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

June 12, 2015

Vehicle Data Recorders

Specialist's Factual Report
By Ben Hsu

1. EVENT

Location:	Cranbury, New Jersey
Date/Time:	June 7, 2014 / 0100 eastern daylight time
Vehicle #1/ID:	2011 Peterbilt 386 Conventional / 1XPHD49X6BD■■■■■■
Vehicle #2/ID:	2012 Mercedes-Benz 2500 EXT Sprinter HT / WD3PE8CC1C5■■■■■■
Vehicle #3/ID:	2011 Buick Enclave / 5GAKVCED5BJ■■■■■■
Vehicle #4/ID	2011 Ford F150 / 1FTFW1EF0BK■■■■■■
Vehicle #5/ID:	2005 Nissan Altima / 1N4AL11DX5N■■■■■■
Vehicle #6/ID:	2006 Freightliner ST 120 Conventional / 1FUJBBCK46L■■■■■■
NTSB Number:	HWY14MH012

2. DETAILS OF DEVICE INVESTIGATION

The National Transportation Safety Board's (NTSB) Vehicle Recorder Division imaged data from the following event data recorders (EDR):

Vehicle 1:	Cummins Engine Control Module (ECM)
Vehicle 1 Device S/N:	79451921
Vehicle 1:	Bendix Wingman System
Vehicle 1 Device S/N:	5Q43100875
Vehicle 2:	Mercedes-Benz Electronic Control Unit (ECU)
Vehicle 2 Device S/N:	Unknown
Vehicle 2:	Garmin nüvi 2555LMT
Vehicle 2 Device S/N:	34D212242
Vehicle 3:	Airbag Control Module
Vehicle 3 Device S/N:	AS5093E050259854
Vehicle 4:	Airbag Control Module
Vehicle 4 Device S/N:	3138451300000000
Vehicle 6:	Detroit Diesel Electronic Controls (DDEC) V ECM
Vehicle 6 Device S/N:	06R0868129

The Cummins ECM (Vehicle #1) was imaged on scene by NTSB investigators. The imaging process was performed through the vehicle's diagnostic port using standard hardware and software.

The Bendix Wingman (Vehicle #1) system's modules were removed from the vehicle and data were imaged with assistance from Bendix engineers at a Bendix facility. NTSB investigators were present to observe the imaging process.

The Mercedes-Benz ECU (Vehicle #2) was imaged on scene by a Mercedes-Benz technician through the vehicle's diagnostic port using Mercedes-Benz hardware and software. NTSB investigators were present to observe the imaging process.

The Garmin nüvi 2555LMT (Vehicle #2) was removed from the vehicle and sent to the NTSB's Vehicle Recorder Division for imaging. Data were imaged using standard hardware and software.

The Airbag Control Module (Vehicle #3) was imaged on scene by NTSB investigators. Due to the damage in the vehicle's electrical system, the module was removed from the vehicle and a bench-top imaging process was used.

The Airbag Control Module (Vehicle #4) was imaged on scene by NTSB investigators. The imaging process was performed through the vehicle's diagnostic port using standard hardware and software.

Vehicle #5 contained no data-recording devices.

The Detroit Diesel ECM (Vehicle #6) was imaged on scene by NTSB investigators. The imaging process was performed through the vehicle's diagnostic port using standard hardware and software.

2.1. Vehicle 1: 2011 Peterbilt 386 Conventional

2.1.1. Cummins ECM Description

The Cummins ECM is an electronic control and data storage system for Cummins-manufactured engines. The ECM stores vehicle parameters and has the capability to record trip activity, including daily, monthly, and lifetime engine data. The ECM does not have an onboard real-time clock.

The ECM is also capable of recording sudden deceleration events when it detects that the vehicle's wheel speed changes more than 9 MPH in 1 second. When this event is triggered, 60 seconds of data prior to and 15 seconds of data after the trigger point are recorded at 1-second intervals (1 Hz).

2.1.2. Cummins ECM Time Correlation

The Cummins ECM does not have an onboard real-time clock. However, the vehicle was equipped with an Omnitracs fleet management system with event triggering. The Omnitracs system is capable of recording a GPS-synchronized time along with the vehicle speed obtained from the vehicle's ECM when triggered by a qualified event. The Omnitracs system on this vehicle was set to record a "hard braking" event when the vehicle's speed changed more than 12.5 MPH in 1 second. The system recorded a "hard braking" event on June 6, 2014, at 11:54:46 EST (June 7, 2014, at 12:54:46 EDT). This timing information was used to correlate the Cummins ECM data. The Omnitracs report is included as Attachment 1.

2.1.3. Cummins ECM Data

Data recorded by the Cummins ECM included two sudden deceleration records. Since the ECM is not equipped with a real-time clock, the vehicle's odometer reading was used to correlate the data recordings. The first sudden deceleration record was determined to be related to the accident. The second sudden deceleration record was not related to the accident.

The first sudden deceleration record showed the vehicle traveling at 65 MPH for the first 58 seconds of the recording. The brake was then activated and the vehicle's speed decreased to 0 MPH in approximately 8 seconds. Figure 1 shows data recorded by the Cummins ECM.

The ECM was programmed to limit the vehicle's speed to 65 MPH. The vehicle had no active diagnostic trouble codes and the cruise control was not activated during the time period that data were recorded. The full report, including tabular data used to generate Figure 1, is included as Attachment 2.

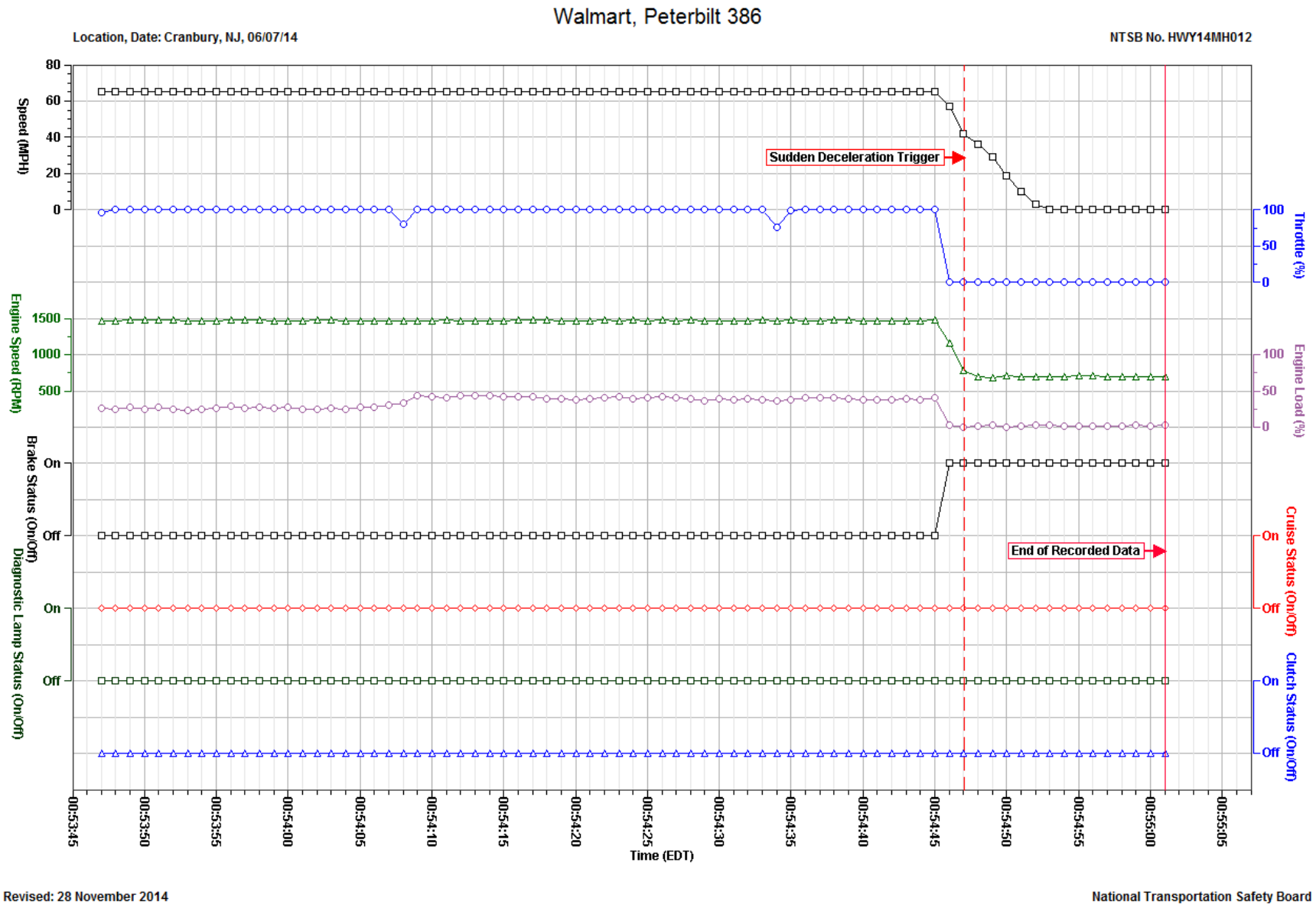

Figure 1: Data recorded by the Cummins ECM

2.1.1. Bendix Wingman System Description

The Bendix Wingman is an active cruise-control with braking (ACB) system and a stationary object alert (SOA) system. The Wingman combines the capabilities of the vehicle's cruise control, electronic stability program (ESP), roll stability program (RSP), and antilock braking system (ABS) with a radar sensor mounted on the vehicle's front bumper. A detailed description of the Bendix Wingman system is available in the *Vehicle Factors Group Chairman's Factual Report*.

2.1.2. Bendix Wingman System Data

Data from the Bendix Wingman System showed that there were no active diagnostic codes prior to the accident, and the system appeared to function normally. Data from three event-triggered recordings were imaged from the system. Based on the engine hours recorded, it was determined that these recordings were related to the accident. One event recorded by the RSP system was unrelated to the accident.

The vehicle's ACB system recorded data based on an event triggered by loss of communication between the radar sensor and the primary control module. Five seconds of pre-trigger data was recorded at half-second intervals (2 Hz). The data indicated that no audible warning was recorded by the ACB system.

The vehicle's ESP system recorded a "near ESP" event and yaw-control brake intervention event. These two recordings have overlapping datasets. Each recording includes 2.5 seconds of pre-trigger data and 5 seconds of post-trigger data. The "near ESP" event was triggered first, followed by the yaw-control brake intervention event. Unknown network latencies may have affected the data recording and introduced recording delays to some data points. The cumulative latencies for the "near ESP" and yaw-control brake intervention events were 1.64 seconds and 0.74 seconds, respectively. Because the exact distribution of these latencies is unknown, the data are plotted as-is, using the original timing information provided. Data from the two ESP system events and the ACB event were combined and plotted together.

Figure 2 is a plot showing the ESP events and the ACB event. The ESP system recorded vehicle velocity, steering angle,[1] primary pressure at the brake pedal, and accelerator position. The ACB system recorded vehicle velocity, audible alert status, and brake status. Labels and arrows indicate where each ESP and ACB event was triggered. A subset of the Cummins ECM data is also included in the plot for comparison. The Cummins ECM data are the same as previously seen in Figure 1 and were correlated using the vehicle speed parameters. The time axis is also the same as Figure 1. Tabular data from the ESP system are included as Attachment 3.

[1] Positive steering angles indicate a clockwise rotation of the steering wheel.

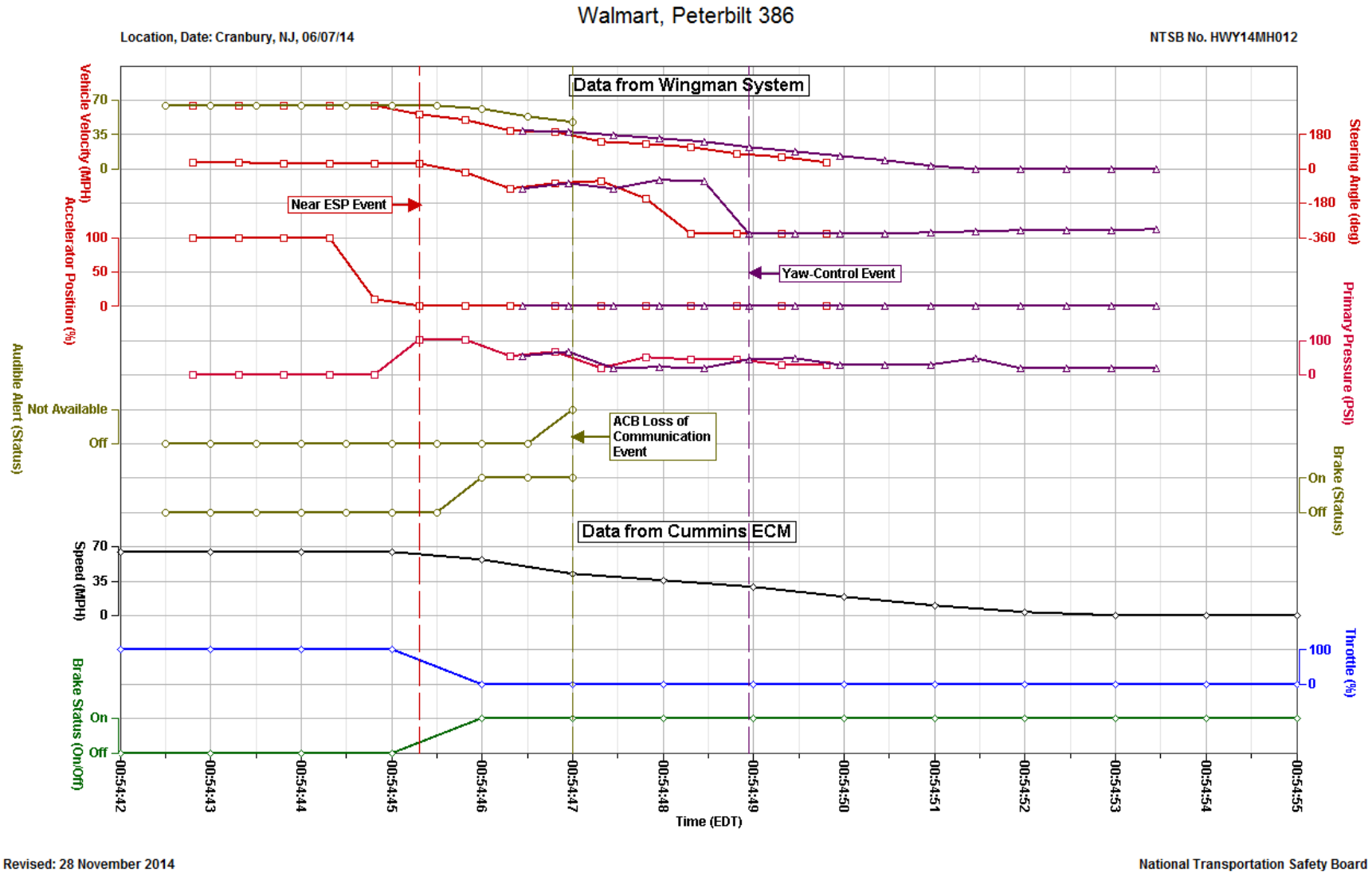

Figure 2: Data recorded by the ESP system combined with a subset of the Cummins ECM data

2.1. Vehicle 2: 2012 Mercedes-Benz 2500 EXT Sprinter HT

2.1.1. Mercedes-Benz ECU Description

The Mercedes-Benz ECU is an electronic control module for Mercedes-Benz vehicles. Each vehicle is equipped with multiple ECUs to monitor various systems. This vehicle was equipped with a module monitoring the supplemental restraint system (SRS). The SRS ECU records only diagnostic codes.

2.1.2. Mercedes-Benz ECU Data

Data from the Mercedes-Benz SRS ECU indicated that both the driver and passenger airbags deployed, and that the passenger seatbelt pretensioner deployed. The driver seatbelt pretensioner did not deploy. According to Mercedes-Benz, a seatbelt pretensioner will only deploy if the seatbelt is buckled. The full report is included as Attachment 4.

2.1.3. Garmin nüvi 2555LMT Description

The Garmin nüvi 2555LMT is a portable global positioning system (GPS) unit designed for use in automotive environments. It is capable of storing a detailed tracklog within the unit whenever the receiver has a lock on the GPS navigation signal. The time recorded by the GPS unit is in UTC[2] and is synchronized to an accurate source. The displayed time has been adjusted to the local time zone, EDT, for this report.

2.1.4. Garmin nüvi 2555LMT Data

Data from the GPS device included the time period up to and including the accident. A summary of the last approximately 45 seconds of data recorded is presented in Table 1. A larger dataset of the last approximately 15 minutes of data recorded is included as Attachment 5.

Table 1: GPS data recorded

Time (EDT)	Speed (MPH)
0:54:14	11.2
0:54:30	3.6
0:54:48	3.8
0:54:50	2.7
0:54:51	4.5
0:54:56	6.3
0:54:57	8.7
0:54:58	6.7

[2] UTC = Coordinated Universal Time. UTC is ahead of EDT by 4 hours.

2.2. Vehicle 3: 2011 Buick Enclave

2.2.1. Airbag Control Module Description

The airbag control module is part of an automobile's supplemental restraint system. Depending on the vehicle, the module may be capable of recording data when triggered by an airbag deployment or near-deployment. Typically, several seconds of pre-collision and post-collision data are recorded when triggered. Parameters recorded vary by manufacturer but may include vehicle speed, engine speed, brake application, throttle position, seatbelt usage, and airbag performance.

2.2.2. Airbag Control Module Data

Data from the airbag control module indicated that two deployment events were detected, consistent with a rear collision followed by a front collision. The module's rear-collision algorithm was activated first, followed 0.81 second later by activation of the module's front-collision algorithm. The data indicated that the vehicle was traveling between 4 and 11 MPH in the 2.5 seconds prior to the triggering events. The data also indicated that both the driver and passenger-side seatbelts were buckled. The first and second stages of both driver and passenger airbags and seatbelt pretensioners were activated. The driver and passenger curtain airbags were not activated. The full report is included as Attachment 6.

2.3. Vehicle 4: 2011 Ford F150

2.3.1. Airbag Control Module Description

The airbag control module is part of an automobile's supplemental restraint system. Depending on the vehicle, the module may be capable of recording data when triggered by an airbag deployment or near-deployment. Typically, several seconds of pre-collision and post-collision data are recorded when triggered. Parameters recorded vary by manufacturer but may include vehicle speed, engine speed, brake application, throttle position, seatbelt usage, and airbag performance.

2.3.2. Airbag Control Module Data

Data from the airbag control module indicated that the vehicle was traveling between 0 to 1 MPH in the 5 seconds prior to the triggering event. The data showed that both the driver and passenger-side seatbelts were buckled. The full report is included as Attachment 7.

2.4. Vehicle 5: 2005 Nissan Altima

The 2005 Nissan Altima contained no data-recording devices.

2.5. Vehicle 6: 2006 Freightliner ST 120 Conventional

2.5.1. DDEC V ECM Description

The DDEC V ECM is an electronic control and data storage system for Detroit Diesel engines. The ECM stores vehicle parameters and has the capability to record trip

activity, including daily, monthly, and lifetime engine data. The ECM is also capable of recording data when triggered by a Hard Brake or Last Stop event.

A Hard Brake event is triggered when the calculated vehicle wheel speed decelerates at a rate greater than 7 MPH per second. When triggered, 1 minute of data prior to and 15 seconds of data after the event are recorded at 1-second intervals (1 Hz).

A Last Stop event is triggered when the vehicle speed changes from the drive state (greater than or equal to 1.5 MPH and engine RPM greater than 0 for 2 seconds) to the stop state (less than 1.5 MPH or ignition turned off) and subsequently remains stopped for 15 seconds. When triggered, 1 minute and 45 seconds of data prior to and 15 seconds of data after the event are recorded at 1-second intervals (1 Hz).

2.5.2. DDEC V ECM Time Correlation

The DDEC V ECM is equipped with an onboard real-time clock with battery backup. The time is set manually by the operator and can be updated using Detroit Diesel software. The ECM clock was found to be 53 minutes and 4 seconds faster than an accurately synchronized time source (Figure 2). Therefore, 53 minutes and 4 seconds were subtracted from the recorded data timestamps to reflect this offset.

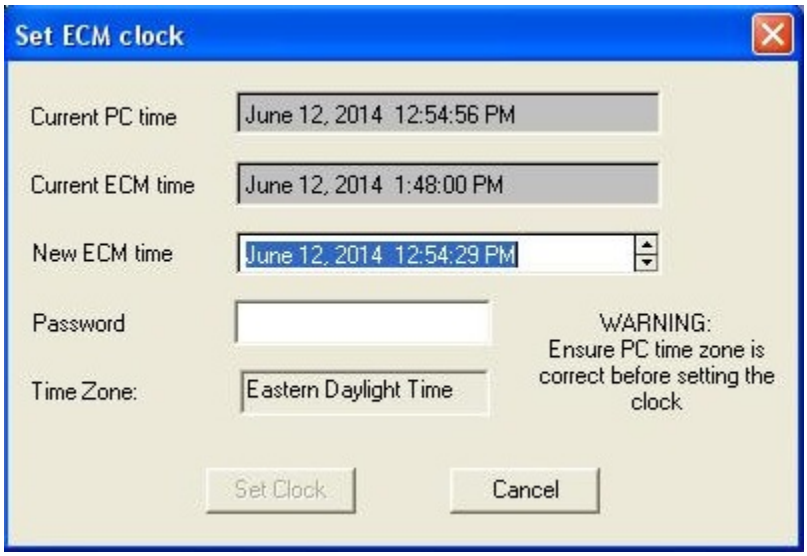

Figure 3: DDEC V ECM Clock Configuration

2.5.3. DDEC V ECM Data

The ECM recorded a Last Stop event on June 7, 2014, at 01:20:51 EDT. The vehicle was traveling between 0 and 5 MPH during the period that data were recorded. No active diagnostic codes were recorded during the same time period.

The ECM also recorded two Hard Brake events unrelated to the accident. The full report is included as Attachment 8.