Memorandum

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**National Highway
Traffic Safety
Administration**

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Subject: Submittal of the Final Report of the NHTSA R&D Event Data Recorder (EDR) Working Group to Docket No. NHTSA-99-5218 – 6

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From: Raymond P. Owings, Ph.D.
Associate Administrator for
Research and Development

Reply to Attn. Of: NRD-01

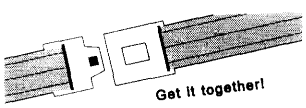
To: The Docket

THRU: John Womack
Acting Chief Counsel

Attached is the Final Report of the NHTSA Research and Development Event Data Recorder (EDR) Working Group. This report was circulated within NHTSA and has received concurrence for publication.

Research and Development requests that this report be placed in the public docket.

Attachment



EVENT DATA RECORDERS

SUMMARY OF FINDINGS
by the
NHTSA EDR Working Group

August 2001

Final Report

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Table of Contents

List of Figures

ID	Identification
IIHS	Insurance Institute for Highway Safety
ISO	International Organization for Standardization
ISO	Insurance Services Office, Inc.
ITS	Intelligent Transportation System
IWI	Independent Witness Incorporated
JPL	Jet Propulsion Laboratory
JPO	Joint Program Office
LMS	Loss Management Services, Inc.
MAC	Mobile Accident Camera
MDB	Movable Deformable Barrier
ms	millisecond
MVSRAC	Motor Vehicle Safety Research Advisory Committee
MY	Model Year
NAS	National Academies of Science
NASA	National Aeronautics and Space Administration
NASS	National Automotive Sampling System
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NICB	National Insurance Crime Bureau
NPRM	Notice of Proposed Rulemaking
NCC	Office of the Chief Counsel, NHTSA
NPS	Office of Safety Performance Standards, NHTSA
NRD	Office of Research and Development, NHTSA
NTS	Office of Traffic Safety, NHTSA
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer
PD	Property Damage
PDOF	Principal Direction of Force
PSAP	Public Safety Answering Point - [the 911-call recipient]
R&D	Research and Development
RAM	Random Access Memory
ROM	Read Only Memory
RP	Recommended Practice
RPM	Revolutions Per Minute
RSA	Rail Safety Advisory Committee
SAE	Society of Automotive Engineers
SAMOVAR	Safety Assessment Monitoring On Vehicle with Automatic Recording
SCI	Special Crash Investigation
SDM	Sensing & Diagnostic Module
SIS	Safety Intelligence Systems
SUV	Sport Utility Vehicle
the "Act"	Privacy Act of 1974, 5 U.S.C. §552a ()
TMC	Technical and Maintenance Council
TRB	Transportation Research Board
TRC	Transportation Research Center

UDS	Umfall Data Schreiber (Event Data Recorder)
VCR	Video Cassette Recorder
VIN	Vehicle Identification Number
VRTC	NHTSA's Vehicle Research and Test Center, NHTSA
WG	Working Group
WOT	Wide Open Throttle

Executive Summary

This report documents the findings of the Event Data Recorder (EDR) working group established by the National Highway Traffic Safety Administration's (NHTSA) Motor Vehicle Safety Research Advisory Committee. The guidelines for Committee activity require that the working group members limit their efforts to fact-finding and not make any recommendations.

Event Data Recorders have the ability to profoundly impact highway safety. While simple or complex in design and scope, EDRs collect vehicle and occupant based crash information. EDRs can assist in real-world data collection, better define safety problems, and aid law enforcement's understanding of crash specifics, ultimately improving safety.

In 1997, the National Transportation Safety Board issued recommendations to pursue vehicle crash information gathering using Event Data Recorders. The National Aeronautics and Space Administration, in the same year, recommended the study of "...the feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles." In early 1998, NHTSA's Office of Research and Development launched a new effort to form a working group comprised of industry, academia, and other government organizations. The members of the working group participated in the forum to study the state-of-the-art of EDRs. Meetings were held on a regular basis, culminating in this EDR findings report.

The working group developed and adopted the following objective for the group: *To facilitate the collection & utilization of collision avoidance and crashworthiness data from on-board Event Data Recorders.* To develop the objective and gather information, the working group targeted the following eight concentration areas: Status of EDR Technology; Data Elements; Data Retrieval; Data Collection and Storage; Permanent Record; Privacy and Legal Issues; Customers and Uses of EDR Data; and EDR Technology Demonstrations.

The report presents an overview of EDR history, which includes a short description of several European and U.S. studies of EDRs. The U.S. on-board EDR experience is explored for other modes of transportation, where the use of on-board recorders began in aviation and has now spread to other modes; marine and rail. The report also provides some details on a recently completed study in New York where EDRs were expanded to include automatic collision notification system and a current study under way in Georgia where EDRs and other instrumentation are being installed in motor vehicles to research driver habits.

The working group explored various types of EDRs, all of which could be classified as either original equipment manufacturer (OEM) designs or aftermarket systems. OEM systems were varied in their capabilities, with General Motors' vehicles having the most sophisticated systems, including precrash and crash data collection, On Star, and a publicly available tool to download the recorded data from these devices. Aftermarket systems also vary quite widely, most likely being driven by the market to meet a specific need, for example, commercial fleet management and driver training. Some systems collect only acceleration/deceleration data, while others collect these data plus a whole host of complementary data, such as driver inputs and vehicle systems status. Other systems have integrated global positioning systems (GPS), video, and audio data collection systems into the EDRs.

The working group looked into data collection and storage. It found no universal collection and storage system. Some aftermarket companies are offering proprietary data storage facilities for their customers. NHTSA recently started collecting EDR data in its National Automotive Sampling System-Crashworthiness Data System, Special Crash Investigation, and Crash Injury Research and Engineering Network data systems. As of the beginning of 2001, NHTSA had collected EDR data from about 100 real-world crashes.

The working group identified privacy and legal issues as a potential major issue related to EDRs. Generally, there is concern about crash-related data being collected from privately owned motor vehicles that could be used against the owner. Most of the working group members held the opinion that the data (collected and stored in an EDR) belonged to the owner of the vehicle. But with ownership often changing hands after a serious crash, due to the vehicle being totaled because of collision damage, the driver may lose control of the data to the insurance company, salvage yard, or the next owner if the vehicle is repaired and sold. Federal statutes only apply to NHTSA data collection activities, and as such, NHTSA cannot divulge any of its own crash information related to personal identifiers.

The working group reviewed several company demonstrations of EDRs in use today, both for assisting NHTSA in crash and vehicle defect investigations, and for assisting insurance company investigations.

There is a wide range of users of these data already in place, and the working group felt that use of EDRs would expand rapidly. The NHTSA rules under which the working group was convened limited activities to fact finding. The findings were divided into several categories, including safety, data collection, and other observations. The following selected findings present the highlights of the report:

1. EDRs have the potential to greatly improve highway safety, for example, by improving occupant protection systems and improving the accuracy of crash reconstructions.

2. EDR technology has potential safety applications for all classes of motor vehicles.

3. A wide range of crash related and other data elements have been identified which might usefully be captured by future EDR systems.

4. NHTSA has incorporated EDR data collection in its motor vehicle research databases.

5. Open access to EDR data (minus personal identifiers) will benefit researchers, crash investigators, and manufacturers in improving safety on the highways.

6. Studies of EDRs in Europe and the U.S. have shown that driver and employee awareness of an onboard EDR reduces the number and severity of drivers' crashes.

7. Given the differing nature of cars, vans, SUVs, and other lightweight vehicles, compared to heavy trucks, school buses, and motorcoaches, different EDR systems may be required to meet the needs of each vehicle class.

8. The degree of benefit from EDRs is directly related to the number of vehicles operating with an EDR and the current infrastructure's ability to use and assimilate these data.

9. Automatic crash notification (ACN) systems integrate the on-board crash sensing and EDR technology with other electronic systems, such as global positioning systems and cellular telephones, to provide early notification of the occurrence, nature, and location of a serious collision.

10. Most systems utilize proprietary technology and require the manufacturer to download and analyze the data.

1.0 Introduction

Event Data Recorders (EDRs) record information related to a vehicle crash, and for the purposes of this working group report, do not include data loggers. EDRs can be simple or complex in design, scope, and reach, and have the ability to have a profound impact on highway safety, ranging from collecting data to formulating the basis for improved automobile safety to aiding law enforcement in understanding the specifics aspects of a crash. These devices collect basic crash related information, mainly vehicle and occupant based, that can provide benefits to crash research and improvements to the transportation system.

In 1997, the National Transportation Safety Board (NTSB) issued recommendations to the National Highway Traffic Safety Administration (NHTSA), indicating that NHTSA should pursue crash information gathering using Event Data Recorders. Further, in 1997, the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) recommended that NHTSA "study the feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles." During this time, NHTSA's Research and Development (R&D) office was evaluating the use of EDRs for vehicle crash research, including gathering data to support rulemaking efforts and support its Special Crash Investigation (SCI) program. R&D held exploratory meetings to determine the use of EDRs in the automotive industry and with other government and non-government bodies to determine the needs for these data outside NHTSA.

Early in 1998, NHTSA held several internal planning meetings and it was decided to propose creating a working group (WG) within NHTSA R&D's Motor Vehicle Safety Research Advisory Committee (MVSRAC). At the April 1998, MVSRAC meeting, NHTSA proposed creation of the WG. The MVSRAC agreed, and NHTSA R&D started this WG shortly after the meeting, sending letters to the MVSRAC full committee as well as the crashworthiness subcommittee members requesting nominations of individuals to serve on the WG. Based on these nominations, and with the addition of several members selected by NHTSA R&D, the WG was formed. The initial membership held its first meeting in October 1998, and continued to meet about three times per year through the end of 2000. During the conduct of the meetings, several new members were added to replace members who left the WG. Also, several other people informally joined the WG. The data collected and presented in this report is based on a team effort of all the WG members, both formal and informal.

1.1 Objectives of Working Group

The WG struggled with a final overall objective statement. The following objective statement was proposed: **To facilitate the collection & utilization of collision avoidance and crashworthiness data from on-board Event Data Recorders**. The WG developed a set of objectives, which were considered the core objectives of this fact-finding effort, as follows:

1. **Status of EDR Technology** - Description of current EDR technology, including OEM and Aftermarket systems.
2. **Data Elements** - Discussion of data elements listed as desirable by a diverse user set.
3. **Data Retrieval** - Discussion of how data is retrieved from the vehicle or EDR system.
4. **Data Collection and Storage** - Discussion of how data is collected by the users and stored for use by others.
5. **Permanent Record** - Discusses who is responsible for maintaining the permanent record of EDR data.
6. **Privacy and Legal Issues** - Discussions of privacy issues as seen by the various users.

7. **Customers and Uses of EDR Data** - Discusses who the customers are, and what their uses might be as they relate to crash data.
8. **Demonstration of EDR Technology** - Demonstration of current EDR data usages.

A discussion of each of these objectives will form the main body of this report - Sections 3 through 10. Breakout sessions were held during the working group meetings to discuss each of these topics. The notes from the breakout sessions can be found in the public docket for this project (NHTSA-99-5218). The format of each discussion section starts with an overview. The overview is based in part on the breakout session, as well as other inputs to the working group. Some topics were covered in more detail than others, but because these eight topics comprised the original focus of the working group, each is covered in its own section.

During the course of the WG activities, the subject of Automatic Collision Notification (ACN) arose often. While some discussion of ACN was appropriate for the WG, the concept of ACN is notification. Further, development of ACN systems, which may make use of the data stored in an EDR, may be useful to states in making decisions related to deployment of EMS services. While this working group did not specifically focus on ACN, it recognizes the interaction between ACN and EDR systems, especially at the users level, such as police, EMS, states, etc.

1.2 Participants

Members of the MVSRAC and its subcommittee on Crashworthiness nominated the participants for the WG. NHTSA R&D added a few members to those who were nominated to obtain a working group which had representations from many areas, including industry, universities, State and Federal governments, and private citizens. The following lists present the names and affiliations of the participants of the EDR working group subdivided into several major categories based on their interest.

Vehicle Manufacturers, EDR Manufacturers, and Transportation Providers

Company	Name
American Transportation	Bob Douglas
Association of Import Automobile Manufacturers	Mike Cammisa
DaimlerChrysler	Kathleen Gravino
Drive Cam	Sophia Rayner
Ford Motor Co.	David Bauch
Ford Motor Co. (retired)	Joe Marsh
General Motors	Jack Haviland
General Motors	Tom Mercer
Honda	Alex Damman
Honda	Ralph Hitchcock
Independent Witness Incorporated	Luther G. Perkins
Independent Witness Incorporated	Scott McClellan
National Association State Directors of Pupil Transportation Services	Charlie Gauthier
Navistar	Brian Shaklik
Safety Intelligence Systems Corporation	Andy Mackevicus
Safety Intelligence Systems Corporation	John Mackey
Toyota	Chris Tinto
United Motorcoach	Norm Littler
Vetronix	Don Gilman
VDO	Dan May

VDO	Tony Reynolds
Volkswagen	Robert Cameron

Universities, Researchers, and Other Interested Parties

Company	Name
Association for the Advancement of Automotive Medicine	Jeya Padmanaban
Click, Inc.	Thomas Kowalick
Florida Atlantic University	Mary Russell
Florida Atlantic University	Susan Walker
Forensic Accident Investigations	Robert McElroy
Georgia Tech	Jennifer Ogle
Insurance Institute for Highway Safety	Raul Arbelaez
National Academy of Science, Transportation Research Board	Chuck Niessner
State Farm Insurance Co.	Regina Dillard
University of Virginia	Greg Shaw
Worcester	John Carney
Worcester	Malcolm Ray

Government - Federal, State & Local

Company	Name
Federal Highway Administration	Bob Ferlis
Federal Highway Administration	Martin Hargrave
Federal Highway Administration	Carl Hayden
Garthe Associates (Massachusetts)	Liz Garthe
NHTSA, Office of Chief Council	Sharon Vaughn
NHTSA, Office of Safety Performance Standards	Ed Jettner
NHTSA, Office of Safety Performance Standards	Gerald Stewart
NHTSA, Office of Research and Development	John Hinch
NHTSA, Office of Research and Development	Lou Lombardo
NHTSA, Office of Research and Development	Lori Summers
NHTSA, Office of Traffic Safety Programs	Doug Gurin
NHTSA, Office of Traffic Safety Programs	Paul Tremont
National Transportation Safety Board	Sarah McComb
National Transportation Safety Board	Vernon Roberts
Transport Canada	Alan German

1.3 Fact Finding Effort

The purpose of a NHTSA-sponsored working group is to gather factual information, and not to develop consensus recommendations for NHTSA or any other Federal agency. As such, there is no "Recommendations" section to this report. Rather, the findings of this fact-gathering effort will be summarized in a section titled "Findings."

The working group used a two-pronged approach to determine the current state-of-the-art facts related to EDRs. This included: Industry briefings by EDR companies (OEM and aftermarket), users, and customers; and breakout session discussions on the main objectives of the working group. The facts presented in this report are based on data collected through these two methods.

1.4 Public Documentation Process

All materials provided to the working group were placed in the Department of Transportation's Document Management System (DMS). This included final meeting minutes and attachments to the minutes. Final minutes are those which are approved by the working group. The docketed information for the EDR working group can be found in docket NHTSA-99-5218. These dockets are viewable and printable from the DMS, which can be located using an Internet browser at http://dms.dot.gov Search for docket 5218.

1.5 Meetings

The EDR working group held seven meetings at NHTSA's headquarters in Washington, D.C. A summary of each meeting is presented below:

1.5.1 October 2, 1998

The first meeting of the EDR WG was held in 1998. The first meeting had several objectives: 1) understand the status of EDR technology; 2) understand the needs for crash data; 3) review the privacy issues; and 4) develop the working group. During this meeting members of the WG provided their inputs regarding EDRs. NHTSA R&D presented operating rules for a MVSRAC working group, which included the public documentation process, a background presentation of EDRs, and a short discussion on privacy. A detailed data element list was circulated for the members to consider.

1.5.2 February 17, 1999

Meeting number two was held in early 1999. The second meeting objectives were: 1) refine working group objectives; 2) review WG members' input for data elements; 3) review of WG's privacy issue white papers; 4) other discussions regarding systems and data. A set of objectives was developed by the WG. Manufacturers, the government, and others presented short "white papers" regarding their individual company's privacy policies. The WG also continued its effort to quantify data elements, including selecting a set of "Top-Ten" data elements which should be considered when developing a new EDR. Presentations included: EDR Validation, NHTSA Research in Vehicle Crash Speed and Loss Management System's Eye Witness EDR.

1.5.3 June 9, 1999

Meeting number three was held in mid 1999. The third meeting objectives were: 1) review of the working group objectives; 2) review WG members' input for data elements; and 3) review of WG's privacy issue white papers. During this meeting, the WG continued to refine its position on data elements and privacy issues. Presentations included: Information regarding an upcoming NTSB symposium on data recorders, Automatic Collision Notification, recent activities in ISO related to EDRs, and current and recent activities at Ford regarding EDRs.

1.5.4 October 6, 1999

Meeting number four was the third meeting of 1999. The fourth meeting objectives were: 1) discuss insurance company issues; 2) continue to learn about EDR systems; and 3) hold two breakout sessions – Data Elements, and Privacy and Legal Issues. The session on data elements reworked the WG's top ten data elements list from individual elements to categories of data elements. The privacy and legal issues session discussed WG members concerns and company and government practices related to EDRs. Presentations included: the I-Witness EDR system, VDO North America, potential for EDR or EDR/ACN use in Massachusetts based on a study of fatal level crashes.

1.5.5 February 2, 2000

Meeting number five was held in early 2000. Meeting objectives included: 1) Review OEM EDR systems and 2) breakout sessions – Status of EDR Technology, and Who Are the Customers. At this meeting, NHTSA announced that the MVSRAC had been terminated because the charter under which it operated had expired and that all activities within MVSRAC would need to be halted. Because the nature of the WG was that of fact finding, NHTSA R&D agreed to continue the WG efforts under a R&D-sponsored WG. Both breakout sessions discussed the two objectives and their outcomes were shared with the WG. Presentations included: OEM discussions of EDR technologies and a NHTSA demonstration of the Vetronix crash data retrieval tool.

1.5.6 June 7, 2000

Meeting number six was held in mid 2000. The meeting included four breakout sessions – How Should the Data be Collected and Stored?, How Should the Data be Retrieved?, Who Should be Responsible for Keeping the Permanent Record?, and Demonstration of EDR Technology. Breakout sessions considered how different uses affect collection and storage, and evidence and traceability issues, as well as the benefits related to collection and storage. Issues related to data retrieval from a vehicle EDR, including current systems, near future systems, and future needs, were discussed. Who was currently storing EDR data, and possibilities for storing data in the future were reviewed as well as discussions regarding electronic collection of EDR data and the need for central repositories. The final breakout session generated a list of possible EDR demonstration sources. Presentations included: Crash Data Collection using EDR Technology at Georgia Tech, Ford and NHTSA SCI on an Advanced Restraint Program using EDRs, and an updated discussion on Manufacturer Data Elements.

1.5.7 December 6, 2000

Meeting number seven discussed the draft final report. The draft report was circulated to the members prior to the meeting. Editorial and content changes were made or recommended.

2.0 Background

2.1 National Highway Traffic Safety Administration Activities

2.1.1 Early Event Data Recorders

EDRs have been used for many years to record crash related metrics, including the crash deceleration of the vehicle. Early efforts conducted by NHTSA included a device, circa 1970s, which used analog signal processing and recording devices to analyze and store the crash data. This recorder was known as the Disc Recorder, and was installed in about 1,000 vehicles in several fleets. During 1973 and early 1974, the fleets equipped with these recorders accumulated about 26 million miles. During that time, 23 crashes were analyzed, which included delta-Vs up to about 20 mph. Actual deceleration-time histories were collected.[1] These devices were expensive to manufacture, and because installation of these recorders in a vehicle was a prerequisite to collection of crash data, data were limited to a few crashes.

2.1.2 Jet Propulsion Laboratory Report

In 1997, NHTSA, under a joint agreement with the National Aeronautics and Space Administration (NASA) contracted with the Jet Propulsion Laboratory (JPL), to

> "evaluate air bag performance, establish the technological potential for improved air bag systems, and identify key expertise and technology within NASA that can potentially contribute significantly to the improved effectiveness of air bags."

In the final report on this project[2], JPL recommended that NHTSA investigate EDRs, stating in recommendation number (6):

> "Study the feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles. Crash recorders exist already on some vehicles with electronic air bag sensors, but the data recorded are determined by the OEMs. These recorders could be the basis for an evolving data-recording capability that could be expanded to serve other purposes, such as in emergency rescues, where their information could be combined with occupant smart keys to provide critical crash and personal data to paramedics. The questions of data ownership and data protection would have to be resolved, however. Where data ownership concerns arise, consultation with experts in the aviation community regarding the use of aircraft flight recorder data is recommended."

2.1.3 Petitions for Rulemaking

NHTSA's Office of Safety Performance Standards (NPS) has received (in 1998 and 1999) two petitions for rulemaking which request the government to require EDR technology on all new passenger vehicles.[3] One petitioner based his petition on a crash, where family members were fatally injured. The petitioner believed that EDR technology could have provided evidence that would have been valuable in determining the crash scenario. The agency agreed with both petitioners stating "...recording of crash data can provide information that is very valuable in understanding crashes, and which can be used in a variety of ways to improve motor vehicle

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1 Teel, Peirce, and Lutkefelder; *Automotive Recorder Research - A Summary of Accident Data and Test Results*; NHTSA; 1974

2 Phen, Dowdy, Ebbeler, Kim, Moore, and VanZandt; *Advanced Air Bag Technology Assessment*; JPL Publication 98-3; April 1998. The report can be found on the JPL web site - http://csmt.jpl.nasa.gov/airbag/contents.html

3 See **Federal Register** 63 FR 60270 (Nov. 9, 1998) and 64 FR 29616 (June 2, 1999).

safety." The agency denied the petitions "...because the motor vehicle industry is already voluntarily moving in the direction recommended by the petitioner." Further, the agency believed ".... this area presents some issues that are, at least for the present time, best addressed in a non-regulatory context."

2.1.4 Automatic Collision Notification Systems

Automated Collision Notification[4] (ACN) is technology that will provide faster and smarter emergency medical services (EMS) response in an attempt to save lives and reduce disabilities from injuries. However, ACN in itself is not related to EDRs. This ACN project combined notification equipment with recording technology, and hence, is included in this report.

This ACN system consisted of an in-vehicle system that determined that a crash had occurred, initiated a request for assistance, determined the location of the vehicle, and utilized a wireless communications system to send the crash notification to the appropriate Public Safety Answering Point (PSAP) for emergency response dispatch.

The in-vehicle system determined location using a Global Positioning System (GPS) receiver, sensed a crash with accelerometers dedicated to the ACN function, and communicated with the PSAP via a cellular phone. Additionally, the in-vehicle system applied the output of its accelerometers to an algorithm that computed a measure of the severity of a possible crash based on the vehicle acceleration history. The ACN notification threshold varied depending on the change in velocity of the vehicle and principal direction of force for the crash. The ACN device stored these data.

The ACN system underwent a Field Operational test (FOT), where the devices were installed in about 700 vehicles. The ACN in-vehicle system worked as expected, including the data storage system. It was able to sense that a crash had occurred, determine the vehicle's position, and deliver a crash notification message to the FOT 9-1-1 dispatch center via a cellular telephone call that was then switched to a voice line.

A major institutional issue, relative to EDR's, noted during the ACN FOT that could impact the development and deployment of ACN systems, was access to ACN data. This issue was raised during the planning phase of the FOT and was based on the fact that the ACN system for the FOT collected data that could provide information concerning collisions and the operation of the vehicle (e.g., position, velocity, heading, and acceleration). There was a concern that the data collected during the FOT would be subpoenaed during litigation involving ACN-equipped vehicles in an attempt to establish fault in a crash.

While this issue did not arise during the FOT, it remains a potential concern for future ACN deployments. Because of this concern, Veridian Engineering developed a Disclosure and Warning Statement and Waiver using proper legal terminology to be signed by owners of ACN-equipped vehicles and a witness. The disclosure and warning statement granted Veridian Engineering the right to use any and all data gathered from the FOT, with the exception of revealing the participant's identity or personal information to persons other than the participants in the program.

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4 For additional reference to this topic, go to NHTSA Web site at:
http://www-nrd.nhtsa.dot.gov/include/summaries/its_13.htm
or the Calspan Web page at http://www.calspan.com/mayday.html

Other approaches to mitigating liability for ACN systems noted during the project included the development of accepted operating standards, dispatcher and notification center certification standards, and accepted procedures and protocols for interfacing and coordinating between private and public emergency response systems. It was also recommended that as requests for ACN data are to be expected, the architecture of future ACN systems should either support the provision of this information, or the ACN systems should not collect or save data that could be used against drivers. In the former case, it was suggested that the recruitment/sales literature should state the information that is available and the policies and procedures for the provision of this information.

2.1.5 R&D on Quantitative Properties of the Relationship between Speeding, Aggressive Driving, and Crash Risk

NHTSA is interested in determining the extent to which drivers who engage in speeding and aggressive driving are over-involved in crashes, and in determining the specific characteristics of these behaviors that lead to crashes. An understanding of the relationship between driving speeds and crashes across a broad range of conditions is needed to allow for the development of countermeasure programs that can be efficiently directed at controlling speeds in those situations where the risks of crashing are greatest. Data are also needed to aid in making informed judgments on speed limits as more states and localities raise their limits.

In a research project being conducted for NHTSA by the Georgia Institute of Technology, data on operating speed and location will be continuously recorded, from 1,100 vehicles, during each trip taken over a two-year period. This study will utilize the Safety Intelligence Systems' (SIS) MACBOX. Crash and other extreme accelerations will also be recorded using tri-axial accelerometers. The data will be used in conjunction with a geographic database to identify the locations, roadway types and class, and posted speed limits where the recorded speeds and extreme accelerations occur. Methods for classifying drivers according to the extent and nature of their speeding and acceleration profiles will be developed and related to crash involvements and driver history.

2.1.5.1 Participants

Participants for this study will be recruited through a cooperative agreement with the Atlanta SMARTRAQ Household Travel Survey. SMARTRAQ, short for Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality, is a comprehensive travel survey of 8,000 households in the Atlanta area sponsored by several organizations including the Georgia Department of Transportation, Atlanta Regional Commission, Federal Highway Administration, Center for Disease Control, and the Turner Foundation. SMARTRAC uses random samples based on income, household size, and residential density. A subsample of 1,100 respondents will be asked to participate in the NHTSA study. Participants will be stratified by age, and up to two vehicles per household will be instrumented.

Several geographically distributed installation facilities will be chosen across the study area to provide convenience for the participants. Installations are expected to be completed in two hours, but to reduce logistical concerns, the vehicles will be kept for one day. Rental cars will be provided at no cost to participants on the installation day.

2.1.5.2 Equipment Package

The 1,100 vehicles will be equipped with an instrumentation package designed to detect and report crashes as well as provide comprehensive and continuous on-road driver and vehicle operating characteristics. The instrumentation package (MACBOX) is being developed by

Safety Intelligence Systems Corporation, formerly Loss Management Services, Inc. in conjunction with Georgia Institute of Technology. This device contains a global positioning system (GPS) receiver with differential corrections (DGPS), a tri-axial accelerometer, a digital cellular transceiver, and a central processing unit (CPU). The GPS receiver provides vehicle position and speed data at 1 Hz; the differential corrections receiver will provide 1-3 meter accuracy levels in GPS position readings; the accelerometer is used to detect crashes and aggressive accelerations/decelerations; the cellular transceiver (transmitting at 9,600 bps) transfers position, speed, aggressive accelerations and crash data to Georgia Tech and also to a Public Safety Answering Point in the event of a crash. The CPU contains the control logic and storage required to manage the data processing, logging, and transfer requirements for this project.

The system components will be kept as small as possible with a minimal amount of external wiring to facilitate installation. The equipment itself will typically be installed under the rear seat (or under the driver's seat in the case of a van or sport utility vehicle), with cabling running under the carpet or behind plastic moldings. External connections are limited to power access, integrated GPS and cellular antenna, DGPS antenna coupler, speaker/microphone button, and an ignition sensor.

2.1.5.3 System Functionality

Data will be transmitted from the participating vehicles for two distinct purposes: first, for the transmission of operating characteristics on a periodic basis, and second for emergency notification calls in the event of a crash of the equipped vehicle.

The periodic transmission of operating characteristics data (speed and location at 1 Hz) from the vehicle will contain information regarding driver behavior in the form of selected trip routes and speeds collected by the GPS component. This data transmission will be triggered by the unit in the vehicle whenever the quantity of data stored in the system's on-board memory reaches a specified level or after a specified time period, whichever occurs first. This level will be finalized during the course of the initial unit testing to provide confidence that data will not be lost due to memory limitations. The data will be transmitted to a central server at the Georgia Institute of Technology where it will be processed, analyzed, and archived.

An emergency notification transmission will occur upon crash detection. The system will transmit a detection message to a computer located within the Fulton County Public Safety Answering Point operations center where an appropriate response will follow. Simultaneously, a second message is sent to the Georgia Tech data server and one or more mobile devices, such as pagers or two-way message devices. This message will inform Georgia Tech researchers that a crash has occurred so that a crash investigation team can be immediately dispatched to the crash site. Following the short messages, a detailed message is sent to Georgia Tech containing the sub-second accelerometer information collected several seconds prior to and following the first impact.

Data analyses will include comparison of driving patterns between crash-involved and non crash-involved drivers on several dimensions and will be used to answer questions regarding the role of speeding and aggressive driving in crash involvement.

2.2 Commercial Highway Vehicle Activities Related to Data Recorders

2.2.1 Federal Motor Carrier Safety Administration Activities Related to Data Recorders

The Federal Motor Carrier Safety Administration (FMCSA) was established in January 2000, as a result of the Motor Carrier Safety Improvement Act of 1999 (the Act). Prior to this time the federal motor carrier safety program was carried out within the Federal Highway Administration (FHWA).

The FMCSA is responsible for the safe operation of commercial motor vehicles (CMVs) used in interstate commerce on our nation's highways. The agency carries out this responsibility through development and enforcement of federal safety regulations, supporting the development of new technologies to enhance CMV safety and information, and by increasing awareness of CMV safety through public outreach programs. The FMCSA is dedicated to preventing truck and bus related injuries and fatalities, and has a major goal of reducing these 50 percent by 2010. In 1999, there were 5,362 fatalities and 142,000 persons injured as a result of large truck involved crashes.

Recognizing the important role that new technology can play in improving CMV safety, the FMCSA has been involved in a variety of activities to explore the use and benefits of electronic recorders.

Although not the primary focus of this discussion, the FMCSA first explored the use of electronic recorders relative to CMV driver hours-of-service (HOS). Research has shown that fatigue is a significant safety problem among CMV drivers. Federal regulations govern the maximum number of CMV driver duty hours, and drivers and carriers are required to document and retain HOS records. However, hand-written paper records are subject to falsification. Electronic recorders can provide a less burdensome method for recording HOS, and a more tamper-resistant record for federal and state enforcement officials. Current federal regulations now allow the use of electronic recorders by motor carriers for documenting driver HOS.

In 1997, the FMCSA also began to focus on the use of Event Data Recorders which can record a variety of vehicle parameters and critical events surrounding the time of a crash or near-miss incident. The information gathered through EDRs can better identify the causes of such events, and thereby help to prevent future crashes. In addition, the use of EDRs has shown in some applications to improve driver behavior, when the driver is aware of its presence onboard the vehicle. Through a contract with Sandia National Laboratories, Albuquerque, New Mexico, the FMCSA gathered information on the status of EDR technology, the types of data that would be most useful, minimum EDR technical parameters, and alternative uses such as monitoring driver alertness.

Since October 1998, the FMCSA has participated in the NHTSA Event Data Recorder Working Group. FMCSA is also participating on a task force established in March 2000, by the Technical and Maintenance Council (TMC) of the American Trucking Associations, Inc. Similar to the NHTSA Working Group on Event Data Recorders, the TMC task force participants include a wide cross-section of government and industry officials. However, in addition to gathering information on EDRs, the task force objective is to specifically develop a Recommended Engineering Practice (RP). The RP will apply to onboard vehicle EDRs for gathering data to be used in post-crash analysis. It will stipulate data collection, storage, and retrieval practices to ensure that comparable EDR parameters are generated by all vehicles.

In the FY2000 Senate Appropriations Committee Report, the Committee requested that FMCSA "...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..." The Committee further stated that its expectation is "...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." The FMCSA is currently preparing a report in response to the Committee's request.

2.2.2 American Trucking Associations Activities Under the Technical and Maintenance Council

The TMC of the American Trucking Associations (ATAs) offers the trucking industry an opportunity to address trucking maintenance and equipment issues in a noncompetitive, noncommercial setting. The TMC's task forces write recommended practices (RP) pertaining to specific issues for the trucking maintenance community. The TMC has recently addressed vehicle event data recorders (EDRs) in two of its task forces, with two separate, associated RPs. One RP is up for approval and the second is still in draft.

The first task force in TMC suggested in its RP (TMC RP1212) an interface for retrieval of the event data. RP1212 recommends that an event output page be added to the user interface from the engine ECU. The output page will be password protected so that the information can be controlled by the vehicle owner. RP1212 does not define what information to collect and store, but it offers a standardized location for the output data. A second task force is addressing what data will be stored there.

The goal of the second TMC task force is to define what event data will be made available in the output location of RP1212. It is the view of TMC that the information currently available in engine ECUs is sufficient for the purposes of event recording. Adding sensors would add complexity and therefore increase both initial and maintenance costs. Although some increased costs will be associated with event data recording, keeping costs to a minimum will be an ongoing goal.

Some of the specific efforts in the second task force include defining the terminology, identifying data elements that are recorded or could easily be recorded, and working on the draft recommended practice. Terminology under discussion includes items like acceleration, brake status, gear selection, speed, engine speed, steering position. Not all of these data elements are readily available from all vehicles. Some of the difficulties that the task force encountered were in agreeing on definitions for some terminology, agreeing on the importance of certain data elements, and wording the RP so that all were satisfied. These difficulties are to be expected since different manufacturers are sensing and transmitting the same data element by different means. Discussion continues as the task force seeks agreement on many of these EDR issues.

TMC has started defining terms related to EDRs. To date, the following definitions have been proposed by their current task force:

- An EVENT is anything of interest that may occur during the operation of the vehicle.
- An INCIDENT is any event in which the safety of the vehicle or any person is threatened.
- A TRIGGER is either any data parameter that exceeds a predefined threshold or external input. A trigger initiates the capture of data.
- CAPTURE is the process of saving recorded data.

2.3 National Transportation Safety Board Activities

2.3.1 National Transportation Safety Board Recommendations Related to EDRs

In 1997, the NTSB issued recommendations to NHTSA, based partly on a public hearing held on March 17-20, 1997, Public Forum on Air Bags and Child Passenger Safety, indicating that NHTSA should pursue crash information gathering using EDRs. The NTSB safety recommendation H-97-18, NTSB stated:

> "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."

In NHTSA's response to the safety board, it indicated that it was currently obtaining data from EDRs through the cooperation of the manufacturer, for use in crash investigations. This cooperation is needed since the technology to "download" data from these devices is only available to the manufacturer.

NTSB has continued to support EDRs by holding two important recent symposia, International Symposium on Transportation Recorders and Transportation Safety and the Law.[5]

2.3.2 On-Board Recorders in Other Modes of Transportation

2.3.2.1 Aviation

Aviation has long been the proving ground for on-board recording devices. Crash-protected flight data recorders have been around since the early 1950s, while cockpit voice recorders were introduced in the late 1960s. Significant improvements in safety have been realized in aviation as a direct result of flight data and cockpit voice recorders. For example, in the case of an ATR-72 that crashed in 1994 in Roselawn, Indiana, the 98-parameter data recorder provided sufficient information to prompt recommendations only eight days after the collision regarding operations of that aircraft in icing conditions.

With advances in technology, current recorders have transitioned from the earlier foil-based analog recorders and then tape-based digital recorders to solid-state technology, ultimately providing more information and greater survivability. New flight data recorders now have the capability of recording hundreds of parameters for at least 25 hours, while two hours of audio can now be recorded on cockpit voice recorders. Further, the government and industry, through international working groups, are now looking toward the implementation of cockpit image recorders as a method of documenting the cockpit environment prior to a collision including electronic displays, crew selections, and crew nonverbal communications.

Many in the airline industry are now taking advantage of recorded data by using it as an operational tool. Flight Operations Quality Assurance (FOQA) programs are in place at major carriers such as British Airways and United Airlines for the purpose of monitoring day-to-day operations and implementing necessary maintenance or changes in training to prevent crashes and incidents before they ever occur.

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5 Detailed information for these symposia are available at the NTSB web site at the following locations: http://www.ntsb.gov/events/2000/symp_legal/default.htm and http://www.ntsb.gov/events/symp_rec/symp_rec.htm

2.3.2.2 Rail

In the rail industry, event recorders were first implemented in the late 1970s for management purposes. Since then, event recorders have also contributed to crash investigations by providing more accurate accounts of the circumstances leading up to crashes, corroborating witness statements, and helping to eliminate much of the guesswork that had previously been involved in investigations. However, current recorders cannot answer questions dealing with train crew actions, they record a minimal number of parameters, and they do not meet any crash and fire survivability requirements. In nearly a dozen major railroad incidents, the locomotive event recorders were seriously damaged, making it virtually impossible to retrieve any meaningful data.

Fortunately, other recorders did survive these crashes and provided some limited information. As a result, government and industry are participating in the Rail Safety Advisory Committee (RSAC) Locomotive Event Recorder Working Group to develop the draft specifications for locomotive event recorder crashworthiness. It is expected that these specifications will be drafted into a notice of proposed rulemaking (NPRM) by the Federal Railroad Administration in the near future.

The addition of a voice recorder is also being considered for use in locomotives. Voice recorders would provide key information about crew communications, train coordination, and the environment in the cab that would otherwise not be available.

Similar to the progression of recorder technology in aviation, the recording of images is already being practiced by members of the rail industry. Some railroads have installed cameras and recorders to record the view of the track in front of their locomotives. This use of video is a promising tool for documenting the outside environment in front of trains, including the status of the track ahead, and the status of equipment and other vehicles at grade crossings.

2.3.2.3 Marine

In the marine industry, the advantages of on-board recorders are just now being fully realized. Current voyage recorders remain very rudimentary and are of limited use in determining the causes of collisions. Similar to other modes, this has resulted in long, expensive investigations, such as that of the *Estonia* that sank in the Baltic Sea in 1994, taking 800 people with it. Millions of dollars and a significant amount of work were spent trying to re-create the circumstances of this collision.

Fortunately, noticeable progress is now being made to improve voyage recorders so that they will become a more valuable tool. An international standard for improved voyage data requirements was approved and became effective in March 2000. Further, in 2000, the International Maritime Organization decided to require voyage data recorders on board all ships over 3,000 gross tons and built on or after July 1, 2002. Passenger ships manufactured before that date must be retrofitted with voyage data recorders by January 2004.

2.4 Event Data Recorder Issues - One State's Perspective

One member of the WG represented the State of Massachusetts. While the views provided in this section are based on current trends in data collection and analysis in Massachusetts, they may have application to many states. Emergency response to motor vehicle crashes is a service usually rendered at the local rather than federal level. Police, fire, and EMS responses to motor vehicle crashes are not coordinated at the state or federal levels. Some states will have a special need for real time access and use of crash severity and other crash-related data – data which could have been transmitted by an ACN or stored in an EDR. Localities and states have a historic new opportunity to use crash data in real-time to enhance EMS response to serious crashes.[6] However, medical uses of crash data for activation of EMS services and triage are new and this dynamic use requires immediate post-crash access to the data. Many of the traditional applications of crash variables for crash investigations and engineering refinements are uses where the time frame in which the data are collected is not critical to the user (within the bounds of a few days or weeks).

If the public perceives that these new and unique data are being used to help them survive a crash, there may be a higher level of support than if it perceives the data are being used against them. However, if the public perceives that crash data are being used primarily by law enforcement to prosecute individuals, such as, police officers responding to the scene of a crash, then this situation could seriously jeopardize the use of the crash data for medical purposes.

There is a strong argument to be made by the state governments that <u>real time</u> use of crash data should be protected for the purpose of saving lives or reducing injury extent. This would prevent a situation where conflicting users of the data are at a crash scene. Everyone responding to a crash would have a common goal: using the data to lessen crash related injury and death. After the fact, law enforcement use of the data would still be possible, but it would be after the medical emergencies had been taken care of and would be subject to the normal search and discovery procedures (warrants, etc.). Routine state data access and disclosure issues would need to be resolved.

States need data collected and studied to help support decision-making about the optimal uses of ACNs and EDRs. States have a different perspective about the use of crash data than the federal government. The federal government traditionally collects data on crashes for research, and, while States could make use of these data in a similar manner, they can go beyond that use into the realm of supporting real-time EMS decision-making processes. This makes sense because 911 and EMS services are provided at the states.

State courts also have a stake in crash data access to minimize litigation and expedite cases that go to trial. State DOTs might use these data to determine smarter responses for rescue and clean-up crews.

There is a need for new real-time EMS protocols for responding to motor vehicle crashes where crash data are available. Current EMS protocols do not contain instructions for how to appropriately dispatch EMS services based on the severity of a crash as defined by ACN and/or EDR data. The opportunity exists for states to reduce response time and optimize the level of service that is provided - from the moment the crash severity data are reported.

Provisions need to be made to add ACN and/or EDR data into appropriate state data bases. Protection of private data must be maintained in a similar manner as currently done with other

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6 ACN systems transmit crash-related data from a vehicle to a receiving agency, such as an emergency medical service or a service provider. While the ACN data may be produced exclusively by the ACN system and not stored in the vehicle, the ACN system may acquire some of the data it transmits from an EDR. ACN and EDR data may be used by States in making EMS-related decisions. While this working group did not specifically focus on ACN, it recognizes the interaction between ACN and EDR systems, especially at the users level, such as police, EMS, States etc.

data collected at the crash scene. Depending on the state, 911 data may be private, public or quasi-public. A set of privacy concerns exists with the EMS and Hospital records, and protocols need to be established early as the transition to ACN and/or EDR data collection is made. States may want the Federal government to play a role to develop models for the collection of these data. Due to the very limited collection of EDR and/or ACN crash data thus far, it is not possible to determine the optimal variables to record and/or transmit to save lives or reduce disabilities at this time.

2.5 Other EDR Related Activities

With the introduction of air bags into the motor vehicle fleet, advanced technologies have been incorporated into the vehicle, including crash analyzers to determine if and when the air bag should be deployed. Early air bag controllers used analog devices, such as Rolomite and ball-in-tube crash sensing switches, to make the deploy/no-deploy decision, based on preprogramed sensor characteristics. As these devices evolved, electronic, often single point sensors, replaced the analog units, and a new generation of crash analyzers were introduced. These electronic devices analyze the actual deceleration-time characteristics of the crash to predict if the air bag should be deployed. As these electronic devices continued to evolve, manufacturers installed electronic memory systems capable of storing information on the air bag deployment system. Early systems recorded air bag status, and other diagnostic data. As this capability grew, manufacturers enhanced the system to store more crash characteristics, such as deceleration and delta-V. Further enhancements have included storage of pre-crash data, including vehicle speed, seat belt status, brake status, etc.

There are other recording devices available on the market. These devices are sold in the aftermarket, for owners, companies, and/or fleets to install in their own vehicles. Generally these devices measure, collect, and store crash-related data, such as deceleration, pre crash vehicle dynamics and other important data related to crash reconstruction. Most of these devices analyze the vehicle's deceleration to determine if the vehicle has been in a crash and start the collection process. Depending on the crash severity and design of the system, they can summon help via cell phone technology. Manufacturers also use EDRs to record the status of other items, such as the air bag diagnostic lamp.

2.5.1 European EDR Activity

The following review (the entirety of section 2.7.1), of the recent history of EDRs in Europe, was extracted from a paper supplied by VDO, titled "The Accident Data Recorder, A Contribution to Road Safety."

In spite of slightly decreasing numbers of crashes, there is still a total of 1.3 million traffic crashes with personal injuries in the EU with 45,000 people killed and more than 1.6 million people injured. The social damage caused by traffic crashes in Western Europe amounts to approximately 145 billion ECU per year. In Germany, about 90 percent of the recorded accidents are a result of human failure of the parties involved. Only 10 percent are caused by technical defects or the condition of the roads. These numbers indicate that action is essentially required in the area of driving behavior.

For this purpose, EDRs are being evaluated to determine their effectiveness in crash mitigation and investigation.

- The analysis of crashes is provided with a new qualitative basis. Entry and recording of speed and movements of the vehicle as well as actuation of brakes, direction indicator, light, and horn during a short period of time immediately before, during, and after a crash make it possible to objectively determine the causes of a collision.

- The use of event data recorders in European fleets shows that a considerable preventive effect can be achieved, i.e. a reduction of the number of crashes and costs. Crashes are reduced between 20 and 30 percent as can be illustrated by some examples.

For some years, the event data recorder represents a suitable system that has been called for by experts and the Deutsche Verkehrsgerichtstag (German Traffic Court Conference) under the aspect of road safety and legal certainty. According to the experiences on hand, it is to be expected that the use of this device has a positive effect on the behavior of the driver. Without doubt, the noticeable contribution to road safety connected with the introduction of the tachograph can also be obtained by means of the event data recorder.

2.5.1.1 Preventive Effects of Event Data Recorders
The use of event data recorders in fleets has shown that the number of collisions and the frequency of damage could in some cases be considerably reduced. The following provide some examples:

a. **Berlin Police Department**: The installation of EDRs in all 62 radio patrol cars of a Berlin police precinct in 1996 resulted in a total reduction of crashes through one's own fault of 20 percent. These positive results occasioned the Berlin police to equip all radio patrol cars of its squadron with EDRs, more than 400 vehicles in all 7 police precincts. See Figure 1.

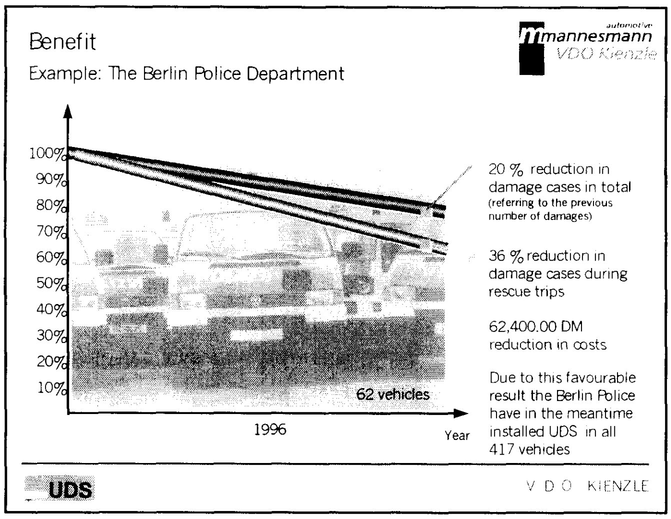

Figure 1. Effect of installing EDRs in 400 radio patrol cars of the Berlin police department, 1966.

b. Viennese Police Department: The Viennese police department equipped a total of 175 vehicles with EDRs. Due to the positive experiences of the Viennese police department, all newly purchased radio patrol cars of the Austrian police were equipped with event data recorders.

c. Samovar: In the SAMOVAR (Safety Assessment Monitoring On Vehicle with Automatic Recording) research program executed in the scope of the European Union Drive II, Project V2007, Great Britain, the Netherlands and Belgium took part with 9 fleets and a total of 341 vehicles that were equipped with different types of vehicle data recording technologies. Together with a control group used in comparable experiments, 850 vehicles participated. The data were recorded for a period of 12 months. The overall synthesis of the results shows that the use of EDRs reduced the crash rate by 28 percent and the costs by 40 percent.

d. WBO Pilot Test: 123 buses equipped with EDR technology took part in this pilot test sponsored by the Ministry of Transport of the German Federal State of Baden-Württemberg. Depending on the company, crashes were reduced by 15 to 20 percent with the buses equipped with EDRs.

e. WKD Security GmbH: All cars (approx. 100) of this company that are used by different personnel for guarding of company premises and buildings etc. are equipped with event data recorders. By virtue of the more conscious and situation-adjusted driving technique of the employees, the number of crashes decreased by 30 percent. Trivial damage was even reduced by 60 percent. In addition, loss adjustment was also simplified thanks to the convincing documentation of damage. Furthermore, due to the existence of objective data, the company climate was considerably improved since disagreements with the drivers were eliminated.

f. Kötter Security: 200 of the 850 vehicles of the Kötter security services are equipped with EDRs. Each of the vehicles covers between 8,000 and 15,000 kilometers every month and is driven in shifts by different employees almost 24 hours a day. The collision damage was reduced and the expenditure for repair decreased.

g. Hatscher Taxi Company: The 15 vehicles of this company cover approximately 150,000 km per year each. Every week, each vehicle is used by frequently changing drivers in an average of 17 shifts. As a result, a reduction of trivial damage was noted after one year only and the collision rate decreased by 66 percent. All in all, the vehicles were treated with more care and the company image was improved. See Figure 2.

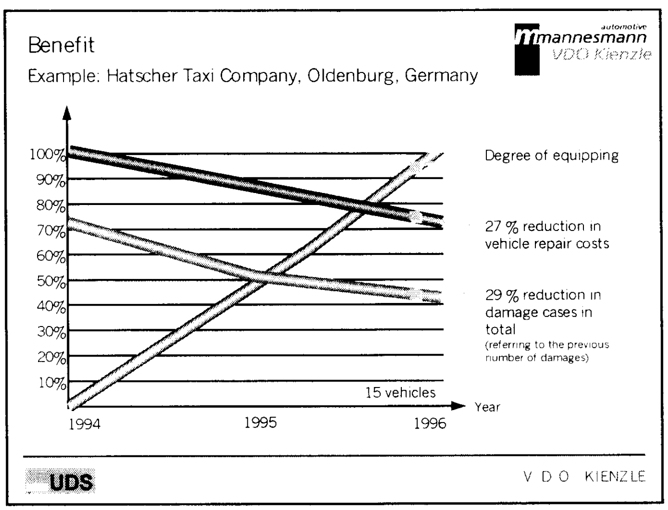

Figure 2. Taxi company experience using EDR technology, 1994-1996.

2.5.1.2 Collision Clarification with Event Data Recorder / Research Findings

The following provide two examples of using EDR data in crash analysis:

a. Bundesanstalt für Straßenwesen Study "UDS as a Source of Information for Accident Research in the Pre-Crash Phase:" The Bundesanstalt für Straßenwesen (bast, German Federal Highway Institute) that has been charged with the study "UDS as a Source of Information for Accident Research in the Pre-Crash Phase" by the German Minister of Transportation, presented the final report in June 1997. The report is based on the collection of data of 42 actual crashes in which vehicles equipped with EDR technology, using an UDS system, were involved. With EDRs, the ratio of collection was increased to 100 percent compared to classical data sources in the pre-crash phase as well as in the other collision phases for individual characteristics that can generally not be completely collected without an EDR. This includes reactions and responsiveness of the driver, speed development over a period of 30 seconds before the collision or the chronological order of series rear-end collisions.

b. EU Study: Samovar: In the research program SAMOVAR (Safety Assessment Monitoring On Vehicle with Automatic Recording) carried out by order of the European Union, data of the 341 involved vehicles were also evaluated as to the achievable quality of the collision analysis in comparison to the options of classical crash reconstruction. The report establishes the result that in comparison to classical ways of crash analyses, event data recorders can be used to provide detailed results with higher accuracy in less time. Event data recorders are thus a suitable means to provide fast and highly accurate, detailed answers to questions of crash analysis.

2.5.1.3 Demands on Road Safety Policy

Event data recorders contribute to road safety under two essential aspects:

- Clarification of crashes is provided with a new quality. Important statements on the cause of the crash and the conclusions drawn on the avoidability of crashes can be made quickly and in a qualified manner. This results in a considerable advantage for crash evaluation also under aspects of civil and criminal law.

- In sufficiently large long-term studies, the preventive effect in fleets has been shown to be from 20 to 30 percent; whereas, these same affects with private users of UDS[7] systems have not been established.

Both aspects directly influence the costs caused to our national economies by crashes, injured and killed people, clarification of these events and subsequent claim settlement.

a. European Union: Within the scope of the work program for the promotion of road safety in the European Union (EU) 1997 - 2001, the EU commission stated under Point 3 "Clarification": "Accident data recorders record important data on the collision and thus considerably facilitate crash analysis. The use of UDS results in less collision because the drivers drive more carefully."

b. Deutscher Verkehrssicherheitsrat (DVR)(German Council for Road Safety): The entire managing board of the German council for road safety, DVR, advocates a request of all vehicle drivers to equip their cars with EDRs of their own accord in the interest of road safety. They also demand that the equipment of vehicles with EDRs in the sense of the law on dangerous goods on the road (Gefahrgutverordnung - Straße (GGVS)) and for busses should be prescribed by law in the EU.

c. Interessengemeinschaft für Verkehrsunfallopfer Dignitas (Traffic Accident Victims Association): In Germany, the Traffic Accident Victims Association Dignitas in line with the respective European federation of road victims demand that the equipment of cars with EDRs should become compulsory. Their objectives are better protection of crash victims by means of just clarification of collisions.

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7 The UDS EDR system is discussed in detail in Section 3 of this report.

d. Deutsche Verkehrswacht (German Road Traffic Safety Organization): The Deutsche Verkehrswacht (DVW) sees its most important task in finding and executing suitable measures to positively influence the behavior of the road users and in this context speaks for the establishment of clear legal rules regulating the exclusive evaluation of EDR data for the clarification of collisions and exclude the use of these data for other purposes.

2.5.2 Event Data Recorders and School Buses in the United States

At the present time, EDRs are not used in school buses. Unlike passenger vehicles that are equipped with air bag systems and crash sensors, which can provide data to be recorded and used to develop a better understanding of the crash severity, school buses currently have no sensing devices that would provide any information about crash conditions or severity. School buses often have electronic engines, transmissions, and anti-lock brakes which employ electronic control systems, which could provide some data for collection. There are some aftermarket EDR systems that could be installed on school buses, but mostly these tend to be in the areas of driver management.

There are ongoing questions within the school bus community as to the potential benefits of developing and installing EDRs on school buses. Given the rarity of serious school bus crashes and the already outstanding safety record of school buses, the school bus community believes that the cost of gathering EDR data may not be offset by the potential benefits. This belief is reinforced by comments made by NHTSA in recent years when the agency considered applying some new Federal Motor Vehicle Safety Standards to school buses. Specifically, NHTSA stated: "NHTSA is increasingly concerned that requiring these vehicles [school buses] to absorb a large additional cost with little benefits would cause more schools to delay purchase of new vehicles or to use non-school buses. This would result in a loss of benefits in other areas that would offset the extremely small benefits of this rule." For this reason, any rulemaking action would need to be carefully reviewed for both its benefits and potential disadvantages.

The school bus community also believes there are technical issues that need to be resolved. These technical issues apply to any large motor vehicle, not just school buses. For example, in a large school bus, it may be necessary to install multiple sensors, since the occupants in the various locations will likely experience different crash severities, particularly in side and multiple-impact crashes. Multiple sensors increase the cost of these devices.

It is important to note that the school bus industry (both manufacturers and users) are committed to explore any means that may further improve school bus transportation. To that end, the school bus industry is an active participant in the study of EDRs, including the technical, privacy, and cost issues associated with placing this type equipment on school buses.

2.5.3 Other Background Information

2.5.3.1 Recent Dissertation Citing a Short History of EDR Initiatives

A recent dissertation provides a review of the worldwide initiatives to implement EDR's. Titled "*Validity and Reliability of Vehicle Collision Data: Crash Pulse Recorders for Impact Severity and Injury Risk Assessments in Real-Life Frontal Impacts,*" it was written by Andres Kullgren as a thesis for a degree of Doctor in Medical Sciences, Department of Clinical Neuroscience, Section for Personal Injury Prevention, Karolinska Institute, Stockholm, Sweden in December of 1999. This dissertation provides a good overview of EDRs.

2.5.3.2 OTA Assessment

The Office of Technology Assessment (Washington, DC) issued a report in February of 1975 titled "*Automobile Collision Data: An Assessment of Needs and Methods of Acquisition.*" The study was requested as an evaluation of the automotive crash recorder program proposed by NHTSA. Although this assessment is dated, a review of the paper reveals that many of the problems and concerns expressed then are still relevant. The assessment addressed the following issues:

- Further data on the characteristics of automobile collisions
- An evaluation of the type of data being produced by existing crash recorders
- The consequences associated with obtaining the data in different ways
- Legal questions associated with the existence of actual physical data from a crash

The following presents some premises from this paper which are specific to crash data analysis today:

- Current national crash databases are inadequate to resolve the uncertainties
- There is a major deficiency in data relating collision forces and actual fatalities and injuries
- A comprehensive crash data program is needed
- The federal Government, not States, manufacturers or insurance companies, should support the central data collection activities
- EDRs provide data that may be admissible in a court of law

2.5.3.3 Using EDRs to Promote Seat Belt Use

Professor Thomas Michael Kowalick authored a paper discussing the possibility of using EDRs to encourage seat belt usage. A copy of this paper "Proactive Use of Highway Recorded Data via an Event Data Recorder (EDR) to Achieve Nationwide Seat Belt Usage in the 90th Percentile by 2002," can be found at the NTSB web site.[8]

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8 http://www.ntsb.gov/events/symp%5Frec/proceedings/authors/kowalick.htm

3.0 Status of EDR Technology

3.1 Overview

The working group found that the current use of EDRs in highway vehicles was generally limited to one OEM (GM) and a few small aftermarket suppliers. During the 2½-year working group process, other manufacturers made EDRs available, but the market penetration is still less than ½ of the new vehicles produced. The WG also found that GM was in the lead in developing EDR technology and by far, comprised the majority of vehicles equipped with EDRs. There were several aftermarket companies in the EDR business, which varied from a European company with many years of experience to new start-up companies.

The WG also found that the type of data collected varied widely from manufacturer to manufacturer. OEM companies have all taken a similar approach, in that, they have incorporated their recording devices into the airbag controller. This has occurred because these systems incorporate sensors and memory devices which are directly applicable to crash data. Aftermarket providers have produced a wide variety of EDR systems, from simple acceleration collection devices, to video collection devices, to devices which are capable of collecting pre-crash, crash, and post crash data using "instrument grade" fidelity.

Downloading EDR data has also been improved over the past few years. Early downloading of data was done solely be the OEM or aftermarket company. Recently, with the public introduction of the Vetronix CDR system, which can download GM EDR systems, these systems can be read by anyone who has been trained. Aftermarket systems have also become simple to operate, with one company offering a system which downloads the stored data via a video link to a TV monitor. Other systems are more complicated, requiring interaction, via an Internet connection, between the user and provider. There is a need for a standardized extraction connector for downloading EDR data, as well as protocols for how to maintain the data in the EDR after the crash. SIS' MACBOX offers an alternative transmission and downloading procedure. With the MACBOX, encrypted crash data are transmitted over a digital wireless network then decoded and downloaded to a secure crash data storage facility.

One clear finding was that there are no standards associated with EDRs. Each company defines how they will collect data and in what format. The WG feels there is a need to clarify EDR technology. Further, the group agrees that a list of data elements needs to be complied for collective use by all EDR developers and manufacturers. Common data element definitions are needed. There was wide concern in the WG over how the car buyers would benefit from this technology. There was also a lot of discussion regarding the privacy of EDR data. This section of the report presents an overview of the OEM and aftermarket systems which were identified during the program.

3.2 Original Equipment Manufacturer (OEM) Systems

3.2.1 Summary of OEM Systems

Several of the OEMs worked together to develop a cross reference which provides tabular information regarding their EDR technology. This table is found on the next few pages. The table references high priority data elements selected by the working group, as well as other data elements that may be recorded in the near future.