EVENT DATA RECORDER
FACTUAL REPORT
(10 Pages)

MEXICAN HAT, UTAH

HWY-08-MH-012

National Transportation Safety Board
Office of Highway Safety
Washington, DC 20594

EVENT DATA RECORDER

GROUP CHAIRMAN'S FACTUAL REPORT

A. ACCIDENT

Type:	Motorcoach, overturn
Date and Time:	January 6, 2008, 7:34 p.m. MST
Location:	Southbound US Rt. 163, near MP29 Mexican Hat, San Juan County, Utah
Vehicle #1:	2007 MCI Model J4500, 56-Passenger Motorcoach
Motor Carrier:	BUSCO, Inc. DBA Arrow Stage Lines
Fatalities:	9
Injuries:	44
NTSB#:	HWY-08-MH-012

B. EVENT DATA RECORDER GROUP

Christopher C. Voeglie	Senior Investigator	Group Chairman
National Transportation Safety Board	Office of Highway Safety	(404) 562-1658

C. ACCIDENT SUMMARY

On January 6, 2008 about 3:30 p.m. MST a 2007 MCI 56-passenger motorcoach with 51 passengers on-board departed Telluride, CO en route to Phoenix, AZ, as part of a 17-motorcoach charter. The motorcoach was returning from a three-day weekend of skiing. The motorcoaches were diverted to an alternate route that included US Route 191 and 163 in Utah, due to the closure of Colorado State Route 145 because of snow. Colorado State Route 145 is the normal route used from Telluride to Phoenix.

At about 7:34 p.m. MST the motorcoach was traveling southbound descending a 6 percent grade leading to a curve to the left, 1,800 feet north of milepost 29, at a driver reported speed of 65 mph. After entering the curve the motorcoach departed the roadway at a shallow angle striking the guardrail with the right rear wheel about 61 feet before the end of the guardrail.

The motorcoach began rotating in a counter clockwise direction as it descended an embankment. The motorcoach began to overturn and struck several rocks in a creek bed at the bottom of the embankment. The motorcoach came to rest on its wheels after overturning 360 degrees. During the rollover sequence the entire roof of the motorcoach separated from the body, and 51 of the 53 occupants were ejected. As a result, nine passengers were fatally injured, 43 passengers and the driver received various degrees of injuries from minor to critical.

The weather was cloudy and the roadway was dry at the time of the accident.

D. DETAILS OF THE INVESTIGATION

The Event Data Recorder investigation was initiated in an effort to determine whether any digital or analog data existed within or upon the 2007 MCI motorcoach that could assist in the Safety Board's investigation and analysis of this accident. This report will discuss data recovered from the following sources: the engine's electronic control module, a DriveCam II video/event data recorder and a Saucon GPS system.

1. ELECTRONIC ENGINE CONTROLS

1.1 GENERAL

The motorcoach was equipped with a Caterpillar, Inc., C-13, 12.5 liter, electronically controlled diesel engine. Because the engine was electronically controlled, it was equipped with an electronic engine control module (ECM).

An ECM, as referenced within this report, is a semiconductor unit for controlling ignition timing, fuel delivery, speed control and other parameters in an engine management system. It is the primary computer responsible for processing signals produced by engine and vehicle sensors and for activating automated engine components, systems, and processes in order to produce optimum engine performance and efficiency.

Depending upon the model, many Caterpillar ECMs have the ability to capture and preserve vehicle operating data in the event of a critical event or incident. These events are typically triggered or recognized by the calculated deceleration rate of the vehicle; through a dedicated algorithm; or by a sensor signal from one of the vehicle's subsystems.

By design, the subject ECM was capable of recording various vehicle operating parameters in connection with critical diagnostic events, as well as a sudden vehicle deceleration defined as a "Quick Stop"[1] event. However, although the subject ECM was capable of capturing and recording data in the event of a "Quick Stop" event, this option had not been enabled and therefore no data was captured in connection with the deceleration the motorcoach encountered during the subject crash sequence.

1.2 INSPECTION / CHAIN OF CUSTODY

[1] A "Quick Stop" event can be defined as an ECM calculated vehicle deceleration rate (speed/time)(mph/sec) that exceeds the user configurable threshold, which is capable of being configured from 0 to 15 mph/sec. When configured at zero, (0mph/sec, which is the factory default for the subject ECM) no Quick Stop event reporting will occur.

According to the Safety Board's Vehicle Group Chairman, the coach's batteries were disconnected during post crash recovery efforts, which took place at approximately 10:00 a.m., on January 7, 2008; approximately 14 hours post-accident. The coach was then secured by the Utah State Highway Patrol at the maintenance facility of the Robert Neilson Construction Company located in Price, Utah.

At approximately 3:00 p.m., on January 9, 2008, the subject ECM was removed from the accident coach and packaged for transport. The ECM was transferred into the custody of the undersigned Group Chairman via FedEx air bill number 8635 9260 0100 for data interrogation and analysis. The subject ECM was received by the undersigned at 10:09 a.m. on January 11, 2008.

On January 11, 2008, the ECM was removed from its packaging materials for inspection. The unit presented to be in good overall physical condition with no indication of physical damage. The unit was covered in varying degrees of dirt and with a substance consistent with that used in dry chemical fire extinguishers. The ECM was photographed and its identifying information documented. **(See Docket Photo EDR#1)**

The subject ECM was identified as an ADEM[2] III ECM, serial number 29366527JJ, configured for use with a 2004 EPA ACERT engine, serial number KCB87996 and with vehicle identification number 2M93JMDA87W064449. All of the above configuration data corresponded with the accident coach.

The ECM utilized two integral 70-pin AMP[3] connectors to interface with the OEM[4] vehicle wiring harness and the engine's wiring harness.

1.3 DATA EXTRACTION

In order to communicate with and extract data from the ECM, proprietary hardware and software were employed. Computer software developed by Caterpillar Inc., entitled "Electronic Technician" (ET) version 2007Cv1.0, serial number ET155991, was used to access and communicate with the ECM. ET is utilized to access available information such as stored diagnostic fault codes, engine and vehicle configuration data, ECM calibrations, and in certain model Caterpillar ECMs, specific reports on driver and trip information, as well as internally and externally triggered events; in some cases, this may include accident related data.

For the purposes of data interrogation, the subject ECM was powered through the use of a 13.8 volt, 15-amp continuous power supply, which was routed through a Drew-Tech CDR-PSU[5] while connected to a serial data translation unit[6]. The serial translation unit utilized to facilitate communication with the ECM was a Caterpillar Communications Adapter II configured with hardware version 2.9 and driver version 2.22 .

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[2] Denotes the model number designation assigned to the third generation of Caterpillar's Advanced Diesel Engine Management, electronic controls.

[3] AMP is a manufacturer trademark

[4] Original Equipment Manufacturer

[5] CDR-PSU is a sophisticated switching power supply that accepts a wide range of input voltages and produces a clean precise 12V output providing protection against reverse polarity, under voltage, over voltage and electrical noise conditions.

[6] A serial data translation device is used to connect PC's or PDA's to a heavy duty vehicle data bus and converts J1708/J1939 communications to RS0232 serial data.

Initial communication with the ECM was unsuccessful, as were two additional communication attempts. These communication failures were identified as an issue with the serial translation unit. Troubleshooting efforts resulted in the use of a special purpose serial cable and the reprogramming of the translation device. Prior to establishing communications with the subject ECM, staff synchronized the host PC with official Eastern Standard Time[7]. At 11:44:00 p.m. EST[8], on January 11, 2008, successful communication with the subject ECM was established. At that time the ECM clock indicated 10:41:45 p.m. All available data files were copied without alteration and no data were deleted or reset.

The ET program not only permits the user to communicate with the ECM, but also to gather available data and generate structured reports. The available reports consisted of the following: Active Codes, Configuration, Critical Events, Current Totals, Custom Data, Driver Reward, ECM Summary, J1939 Status, Logged Diagnostic Codes, Maintenance Indicator, Rating History, Group Status Data, System Trouble Shooting Settings, Time vs. Engine and Vehicle Speed Histograms, Driver Trip Data and Fleet Trip Data. Copies of these reports are provided as an attachment to this report.

1.4 ECM TIME VS. ACTUAL TIME

The ECM was equipped with a real time clock which was designed with an internal power source. The ECM clock is utilized to determine the start of each day, and the start of each month. This time/date information is also utilized to time/date stamp the following critical event codes: 84-00 Vehicle Overspeed Warning, 190-15 Engine Overspeed Warning, 110-16 Very High Coolant Temperature, 100-1 Very Low Oil Pressure, and 111-1 Very Low Coolant Level.

The clock has a designed accuracy of +/- 4 minutes per month, and is not capable of automatic adjustment to compensate for time zone changes or daylight savings time. As discussed in section 1.3, interrogation of the ECM was initiated on January 11, 2008 at 11:44:00 p.m. EST, and at that time the ECM clock indicated 10:41:45 p.m. This correlates to a base ECM time differential of -01:02:15.

1.5 AVAILABLE DATA

As previously indicated, the subject ECM was not configured to capture data as it applies to "Quick Stop" events, which have historically proven useful in accident investigation and reconstruction.

The available data were as follows:

Active Codes - The Active Codes report displays all of the currently active diagnostic and event codes. This report indicated that at the time the ECM was being interrogated, there were nine (9) active codes. The active fault codes reported were: Inlet Valve Actuation System Oil Pressure Solenoid current low (97), Engine Cooler Diverter current low (98), J1939 Device

[7] The host PC was synchronized utilizing a software program that permits direct communications with the National Institute of Standards and Technology.
[8] As reported by the National Institute of Standards and Technology (NIST) Internet Time Service (ITS).

Not Responding, Barometric Pressure voltage high (26), Coolant Level signal invalid (12), Fuel Temperature voltage high (13), Intake Manifold Air Temperature voltage high (38), Oil Pressure voltage high (24), Intake Valve Actuation System Oil Pressure voltage high (95), Boost Pressure voltage high (25). See attachment A.

ECM Configuration - The ECM Configuration report allows the user to view the ECM's current configuration data. A review of this report indicated that ECM, serial number 29366527JJ had been configured for use with a Caterpillar C-13 diesel engine, serial number "KCB87996", and vehicle identification number 2M93JMDA87W064449; both of which corresponded with the coach's engine and vehicle serial numbers. The ECM was equipped with Personality Module part number, 2951519-00 with a release date of MAY06[9].

The ECM was configured to control the engine's idle speed at 700 rpm and to govern engine speed at 2100 rpm. The configured vehicle speed parameters indicated a J1939 transmission based vehicle speed calibration of 1677 revolutions-per-mile and the Vehicle Speed Limit (VSL) was set at 72 miles-per-hour. The control or limiting of a vehicle's cruise and / or road speed, as well as engine speed, is accomplished by restricting the fuel supply to the engine at vehicle or engine speeds, which exceed these set parameters.

The cruise control parameters indicated that although adaptive cruise control was disabled, traditional cruise control was enabled with the Low Cruise Control (LCC) set to 20 miles-per-hour and the High Cruise Control (HCC) set at 70 miles-per-hour.

The subject ECM was capable of capturing and recording data in the event of a "Quick Stop" event, however this event threshold was set at 0 miles-per-per/per second, which was the factory default for this engine/ECN configuration. Because the Quick Stop rate had been set to zero, the ECM's ability to capture any potential pre-crash data was disabled. In addition, the vehicle overspeed reporting threshold[10] was set to 127 miles-per-hour, which would result in no vehicle overspeed events until the vehicle exceeded 127 miles-per-hour. See attachment A for entire report.

Critical Events[11] - This report provides a list of specifically logged events containing information when the event started, how long it was active, the extreme value, and the average value. Single event codes can be logged multiple times.

This report indicated the presence a single critical event of "very low coolant level" that occurred at ECM time of January 6, 2008 at 11:46:36 a.m. and had a reported elapsed time of 00:00:44 seconds. Applying the known base ECM time differential would result in an event time of approximately 12:48:51 EST[12]. See attachment A.

Current Totals - The Current Totals report allows the user to view the current total values for the available parameters. See attachment A.

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[9] "Personality Modules" are utilized by Caterpillar to differentiate software versions and ECM capabilities

[10] Vehicle Overspeed Threshold is the user configurable parameter employed by the ECM to trigger the reporting of an overspeed event.

[11] Critical events as they apply to the subject ECM are limited to the following conditions: Vehicle Overspeed Warning, Quick Stop Occurrence, Very Low Oil Pressure, Very High Coolant Temperature, Very Low Coolant Level and Engine Overspeed Warning.

[12] Note: as indicated this approximate time is that of eastern standard time, and does not represent local time at the scene, or in the area of the accident.

Custom Data - The ECM provided 5 user definable Custom Data Reports. Custom Data is part of the Fleet Trip Data and when the Fleet Trip Data is reset the Custom Data is also reset. This report indicated that no custom data parameters had been defined/enabled. See Attachment A.

Driver Reward – The driver reward feature is a user configurable feature used to reward drivers for staying within the operating limits set by the fleet manager. This report indicated that Driver Reward was not enabled. See Attachment A.

ECM Summary - The ECM Summary report displays all of the ECM and service tool software information. See attachment A.

J-1939 Communications – This report provides information regarding communications between the ECM and other controllers on the J-1939 Datalink network. This report indicated that no J-1939 communications were occurring at the time of data extraction. See Attachment A.

Logged Diagnostic Codes – This report displays a list of diagnostic codes logged by the ECM. These codes are similar to the active diagnostic codes except that they are logged over time and may include past events, which arte no longer active.

This report indicated that there were nine (9) diagnostic codes logged by the ECM. All of the logged diagnostic codes were identified as those listed within the Active Codes report. The logged diagnostic codes indicated they occurred during ECM diagnostic clock hour of 1163, which corresponds with the ECM time documented at the time of data extraction. See attachment A.

Maintenance Indicator - This report provides information regarding how the ECM's maintenance reminder or indicator will function. This report indicated that the ECM's Maintenance indicator was not enabled. See Attachment A.

Rating History – This report provides information regarding the current engine rating configuration, original, highest and previous settings, as well as the identity of the service tool making any changes. See Attachment A.

Status Group Data – This reporting feature is utilized to monitor in real-time select operating parameters that can then be assigned to groups. Status group data represents data parameter information as it occurs in real-time. See Attachment A.

System Troubleshooting Settings – This report displays the current system troubleshooting configuration. See Attachment A.

Histograms – These are tabular and graphical representations of parameter data over time. See Attachment A.

Driver Trip Data – This report displays data that is collected from the time the engine is turned on until it is turn off. See Attachment A.

Fleet Trip Data – This report displays data that is collected from the time the fleet job begins. This data is ongoing until it is reset again. See Attachment A.

2. GLOBAL POSITIONING SYSTEM (GPS)

In addition to the engine's electronic control module, the motorcoach had been equipped with an on-board GPS system as part of the motor carrier's subscription to Saucon Technology's[13] Telemetry Delivery System (TDS). As with most data management applications currently available to the commercial vehicle industry, the Saucon TDS system is available with different levels of performance in order to suit the specific needs of each end user.

As part of the TDS system, the coach was equipped with a GPS receiver and cellular transmitter. The GPS receiver was manufactured by the Saucon Corporation based out of Bethlehem, Pennsylvania. The Saucon TDS application as configured on the accident coach, integrated the use of onboard GPS technology and wireless communication with an internet-based user interface or web portal. The principle component of the system was that of the receiver module, which functions as the GPS signal receiver and data repository.

The principal operation of the Saucon TDS system can be broken down into several separate processes. The GPS receiver monitors and collects GPS data as well as data obtained from the vehicle's data bus. This data is then temporarily stored within the module until transmitted via cellular service.

According to information provided by Saucon, the subject system was configured to capture a single one-second GPS data stream every two (2) minutes. These two (2) minute interval data streams were then grouped in sets of five (5) representing a ten (10) minute data set containing operational data with a resolution of a single 1 second entry every 2-minutes. The collected data are ultimately transmitted as data packets via a wireless communication network to Saucom, where the data is processed and archived on a network server. This data, once received by Saucon, is made available to the subscriber through an internet based web portal application, allowing the subscriber to access the data at anytime and determine where each fleet vehicle is located, as well as the status of each operator.

In the event the coach would enter into an area absent of cellular service, the system would then begin archiving the GPS data as well as any event or alert messages into its internal memory. This data collection process would continue until the coach returned into a cellular service area at which point all of the stored data would be transmitted to Saucon servers. The amount of stored data varies depending on the amount of time the coach is without cellular service.

The subject Saucon unit was designed to capture and store GPS data until such time that the stored data could be successfully off loaded. All data storage was accomplished through the use of internal random access memory (RAM). RAM memory is often referred to as "volatile memory" because it is dependant upon an uninterrupted power supply in order to maintain the storage of its data.

As discussed in section 1.2 above, post crash recovery of the coach took place on January 7, 2008, at approximately 10:00 a.m. It was determined that during post crash recovery; main power from the batteries to the chassis had been switched off, severing power to the Saucon unit. Because the Saucon unit was not intended to function as an event data recorder, or to survive

[13] Saucon Technologies, Inc.; www.saucontech.com

crash events, it was not designed with an internal or back-up power source, thus the loss of chassis power resulted in a complete loss of power to the Saucon unit which resulted in the loss of any stored data from within its memory.[14]

The undersigned requested the last 14 days of TDS data for the accident coach, which are included in this report as an attachment. A review of the last data received from the accident coach indicated that at 15:19 hrs on the day of the accident the coach was traveling 13.92 miles-per-hour on State Highway 145 in Telluride, Colorado.

3. VIDEO / EVENT DATA RECORDER

The accident coach was equipped with a model DriveCam[15] II video event data recorder (VEDR) manufactured by DriveCam, Inc,. The unit serial number 03463906, incorporated the use of a digital camera equipped with interior as well as exterior lens' and a dual-axis accelerometer (longitudinal and lateral). The VEDR utilized an internally housed 64MB compact flash memory card to store video, audio and accelerometer data. Under normal conditions access to its contents would be accomplished through the use of a universal serial bus (USB) cable and proprietary software entitled HindSight 20/20 made available to DriveCam customers.

The VEDR is designed to be mounted on a vehicle's windshield out of the driver's field of vision there providing a driver's view forward as well as a view of events and actions which occur within the vehicle. The DriveCam II was also capable of being interfaced with a third party GPS system for recording speed and location data. The subject VEDR was not connected to the Saucon GPS system discussed previously in section 2.

The VEDR was removed from the accident coach prior to the coach's recovery. The VEDR was found dislodged from the windshield, however its wiring via an RJ11 plug remained intact and connected to the accident coach. The VEDR was transferred into the custody of the undersigned Group Chairman via FedEx air bill number 8635 9260 0111. The subject VEDR was received by the undersigned at 10:09 a.m. on January 11, 2008.

On January 11, 2008, the VEDR was removed from its packaging materials for inspection. The unit presented to be in good overall physical condition with no indication of physical damage. The VEDR was photographed and its identifying information documented. **(See Docket Photo EDR#2)**

Because DriveCam's proprietary software (HindSight 20/20) was required to extract data from the VEDR, the undersigned transported the VEDR on January 14, 2008 to DriveCam's corporate headquarters located in San Diego, California. Also present for the data extraction from the VEDR was Mr. Kimball Kinnersly, the Director of Safety from Arrow Stage Lines.

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[14] The subject Saucon unit was considered an early model and the Safety Board has learned that Saucon's newer models were designed with the use of "non volatile" memory which preserves all data regardless of power loss or interruptions.

[15] DriveCam is headquartered in San Diego, California, and focuses on the reduction of claims costs and saving lives by improving the way people drive. DriveCam operates in North America, Europe, Africa, Australia and Asia. www.drivecam.com

The compact flash card was removed from the DriveCam II unit by a DriveCam engineer[16] and all event data as well as proprietary diagnostic data was copied onto CD-ROM leaving the original files on the memory card unmodified. The data that was recovered included video as well as audio event data with its associated parametric data. The undersigned also requested a copy of the uncompressed video data for an event file that corresponded with the approximate date and time of the accident. This data was also provided to the undersigned on CD-ROM.

At the conclusion of the data extraction process the compact flash memory card was placed back into the DriveCam unit and the case of the unit resealed in the presence of the undersigned who maintained possession of the unit from this point on. At no point was the VEDR or the memory card removed from the sight and general custody of the undersigned.

On January 22, 2008, the undersigned transported the VEDR along with the CD-ROMs containing the extracted data from the VEDR's compact flash card to the Safety Board's Cockpit Voice Recorder Laboratory located in Washington D.C. where custody of the VEDR and the CD-ROMs was transferred into the custody of D. Brazy, a Vehicle Recorder Specialist with the Safety Board's Research and Engineering Division for analysis.

E. LIST OF ATTACHMENTS

Attachment A – Caterpillar ECM Data
Attachment B – Saucon GPS Data

END OF FACTUAL REPORT

_***S/***_____March 5, 2008
Christopher C. Voeglie, Senior Investigator
Event Data Recorder Group Chairman

[16] Mr. Larry Richardson, Senior Software Engineer, DriveCam Inc.