RECORDERS
FACTUAL REPORT

Baltimore, MD

HWY17MH007

(18 pages)

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

January 29, 2018

Recorders

Specialist's Factual Report
by Jane Foster

1. EVENT

Location:	Baltimore, MD
Date:	November 1, 2016
Vehicle #1:	2015 IC School Bus
Operator #1:	AAAfordable Transportation LLC
Vehicle #2:	2012 Ford Mustang
Operator #2:	Private
Vehicle #3:	2005 New Flyer Transit Bus
Operator #3:	Maryland Transit Administration
NTSB Number:	HWY17MH007

For a summary of the accident, refer to the *Crash Summary Report*, which is available in the docket for this investigation.

2. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device 1:	International Maxxforce Engine Control Module (ECM)
Device 1 Serial Number:	3518196
Vehicle:	#1
Device 2:	Meritor WABCO Hydraulic Power Braking (HPB) System
Device 2 Serial Number:	50042957
Vehicle:	#1
Device 3:	Samsung Galaxy GRAND Prime
Device 3 Serial Number:	R28G610DJVF
Vehicle:	Removed from driver of Vehicle #1's personal vehicle
Device 4:	Magellan Roadmate Global Positioning System (GPS)
Device 4 Serial Number:	0891000269043
Vehicle:	Removed from driver of Vehicle #1's personal vehicle
Device 5:	Airbag Control Module (ACM)
Device 5 Serial Number:	3133911400000000
Vehicle:	#2

Device 6:	Cummins Engine Control Module (ECM)
Device 6 Serial Number:	32195866
Vehicle:	#3
Device 7:	Automatic Vehicle Locator (AVL) System
Device 7 Serial Number:	n/a
Vehicle:	#3

2.1. International ECM Device Description (Vehicle #1)

The International Maxxforce ECM is an electronic control and data storage system for International engines. The ECM stores vehicle parameters and has the capability to record trip activity, including daily, monthly, and lifetime engine data. The ECM interfaces with many onboard sensors that help monitor and perform its functions.

2.1.1. International ECM Data Recovery

The electrical system of the school bus was compromised so the International ECM could not be imaged on the vehicle. The accident ECM was removed from the accident bus and placed in a surrogate bus. This prevents additional fault codes that appear on a bench top download. The International ECM that was removed from the accident bus is shown in **Figures 1 through 3**. Service Maxx Pro software application was used to image both the accident ECM and the surrogate ECM.

Figure 1. Front of International ECM removed from accident vehicle.

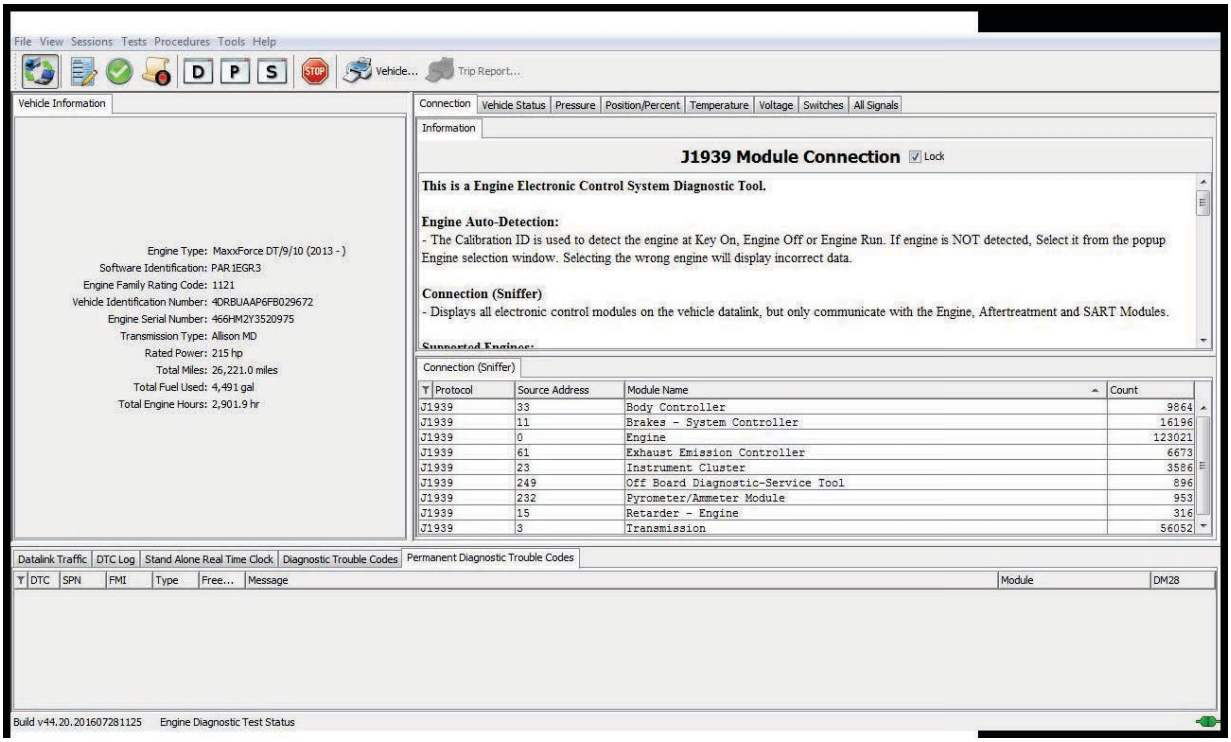
Figure 2. Back of International ECM removed from accident vehicle.

Figure 3. Side of International ECM removed from accident vehicle.

2.1.2. International ECM Data Description

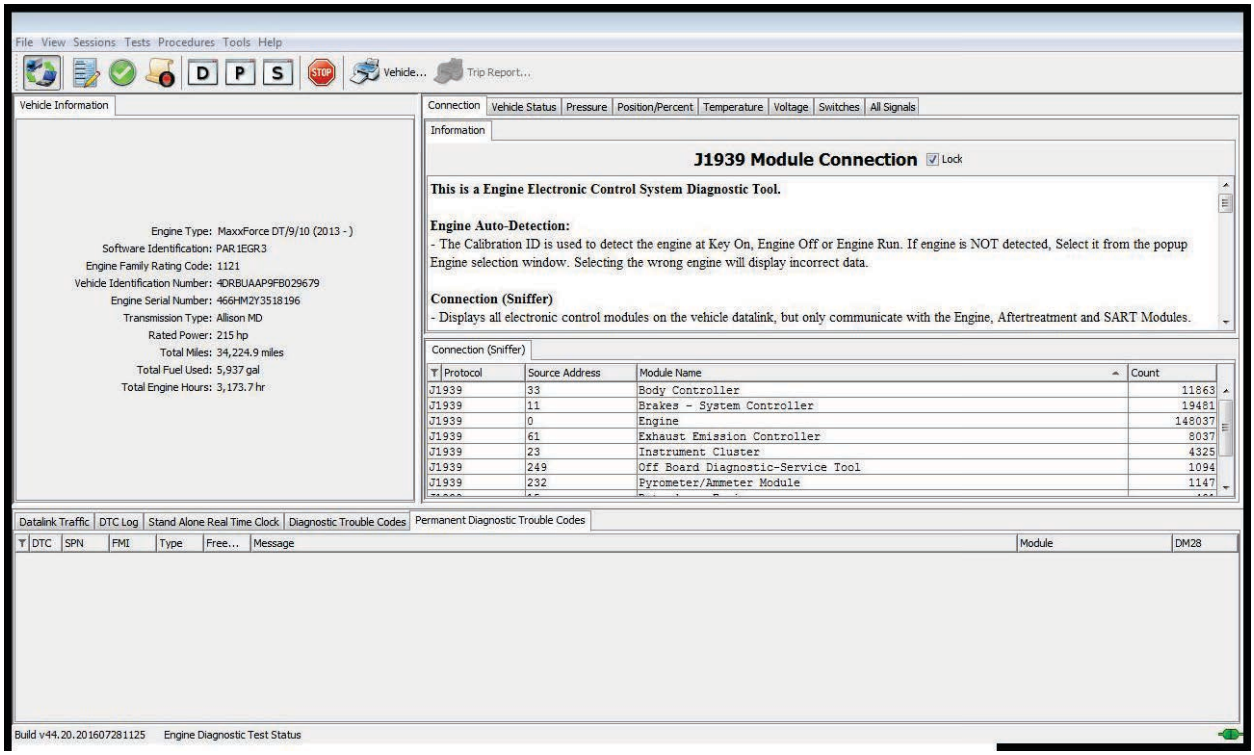
The surrogate ECM was imaged first to ensure that no fault codes were on the ECM and could be transferred to the accident ECM. No permanent diagnostic trouble codes were found on the surrogate ECM. **Figure 4** is a screenshot of the ServiceMaxx Pro software showing no permanent diagnostic trouble codes on the surrogate ECM.

Figure 4. Screenshot showing no permanent diagnostic trouble codes on the surrogate ECM.



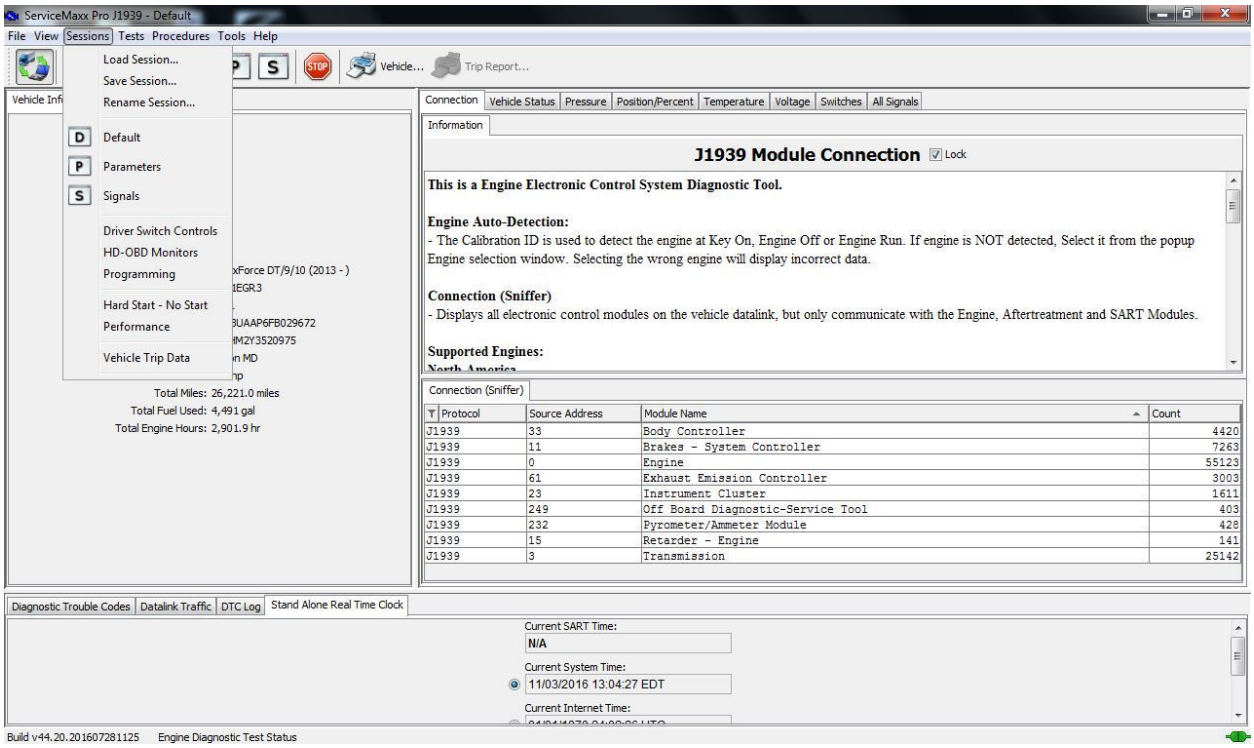
After determining that the surrogate engine would not produce new fault codes into the accident ECM, the accident ECM was installed in the surrogate vehicle. Three diagnostic trouble codes were found on the vehicle. Snapshots of the engine parameters known as freeze frames were taken at the time of the diagnostic trouble codes. None of the codes were accident pertinent. No permanent diagnostic trouble codes were present on the vehicle as shown in **Figure 5**.

Figure 5. Screenshot showing no permanent diagnostic trouble codes present on the accident ECM.



There was no Event Data Recorder or Vehicle Events recorded on the accident ECM. The menu where these options would normally reside is shown in **Figure 6** to confirm the lack of these options. This indicated that the recording features of the ECM were disabled. This ECM was not configured to record any last stop information or hard acceleration or deceleration data.

Figure 6. No Vehicle Events or Event Data Recorder available where they are normally found in the sessions menu for the accident ECM.



Vehicle Trip Data and parameters were imaged. The total engine hours were 3,173.70 hours. The total engine miles were 34,224.90 miles. The vehicle idle timer was not enabled. Cruise Control was disabled. The max vehicle speed was 74 miles per hour (mph). Traction control was enabled. More data and parameters were available but were not determined to be accident pertinent. For more detail, see Recorders Attachment 1, Data from 2015 IC School Bus International ECM.

2.2. Meritor WABCO HPB System Device Description (Vehicle #1)

The Meritor WABCO HPB System is the braking system Meritor WABCO's Hydraulic Brake (HPB) is a braking and vehicle control system for business class trucks, classes 4 through 7, and buses that are equipped with hydraulic brakes. The HRB provides the following functions, Full power brake performance, brake control functions including Anti-lock braking system (ABS), Automatic Traction Control (ATC), Electronic Brake force Distribution (EBD) and optional parking brake control. The braking system potentially stores data such as unit operating time, pump run hours for front and rear axle circuits, brake deceleration counters, park brake event counter, anti-lock braking system (ABS) event counter, traction control event counter, ignition cycle counter, warning lamp counters, low voltage, over voltage, low pressure, and low fluid faults.

2.2.1. Meritor WABCO HPB System Data Recovery

The electrical system of the bus was compromised so the Meritor Wabco HPB system could not be imaged normally. The Meritor WABCO HPB System was imaged with the assistance of Meritor WABCO using Meritor WABCO Toolbox. The system was not removed from the bus and was imaged on the vehicle.

2.2.2. Meritor WABCO HPB System Data Description

Figure 7 shows the information about the Meritor WABCO HPB System. **Figure 8** shows the HPB Counters. **Table 1** shows the ABS fault report and shows the fault number (fault #), a description of the fault, the status, the system identifier (SID) the failure mode (FMI) and the count.

Figure 7. Screenshot showing information about the Meritor WABCO HPB System.

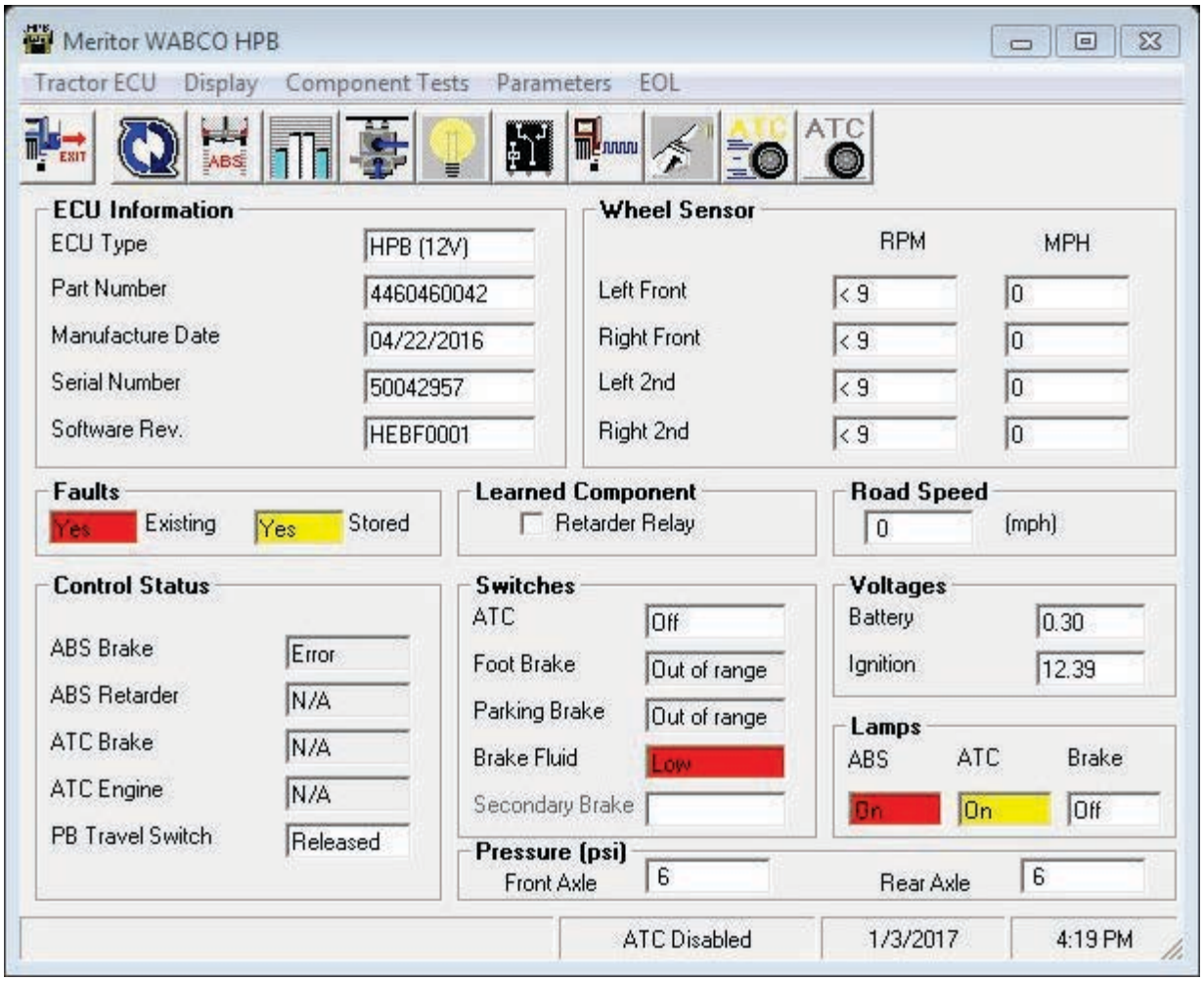


Figure 8. Screenshot showing HPB Counters.

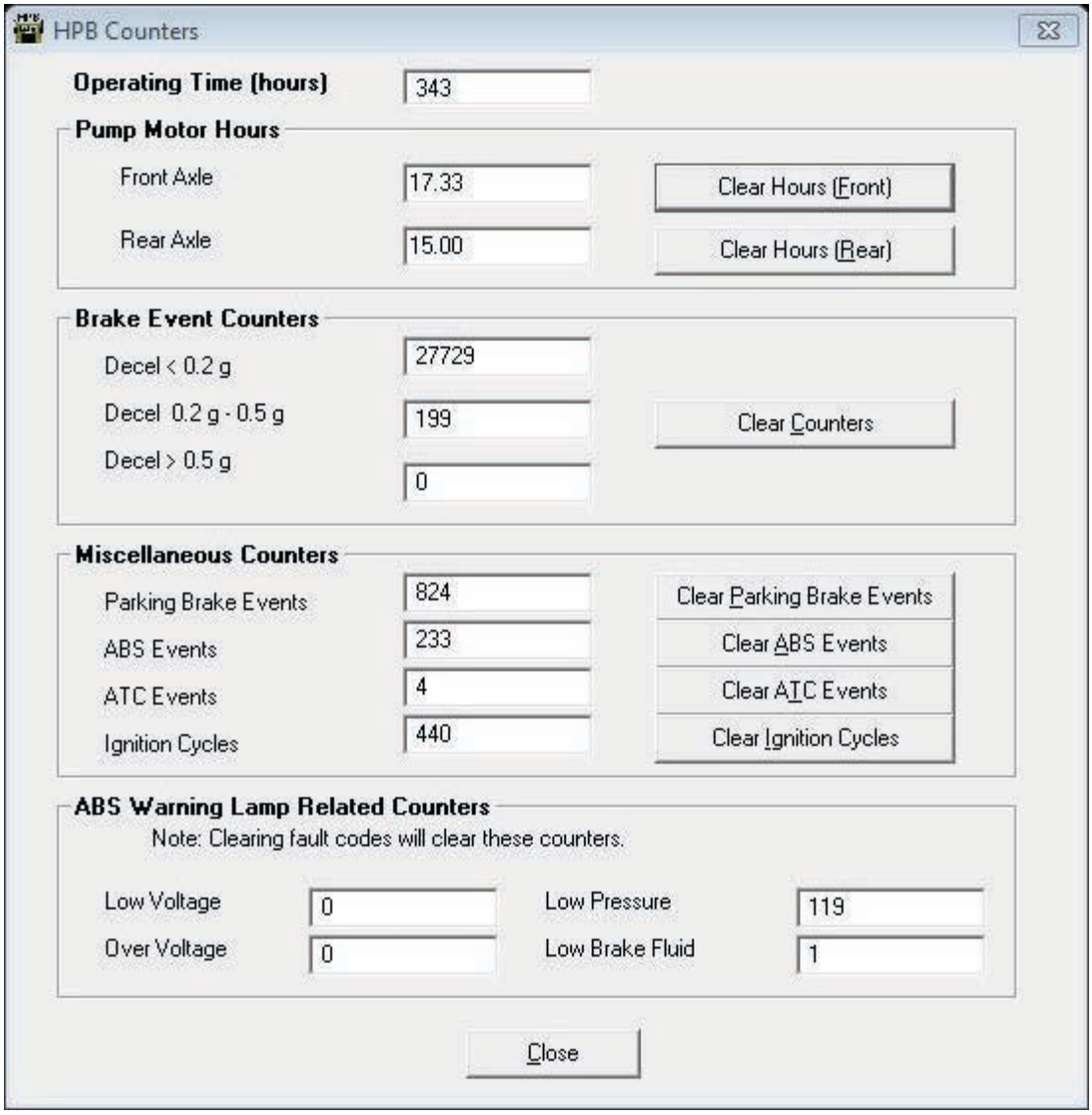


Table 1. ABS fault report.

Fault #	Description	Status	SID	FMI	Count
1	Pump Motor Rear - Missing supply voltage	Active	60	5	2
2	Pump Motor Front - Missing supply voltage	Active	57	5	2
3	Park Brake - Travel switch output implausible	Active	61	3	1
4	Right Rear Sensor - Open	Active	4	5	1
5	Left Front Sensor - Open	Active	1	5	1
6	Left Rear Sensor - Open	Active	3	5	1
7	Right Front Sensor - Open	Active	2	5	1
8	Foot Brake Switch - Out of range	Active	246	3	1
9	Brake Light Signal - Open	Active	100	5	1
10	Parking Brake Switch - Out of range	Active	70	3	1
11	Park Brake - SAHR overtravel detected	Inactive	61	13	17
12	Parking Brake Switch - Long term supervision	Inactive	70	10	2
13	Pump Motor Front - Brake circuit failure	Inactive	57	7	1

2.3. Samsung Galaxy GRAND Prime Device Description (Removed from driver of Vehicle #1's personal vehicle)

The Samsung Galaxy GRAND Prime is a touch-screen smart-phone capable of voice calling, text messaging, email, photo/video recording, audio (music) playback, and numerous other specialized functions depending on configuration. Specialized functions are supported by additional user-installed program applications (Apps). Application data is stored in non-volatile memory[1] and may include call logs, text messaging logs, image, video, and position location information. In addition, the specialized application data may be stored in a proprietary file structure using numerous file formats. The amount and type of data stored varies based on the software version and configuration of the specific device.

2.3.1. Samsung Galaxy GRAND Prime Data Recovery

Upon arrival at the NTSB Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage. **Figure 9** shows the front and back of the Samsung Galaxy GRAND Prime as received. Information was extracted using forensic software.

Figure 9. Front and Back of Samsung Galaxy GRAND Prime as received.

[1] Non-volatile memory is semi-conductor memory that does not need power for data retention.

2.3.2. Samsung Galaxy GRAND Prime Data Description

The Samsung Galaxy GRAND Prime was removed from the personal vehicle of the driver of the 2015 IC School Bus by the Baltimore Police. **Table 2** below shows the activity from October 29, 2016 up until November 1, 2016. Times are shown in eastern daylight time.

Table 2. Activity of Galaxy GRAND Prime from October 29, 2016 to November 1, 2016.

Call/SMS	Direction	Date and Time	Duration	Completed?
Call	Incoming	10/29/2016 11:48:32 AM	00:00:00	Missed
Call	Incoming	10/29/2016 12:29:27 PM	00:02:03	Completed
Call	Incoming	10/29/2016 3:38:42 PM	00:00:00	Missed
Call	Incoming	10/29/2016 3:39:22 PM	00:00:02	Completed
Call	Outgoing	10/29/2016 3:39:49 PM	00:00:30	Completed
Call	Incoming	10/29/2016 4:19:45 PM	00:03:49	Completed
Call	Incoming	10/29/2016 5:53:00 PM	00:00:55	Completed
SMS	Outgoing	10/30/2016 5:10:26 AM	n/a	n/a
Call	Incoming	10/31/2016 11:58:49 AM	00:00:00	Missed
Call	Incoming	10/31/2016 1:03:03 PM	00:00:00	Missed
Call	Incoming	10/31/2016 2:10:49 PM	00:00:00	Missed
Call	Incoming	10/31/2016 4:40:19 PM	00:00:00	Missed
Call	Incoming	10/31/2016 5:50:17 PM	00:00:00	Missed
Call	Incoming	10/31/2016 6:06:54 PM	00:00:00	Missed
Call	Incoming	10/31/2016 6:07:31 PM	00:00:00	Missed
Call	Incoming	10/31/2016 6:27:41 PM	00:00:00	Missed
Call	Incoming	10/31/2016 6:28:26 PM	00:00:00	Missed
Call	Incoming	10/31/2016 10:14:19 PM	00:00:00	Missed
Call	Incoming	11/1/2016 5:59:34 AM	00:00:00	Missed
Call	Incoming	11/1/2016 6:00:21 AM	00:00:00	Missed
Call	Incoming	11/1/2016 6:39:03 AM	00:00:00	Missed
Call	Incoming	11/1/2016 6:43:15 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:11:21 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:15:22 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:37:44 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:38:13 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:53:59 AM	00:00:00	Missed
Call	Incoming	11/1/2016 7:54:49 AM	00:00:00	Missed
Call	Incoming	11/1/2016 8:01:54 AM	00:00:00	Missed
Call	Incoming	11/1/2016 8:02:29 AM	00:00:00	Missed
Call	Incoming	11/1/2016 9:19:06 AM	00:00:00	Missed
Call	Incoming	11/1/2016 9:19:40 AM	00:00:00	Missed
Call	Incoming	11/1/2016 10:21:40 AM	00:00:00	Missed
Call	Incoming	11/1/2016 3:22:09 PM	00:00:00	Missed
Call	Incoming	11/1/2016 6:09:51 PM	00:00:00	Missed

2.4. Magellan Roadmate GPS Device Description (Removed from driver of Vehicle #1's personal vehicle)

The Magellan RoadMate GPS is a touch-screen vehicle navigation product that utilizes GPS signals from satellites to calculate location and compute navigational information. The Magellan RoadMate GPS has a built-in battery The Magellan RoadMate GPS includes Voice Alerts (Text-to-Speech) for driving instructions and traffic information. The Magellan Roadmate GPS stores addresses and points of interest on the device.

2.4.1. Magellan Roadmate GPS Data Recovery

Upon arrival at the NTSB Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and information was extracted using the manufacturer's software normally. **Figures 10 and 11** show the Magellan Roadmate GPS as received.

Figure 10. Front of Magellan Roadmate GPS as received.

Figure 11. Back of Magellan Roadmate GPS as recieved.

2.4.2. Magellan Roadmate GPS Data Description

The device was not configured to store tracklogs. No crash related data was found on the device.

2.5. ACM Device Description (Vehicle #2)

The ACM is part of an automobile's supplemental restraint system. Depending on vehicle, the module may be capable of recording data when triggered by an airbag event known as a deployment or non-deployment. A non-deployment event involves a change in velocity that was significant enough to initialize the ACM, but the airbag does not deploy.

Typically, several seconds of pre-collision and post-collision data is recorded when triggered. Parameters recorded vary by manufacturer and model year but may include vehicle speed, engine speed, brake application, throttle position, seatbelt usage, and airbag performance.

2.5.1. ACM Data Recovery

The ACM was imaged by the Baltimore Police Department. All post processing of the data was performed by the Crash Data Retrieval (CDR) software. The software organizes the imaged data in a (*.pdf) report that contains the following sections: user information including date and time the device was imaged, user comments, data limitations, data source, tabular data and plot(s) from event(s), and raw hexadecimal data used in the report.

The software does not correlate time to any standard such as eastern standard time (EST), and is recorded as seconds elapsed based on the start of the event referenced to an ignition cycle.

2.5.2. ACM Data Description

The ACM imaged normally and the CDR report indicated two records. The two records corresponded to a multi-event. The first record was the first event and the second record was the second event. The ignition cycles at the multi-event (6,400) compared to the ignition cycles during the time of download (6,403) were such that the two records could be related to the accident. The time between the two events in the multi-event was recorded as N/A and the two events occurred at the same key-on time of 1620 seconds. These two points are only measured in whole seconds, so the events occurred up to one second apart. The pre-crash data shows the two events about 0.5 seconds apart.

The first record occurred at a key-on time of 1620 seconds with a maximum longitudinal delta-V of 28.01 miles per hour (mph) and a maximum lateral delta-V of -3.20 mph. Maximum longitudinal delta-V is the maximum change of speed along the vehicle's longitudinal axis. Maximum lateral delta-V is the maximum change of speed along the vehicle's lateral axis The driver was buckled. **Figure 12** shows the longitudinal crash pulse (first record) and **Figure 13** shows the lateral crash pulse (first record).

Figure 12. Plot of longitudinal crash pulse (first record).

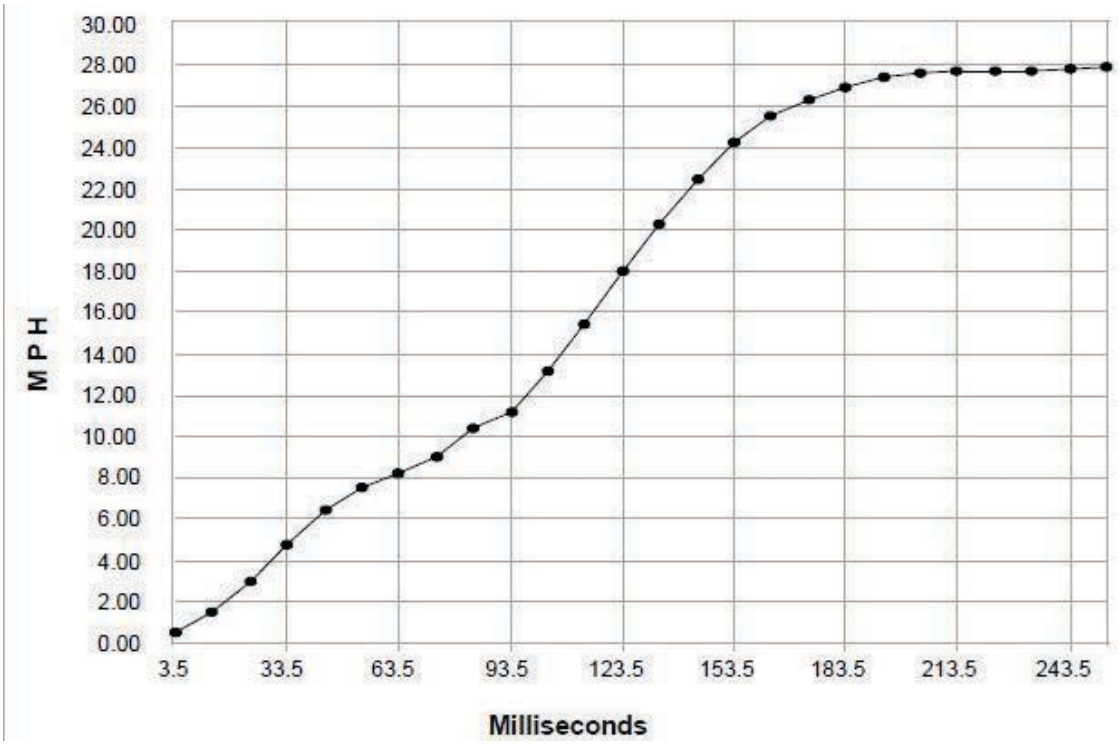
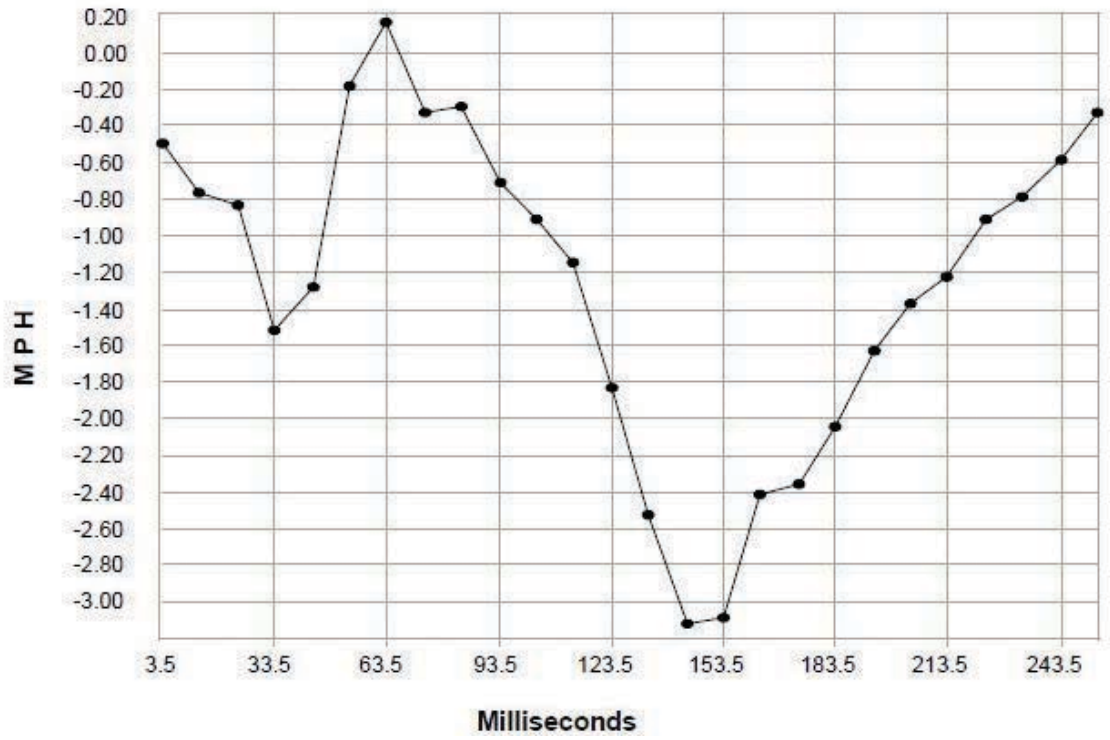


Figure 13. Plot of lateral crash pulse (first record).



The second record occurred at a key-on time of 1620 seconds with a maximum longitudinal delta-V of 4.3 mph and a maximum lateral delta-V of 4.64 mph. The driver was buckled. **Figure 14** shows the longitudinal crash pulse (second record) and **Figure 15** shows the lateral crash pulse (second record).

Figure 14. Plot of longitudinal crash pulse (second record).

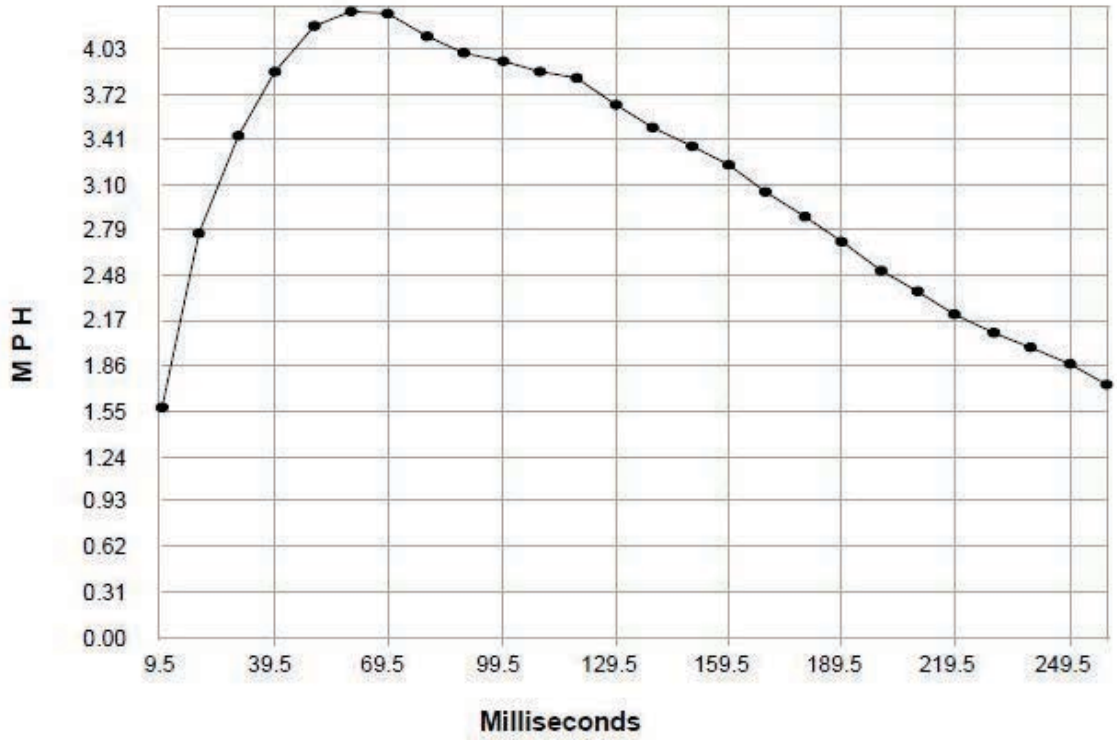
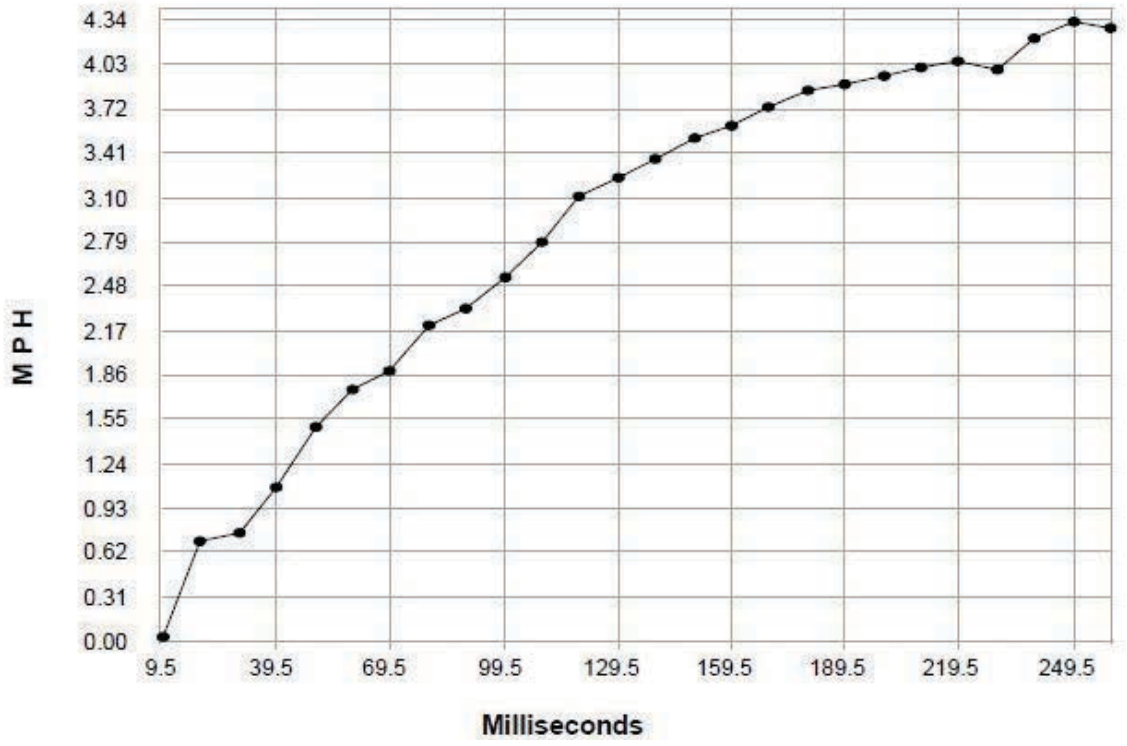


Figure 15. Plot of lateral crash pulse (second record).



The full report generated by the CDR software in .pdf form is included as Recorders Attachment 2, Data from 2012 Ford Mustang ACM.

2.6. Cummins ECM Device Description (Vehicle #3)

The Cummins ECM is an electronic control and data storage system for Cummins engines. The ECM stores vehicle parameters and has the capability to record sudden deceleration and last stop records and trip activity including daily, monthly, and lifetime engine data. The ECM interfaces with many onboard sensors that help monitor and perform its functions.

2.6.1. Cummins ECM Data Recovery

The electrical system of the transit bus was compromised so the Cummins ECM could not be imaged on the vehicle. The accident ECM was removed from the accident bus and placed in a surrogate bus. This prevents additional fault codes that appear on a bench top download. The accident ECM that was removed from the accident bus is shown in **Figures 16 and 17**.

The surrogate ECM was imaged first and no fault codes were present on the surrogate ECM. The accident ECM was then installed on the surrogate vehicle and then the accident ECM was imaged through the J1939 off-board diagnostic connector.

Figure 16. Front of Cummins ECM after removal from vehicle.

Figure 17. Back of Cummins ECM after removal from vehicle.

2.6.2. Cummins ECM Data Description

The ECM was first imaged using Cummins Power Spec 6.1 software. The sudden deceleration records did not capture the accident. The accident ECM had one active fault code which was described as “Accelerator Pedal or Lever Idle Validation Circuit - Data erratic, intermittent or incorrect”. The image of the ECM included four versions of an Engine Trip Report which contained the max vehicle speed of 68 miles per hour. The Feature Settings Report showed a governed global road speed maximum of 70 miles per

hour; idle shutdown, driver rewards, and cruise control were disabled. Additional information present in the image was determined not to be accident pertinent.

The ECM was then imaged again using Cummins INSITE software. An initial ECM image and a final ECM image was taken. No additional accident pertinent information was retrieved from these images. The final image is included as Recorders Attachment 3, Data from 2005 New Flyer Transit Bus Cummins ECM.

2.7. AVL System Device Description (Vehicle #3)

The AVL system tracks the location of the MTA bus. The data is stored at the MTA Control Center.

2.7.1. AVL System Data Recovery

The AVL system was imaged by the MTA Control Center. A screenshot was provided to the NTSB. The screenshot is included as Attachment 4, Data from 2005 New Flyer Transit Bus AVL System.

2.7.2. AVL System Data Description

The data could not be verified and was determined not to be useful for the investigation.

3. Docket Material

The following attachments and photographs are included in the docket for this investigation.

3.1. List of Attachments

Recorders Attachment 1 – Data from 2015 IC School Bus International ECM

Recorders Attachment 2 – Data from 2012 Ford Mustang ACM

Recorders Attachment 3 – Data from 2005 New Flyer Transit Bus Cummins ECM

Recorders Attachment 4 – Data from 2005 New Flyer Transit Bus AVL System