerospace Engineer
National Transportation Safety Board

Member: Ramon Chavez
Railroad Safety Inspector – Motive Power & Equipment
U.S Department of Transportation – Federal Railroad Administration

Member: Robert Cook
Mechanical Compliance Officer
MetroLink – Southern California Regional Rail Authority

3. FEDERAL EVENT RECORDER CARRIAGE REQUIREMENTS

Federal Regulations regarding the carriage requirements of event recorders on railroad locomotives can be found in Federal Railroad Administration 49 *Code of Federal Regulations* (CFR) Part 229.135. The locomotive was operating such that it was required to have a crash survivable event recorder recording a minimum of 25 parameters depending upon the specific type and configuration of the locomotive type as described in 49 CFR Part 229.135(b)(3).

4. DETAILS OF RECORDER INVESTIGATION

Train 102 consisted of 4 cars and a trailing locomotive. A Wabtec Train Trax event recorder existed in each car and locomotive. Figure 1 shows the compartment containing the event recorder.

The event recorder receives inputs from the Train Management Computer (TMC) that supplies Positive Train Control (PTC) related parameters and status messages, and a Bach Simpson recorder, used as a data acquisition system, supplies traditional parameters such as; Horn, Speed, Cab Signals, and Brake Applications. Parameters from the TMC are distinguished with an "IETMS" tag prefacing the parameter.

Figure 1. TMC and Event Recorder placement in Locomotive 870.

Only a download of lead car 645 and the trailing locomotive 870's[1] event recorders were performed. The download of the Locomotive's event recorder data was successfully performed on-scene using manufacturer recommended procedures.

Due to damage sustained by the Lead Car, its event recorder was removed and placed in the locomotive's compartment (figure 2) for download and the data was successfully downloaded.

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[1] Lead car #645 and trailing locomotive #870 will be referenced as Lead Car and Locomotive for the duration of this report.
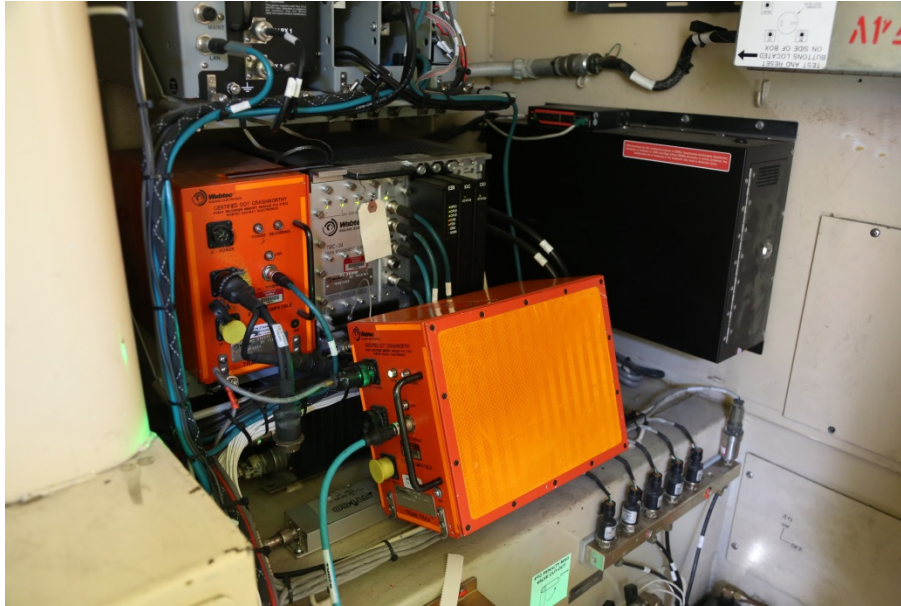
Figure 2. Lead car event recorder placed in locomotive 870.

4.1. Event Recorder Data Description

The data from the Lead Car event recorder contained 82^2 parameters and spanned about 24 days from January 31, 2015 to February 24, 2015.

The data from the Locomotive event recorder contained 71 parameters and spanned about 18 days from January 17, 2015 to February 4, 2015.

The accident event was identified by based on the parameters recorded including; time and emergency application.

The Horn and Cab Signal parameters are only available on the lead car's event recorder. Conversely, the Horn and Cab Signal parameters are not available to an event recorder of a car acting as the rear or middle of the train consist; therefore, data from the locomotive were considered redundant and only data from the lead car's event recorder is used in this report; however, data from the locomotive are provided in electronic comma separated value (*.csv) format as attachment 1 to this report. [3]

4.1.1 Recorder Parameter Discrepancy

Due to the recorder manufacturer's software, the Distance Traveled parameters evaluated for the purpose of this report were not in accordance with the federal carriage requirements. The values associated with the parameter appeared exaggerated. The operator was notified of the discrepancy through electronic correspondence.

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[2] Five of the 82 parameters on the event recorder were PTC related.
[3] Rear and Front are defined by the train's direction of travel.

4.1.2 Derivation of Event Recorder Speed and Distance

The speed for each recorder is derived in the event recorder software. A wheel size is manually entered into the software to obtain the calculated speed. Using a wheel size of 32.5 and 37.63 inches for the Lead Car and Locomotive event recorder, respectively as measured by investigators, the speed values were computed. The IETMS Speed is calculated through the TMC and no additional corrections are needed.

The event recorder provided parameter, distance travelled, appeared exaggerated and was not used; therefore the locomotive's distance traveled was calculated by the parameters, speed and time, recorded by the event recorder using the following formula:

$$(1)\ D = d_0 + \frac{v\,(t_1 - t_0)}{3600}$$

Where:

D = Distance Traveled (miles)

d_0 = Prior Distance (miles)

v = Velocity (mph)

t_1 = Time (sec)

t_0 = Prior Time (sec)

The derived parameter is referred to as Calculated Distance Feet and Calculated Distance Miles in this report. The distance was only calculated for the period of data provided in this report and began incrementing from a value of zero with a corresponding speed of zero.

4.1.3 Event Recorder Status Messages

Status messages are captured by the event recorder. Messages containing the state of the train are recorded once a second. GPS location messages are sent once every 30 second. Faults are recorded at the time of occurrence. The recorded messages pertinent to the investigation are shown in Table 1.

Table 1. Verified status messages from Lead Car event recorder.

Time (PST)	Type	Message
5:42:39	LOC	ETMS Speed: 71.21 (MPH)
5:42:39	BHA	Horn: Engineer Induced
5:42:45	GPS	Source: GPS 1 | LAT: 34:11.8279 N | LON: 119:8.5648 W | Position: Valid DGPS |
5:42:46	GPS	Source: GPS 2 | LAT: 34:11.8279 N | LON: 119:8.5640 W | Position: Valid DGPS |
5:42:48	LOC	ETMS Speed: 5.40 (MPH)
5:42:52	FLT	GPS1: GPS1: Data Invalid (Active) | Code: 0617
5:42:52	FLT	GPS2: GPS2: Data Invalid (Active) | Code: 0618

4.2. Time Correlation

The Wabtec event recorder receives input from a GPS source that synchronizes its clock to Coordinated Universal Time (UTC) automatically when the GPS source is valid. The locomotive event recorder time matched the local time, Pacific Standard Time (PST), with an 8 hour offset at the time of download.

The lead car event recorder contained an offset in time because it was downloaded in the locomotive cab without a valid GPS signal. The time from the lead car event recorder was correlated to the Locomotive by plotting common parameters between the recorders. An offset of 1320 subtracted from the lead car recorders time to obtain the local time, PST.

4.3. Parameters Provided and Verified.

Table 2 lists the parameters from the event recorder that were verified and provided in this report. Additionally, table 3 contains the unit and discrete[4] state abbreviations for the verified parameters.

Table 2. Verified and provided event recorder parameters.

Parameter Name	Parameter Description
1. Car Speed (mph)	Car Speed
2. Car BCP (psi)	Car Brake Cylinder Pressure
3. Car BPP (psi)	Car Brake Pipe Pressure
4. Car Headlight Switch[5] (V)	Car Headlight Voltage
5. Car Throttle (discrete)	Car Throttle
6. Car PCS Open (discrete)	Car Pneumatic Control Switch Open/Closed
7. Car Alerter Manual Reset (discrete)	Car Alerter Manual Reset
8. Car Emer Brake Appl (discrete)	Car Emergency Brake Application

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[4] 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.
[5] Not Plotted but is included in the attached tabular data.

Parameter Name	Parameter Description
9. Car IETMS Speed (mph)	Car IETMS Speed
10. Car Horn Switch (discrete)	Car Horn Switch
11. Car Bell (discrete)	Car Bell
12. Car Reverser Pos (discrete)	Car Reverser Position
13. Calculated Distance Miles (miles)	Calculated Distance in Miles
14. Calculated Distance Feet (ft)	Calculated Distance in Feet

Table 3. Unit and discrete state abbreviations.

Unit and Discrete State Abbreviations	Description
T1 - T8	Throttle Detents 1 through 8
I	Throttle Idle
DB	Throttle Dynamic Break
Forward	Car Position Forward
Neutral	Car Position Neutral
Reverse	Car Position Reverse
psi	pounds per square inch
mph	miles per hour
ft	feet
miles	miles

5. PLOTS AND CORRESPONDING TABULAR DATA

Figures 3 and 4 contain data plotted from the lead car event recorder during the February 24, 2015, event.

Figure 3 is an overview of the entire event trip. Figure 4 is a four minute segment from figure 3, highlighting the emergency brake application. The data includes operator inputs, car discrete(s), and car performance parameters. The data shows the train complete one stop at the Oxnard Station.

In brief, the data indicated that the train departed at 5:25:19 PST. The trip remained uneventful until 5:42:34 PST, when the emergency brake application and PCS Open recorded active. Concurrently, the brake pipe pressure fell from 108 to 0 psi, consistent with emergency. Following the emergency application, the trains speed decreased from 71 to 58 mph over 7 seconds, when the speed recorded an abrupt change consistent with impact.

Prior to the emergency braking, a series of recorded engineer movement applications were noted. A horn application was recorded at 5:52:29 PST, at a calculated distance of about 1200 feet from impact. A second later at 5:42:30 PST and about 1100 feet from impact, the throttle was moved from 'T8', to its idle detent.

No pertinent cab signals were noted prior to the emergency application and a series of horn applications were recorded at 5:41:31 PST, consistent with a grade crossing.

The tabular data used to generate figures 3 and 4 are provided in electronic comma separated value (*.csv) format as attachment 2 to this report.
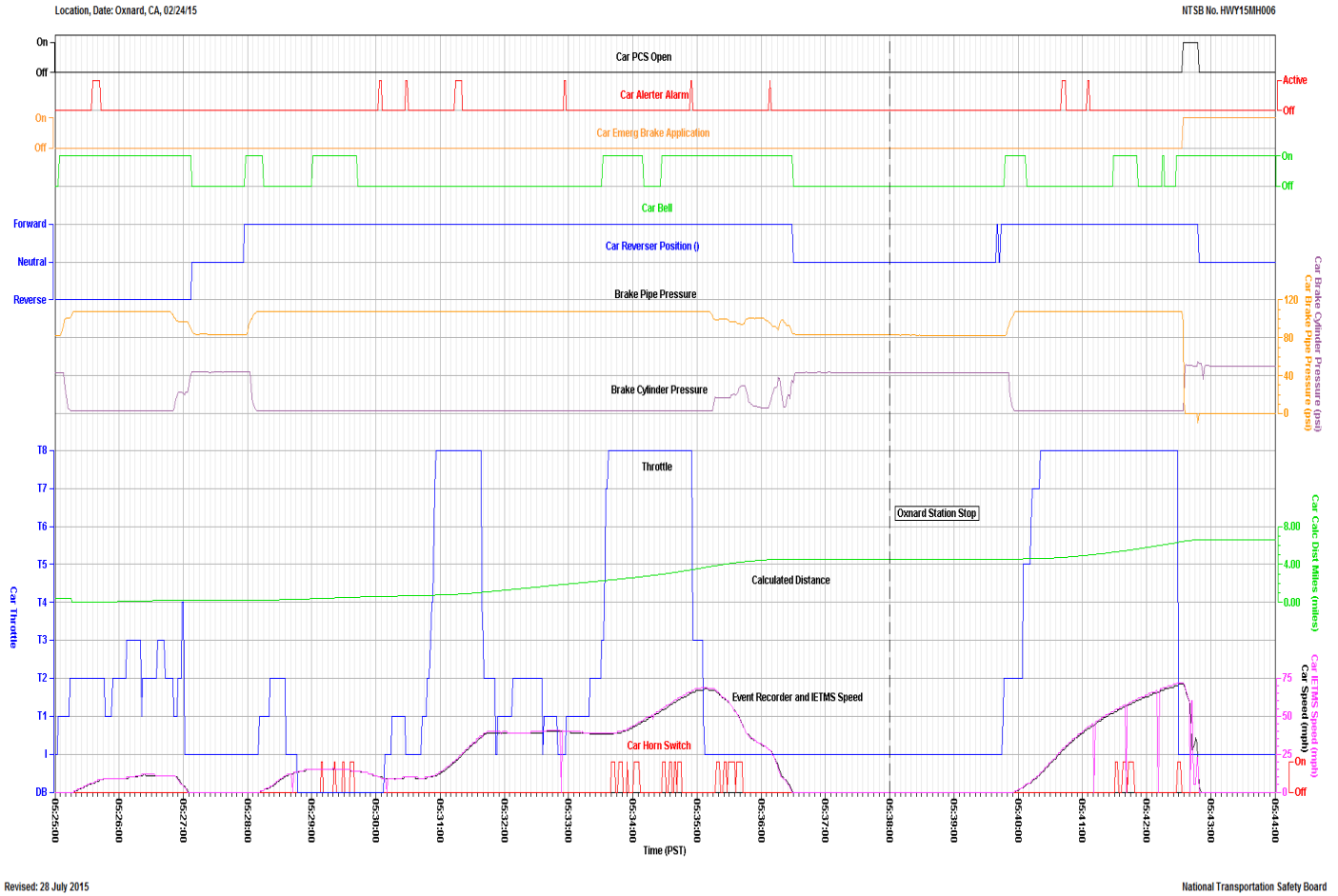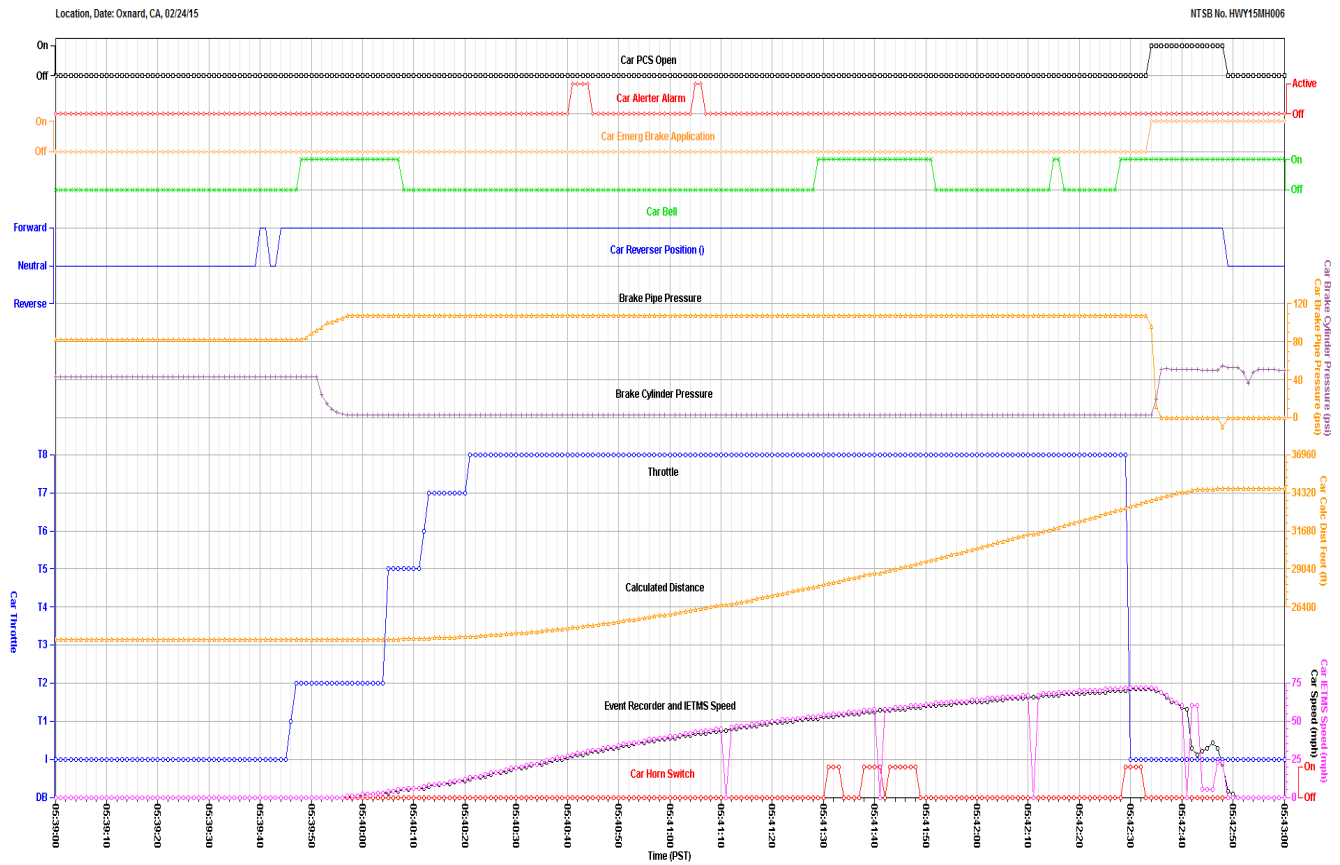

Figure 3. Plot of event recorder parameters for entire event trip.

Figure 4. Plot highlighting emergency brake application.

END OF REPORT