**U.S. Department
Of Transportation**

**Federal Motor Carrier
Safety Administration**

A Report to Congress on Electronic Control Module Technology for Use in Recording Vehicle Parameters During a Crash

DOT-MC-01-110 September 2001

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I. Executive Summary

This report is in response to the FY2000 Senate Appropriations Committee request (the Committee) in Senate Report 106-55, dated May 27, 1999. The Committee requested the agency[1] to work with interested parties to explore a standard of protocol for relevant operational data to be recorded on electronic control modules in trucks, and for access to that data. The Committee believes there are potential benefits of this technology in that it could prove useful to law enforcement investigations of highway crashes.

For the purposes of this report, electronic control module is referred to as "event data recorder (EDR)," because in this application the technology is used to gather a variety of vehicle and events data surrounding a crash or near-miss incident when, or just before, it occurs. As the Committee noted in its report, these include data such as vehicle speed, and brake pedal and throttle position. Data is typically recorded continuously over a specified time interval, such as three minutes. The data is then replaced unless an event occurs, in which case the EDR saves the data surrounding the event, such as 30 seconds before and 15 seconds after a crash. Events that trigger the EDR to save such data can include sudden deceleration, air bag deployment, or manual activation by the driver.

In response to the Committee's request, the FMCSA has been and is continuing to work with interested parties to address the issues of concern to the Committee. These include the National Highway Traffic Safety Administration (NHTSA), the National Transportation Safety Board (NTSB), the Technology & Maintenance Council (TMC) of the American Trucking Associations, Inc. (ATA), and others from the public and private sectors. Much of the work is

[1] It was then the Office of Motor Carrier Safety, Federal Highway Administration (FHWA), and is now the Federal Motor Carrier Safety Administration (FMCSA).

being carried out by activities conducted by the following parties: (1) the NHTSA Truck and Bus EDR Working Group, and (2) the TMC Vehicle Event Recording Task Force.

The NHTSA Truck and Bus EDR Working Group was formed in June 2000, following two NTSB recommendations urging NHTSA to: (1) Require all school buses and motor coaches manufactured after January 1, 2003, to be equipped with on-board recording systems that record specific vehicle parameters, and (2) develop and implement in cooperation with other government agencies and industry, specific standards for on-board recording of bus crash data. The purpose of this working group is to gather information relative to the NTSB's recommendations, including the data to be recorded, and access to that data. Participants represent a broad cross-section of interested parties from the highway safety community, including FMCSA representatives. Work is ongoing, and a report summarizing the group's findings is expected to be available in 2002.

In 1999, TMC formed its Vehicle Event Recording Task Force. Its objective is to publish a recommended practice, "Vehicle Event Recording," which addresses EDR technical issues, including data to be recorded and access to that data. Participants include representatives from FMCSA, other government agencies, and industry. The recommended practice has been drafted and is under review as part of the approval process.

The scope of the TMC Vehicle Event Recorder Task Force is more limited than that of the NHTSA working group. NHTSA is looking at the universe of data elements that could be beneficial for recording in the event of a crash. In contrast, TMC is addressing only those data elements that are available on all new trucks and truck tractors through the engine control module or its corresponding data bus. The TMC task force is not attempting to define the ultimate EDR for trucks. It is working to provide uniformity to the data already available 100 percent of the time on all new trucks, regardless of make.

Based on information gathered to date, the FMCSA has summarized its key findings below:

- Technology appears to be available today for monitoring the following parameters on all new trucks and truck tractors: engine brake, brake pedal switch, cruise control, engine speed, engine throttle status, odometer reading, time-date, and vehicle speed.
- The following standards of protocol should be considered for controlling access to EDR data:
  - The vehicle owner at any given time should own the EDR data.
  - Only the vehicle owner, or another party having the owner's permission, may access the EDR data.[2] Exceptions would include instances where a law enforcement official has a warrant in connection with a crash investigation.
  - One method of assuring vehicle owner access only is through use of an EDR system password, as specified in the draft TMC Recommended Practice, "Vehicle Event Recording."
  - The storage and retrieval of EDR data must protect the privacy rights of individuals in accordance with Federal and State laws.
- EDR technology should be viewed as a tool to assist trained crash investigators and not as a substitute for such personnel.
- Based on available information, the FMCSA estimates that the number of EDRs in use for the purpose of crash data collection is relatively small. Commercial motor vehicle applications today are focused more toward fleet management.
- In addition to helping determine crash causation, there is some research indicating that EDRs may result in reduced crash risk through improved driving behavior.

[2] This raises the possibility that an owner could erase the data if it is not favorable to the owner.

- While the potential safety benefits of EDRs appear clear, there is little real-world data available to quantify those benefits.

The FMCSA is committed to facilitating the development and deployment of new technologies, such as EDRs; to help meet its goal of reducing the number of deaths and injuries in truck and bus-related crashes 50 percent by 2010. There are important issues that will need to be addressed as this new technology continues to be developed, including individual privacy with respect to the data collected, and access to that data.

The FMCSA will continue to partner with industry and other government agencies to facilitate the use of EDRs through continued research and demonstration, development of voluntary standards, and the removal of any regulatory barriers that could inhibit their development and use. In addition, the agency plans to publish in the Federal Register a Request for Comments to gather more specific data on truck and bus EDR use, benefits, costs, and other issues of concern to users. In conjunction with this notice the FMCSA will open a public docket through which its partners, industry, and the public can continue to provide data and other information as it becomes available.

II. Introduction

The FMCSA was established on January 1, 2000, as a new Federal agency within the U.S. Department of Transportation (DOT). This came about as a result of the Motor Carrier Safety Improvement Act of 1999 (Public Law 106-159). Prior to this, the Federal motor carrier safety program was carried out within the DOT's Federal Highway Administration.

In establishing the new agency, Congress placed safety as the highest priority with the goal of reducing both the number and severity of large truck and bus involved crashes. The FMCSA is responsible for the safe operation of commercial motor vehicles (CMVs) used in interstate commerce on our nation's highways.

The vast majority of truck and bus-related crashes involve large trucks. In 1999, there were 5,362 fatalities and 142,000 persons injured as a result of large truck involved crashes. During 2000, there were 5,211 fatalities and an estimated 140,000 persons injured. The causal factors for these crashes are complex, involving the driver and safety equipment of both the large trucks and nearby passenger vehicles, as well as roadway conditions and design.

The FMCSA has launched a comprehensive program designed to achieve its goal of reducing the number of deaths and injuries in truck and bus-related crashes 50 percent by 2010. The program includes: (1) Strengthening targeted enforcement of Federal safety regulations, (2) enhancing CMV operating and equipment safety standards, (3) improving the agency's safety information, (4) facilitating the development and deployment of new technologies, and (4) increasing safety awareness on the part of both the CMV industry and the public.

The agency believes that new technologies hold great potential for reducing both the number and severity of large truck and bus involved crashes. Because of this, the FMCSA is committed to working with industry, safety advocacy groups, and other government agencies to facilitate development and deployment of new technologies. These include electronic control modules that can be used to record a variety of vehicle parameters and critical events surrounding a crash or near-miss incident.

III. Senate Appropriations Committee Request

In Senate Report 106-55, the Committee requested the agency to conduct work in the area of electronic control module technology. The Committee requested that the agency work with interested parties to explore a standard of protocol for the relevant data to be recorded on electronic control modules and for access to that data. The Committee Report specifically reads:

> *Electronic Control Module Technology*.—The Committee is aware of the potential benefits of electronic control module technology in trucks. Electronic control modules store data, such as vehicle speed and brake pedal and throttle position, that could prove

useful to law enforcement investigations of crashes on our nation's highways and roads and prevent future loss of life in much the same way that flight data recorders contribute to airplane crash investigations. The Committee requests that the FHWA work with interested parties to explore a standard of protocol for access to and the relevant data to be recorded in this area and report back to the Committee by June 2000. It is the Committee's expectation that in the development of any such safety enhancement tool, any standards or protocols would follow high standards of privacy and would only apply to instances in which law enforcement had secured a warrant with the intention of investigating a serious crash.

IV. Electronic Control Module Applications

The most extensive use of EDRs is in the aviation industry, although there is increasing use of such devices in the rail and marine industries. The use of such devices in motor vehicle applications has been limited.

Crash protected flight data recorders have been in use since the 1950s, and current devices have the capability of recording hundreds of parameters of data for at least 25 hours. These devices have made significant safety contributions to the aviation industry, through the data and information that has been acquired.

In the rail industry, event recorders were first implemented in the late 1970s for management purposes. The Federal Railroad Administration (FRA) mandated their use in 1995. However, current devices record only a minimal number of parameters, and do not meet any crash or fire survivability requirements. Government and industry representatives are participating in a working group to develop draft specifications for locomotive event recorder crashworthiness. It is anticipated that these requirements will be proposed in the near future as part of an FRA notice of proposed rulemaking.

Until recently, voyage recorders in the marine industry have been fairly rudimentary and of limited use for determining crash causation. Fortunately, progress is being made to improve such devices. An international standard for improved voyage data requirements was approved and became effective in March 2000. Earlier this year, the International Maritime Organization

required voyage recorders to be on-board all passenger-carrying ships, and a decision is planned for requiring such devices on cargo ships by the end of this year.

As referenced above, the use of EDRs in motor vehicle applications has been limited. The NHTSA first used them in crash testing research, and more recently in field operational tests to gather air bag related data. The agency has also used EDRs in connection with field operation tests of automatic collision notification (ACN) technologies. ACN technology is used to notify local emergency response personnel that a crash has occurred, along with its location, to improve response time and thereby save lives.

Electronic control module technology in CMV applications can be used for recording various vehicle parameters surrounding the time of a crash. The technology is also being used increasingly to improve CMV operational efficiency and productivity. Based on the Committee's request, the FMCSA is addressing in this report the application of this technology for recording critical events surrounding a crash, similar to flight data recorders used for airplane crash investigations. As referenced above, in this application the technology is referred to as an EDR.

Although not the subject of this report, it is worth noting that the agency's first involvement with the use of such technology was in the area of CMV driver hours-of-service (HOS). In that application, the technology is referred to as an on-board recorder (OBR).

Agency research has shown that fatigue is a significant safety problem among CMV drivers, particularly those involved in long haul operations. Federal Motor Carrier Safety Regulations (FMCSRs) govern the maximum duty hours of CMV drivers. Both drivers and motor carriers are required to document and retain HOS records for possible examination by enforcement personnel. However, hand-written paper records are subject to falsification. OBRs can provide

a more tamper resistant record for State and Federal enforcement personnel, and a less burdensome method to record CMV driver HOS.

In 1988, the former Office of Motor Carrier Safety modified its CMV driver HOS regulations to encourage the use of this technology. Section 395.15 of the FMCSRs, Automatic On-Board Recording Devices, allows the use of automatic recorders for recording driver HOS, but does not mandate their use. The agency also proposed requiring electronic OBRs for certain CMV operations as part of its May 2000 notice of proposed rulemaking on the HOS regulations.

V. Working With Interested Parties

The FMCSA is pleased to report to the Committee that over the last three years it has been working with other interested parties and gathering information on EDRs. The other parties include NHTSA, the NTSB, and the TMC of the American Trucking Associations, Inc.

In addition, the former Office of Motor Carrier Safety completed a research study on CMV electronic control module technology, "Commercial Vehicle Incident Monitors," February 19, 1997. The research was conducted under contract with Sandia National Laboratories, Albuquerque, New Mexico, and involved the gathering of information on the following: (1) The status of data recorder technology, (2) potential CMV applications, (3) types of data useful for crash investigation, and (4) vehicle industry standards applicable to installation of the new technology. The research was broad in scope and provided the agency with a good introductory overview of the new technology.

Below is a summary of each of the key activities in which the FMCSA and its staff have been or are involved. Section VI. Findings, summarizes what the FMCSA has learned about the critical issues of interest to the Committee.

A. National Highway Traffic Safety Administration

The FMCSA works with NHTSA on a variety of issues because of the role that each agency has with regard to vehicle safety. The NHTSA regulates the safety of new vehicles, including trucks and buses, through the Federal Motor Vehicle Safety Standards that it promulgates. Similarly, the FMCSA regulates the safe operation of trucks and buses used in interstate commerce, as well as the drivers and motor carriers, through the FMCSRs.

In 1998, NHTSA began a working group to gather information on EDRs, focusing primarily on light vehicles – those weighing 10,000 pounds or less. NHTSA took this action following recommendations in 1997 from NTSB and the National Aeronautics and Space Administration's Jet Propulsion Laboratory (JPL). The NTSB Recommendation H-97-18 urged NHTSA to "Develop and implement, in conjunction with the domestic and international manufacturers, a plan to gather better information on crash pulses and other crash parameters in actual crashes, utilizing current or augmented sensing and recording devices." JPL recommended that NHTSA "Study the feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles."

The NHTSA EDR Working Group was established with participants representing a broad cross-section of interested parties from the highway safety community, including vehicle manufacturers, the insurance industry, crash investigators, universities and other research organizations, State and Federal governments, Transport Canada, and private citizens. Participation is open to any interested person. The purpose of the working group was strictly fact-finding for possible future decision-making. Its focus has been to gather information on the following specific issues:

- What is the status of EDR technology?
- What data is needed for recording?

- How is the data collected and stored?
- How is the data retrieved?
- Who is responsible for keeping the permanent record?
- Who owns the data?
- Who are the customers for EDR data?
- Demonstration of EDR technology.

The first meeting was held on October 2, 1998, with six subsequent meetings during 1999-2000. Copies of the final report and minutes to each meeting, along with documentation submitted by participants, are available in public docket NHTS A-99-5218, U. S. DOT Dockets, Room PL-401, 400 Seventh Street, SW., Washington, D.C. 20590. The documents may also be accessed on the Internet at http://dms.dot.gov, by searching for Docket Number 5218.

In June 2000, with most of the work of this group completed, NHTSA began another working group to focus strictly on EDRs for large trucks and buses, including school buses. This action followed two 1999 NTSB recommendations addressing buses. Further information on these two NTSB recommendations, H-99-53 and H-99-54, respectively, is presented below.

As with the earlier working group, participants in this ongoing NHTSA Truck and Bus EDR Working Group represent a broad cross-section of interested parties from the highway safety community, and participation is open to any interested person. Its purpose is also strictly fact finding with respect to issues similar to those addressed by the earlier working group. The latest meeting was held on February 16, 2001. The group plans approximately three meetings per year until work is completed. Copies of the meeting minutes and other documentation from participants are publicly available in docket NHTSA-00-7699, at the same addresses cited above.

B. National Transportation Safety Board

As referenced above, the NTSB has been a strong proponent of using EDRs in highway transportation applications, similar to their use in other transportation modes. NTSB has issued several recommendations in recent years to both NHTSA and the CMV industry on this subject. In 1999, the NTSB issued two EDR related recommendations to NHTSA, following a special investigation of several school bus and motor coach crashes. The full text of the two recommendations is presented below:

> *NTSB Recommendation H-99-53*. -- Require that all school buses and motorcoaches (sic) manufactured after January 1, 2003, be equipped with on-board recording systems that record vehicle parameters, including, at a minimum, lateral acceleration, longitudinal acceleration, vertical acceleration, heading, vehicle speed, engine speed, driver's seat belt status, braking input, steering input, gear selection, turn signal status (left/right), brake light status (on/off), head/tail light status (on/off), passenger door status (open/closed), emergency door status (open/closed), hazard light status (on/off), brake system status (normal/warning), and flashing red light status (on/off) (school buses only). For those buses so equipped, the following should also be recorded: status of additional seat belts, airbag deployment criteria, airbag deployment time, and airbag deployment energy. The on-board recording system should record data at a sampling rate that is sufficient to define vehicle dynamics and should be capable of preserving data in the event of a vehicle crash or an electrical power loss. In addition, the on-board recording system should be mounted to the bus body, not the chassis, to ensure that the data necessary for defining bus body motion are recorded.
>
> *NTSB Recommendation H-99-54*. -- Develop and implement, in cooperation with other Government agencies and industry, standards for on-board recording of bus crash data that address, at a minimum, parameters to be recorded, data sampling rates, duration of recording, interface configurations, data storage format, incorporation of fleet management tools, fluid immersion survivability, impact shock survivability, crush and penetration survivability, fire survivability, independent power supply, and ability to accommodate future requirements and technological advances.

In addition, the NTSB recently held two international symposiums, both in Arlington, Virginia, which addressed information collection at the time of a crash for all modes of transportation. The first one, "International Symposium on Transportation Recorders," was held in May 1999. It focused on the status of EDR technology, the importance of data accuracy and its benefits, and the legal implications associated with such data. The second symposium,

"Transportation Safety and the Law," was held in June 2000. It focused on the legal aspects of gathering such information, including privacy, data ownership, regulatory enforcement, and litigation. Both symposiums involved a large number of attendees from both public and private sectors, representing all modes of transportation, and provided the opportunity to share valuable information.

C. Technology & Maintenance Council, American Trucking Associations, Inc.

In 1999, the ATA and the TMC of the ATA initiated activities to address the legal and technical issues surrounding EDRs. This activity followed the Committee's request in Senate Report 106-55, referenced above.

The overall mission of the ATA is to serve and represent the interests of the trucking industry, whereas the mission of the TMC is to improve trucking equipment, its maintenance, and maintenance management. TMC serves as a forum, through which members can come together and exchange information among themselves and with other elements of the industry.

A TMC task force, known as the TMC Vehicle Event Recording Task Force, is addressing the technical issues. Its objective is to publish a TMC Recommended Practice, "Vehicle Event Recording," which addresses the following issues:

- What events are to be recorded?
- What constitutes an event (for example, what deceleration defines a panic stop)?
- How long must the recorded data be saved?
- What security should be in place (tampering before and after an event)?
- Under what conditions will the data be retained (no electrical power, engine ripped from truck, recorder engulfed in fire)?
- How will the data be acquired (hardware and software)?

The TMC Recommended Practice, "Vehicle Event Recording," is in final development. Task force participants include TMC members and others from industry, FMCSA, NHTSA, and NTSB. Participation is open to any interested person. The first meeting was held in March 2000, with subsequent meetings in June and October 2000, and January and March 2001. At the meeting on March 12, 2001, the task force adopted a motion to send the latest draft of the Recommended Practice to the Total Vehicle Electronics Study Group for review, which is the next step in the approval process.

The legal issues include whether the gathered data should involve vehicles, drivers, or both; who will use the data, and for what purpose; and how the data will be legally protected. An ATA internal working group consisting of members, attorneys, and staff of its Technology and Engineering Committee is currently addressing these issues. The committee developed a policy statement (see Appendix A) on the use and access of electronic data, which the ATA Board of Directors adopted in February 2000. The policy statement points out that motor carriers are reluctant to adopt new technologies that result in data production, because of its potential misuse in regulatory enforcement and civil litigation. It states that in order to benefit from new technologies that can improve highway safety and efficiency, while providing protection against information misuse, the trucking industry supports creation of reliable data parameter standards only if:

(1) [T]hey are developed and implemented for all vehicles, including passenger cars, concurrently;
(2) all vehicle owners and operators are properly protected against the use of electronically-generated data in regulatory enforcement and civil litigation;
(3) data are anonymous and used for safety research and trend analysis by a single lead agency or institution;
(4) reasonable privacy can be assured regarding access and use of the information;
(5) access to data is controlled;
(6) data are recorded only for a limited period of time relative to an event; and
(7) there is no burden on individual vehicle owners or operators for the reporting or collection of such data at any time.

Finally, it is worth noting that in addition to the Senate Appropriations Committee, the Congress as a whole is also sensitive to the issues surrounding individual privacy. Through the recent National Transportation Safety Board Amendments Act of 2000, the 106th Congress extended to surface transportation employees the confidentiality of voice and video recordings that is already provided for cockpit recordings in connection with NTSB investigations.

VI. Findings

The FMCSA has gathered much EDR-related information through its preliminary research, and work with other interested parties. Key findings and information of interest to the Committee are summarized below, including a description of EDR technology, standards for the relevant data to be recorded and access to it, privacy issues, and EDR benefits.

A. Event Data Recorder Technology

All EDRs are fundamentally the same in their functioning, consisting of sensors and other components that provide data processing, data storage, data retrieval, and power supply. The general configuration is illustrated below:

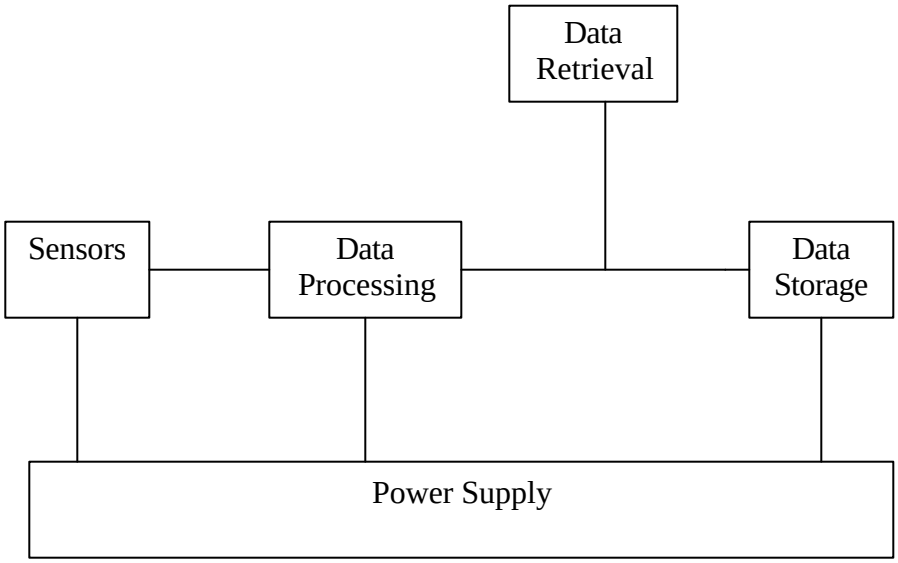

Figure 1

Sensors measure the various vehicle parameters of interest, such as speed, and brake pedal and throttle position. Data processing is done by a microprocessor, which may filter, average, or otherwise process the data. It is then stored in a data storage block for subsequent retrieval. The data may also be retrieved as it is processed. In most cases the EDR power supply is a battery or other external source, which operates independent of vehicle electrical power supply to assure no disruption in data recording.

An EDR system can be built using individual off-the-shelf components or modules, such as microprocessors, and data acquisition and storage cards. Tradeoffs in configuring the system include size limitations, software complexity, power consumption, data storage capacity, data sampling rate, and cost.

There are also several commercially available EDR systems designed for vehicle applications. Some are designed specifically for crash reconstruction or can be modified for that purpose. Others are designed for crash testing purposes, or for improving fleet management and productivity. Thus, the types and number of measured vehicle parameters vary significantly among EDR systems.

EDRs typically record data continuously over a specified time interval, such as three minutes. The data is replaced every three minutes unless an event occurs. In that case the EDR saves the data surrounding the event, such as 30 seconds before and 15 seconds after a crash. Events that trigger the EDR to save such data include sudden deceleration, air bag deployment, or manual activation by the driver.

In the large truck and bus industry, the engine electronic control module (ECM) has been used for several years to collect and process data critical to proper engine operation, such as

engine rpm,[3] temperature, fuel/air mixture, and other parameters. Use of the engine ECM came about in large part due to increasing emission control requirements beginning in the early 1990s. The engine ECM facilitates more efficient engine operation, and thereby reduced emissions. Its use for this purpose has led to further onboard applications, including measurement of vehicle parameters to improve fleet maintenance and productivity, or provide beneficial data in the event of a crash. The data include fuel economy, mileage, time and date, battery voltage, brake pedal and throttle position, speed, deceleration, and others. Although a number of truck manufacturers use the engine ECM for this purpose, others use a separate data-logging unit (DLU). The DLU captures all of the information generated by the various electronic systems on the vehicle.

Prior to development of the draft TMC Recommended Practice referenced above, there was no uniform specification for the relevant data to be recorded. Thus, current parameters, whether for fleet maintenance or event recording, vary widely based on the engine or truck and bus manufacturers involved, as well as the needs of the motor carrier. Further information on the draft TMC Recommended Practice, "Vehicle Event Recording," is given below.

One effort that has already brought some degree of standardization to this area is that of the Society of Automotive Engineers (SAE). Since 1993, the SAE has published a number of recommended practices, which facilitate compatibility and communication among various vehicle onboard electronic networks. Those pertaining to trucks and buses are:

- J1708, Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications, October 1993.
- J1587, Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications, July 1998.

[3] The term, rpm, refers to revolutions per minute.

- J1922, Power-train Control Interface for Electronic Controls Used in Medium- and Heavy-Duty Diesel On-Highway Vehicle Applications, September 2000.
- J1939, Recommended Practice for Truck and Bus Control and Communications Network, April 2000.

SAE J1708 provides for hardware and basic software compatibility among the various electronic network sub-systems, whereas J1587 and J1922 define the format for the messages and data communicated between the various onboard microprocessors. Together, these help reduce the costs and complexity of both the hardware and software associated with onboard vehicle microprocessor applications. SAE J1939 addresses these areas as well, but for longer term, high speed networks.

In September 2000, SAE established a committee (SAE Committee) to look at the need for additional standards and recommended practices relative to the use of EDRs in light and heavy vehicles, and school and transit buses. This work is ongoing, and the SAE Committee currently has no specific time frame for completing its work. The EDR data to be recorded, data storage and retrieval, and crash resistance are among the issues being addressed by the SAE Committee.

B. Relevant Data to be Recorded and Access to the Data

In response to the Senate Committee's request, the FMCSA is exploring a standard of protocol for access to, and the relevant data to be recorded on, EDRs. This is being carried out through the agency's work with the NHTSA Truck and Bus EDR Working Group and the TMC Vehicle Event Recording Task Force. Both of these activities are ongoing. The status of each is presented below.

(1) NHTSA Truck and Bus EDR Working Group

As referenced above, the NHTSA Truck and Bus EDR Working Group began in June 2000, following two 1999 NTSB recommendations. Although the working group focus is strictly fact-

finding for possible future decision-making, the group is gathering information on those issues specifically referenced in the NTSB recommendations, including the data to be recorded and access to it, electrical power loss, EDR crashworthiness requirements, incorporation of fleet management tools, and accommodating future requirements and technological advances. A report summarizing the working group's findings is expected to be available in 2002.

As referenced earlier, the NHTSA's EDR Working Group for light vehicles has recently completed a final report summarizing its findings. While that working group has focused strictly on EDR applications for light passenger vehicles, many of the issues are relevant or parallel to those of large trucks and buses. An overview of the group's findings on data to be recorded and access to it are presented below.

With respect to the relevant data to be recorded the working group developed categories in which all data elements could be placed. The categories are presented below, along with a list of "top ten" data elements that the light vehicle working group believes are the most important for EDR collection and storage in the event of a crash. Appendix B contains a more detailed list of 74 data elements, which the working group believes could be useful for EDR collection and storage, depending on the application. These may not all apply for heavy vehicles. Likewise, there may be other data elements that are more important for heavy trucks.

Data Element Categories

- Restraint System Usage
- Crash Pulse
- Vehicle/EDR Identification
- Speed
- Driver Controls
- Location

- Automatic Collision Notification
- Environmental Conditions

"Top Ten" Data Elements for Light Vehicles

1. Longitudinal and Lateral Acceleration, and Principal Direction of Force
2. Crash Location
3. Safety Belt Status by Seating Location
4. Number of Occupants and Location
5. Pre-Crash Data (such as vehicle speed, braking status, and steering input)
6. Time of Crash
7. Rollover Sensor
8. Yaw[4] Data
9. Anti-Lock Brake System, Traction Control, and Stability Control Data
10. Air Bag (such as deactivation status, deployment time, and deployment stage)

In looking at the issue of EDR data access, the NHTSA light vehicle EDR working group developed a list of potential users of the data in the event of a crash. The list includes vehicle owners and manufacturers, fleets and drivers, law enforcement agencies, insurance companies, State insurance commissioners, plaintiff and defense attorneys, courts, hospital and emergency medical service providers, government safety agencies (Federal, State, and local), safety advocates, and transportation and human factors researchers. These represent a broad cross-section of potential users, all of which have varying levels of interest in determining crash

[4] Yaw motion is vehicle rotation about its vertical axis.

causation and improving safety. Depending on the particular crash or circumstance, the users may also have competing interests in accessing the EDR data.

Given this broad and varied list of potential users, the working group reached agreement that:

- The owner of the vehicle at any given time owns the EDR data.
- Only the vehicle owner, or another user having the owner's permission, can access the EDR data. Exceptions include instances where law enforcement officials have a warrant in connection with a crash investigation, and litigation where the court or either party can obtain the data through discovery.
- The storage and retrieval of EDR data must protect the privacy rights of individuals in accordance with federal and state laws.

(2) TMC Vehicle Event Recorder Task Force

The scope of the TMC Vehicle Event Recorder Task Force is more limited than those of the two NHTSA working groups. As referenced above, NHTSA is looking at the universe of data elements that could be beneficial for recording in the event of a crash. In contrast, TMC is addressing only those data elements that are available on all new trucks and truck tractors through the engine control module or its corresponding data bus. There are other data elements that are sensed on the vehicle, but cannot be recorded because they are not connected to the electronic control module data bus. The TMC task force is not attempting to define the ultimate EDR for trucks. Instead, the task force is working to provide uniformity to the data already available 100 percent of the time on all new trucks regardless of make. The recommended practice would apply to on-board ECMs that record and store vehicle data to be used for post-crash analysis. The TMC data elements for commercial vehicles are:

- Engine Brake – Engaged, disengaged
- Brake Pedal Switch – On, off

- Cruise Control – On, off, speed set (mph)
- Engine Speed – RPM
- Engine Throttle Status – Percent applied
- Odometer Reading – Miles
- Time - Date – Day, month, year
- Vehicle Speed (calculated) – Miles per hour

Other items in the draft TMC Recommended Practice relevant to the data to be recorded are:

- Recording will commence with the starting of the engine.
- All information should be stored for a minimum of 30-seconds before and 15-seconds after an event is triggered.
- Information should be stored for a minimum of two events.
- The information-sampling rate shall be at least one time per second.
- The triggering mechanism used to initiate the capture of data should be a computed vehicle deceleration that is selected to minimize false information, 10 mph/sec or less.

Consistent with the NHTSA findings referenced above, the draft TMC Recommended Practice specifies that "[t]he vehicle owner is the exclusive owner of the data," and that the information can only be extracted or cleared by the owner. Further, it recommends that the on-board data be accessed solely through use of a password, as specified in an earlier TMC Recommended Practice, "PC to User Interface Recommendations for Electronic Engines." That recommended practice addresses security, terminology, and functionality standardization to help suppliers provide a similar look and feel to all service software packages for use by technicians. Section 7.0, "Incident Events Data," specifies that once event data is logged onto an ECM, it should be accessed only by use of a unique password, which resides within the ECM and is

assigned by a System Administrator. Anyone wishing to access the event data must first obtain the password from the System Administrator. The System Administrator could be a company's Director of Maintenance, or other person designated by the company that owns the vehicle. Copies of both TMC Recommended Practices, "Vehicle Event Recording" and "PC to User Interface Recommendations for Electronic Engines," are contained in Appendices C and D, respectively.

C. Safety Benefits of Event Data Recorders

As referenced in the Committee's Report to the agency, one of the major potential benefits of using ECM technology on trucks is the gathering of data on critical vehicle parameters surrounding the time of a crash. This can be extremely valuable in determining crash causation.

One method of demonstrating this potential benefit is through the Haddon matrix, which was developed by the first Administrator of the NHTSA, Dr. William Haddon, Jr. The matrix illustrates the interaction of the persons involved, the vehicle, and the highway environment before, during, and after a crash. Data in each cell help to determine the cause and extent of a crash. The Haddon matrix is shown below in Figure 2, along with some examples of data in each of the cells.

Haddon Matrix	**Human**	**Vehicle**	**Environment**
Pre-Crash	Safety Belt Use Steering/Braking Input	Speed Deceleration Anti-Lock Brakes	Road/Conditions
Crash	Air Bag Data Safety Belt Pre-Tensioners	Crash Pulse Change in Velocity Air Bag Deployment Time	Location
Post-Crash	Injuries	Damage	Road/Conditions

Figure 2

A trained expert through crash investigation traditionally obtains the kind of data shown in the cells. However, in many cases the investigator must rely on evidence gathered at the crash scene, professional experience, and other tools to derive estimates of the data shown in the shaded cells. While this approach is productive and provides valuable information, it cannot always provide exact, documented evidence of the data in question. In contrast, EDRs are able to measure such data before, during, and after the actual crash, which would greatly enhance the job of determining the cause of a crash.

Although the EDR data would provide a tremendous benefit, it should not be used without taking into account other information that can be gleaned from the crash scene by a trained investigator. In addition, having an EDR on all vehicles involved in the crash – not just the large truck or bus – would provide a more complete picture of the events surrounding a crash.

There is also some research indicating that onboard data recorders can result in reduced crash risk through improved driving behavior. During 1989-96, a European study was conducted in which crash and exposure data were collected on 840 commercial vehicles, 270 of which were equipped with data recorders. The vehicles represented 11 different fleets involving heavy and medium trucks, motor coaches, taxis, vans, and company passenger cars. The vehicles were

divided into seven sets with each set consisting of an experimental group and a control group. Crash and exposure data were gathered on all vehicles for a period of time, after which data recorders were installed on the experimental vehicles with continued monitoring of all vehicles. Fleet owners participating in the study agreed to give regular feedback to their drivers of the vehicles equipped with data recorders. The drivers were informed about the presence of the recorders and the purpose. Analysis of the results suggested that use of data recorders and the regular feedback given those drivers resulted in a reduction in crash risk of some 20 percent on average.

VII. Intelligent Vehicle Initiative

In partnership with U.S. DOT's Joint Program Office, NHTSA, and industry, the FMCSA is participating in a field operation test to demonstrate the benefits of new onboard safety technologies on large trucks. The project is being funded by the Intelligent Transportation Systems Program through a cooperative agreement between government and industry under the Intelligent Vehicle Initiative (IVI). The IVI is a component of the DOT Intelligent Transportation Systems program, which is administered by the Joint Program Office of the FHWA.

The project is a good example of how critical vehicle event data can be recorded, stored, and retrieved on trucks in actual use. The demonstration vehicles involve 100 new Volvo truck tractors operated in actual service by U.S. Express, a motor carrier operating approximately 5,000 units nation-wide. A portion of the 100 trucks are equipped with electronically controlled disc brakes, adaptive cruise control[5], and a driver collision warning system (front closing distance and right side blind spot). The remaining portion of the 100 vehicles are equipped with

[5] Adaptive cruise control is different than conventional cruise control in that the adaptive version will automatically maintain a minimum distance away from the vehicle in front of it. This is achieved through engine braking. With conventional cruise control the driver must activate the brake pedal to slow the vehicle.

conventional brakes, conventional cruise control, and either an activated or deactivated collision warning system.

The goal is to determine any measurable safety benefits of the electronically controlled disc brakes, adaptive cruise control, and collision warning system. In order to do this each truck is equipped with a data-logger unit - DLU, which continuously records key vehicle parameters while the vehicle is in operation. The parameters being recorded and monitored are road speed, throttle percentage, GPS[6] location, GPS time, anti-lock brake status, brake application, ambient temperature, cruise control status, steering position, lateral acceleration, longitudinal acceleration, following distance, engine brake status, brake system pressure, fault code status, and odometer. Data from each truck is retrieved daily and sent by cellular telephone to a central location responsible for data processing and storage.

Aside from driver interviews, the data logger unit onboard each truck is the critical information source in helping to measure the in-use safety benefits of the new technologies. The project completion date is expected to be in 2003.

VIII. Conclusions

- Technology appears to be available today for monitoring the following parameters on all new trucks and truck tractors: engine brake, brake pedal switch, cruise control, engine speed, engine throttle status, odometer reading, time-date, and vehicle speed.
- The following standards of protocol should be considered for controlling access to EDR data:
    - The owner of the vehicle at any given time should own the EDR data.

[6] GPS stands for Global Positioning System, which can monitor a truck's geographic location through radio frequency and satellites.

- Only the vehicle owner, or another party having the owner's permission, may access the EDR data.[7] Exceptions could include instances where a law enforcement official has a warrant in connection with a crash investigation.
- One method of assuring vehicle owner access only is through use of an EDR system password, as specified in the draft TMC Recommended Practice, "Vehicle Event Recording."
- The storage and retrieval of EDR data must protect the privacy rights of individuals in accordance with federal and state laws.

- EDR technology should be viewed as a tool to assist trained crash investigators and not as a substitute for such personnel.
- Based on available information, the FMCSA estimates that the number of EDRs in use for the purpose of crash data collection is relatively small. Commercial motor vehicle applications today are focused more toward fleet management.
- In addition to helping determine crash causation, there is some research indicating that EDRs may result in reduced crash risk through improved driving behavior.
- While the potential safety benefits of EDRs appear clear, there is little real-world data available to quantify those benefits.

IX. Future Agency Plans

The FMCSA is committed to facilitating the development and deployment of new technologies to help meet its goal of reducing the number of deaths and injuries in truck and bus-related crashes 50 percent by 2010. This includes the use of EDRs on trucks and buses to record critical vehicle parameters at the time of a crash.

[7] As noted above, this raises the possibility that an owner could erase the data if it is not favorable to the owner.

The FMCSA will continue to partner with industry and other government agencies to facilitate the use of EDRs through research and demonstration, development of voluntary standards, and removal of any regulatory barriers that could inhibit their development and use. In addition, the agency plans to publish in the Federal Register a Request for Comments to gather more specific data on truck and bus EDR use, benefits, costs, and other issues of concern to users. In conjunction with this notice the FMCSA will open a public docket so that its partners, industry, and the public can continue to provide data and other information on this subject as it becomes available.

Based on information gathered by the TMC task force, all new trucks and truck tractors are capable of recording the eight data elements referenced in the TMC Recommended Practice (see Appendix C). These could be useful for crash causation purposes. However, task force information also indicates that data currently recorded by fleet owners is focused more toward fleet management purposes.

There are important issues that will need to be addressed as this new technology continues to be developed. These include individual privacy with respect to the data collected, and access to that data. The actions of the NHTSA working groups, and the draft TMC Recommended Practice, "Vehicle Event Recording," will help determine the relevant data to be recorded, access to it, and data ownership.

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