A STUDY TO IDENTIFY THE CRITERIA FOR THE USE OF EVENT DATA RECORDERS IN EMERGENCY VEHICLES IN MONTGOMERY COUNTY, MD

EXECUTIVE LEADERSHIP

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ABSTRACT

The problem was adverse loss trends for the vehicle portion of the Montgomery County Fire-Rescue commercial insurance program have been increasing for over 36 months. Efforts are underway by officials in Montgomery County to minimize the frequency of collisions involving fire-rescue vehicles. Yet, there is no reliable means to verify the actions and behaviors of fire-rescue vehicle drivers, or verify the condition of critical vehicle operating systems at the time of a collision. As a result, an unacceptable number of collisions continue to challenge the department.

The purpose of this applied research project was to identify necessary criteria for the use of event data recorders (EDRs) as a means to reduce the number of collisions in the Montgomery County, Maryland Fire-Rescue Department (MCFRS).

Historical research, including the literature review, was used to identify and summarize known information regarding EDRs. The review included evaluations by other organizations who have gained experience with EDRs. Information found was compared to circumstances unique to Montgomery County, Maryland.

Using descriptive research, an electronic survey of MCFRS certified collision investigators was conducted to identify criteria necessary to analyze and facilitate future efforts to improve collision investigations in Montgomery County, MD. Finally, the study combines the results of these research efforts to formulate conclusions regarding the use of event data recorders and to recommend a strategy for future efforts to minimize collisions in the MCFRS in the pursuit of their commendable goal to improve collision loss experience.

The research questions examined were:

1. What are event data recorders?
2. What types of event data recorders are available?
3. What criteria do other organizations use to monitor the actions and behaviors of their drivers?
4. What are the criteria for the use of event data recorders in the Montgomery County, Md. fire-rescue service?

Event data recorders were found to be in widespread use in a variety of applications external to the fire-rescue service. Data collected through the use of various EDRs was largely dependent upon the specific type of EDR in use. Fleets using EDRs reported significant improvements in safety and efficiency. Some problems were noted with the use of EDRs including reliability, data collection, and storage capacity.

Participants in a survey to evaluate MCFRS collision investigation criteria agreed that current data collection within the scope of MCFRS collision investigations is inadequate. Additional driver and vehicle information is needed to successfully investigate collisions and improve collision loss experience.

Future recommendations were developed to expand a comprehensive data collection and management program to improve the quality and quantity of MCFRS collision data. To accomplish this, the MCFRS was challenged to proceed with a pilot test of EDRs in a series of different weight class vehicles. In addition, development of a standard operating procedure and evaluation of the EDR pilot program was recommended through the use of a joint management-labor group appointed by the Fire Chief.

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INTRODUCTION

The Montgomery County, Maryland, Fire Rescue Service (MCFRS) is a combination department that employs 983 full time career personnel, 478 length of service awards program certified (LOSAP) volunteer personnel, and 74 civilians (D. Shaw, personal communication, March 24, 2005). Together, they provide fire, rescue, and emergency medical services to a population of approximately 1,000,000 persons. These services are deployed from 33 stations located in a combination of urban, suburban, and rural settings that span just less than 500 square miles of land area.

In October of 2001, the Montgomery County Fire Rescue Service (MCFRS) received a collision analysis findings and recommendations report from Risk Control Consultant Willis of Maryland, Inc. that said in part: “poor loss experience indicates that better risk controls are needed to control fleet losses and reduce loss exposure (Raughley, 2001, p. 1).”

Fire Administrator Gordon Aoyagi brought the fleet loss problem to his management team for action. “While the MCFRS finances its automobile collision and liability risks, insurance should not serve as the primary method to control loss exposures. Other risk controls should be considered to reduce the organization’s reliance on insurance (Aoyagi, 2001).”

The problem is adverse loss trends for the vehicle portion of the Montgomery County Fire-Rescue commercial insurance program have been increasing for over 36 months. Efforts are underway by officials in Montgomery County to minimize the frequency of collisions involving fire-rescue vehicles. Yet, there is no reliable means to verify the actions and behaviors of fire-rescue vehicle drivers, or verify the condition of critical vehicle operating systems at the time of a collision. As a result, an unacceptable number of collisions continue to challenge the department. The problem was identified in a memorandum prepared by Assistant Chief Roger McGary, MCFRS Safety Officer to the MCFRS management team.

"For some period of time we have been working on revisions to the vehicle collision situation. In addition to driver performance, two other problems exist. First is the proper notification of the collision to the MCFRS insurance carrier, and second, a collision report that collects valuable data for collision analysis (McGary, 2002, p. 1)."

Event Data Recorder (EDR) technology has been available to the commercial truck market for over two decades. With this technology came the opportunity to monitor first, vehicle performance; and more recently, driver performance. Use of newer technologies allow some fleet operators to review performance measures in real time which can significantly improve the safe operation of the fleet as well as advance the efficiency of day to day operations. Although successfully deployed in many commercial fleets throughout the United States, EDR technology has failed to find widespread acceptance in the fire-rescue service or, in Montgomery County, MD.

If EDRs can deliver according to the accolades made by the many supporters of the technology, this added collision analysis capability could have a direct impact on the ability of the MCFRS to further reduce their collision loss experience.

The purpose of this applied research project is to identify necessary criteria for use with event data recorders to monitor the actions and behaviors of fire-rescue vehicle drivers while recording critical vehicle component information as a means to reduce the number of collisions in the MCFRS.

Historical research, including the literature review, was used to identify and summarize known information regarding EDRs. The review included evaluations by other organizations who have gained experience with EDRs. Information found was compared to circumstances unique to Montgomery County, Maryland.

The research questions examined were:

1. What are event data recorders?
2. What types of event data recorders are available?
3. What criteria do other organizations use to monitor the actions and behaviors of their drivers?
4. What are the criteria for the use of event data recorders in the Montgomery County, Md. fire-rescue service?

BACKGROUND AND SIGNIFICANCE

Montgomery County is Maryland's most populous and affluent jurisdiction. The County is located adjacent to the nation's capital, Washington, D.C., and includes 497 square miles of land area.

According to the Maryland National Capital Area Park and Planning Commission, there were 2,490 miles of roads and streets in Montgomery County in 2001. The Washington DC Metro area, which includes Montgomery County, ranked fourth in the nation for traffic congestion. Finally, Montgomery County has four of the top ten roads with the greatest number of accidents in the State of Maryland (MNCPP, 2004).

The MCFRS is an all-hazard fire-rescue organization that provides fire, rescue, and emergency medical services including patient transport for a diverse population of approximately 1,000,000 citizens. Montgomery County delivers these services from 33 fire-rescue stations. The proposed FY06 MCFRS operating budget is approximately 154 million dollars.

Four additional fire rescue stations and a sixth on-duty command officer have been recommended to improve service delivery in the growing areas of the county by FY08. The improvements in deployment of resources will add an additional 26 units to an existing fleet of approximately 440 vehicles. While these additional resources are necessary, additional risk exposure for collisions is evident. Therefore, new technologies like EDRs offer the opportunity for improved reductions in collision loss exposure while expanding key services.

During calendar year 2003, MCFRS units were involved in a total of 146 collisions, a record high for the department. This reflected a peak in adverse loss trends that has driven insurance premiums steadily higher drawing management attention to a significant problem.

A five year review of the vehicle portion of the MCFRS insurance policy reflects unacceptable increases and exemplifies the problem: FY01, $493,109; FY02, $513,553; FY03, $641,975; FY04, $794,991; and FY05, $905,688. By order of magnitude, the vehicle insurance premium has nearly doubled in five years. The primary reason for the increase in premiums is adverse loss trends, although an overall increase in fleet value is also a factor (Shorb, 2005).

As a result of this poor loss experience, MCFRS leaders initiated a program to monitor driving performance by creating a tiered driver qualifications program that establishes designated primary and back-up drivers at each worksite. Further, this program has initiated mandatory certification and recertification requirements for all drivers. As a result, the number of collisions experienced during FY04 was 114, a 22 percent reduction. Even though this is a substantial improvement, additional reductions in loss trends are required (Bowers, 2005).

Presently, the number of fire-rescue stations located throughout the county is unevenly distributed and may be a contributing factor to the larger collision problem. A disproportionate number of stations are densely located in the urban areas of the county while fewer resources are deployed from the rapidly growing suburban and rural areas of Montgomery County. Units responding from stations in suburban and rural portions of the county have been experiencing a steady increase in both demand for service and total miles traveled by units from those worksites. One of the consequences associated with poor station distribution is increased demand on the vehicles responding from the stations compounded by increased fatigue levels of the personnel operating from those stations. Two additional factors have been identified.

First, these units are on the road more often, thereby increasing their exposure to a potential collision. As a result, ongoing efforts to reduce the collision rates have been met with frustration by the vehicle drivers who are faced with a steadily increasing call load. Second, improved mandatory collision investigation reporting and resultant disciplinary actions against at fault drivers have resulted in controversial challenges by employees and their bargaining agent representatives. An above reproach method for determining both vehicle and driver root cause analysis should be a welcome addition to the collision investigation process for both management and labor.

Efforts already underway to minimize the impacts of the collision problem include mandatory collision reporting procedures, appointment of a dedicated collision project manager, revision of key policies and procedures regarding operation of fire-rescue vehicles, initiation of a driver improvement program with increased accountability, and initiation of a designated drivers program at each worksite. In addition, modifications to existing and future vehicles in the MCFRS fleet will allow for greater driver visibility, enhanced technologies for improved braking, steering, and crew accountability.

If the advantages of EDRs for use in monitoring and evaluating root cause collisions can be validated, additional work will be required to implement the technology as a component of the collision reduction effort within the larger health, safety, and wellness strategy for the MCFRS. If EDRs fail to be an effective tool for reducing the collision rate, then this research effort will provide necessary information for others to make informed decisions regarding the future use of these devices.

This Applied Research Project (ARP) is important for several reasons. First, the project offers the promise to reduce the fire-rescue vehicle collision rate in Montgomery County by applying non-traditional technology to a well known problem. Second, this effort relates to the course work found in the Executive Leadership program at the National Fire Academy (NFA). This ARP relates to the course material in unit two, transformational leadership characteristics, unit eight, influencing, and several other broad based themes identified throughout the course. They include: problem solving, data analysis, creativity and leadership, and improving team performance. Finally, this effort supports the United States Fire Administration’s (USFA), operational objective “to promote within communities a comprehensive, multi-hazard risk reduction plan led by the fire service organization", and clearly provides an opportunity to "reduce the loss of life to firefighters (NFA, 2001, p.II-2)."

LITERATURE REVIEW

The purpose of this literature review is to provide a comprehensive overview of existing data and information regarding vehicle event data recorders. To accomplish this task, several questions need to be addressed. First, what are vehicle event data recorders and how can the use of event data recorders impact the collision rate in the Montgomery County fire rescue service? Second, what experience do others have with vehicle event data recorders that can assist Montgomery County in their efforts to improve their collision risk exposure?

The National Highway Traffic Safety Administration defines event data recorders (EDRs) as devices that record safety information about motor vehicles involved in crashes. Manufacturers have been voluntarily installing EDRs as standard equipment in increasingly larger numbers of light duty vehicles in recent years. They are now being installed in the vast majority of all new vehicles. The information collected by EDRs aids investigations of the causes of crashes and injuries, and makes it possible to better define and address safety problems. As the use and capabilities of EDRs increase, opportunities for additional safety benefits, especially with regard to emergency medical treatment, may become available. (NHTSA, 2002, p.1).

Thomas Michael Kowalick of Transportation Safety Technologies defines an event data recorder as:

> "An on-board device or mechanism capable of monitoring, recording, displaying, storing or transmitting pre-crash, crash, and post-crash data element parameters from a vehicle, event and driver" (Kowalick, 1998, p-2).

Simply stated, event data recorders can identify information concerning driver and vehicle operating characteristics.

Accident investigations are typically conducted by three types of entities including government agencies, law enforcement, and insurance companies. Each of these entities tends to investigate an accident from a different perspective or for different purposes, with one common goal. That goal is to determine the exact cause of an accident, based upon the best information available to them. Evicam International, Inc. states that "the current methods of accident reconstruction being used by the transportation industry are inefficient and outdated, based on today's technology".
R. Jeffrey Scaman, CEO of Evicam International, Inc. further develops the purpose of event data recorders: "The main purpose of the system would be to capture an unimpeachable record of the events surrounding an accident and format it to be accessible only by proper authorities" (Scaman, 2001, p-3).

Alan German of Transport Canada further develops the role of event data recorders: "The use of on-board electronic recorders in the aviation industry is well known. In the event of a crash, the recovery of in-flight recording systems is a priority for collision investigators, and the data obtained becomes an integral part of the crash reconstruction process" (German, 2001, p.1).

Transfer of EDR technology from the aviation industry to other methods of transportation has not been fully embraced. However, the advantages of using event data recorders in motor vehicles are well documented and can be summarized as follows:

On October 11, 2002, the National Highway Traffic Safety Administration (NHTSA) published in the Federal Register, a request for comments concerning EDRs. A wide variety of respondents expressed the belief that EDRs will improve vehicle safety by providing necessary and accurate data for crash analysis, information for potential injury prediction, and data for vehicle/roadway design improvement. NTSB stated that the issue of automatic recording devices for all modes of transportation has been on its "Most Wanted" list since 1997 (NHTSA, 2002).

Additional advantages of EDRs as a collision reconstruction tool were identified by several manufacturers of EDRs. Event data recorders provide fleet managers with factual information they need to manage their drivers and equipment. Some EDRs provide real time onboard driver information while others can only provide summary extraction capabilities. In either case, improved driver performance and compliance with vehicular operating and safety standards have been reported.

The potential use of EDRs in the fire-rescue service cannot be overstated:

The United States Fire Administration has initiated partnerships with the International Association of Fire Chiefs (IAFC), the International Association of Fire Fighters (IAFF), and the National Volunteer Fire Council (NVFC) to reduce the number of firefighters killed while responding to or returning from the emergency scene. In the last ten years, over 225 firefighters have been killed in the line of duty, as the result of vehicle crashes. This makes vehicular accidents to and from emergency scenes the second leading cause of deaths among on-duty firefighters (USFA, 2004, p-1).

Since EDRs are relatively new to the fire service, a discussion of the various types and operating characteristics of EDRs is appropriate.

The oldest recording device used on commercial vehicles is the tachograph, which graphically records the time and engine speed. In all vehicles, there is a direct correlation from the engine speed to the vehicle speed given the different gear ratios of the transmission, the gear ratios of the axle(s) and the wheel size measured in revolutions per mile. An ink pen records the engine speed on circular graph paper that is automatically advanced according to the internal clock of the tachograph. Graph paper must be removed on a regular basis and maintained by fleet operators. As solid state computer technology came to the marketplace, the tachograph was largely replaced with the tacholink which contained a memory card that permitted the downloading of many items in addition to engine speed and time. They include: idle time, excessive RPM's, hours driven, heavy braking, fast accelerations, fuel consumption, and others.
(Menig, 2002, p-1-2).

After 1985, electronic engines became standard equipment. Engine manufacturers took advantage of the computer driving the engine to provide additional information for the driver. Over time, these displays were expanded to include trip recording devices. Almost simultaneously, mobile radio, satellite and cellular telephone based equipment was being introduced into commercial vehicles. The original intent of this equipment was to improve the routing and tracking of the vehicle to improve logistics management. However, as the electronics in the engines improved, and the users of trip recorders asked for more information, these communications systems became full featured trip recorders with many monitoring capabilities. For example, the mandatory use of anti-lock brakes necessitated the recording of faults in those systems. Vehicle original equipment manufacturers (OEMs) have taken advantage of the standardized data link on electronic motors to provide various features in their data logging units that records information much like the flight recorders of aircraft. It should be noted that many of these devices are limited to information relevant to computer failures for computer assisted diagnostics associated with component failure. Other features are typically available as options such as RADAR based collision avoidance systems, vehicle information management systems, and accident reconstruction (Menig, 2002, p-4).

When equipped with the more advanced vehicle information management systems that may or may not include an accident reconstruction module, information is recorded in a continuous loop and may contain from 2-20 minutes worth of information. A typical state of the art system records information at the rate of sixteen times per second. Information recorded includes time, vehicle ID, speed, steering angle, turn signal status, brake status, braking events, range to vehicle, closing speed, side sensor status, alarms given, alarm settings, and others. Typically interpretation of the data can only be done by the manufacturer of the recording unit. The user can be provided with all information including graphs of the recorded data. Expert testimony is available as well

In the late 1980’s, wireless communications using satellite technology became readily available that permitted transmission of any or all of the recorded information back to the fleet office. Some systems forward information collected elsewhere on the vehicle while others take in additional information, preprocess exceptions and transmit that information to the fleet office thereby reducing the overall costs associated with wireless communications. Most now offer the advantage of global positioning triangulation for the monitoring and real time location of their assets.

A product known as DriveRight provides a representative example of EDR technology that monitors and records how and when vehicles are being used. This system provides for the setting of limits on speed, acceleration and deceleration. The recorder digitally records how often the limits are exceeded. In-cab alarms alert the driver whenever a limit is exceeded. The system hardware interfaces with the electronic data port on any major brand of electronic engine. It provides a driver performance score, driver ID and location ID, stores data from over 500 independent trips and maintains up to five accident logs. All information is security protected against power failure. A password prevents unauthorized changes to data or limits. The unit also contains a tamper indicator as notification of a disconnection or if an unauthorized person attempts to change limits or other settings. DriveRight software allows the recorded data to be sorted by driver and vehicle, as well as accessing the incident log. (Tripmaster, 2005).

According to documentation prepared by employees of the Freightliner Truck Corporation,

> "Information has been sensed, recorded, or off loaded from commercial vehicles for almost twenty years, excluding the recording of speed by tachographs. The recording devices include trip recorders, engine controls, on-board computers, wireless communications equipment, RADAR collision warning devices and instrument clusters. The information is used to improve driver safety, help

> diagnose problems, improve the efficiency of logistics for the fleet, and reduce operating costs" (Menig, 2002, p.1).

Driving behavior has a huge impact on safety and the operation of fire-rescue vehicles, particularly during emergent responses. In the Collision Analysis Findings and Recommendations Report by Willis of Maryland, Inc. numerous shortcomings were identified specifically for the MCFRS. In part the report identified that: "only 36% of the collisions were determined to be preventable, while 64% of the collisions were determined to be non-preventable". The Willis risk control consultants were surprised by this distribution and had typically found that preventability distribution is in fact reversed among other fleets that they represented. The Willis report examined why the preventability distribution was different and identified the following primary barriers to determining collision preventability.

First, some of the collision reports were incomplete, missing critical information necessary to determine preventability. Second, biased collision reports were common. Collision investigators had concluded preventability without gathering all of the facts. Without all the facts, the collision review committee cannot consistently determine preventability or recommend corrective actions. Third, Willis reviewers concluded that the MCFRS lacks preventability determination guidelines, a recommended best practice. More importantly, the report identified 33 at-risk driving behaviors that were evident in five primary driving tasks that accounted for 95% of 185 collisions evaluated. They concluded in part:

> "The root cause of the at-risk behaviors during critical driving tasks is that the organization lacks a structured driver improvement process based upon a strong

defensive driving philosophy. Other contributing causes include a lack of vertically integrated safety accountability and behavior-influencing consequences; and a historically fragmented training process for new ambulance and heavy apparatus operators" (Willis, 2001).

The literature review provided key insights into the use of event data recorders even though the uses of these devices have not found widespread acceptance in the fire-rescue service.

A preliminary review of the history of EDRs revealed that they have been instrumental in developing and sustaining improvements in fleet operations throughout the commercial trucking industry while improving safety in fleets that have operated with EDRs. Government, law enforcement, and insurance investigators have successfully used EDRs to determine the exact cause of an accident, based upon the detailed information available to them. Industry experts assert that current methods of accident reconstruction being used by the transportation industry are inefficient and outdated.

Newer technology like DriveCam Video Systems offer a unique product that continually monitors driving performance while lowering operating costs for fleet operators. Their marketing literature claims that: "improved driving performance is the single most important factor in controlling insurance losses and reducing expenses for fleets". Driving events are continuously recorded by a video recorder mounted to the windshield that provides digital stream video of a given event. When collisions occur, DriveCam recordings provide unbiased evidence to determine fault and expose fraudulent claims (Hoffman, 2005).

A further review of the benefits of EDRs concluded that various generations of EDRs have been in use throughout the commercial trucking industry for over two decades. Information available has improved with corresponding improvements in solid state technology and the ability to transfer data to reviewers other than the driver have significantly improved fleet operational efficiency.

The literature stressed that as improvements in electronic engine components improved, corresponding improvements in the type and amount of available data collected improved as well. Mandatory use of anti-lock brakes and the need to monitor the various braking components also influenced advancements in EDR technologies. The newest generations of EDRs offer the ability to store, download, and or wirelessly transmit data in real time to fleet operators and safety managers.

The works of the various authors summarized in the literature review influenced this project in various ways. First, the review highlighted the need to examine criteria necessary to monitor the actions and behaviors of drivers in addition to the vehicle operating information typically available from EDRs through original equipment manufacturers. Second, implied inadequacies of the MCFRS collision investigation process illustrated the need to consider which criteria existing collision investigators determined to be most useful when determining root cause analysis and for safety reviewers who must judge preventability for each collision.

PROCEDURES

The initial literature review for this project began at the Learning Resource Center (LRC) at the National Emergency Training Center in October of 2004. Additional information was gathered from the World Wide Web, personal interviews, and literature made available from various original equipment manufacturers literature.

The focus of the literature review was limited to two general areas: a current evaluation of EDR technology including current state of the art products, and the experience obtained by others who have used EDRs.

Historical research in the form of statistical data analysis was used to identify and summarize known information regarding the frequency and risks associated with emergency vehicle collisions internal and external to the MCFRS.

The research effort began with several interviews and personal meetings with Assistant Chief Richard Bowers and other members of the Safety Office of the Montgomery County Division of Fire and Rescue Services. These interviews were conducted to gather specific history and background regarding the history of the collision problem in Montgomery County and specifically; to determine why previous efforts to enact improvements failed. Additional personal interviews were conducted with Mr. Gordon Aoyagi, Montgomery County Fire Administrator, Mr. Neil Shorb, staff liaison for the MCFRS insurance program, and Captain Michael Nelson. These employees within the MCFRS have primary responsibility and firsthand knowledge of the past events that have prohibited improvements in the collision loss problem.

Using descriptive research, an electronic survey of MCFRS certified collision investigators was conducted to identify criteria necessary to analyze and facilitate future efforts to improve collision investigations in Montgomery County, MD. Finally, the study combines the results of these research efforts to formulate conclusions regarding the use of event data recorders and to recommend a strategy for future efforts to minimize collisions in the MCFRS in the pursuit of their commendable goal to improve their loss experience.

The study was conducted in Montgomery County, MD for the purpose of identifying critical collision investigation criteria as viewed by the personnel with primary responsibility for determining root cause collision analysis. Three distinct levels of review should occur for each collision investigated within the MCFRS.

First, the on-duty MCFRS Battalion Chief as the on-scene investigator who gathers facts, records key information, and is charged with the responsibility to determine preventability based upon published guidelines. Second, the on duty Shift Operations Chief (Assistant Chief) that is responsible for reviewing the reports, and who at times is involved in the collision investigation based upon the seriousness of the incident; and finally, the staff of the MCFRS Safety Office who serve as the primary link between the MCFRS, and other internal and external agencies with a vested interest in the collision problem.

Results of personal interviews was used to formulate seven questions in a survey instrument prepared using WebSurveyor.net. This survey method provides a researcher the opportunity to develop, send, and analyze the results of a fully customized survey electronically. The license for this electronic survey instrument is owned and maintained by the MCFRS. The survey was prepared and reviewed for distribution to the survey population during early February, 2005. The primary elements of the research questions were:

Question 1 addressed the adequacy of current collision investigation information regarding the vehicle driver. Survey participants were offered a yes-no choice.

Questions 2 surveyed the respondent’s assessment of the adequacy of information regarding vehicle systems. Once again, they were offered a yes-no choice.

Questions 3 surveyed the respondent’s personal ranking of five collision investigation criteria that included 1) post collision physical evidence, 2) vehicle systems status, 3) traffic conditions, 4) weather and environmental conditions, and 5) status of traffic control devices.

Questions 4 required survey participants to rank five measures of pre-crash vehicle condition in order of importance to them. The five criteria were: 1) review of vehicle maintenance records, 2) review of written driver’s statements, 3) review of vehicle daily checkout sheets, 4) post crash vehicle inspection, and 5) review of crew and witness statements.

Questions 5 surveys the respondent’s order ranking of human response investigation criteria. The available criteria to rank were 1) review of written statements by drivers and crew, 2) witness statements, 3) crew cab physical evidence, 4) review of the post crash police report, 4) review of the driver’s collisions history.

Question 6 asks the collision investigator to rank the importance that best determines the driver’s response to an imminent collision. The available criteria were 1) driver alertness, 2) driver’s use of required seat belts, 3) driver’s head and eye movement, 4) driver’s field of vision, and 5) driver’s hand position on the steering wheel.

Questions 7 addresses the various criteria that could enhance the MCFRS collision investigation process.

An electronic email database consisting of 24 Battalion Chiefs, nine Assistant Chiefs, five Division Chiefs, one Fire Chief, and 13 Captains who are on the Battalion Chief promotional eligibility list was prepared. The author concluded that this would provide the best sample of stakeholders with vested interests and opinions regarding the collision investigation criteria survey. Further, it was assumed that the total survey population (52) was sufficiently small to eliminate the need for selecting a random sample. This decision was further influenced by the electronic delivery method selected. Finally, these employees have received training regarding collision investigations utilizing criteria that may be unique to the MCFRS. Therefore, all survey participants were sufficiently versed in the criteria outlined to fully understand the intent of each question.

An email cover letter outlining the conditions of the survey and a direct hyperlink to the survey instrument was launched on March 6, 2005 and posted for 21 days on the World Wide Web. A copy of this survey is included in Appendix A. A total of 51 potential participants in the survey opened the link and at least reviewed the instrument. Of those, 47 completed the survey for a response rate of 92.20%. With $N = 52$ and $S = 47$, the sample falls just short of the required 49 responses necessary to assure a 95 % confidence level in the survey.

As a feature of the electronic software product, statistics relative to the seven questions were automatically calculated and presented in graphical format. However, these graphs were not exportable to MS Excel for conversion to a format that meets the requirements of the National Fire Academy (NFA) ARP published guidelines. Therefore, raw data was entered into an MS Excel spreadsheet for conversion to seven separate figures included in Appendix B.

The limitations that affected this research project included time, the absence of critical collision data including agreed upon preventability guidelines, and the selection of personnel other than MCFRS personnel for the collision criteria survey.

An initial review of MCFRS collision data revealed gaps in the quality and quantity of collision reporting over the previous five years. In addition, confirmations of training levels of collision investigators external to the MCFRS were not available. As a result, the author chose to limit the survey to MCFRS collision investigators who had similar training and experiences regarding collision investigations.

The author assumed that the participants in the study would fully understand all of the questions and would respond to the questions in a truthful manner. There is no way to confirm these assumptions.

Finally, due primarily to time constraints and competing calendars, the author was unable to conduct follow-up interviews with survey participants to further clarify other responses to question number seven.

Definition of Terms

Anti-lock brakes—A braking system that contains a series of wheel sensors and modulators controlled through a computer designed to eliminate dangerous out-of-control skids.

Combination department—Refers to the use of both career (salaried) and volunteer (non-salaried) employees to deliver fire-rescue services.

<u>DriveCam</u>—Refers to a single manufacturer's in-vehicle digital video technology that when interfaced with proprietary software produces digital videos of driving events.

<u>DriveRight</u>—Refers to a single manufacturer's event data recorder that when interfaced with proprietary software produces digital recordings of critical vehicle data through the standardized data link on the electronic motor.

<u>Event data recorder (EDR)</u>—A device that records critical information about the vehicle, driver, or both.

<u>GVWR</u>—Gross Vehicle Weight Rating.

<u>Multiplex wiring</u>—In automotive applications, multiplex wiring allows a host of separate computer modules to communicate with one another through one or two wires. Without multiplexing, a bundle of wires is necessary to transmit information from module to module.

<u>RPMs</u>—Revolutions per minute. The preferred way of describing vehicle engine speed ratings.

<u>Standardized electronic data link</u>—A computer connection terminal on electronic engines that serves as a data hub for all other connected devices.

<u>Tacograph</u>—A device that graphically records time and engine speed in RPMs.

<u>Tacholink</u>—A device that replaced the tachograph that uses an electronic data link.

RESULTS

This study analyzed the survey responses of 47 individuals through a series of seven research questions. The complete survey and survey results are represented in a series of figures and tables in Appendix B. The individuals surveyed included 24

Battalion Chiefs (46.2%), nine Assistant Chiefs (17.4%), five Deputy Chiefs (9.6%), one Fire Chief (1.9%), and 13 Captains (25%) serving on the Battalion Chief Eligibility list. Survey results are discussed throughout this section. Graphs and tables are presented in Appendix B.

Only 45 out of 47 (95.8%) survey participants responded to question number one. Two respondents failed to provide an answer. Of those 45, only 31 (68.9%) felt that the current MCFRS collision investigation process provided adequate information. regarding the driver's actions and behaviors The remaining 14 (31.1%) felt that the current level of information is adequate and responded affirmatively to question number one (Figure B-1).

Question two yielded 45 out of 47 (95.8%) possible responses and asked if the respondents believe that the current MCFRS collision investigation process provides adequate data concerning the condition and status of key vehicle systems at the time of the collision. Thirty-seven (82.2%) felt that the process did not provide adequate information while eight (17.8%) believed that the information was adequate (Figure B-2).

Questions three through six ask the participants in the survey to rank order a set of pre-determined criteria. The author chose this method to force the participants to think of the factors as a set and rank them. Because this type of question generates ordinal data rather than interval data, analysis is limited to cumulative frequency distributions for each criterion.

Question number three asked respondents to rank five different criteria in order of importance to them when conducting a collision investigation. The criteria included 1) weather and environmental conditions, 2) status of traffic control devices, 3) traffic conditions, 4) vehicle system status, and 5) post collision physical evidence including body damage, skid marks, yaw, and others. Forty-seven (100%) of the respondents ranked the choices posed in this question.

Post collision physical evidence was ranked first or second by 26 (55.4%) of the respondents. Vehicle systems status was ranked first or second by 25 (53.2%) of survey participants. Traffic conditions were ranked first or second by 16 (34%) respondents, while 15 (31.9%) ranked weather and environmental conditions first or second. Finally, 12 (25.5%) people ranked the status of traffic control devices as either first or second (Table B-1).

Respondents were asked in question four to rank selected criteria in order of importance that provides the collision investigator the best assessment of pre-crash vehicle condition. Forty-seven (100%) of the respondents ranked the choices posed in this question. The available choices were 1) review of vehicle maintenance records, 2) review of written driver's statement, 3) review of daily vehicle checkout sheets, 4) third party post crash vehicle inspection, and 5) review of crew and witness statements.

Twenty-five persons (53.2%) ranked vehicle maintenance records review as either first or second. Review of daily checkout sheets was ranked first or second by 22 (46.8%) of the participants. Review of the written driver's statement was ranked first or second by 17 (36.2%) of the survey respondents, while both third party post crash vehicle inspection, and review of crew and witness statements were ranked one or two by 15 (31.9%), (Table B-2).

Question number five asked respondents to rank five different criteria in order of importance to them regarding human response criteria when conducting a collision investigation. The criteria included 1) driver and crew's written statements, 2) witness statements, 3) crew cab physical evidence, 4) official police report, and 5) driver's collision history.

Forty-seven (100%) of the respondents ranked the choices posed in this question. Driver and crew's witness statements was ranked first or second by 34 (72.3%) of the respondents. Review of witness statements (civilian) was ranked first or second by 32 (68.8%) of survey participants. Crew cab physical evidence and review of the official police report both received 11(23.4%). Finally, 6 (12.8%) of the people ranked driver's collision history as either first or second in the survey (Table B-3).

Respondents were asked in question six to rank selected criteria in order of importance that provides the collision investigator the best assessment of a driver's response to an imminent collision. Forty-seven (100%) of the respondents ranked the choices posed in this question. The available choices were 1) driver alertness, 2) driver's use of required safety belts, 3) driver's head and eye movement, 4) driver's field of vision through the windshield and 5) driver's hand positions on the steering wheel.

Forty-five persons (95.8%) ranked driver alertness as either first or second. The driver's use of required safety belts was ranked first or second by 7 (14.1%) of participants. Drivers head and eye movement was ranked first or second by 25 (53.2%) of the survey respondents, while drivers field of vision received a total of 16 (34%) of the first or second choice rankings. Finally, drivers hand positions on the steering wheel received a total of one (2.2%) of the first or second place rankings (Table B-4).

Question seven asked respondents to identify criteria that would enhance the MCFRS collision investigation process by selecting all that apply. The criteria listed within this question were selected from the previous questions and presented in a manner that did not force the survey participant to rank their choices within a fixed set. Therefore, based upon the experience of the ranked order questions, the author hoped to glean a sense of the importance of individual investigation criteria. The criteria included: 1) vehicle speed history, 2) video recording of driver's view through the windshield, 3) audio recording of crew conversations, 4) brake system status, 5) video recording of crew's actions and behaviors, 6) vehicle steering control status, 7)vehicle stability control status, and 8) other. All 47 (100%) participants answered this question (Figure B-3).

Vehicle speed history was identified by 46 (97.9%) of the respondents as a criteria that would improve the collision investigation process. Video recording of the driver's view through the windshield and audio recording of crew conversations both received 39 (83%) of the responses. Evaluation of the status of the vehicle brake system was identified by 36 (76.6%) of the participants. Thirty-one (66%) of respondents believed that a video recording of the crew's actions and behaviors would better the process. The status of the vehicle steering system was considered important by 30 (63.8%) of survey participants. Stability control of the vehicle was determined to be an important enhancement to the MCFRS collision investigation process by 11 (23.4%) of the survey participants. Eleven (23.4%) participants offered other additional comments. Specifically, the comments included a desire for additional training, video driver's actions at all times, alarms for all safety devices in place to prevent an event, initiation of a near miss program, and a standard county wide vehicle condition report and maintenance record to simplify the investigation process. One survey participant questioned the honesty of driver and crew written statements submitted as part of the investigation process.

Finally, several comments were received indicating that present training was inadequate, and that collision investigation is very technical in nature, and therefore, a process that should be limited to highly trained and experienced personnel that can perform the duties consistently day in and day out.

The analysis and interpretation of the survey responses largely support the findings within the literature review. Respondents noticeably agree that current data collection within the scope of MCFRS collision investigation is inadequate and that additional driver and vehicle information is needed to successfully evaluate collision loss experience while improving the collision investigation process for the future. Although respondents fundamentally agree that this information is needed, it is less clear as to which criteria they believe will provide the best view for investigators.

There are strong indications that existing collision investigators do not uniformly agree on the criteria regarding driver behavior, vehicle systems condition, or physical evidence at the scene of a collision. However, the majority of respondents believe that there are potential benefits for monitoring criteria such as vehicle speed, audio and video recordings of crew actions, and the status of braking components prior to and during a collision.

Comments received indicate at least some investigators feel unqualified to conduct investigations while others expressed concerns regarding the honesty of driver and crew statements in the process.

To further explore these results, the following research questions were addressed to provide additional understanding regarding the installation of EDRs in emergency vehicles:

1. Event data recorders are designed to provide critical data necessary to monitor and evaluate vehicle system status and in some cases, driver behavior. As a result EDRs offer the potential to reduce the frequency and severity of emergency vehicle collisions that are substantial in Montgomery County, MD. These collisions present a well known risk and a noteworthy threat to the community, and to responding firefighters. In addition to regulatory and safety organizations presented in the literature review, several noteworthy references relevant to this ARP are presented here.

"Computers can track driver safety and efficiency, monitor engine condition and critical components, and automatically log information you need to assess vehicle profitability. Combined with wireless communications, onboard computers can even give you all this information on a real time basis so you can respond to a situation as it occurs". For example, Weleski Transfer Co., a 41-truck carrier based in Tarentum, Pa., uses onboard computers (EDRs) to collect information about each truck, and uses printed results to "improve safety and productivity" according to safety director Jim Stewart (Huff, 2004, p-3).

D.M. Bowman trucking, a 500-truck regional hauler based in Williamsport, MD. uses the Qualcomm onboard computer, with its OmniTracs and OmniExpress mobile messaging systems to monitor both vehicle and driver performance in real time. Corporate safety officers use this information to reward or penalize drivers whose salaries are tied to very rigorous performance measures regarding idle time, speed, over revs of the motor, etc. According to Sam Kennedy, Chief Maintenance Officer, the company has "substantially reduced their collision experience" as a result of using first Tripmaster and now Qualcomm technologies (Kennedy, 2004).

Vehicular collisions involving emergency vehicles have been an issue in the fire service for years. The University of Michigan Transportation Research Institute reports:

> "Overall, there is an average of 2,472 fire trucks involved in police-reported accidents per year in the United States. These accidents result in six deaths to truck occupants, 413 fire truck occupant injuries, and a total of 1,076 injured persons involved in these accidents (including a total of 21 deaths) each year. These statistics demonstrate the significant risk of traffic collisions to firefighters and the general public" (Campbell, 1999).

Nick Brunacini of the Phoenix, AZ Fire Department provides additional insight to the problem. "United States emergency response vehicles were involved in a staggering 156,000 traffic accidents resulting in 6, 550 deaths between the early 1980's and 1995 (Brunacini, 2004)".

During the literature review a number of previous ARP's were identified that dealt with fire-rescue collision rates within their respective departments. Among those reviewed were efforts by Los Angeles, CA, Metro Dade County, FL., and Akron, OH. The focus of these efforts however, was largely centered on improvements to driver training rather than the use of EDRs as a means to reduce collision loss experience.

In a text entitled EMS driving the safe way, Peto and Medve write "research has disclosed that accidents do not just happen, more than 90% of them are caused. Accidents usually occur when drivers fail to do everything reasonably possible to avoid a collision…if collision causing (human) behavior could be modified then most motor vehicle accidents could be prevented" (Peto, 1992, p-24). This strongly suggests that motor vehicle collisions are preventable and that driving behavior is the best way to impact the collision problem.

The risks of excessive collision losses have been experienced in other fire rescue agencies as evidenced in an ARP by Battalion Chief Roxanne V. Bercik of the Los Angeles, CA Fire Department. She says in part:

> “The overall impact of LAFD vehicular collisions can be seen on a regular basis. There are some firefighters who are still recovering from their injuries sustained during these collisions. Some firefighters will never return to duty and will be required to work a staff assignment or take their pension”. She goes on to predict “there is a potential for additional injury/loss of life to LAFD personnel or civilians along with the probability of financial costs to the City of Los Angeles due to litigation involving these collisions”(Bercik, 2003, p-8).

These risks outlined in the Los Angeles experience are further enumerated in a press release by the United States Fire Administration regarding nationwide firefighter fatalities for on duty deaths during calendar year 2004: “Twenty firefighters died in vehicle collisions”. This represents 13% of the on-duty deaths for 2004 (USFA, 2004).

2. Among the advantages and disadvantages of the various types of EDRs, respondents believe that the fundamental vehicle information available from all engine data links would be helpful in the MCFRS quest to improve collision losses. More importantly, state of the art recorders could provide supplemental information in the form of downloaded audio and video recordings of the crew and their actions as well as the driver’s view of a given event from the front windshield. Equipping vehicles with ERDs could have a further positive impact on collision losses. While cost is always a concern

that could discourage EDR installations, the results of this research indicate that EDRs should not necessarily be the only collision reduction solution explored. Noted negative comments suggest that additional training in collision investigation and vehicle systems may be prudent.

Widespread deployment of EDRs promises a new and unique glimpse of the events that occur during a collision. Mike Cusik, sales director for DriveCam markets a combination video/audio recording camera that enables users to collect a twenty second digital recording of a collision event when used with DriveCam's proprietary software. A collision event is triggered by an aggressive action that is field programmable by persons with software authorization. The device digitally stores up to 64 MB of information in 20 second (4MB) clips. Used extensively in commercial businesses, the technology has failed to gain acceptance in the fire service community, possibly because of costs ($1,200 per vehicle). However, accolades are substantial. Users of the product have experienced an average 25%-70% reduction in maintenance costs when drivers are appropriately counseled about aggressive driving habits identified by the recordings. Additional financial benefits are derived through "reduced accident costs, costs of investigating claims, and prevention of fraudulent claims against the owner and driver of the vehicle" (Cusik, 2005).

According to Thomas A. Roston of the U.S. National Highway Traffic Safety Administration, et al; "The EDR in a colliding vehicle can in some cases , provide a comprehensive snapshot of the entire crash event- pre-crash, crash, and post crash"(Roston, 2002, p-1).

ERDs are not without shortcomings. A crash is frequently characterized by multiple events. For example, a car may first inadvertently leave the roadway and glance off a guard-rail (the first event), careen into the path of an oncoming vehicle (the second event), and finally strike a tree (the third event). Most current EDRs are not equipped to record all events that may occur in a crash. In addition, EDR download failures have been documented in a study performed at Rowan University with a sampling of 684 vehicles. Sixty percent of the vehicles involved were downloaded successfully. Among the reasons for failure to download EDR data in the remaining vehicles: data collection failed because no data was present (15%), software cable issues (23%), Data connection point was unusable (13%), technical training issues (30%), crash damage (6%), and lack of permission (13%) (Gabler, 2002, p-10).

3. The experience in Montgomery County is not unique in that injuries sustained while traveling to and from the scene of emergency incidents has traditionally been the second leading cause of fire fighter fatalities in the United States. In addition, the author was able to determine throughout the literature that many fire-rescue departments have or are experiencing significant collision problems. Therefore, ongoing efforts to establish criteria for more complete collision analysis can be beneficial to agencies internal and external to the MCFRS.

In a report for the Journal of Emergency Management, Proudfoot and Husting report: “from 1991 through 2000, 33 incidents involving 38 firefighter fatalities, including 23 apparatus drivers occurred”. They further report that “since 1984, motor vehicle collisions have accounted for between 20 and 25 percent of firefighter fatalities annually” (Proudfoot, 2004). This statistic cannot be ignored.

The Centers for Disease Control and Prevention's National Institute for Occupational safety and Health Fire Fighter Fatality Investigation and Prevention Program investigate occupational firefighter fatalities. The program has provided recommendations for driver's of fire department apparatus, including the following: 1) recognize that driver's are responsible for safe and prudent operation of the vehicle at all times, 2) driver's should wear a seat belt at all times, 3) refresher training should be available at least once a year, 4) driver's should understand the vehicle characteristics, capabilities, and limitations, and 5) driver's must adjust speed when driving on wet, or icy roads, in darkness or fog, or under any other conditions that make emergency vehicle operation especially hazardous (Proudfoot, 2004).

4. Results of the survey indicate that the majority of respondents do not believe that current reporting methods or the criteria used in the reporting afford an appropriate level of information necessary to properly investigate collisions. In addition, they believe that additional information available from the use of EDRs would be useful in efforts to reduce collision losses. The results of this survey could be viewed as an opportunity for Montgomery County, MD to further explore the use of EDR technologies.

One local fire-rescue agency has been installing DriveCam recorders in their apparatus for some time. The Prince Georges County Fire and EMS Department's fleet manager reports considerable success in determining root cause collision analysis, compliance with required safety procedures, and validation of driver, crew, and witness statements. He specifically identified several cases where the use of these cameras clearly exonerated the emergency vehicle driver from an at fault collision, determined fault between two emergency vehicles involved in an incident, and provided ready proof of a mechanical failure that forced a driver to take evasive actions resulting in vehicle damage. The combination of the available audio, video, and stored engine data provides investigators with material evidence that is undisputable (Dibenidetti, 2005).

DISCUSSION

The author was unable to locate a national database that contains information describing the root cause and significant contributing factors for emergency vehicle collisions, particularly large trucks.

Recognizing the importance and absence of such data, The Federal Motor Carrier Safety Administration (FMCSA) began investigating methods to collect critical data for large truck crashes in the fall of 1998. They concluded that an investigation team consisting of at least two individuals was necessary to complete the collision investigation process. While collecting this data, the FMCSA paired a Department of Transportation (DOT) researcher with a State certified truck inspector to create an unprecedented database of 1,000 serious large truck crashes. As a result, detailed data elements were identified for use by future researchers. The DOT researchers concluded that: a) " the sequence of data collection activities varies from crash to crash and is dependent upon the number of vehicles and participants involved, and the amount of time available before the crash scene is cleared", b) "scene evidence documentation is another priority and is best obtained while on-scene and that scene evidence is easier to obtain when the roadway is closed to traffic", c) "interviewing crash participants is clearly the most important aspect of investigating collisions". Unfortunately, " a small number of crash participants are unwilling to discuss pre-crash events while on-scene, especially when criminal charges were pending or where the driver had been counseled by others not to discuss aspects of the crash" (Toth, 2003, p-3).

Critical root causes of large truck crashes are now generally classified in one of four broad categories by the National Highway Traffic Safety Administration. They are: 1) driver error, 2) vehicle failure, 3) environmental factors, and 4) others. Specific criteria contained within these broad categories include: cargo weight, pedestrian data, pre-crash environmental conditions, truck conspicuity, driver citation history, driver experience, driver hours on duty, driver physical condition, driver sleep history, suspected aggressive driving behaviors and other driver attention issues (Toth, 2003, p-4).

Clearly, use of EDRs would enhance every aspect of obtaining these referenced data points and other unimpeachable data in a timely fashion. More importantly, in cases where drivers and others are unwilling to provide critical information in a truthful manner, data recorded and stored by EDRs could be an invaluable resource.

Every new vehicle contains at least an engine controller and an antilock brake controller that records fault information in addition to some service and maintenance information. New vehicles purchased by the MCFRS are also equipped with antilock brake technology while some are equipped with multiplexed wiring components that can provide some additional vehicle component data (Lamphier, 2005). Information beyond the scope provided through the engine data port would have to be captured through another type of EDR.

In a report by Hino Motors, Ltd. for the Ministry of Land, Infrastructure and Transport in Japan, researchers there concluded that "to prevent vehicles from causing accidents, the fundamental performance of vehicle hardware must be improved above all". They site shortening the braking distance versus truck weight and alleviating fatigue inherent in long haul operations as fundamental and important issues. Further, this report concludes that "safety measures presuppose an overall approach of sustaining three phases --- driver training, infrastructure, and vehicle hardware" (Akiyama, 2003, p-8). Both of these conclusions support improved monitoring of both vehicle and driver.

Throughout the literature, claims of improved safety and fleet management efficiencies have been made for EDRs when used in the commercial truck and bus industry. The value placed upon EDRs is evident from actions initiated by the National Transportation Safety Board (NTSB). "Between 1997 and 2001, the NTSB made five recommendations that set into motion research and development of EDR technologies. These recommendations are listed on the NTSB Most Wanted List of Transportation Safety Improvements, "a program to increase the public awareness of, and support for, action to adopt safety steps that can help prevent accidents and save lives" (NTSB, 2005).

The survey conducted in this ARP concluded that improvements resulting from the use of EDRs could likely be extended to emergency vehicles in the MCFRS. Commercial vehicles and buses already use various recorders extensively.

The author believes that the successes realized in the commercial trucking experience with ERDs can be transferred successfully to vehicles in the MCFRS. Although use of EDRs is no guarantee, it is likely that the risks associated with excessive collision loss experiences can be further reduced.

Given the survey results, including commentary fearing the technical knowledge to properly investigate collisions, this author believes that afforded the opportunity, existing MCFRS collision investigators would desire to use technology using an on-board video cam to investigate collisions. The video provides a multitude of information that would otherwise have to be gleaned from data collected through the vehicle engine data port.

Clearly, increased loss experience regarding vehicle collisions is not unique to the MCFRS. Several notable examples have been provided that should help the reader understand the scope of the problem. Use of EDRs to improve driver behaviors and monitor vehicle condition could improve the loss experience.

Any attempt to use EDRs in Montgomery County will have to survive unresolved issues related to privacy of information and how that information can be used by fire-rescue departments as an agent for the larger county government. Additional research will be required to determine issues regarding privacy, employee and employer relationships particularly where volunteer drivers are utilized. These privacy issues are beyond the scope of the ARP.

The results of this research project present various challenges for the MCFRS. First, improvements in the data collection process for collision investigations have been identified by survey respondents who believe that additional data point criteria would enhance the collision investigation process. Second, steps should be taken to improve the training levels for collision investigators to assure that they collect, analyze, and report key data findings while drawing valid conclusions from the data. Finally, additional work will be necessary to determine which criteria identified within this ARP should be used in the MCFRS collision investigation process.

Like most large municipal departments, Montgomery County has competing needs and priorities that drive day to day operations. To be successful, EDRs must provide value in the form of further reductions in preventable collisions, increased cost savings and efficiency improvements for MCFRS managers, improved performance from vehicle drivers, and reliability for ongoing use.

RECOMMENDATIONS

A careful analysis of existing EDR capabilities already built into apparatus operated by the MCFRS should be performed to determine if critical criteria can be discerned from existing resources. In vehicles that are not equipped with EDR technology, state of the art EDR technology should be considered.

The MCFRS Bureau of Health, Safety and Wellness should expand their collision investigation efforts to develop a comprehensive data collection and management program to improve the quality and quantity of collision data for analysis and future forecasting purposes. The data targeted by this effort should include at a minimum vehicle speed history, video recordings of the driver's view through the windshield, audio recordings of the crew's conversation prior to a collision, and the vehicle brake and steering systems status. This is addition to the photo array and physical evidence collection that presently occurs. Video recordings of the driver's view will confirm the status of traffic control devices, weather and other environmental concerns, traffic conditions, and the status of other approaching vehicles.

Data collected from this effort should be collected, analyzed, and disseminated in monthly reports to the entire workforce that can improve collision losses within the MCFRS.

The author recommends that the MCFRS proceed with the pilot test of a latest generation EDR in a series of different weight class vehicles for field evaluation. These vehicles should include by breed: pumpers, ambulances, heavy rescue squads, aerial ladders, and staff vehicles including SUV's and sedans. The units in this pilot program should be leased so that the department is not locked into a specific EDR technology if the field evaluation is not successful. Additional research will be needed to acquire the most appropriate unit for the anticipated use. The pilot test should occur in each of the five battalions in stations where the workload is sufficient to properly evaluate the units in a reasonable period of time, possibly 90 days.

Key variables to evaluate during this pilot program include initial cost, warranty, ease of installation, durability, ease of use when retrieving data, and reliability.

To accomplish this, time and monies must be reserved to train key personnel on the proper use of EDRs. The impacts on current policy and procedures will need to be considered. An interim standard operating procedure unique to units equipped with EDRs will need to be developed. The author further recommends that a joint management labor group be appointed by the Fire Chief to review the findings of the pilot program.

Future efforts regarding the use of EDRs should be aimed at the broader fire service community, either regionally or nationally where statistically significant, comparative analysis can validate the use of EDRs in fire service applications.

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Appendix A

Survey A-1: Collision Investigation Criteria Survey

Collision Investigators Survey
2004-05 Executive Fire Officer (EFO) Applied Research Project
National Fire Academy

This survey is part of an applied research project for the Executive Fire Officer Program at the National Fire Academy. As a MCFRS collision investigator, you are requested to complete this survey within seven days. The results will be used to identify criteria for the potential use of vehicle event data recorders as a means to reduce the collision rate in the Montgomery County Fire-Rescue Service. Please complete the survey by clicking on the link below:

---

1) Do you believe that the current MCFRS collision investigation process provides adequate information about the driver's actions and behaviors?

- [ ] Yes
- [ ] No

2) Do you believe that the current MCFRS collision investigation process provides adequate vehicle systems condition and status information?

- [ ] Yes
- [ ] No

3) Rank the following criteria in order of importance when conducting a collision investigation.

1) __________
2) __________
3) __________
4) __________
5) __________

4) Rank the following criteria in order of importance that provides the collision investigator the best assessment of pre-crash vehicle condition.

1)
2)
3)
4)
5)

5) Rank the following *human response* investigation criteria in order of importance to you when conducting a collision investigation.

1)
2)
3)
4)
5)

6) Rank the following criteria in order of importance that best determines the driver's response to a imminent collision.

1)
2)
3)
4)
5)

7) Select all that apply. Which of the following criteria would enhance the MCFRS collision investigation process?

- [ ] Vehicle speed history
- [ ] Brake system status
- [ ] Vehicle stability control status
- [ ] Vehicle steering control status
- [ ] Audio recording of crew conversations
- [ ] Video recording of driver's view through the windshield
- [ ] Video recording of crew's actions and behaviors
- [ ] Other (please specify)

If you selected other, please specify:

Additional comments:

Thank you for your participation in this survey. If you have additional questions or comments, please contact Assistant Chief Steve Lohr @ 7-2451, or, by emailing steve.lohr@montgomerycountymd.gov

Appendix B

Figure B-1: Driver's Action and Behaviors

Do you believe that the current MCFRS collision investigation process provides adequate information about the driver's actions and behaviors?

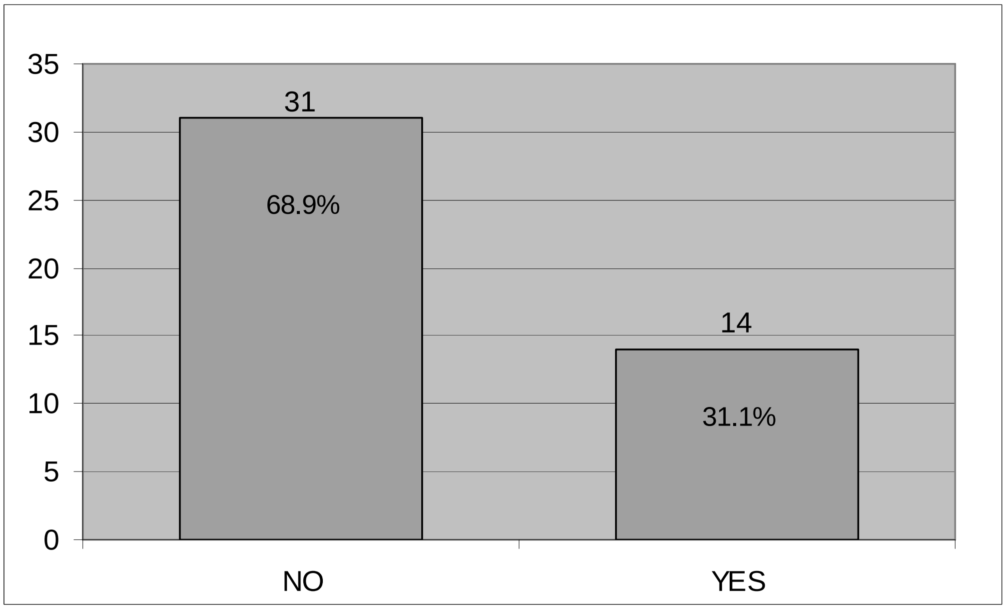

Figure B-2: Vehicle Systems Condition and Status

Do you believe that the current MCFRS collision investigation process provides adequate vehicle systems condition and status information?

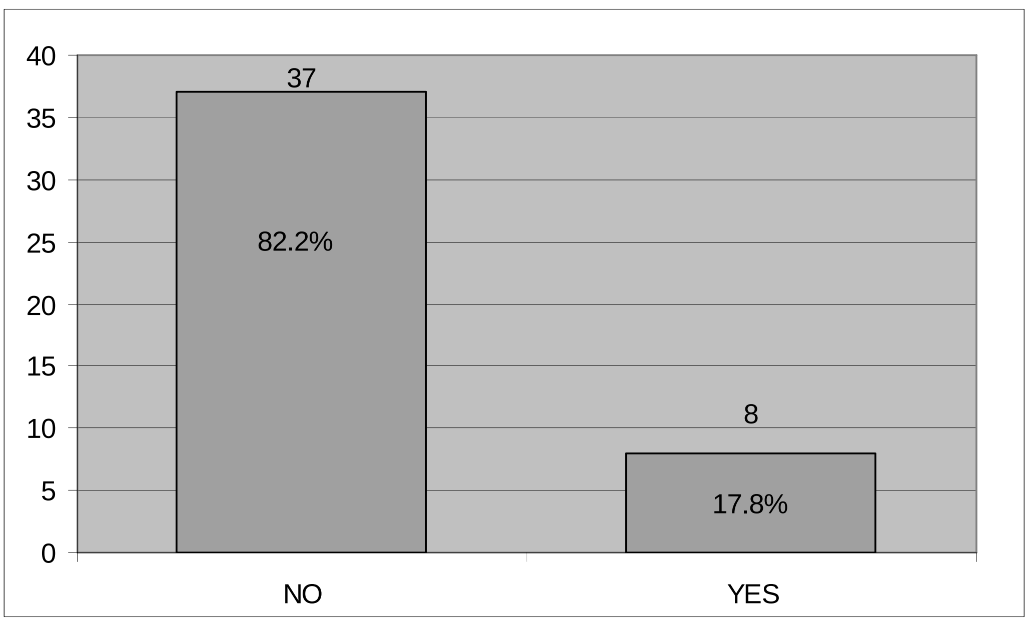

Figure B-3

Criteria That Would Enhance the MCFRS Collision Investigation Process

Select all that apply. Which of the following criteria would enhance the MCFRS collision investigation process?

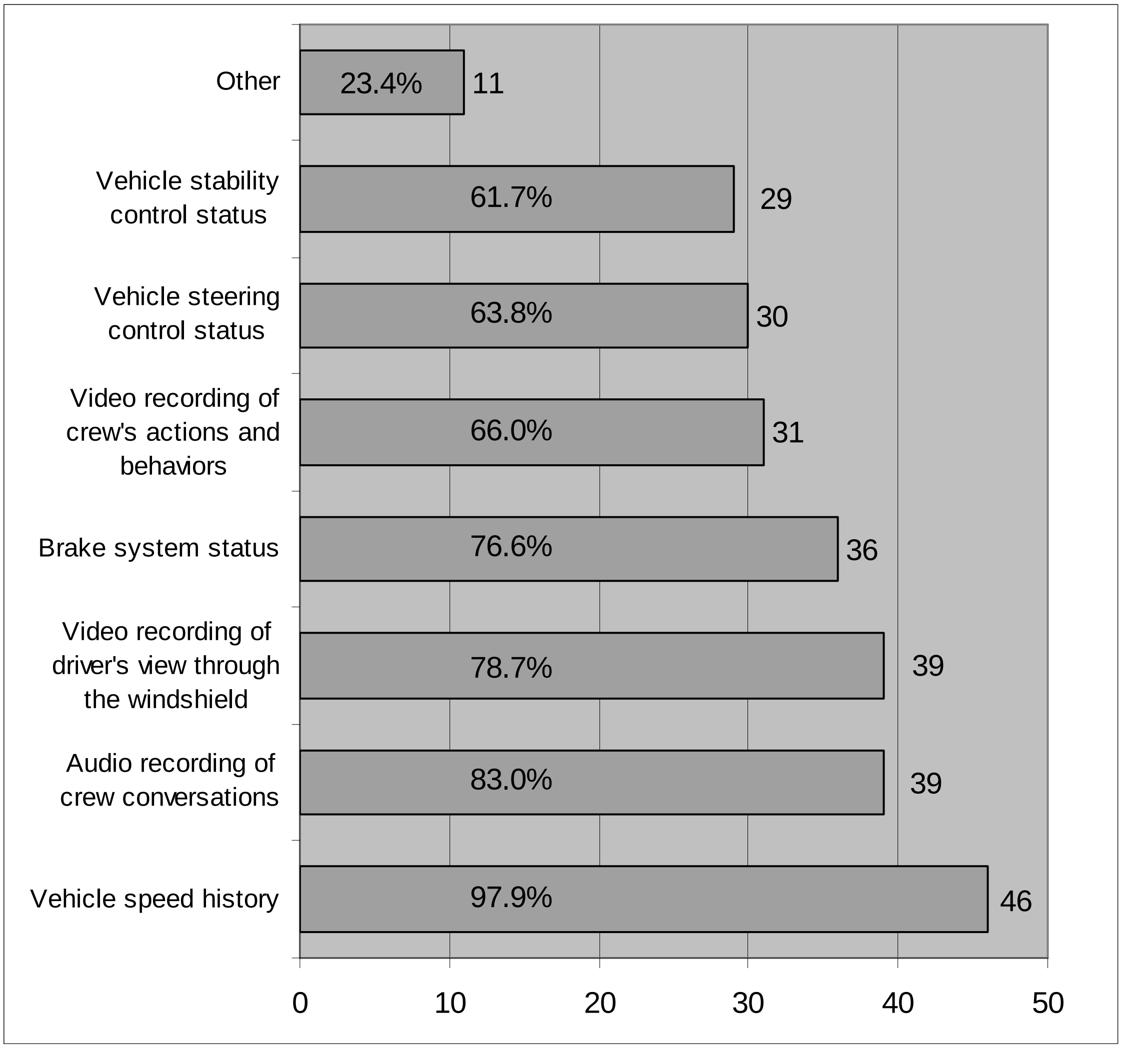

Table B-1

Collision Investigation Criteria

Rank the following criteria in order of importance when conducting a collision investigation.

Criteria	**Respondents Rankings**				
	1	**2**	**3**	**4**	**5**
Post collision physical evidence (skid marks, yaw, etc.)	16	10	5	6	10
Vehicle systems status	15	10	3	10	9
Traffic conditions	6	10	11	14	6
Weather and environmental conditions	8	7	13	6	13
Status of traffic control devices	2	10	15	11	9

Table B-2

Assessment of Pre-crash Vehicle Condition

Rank the following criteria in order of importance that provides the collision investigator the best assessment of pre-crash vehicle condition.

Criteria	**Respondents Rankings**				
	1	**2**	**3**	**4**	**5**
Review of vehicle maintenance records	14	11	8	8	6
Review of the written driver's statement	10	7	6	18	6
Review of daily vehicle checkout sheets	8	14	11	7	7
Third party post crash vehicle inspection	8	7	16	6	10
Review of crew and witness statements	7	8	6	8	18

Table B-3

Collision Investigation Criteria-Order of Importance

Rank the following human response investigation criteria in order of importance to you when conducting a collision investigation.

Criteria	**Respondents Rankings**				
	1	**2**	**3**	**4**	**5**
Driver and crew's written statements	19	15	9	2	2
Witness statements	10	22	5	10	0
Crew cab physical evidence	9	2	14	10	12
Official police report	6	5	15	13	8
Driver's collision history	3	3	3	12	25

Table B-4

Criteria to Determine Driver's Response to a Imminent Collision

Rank the following criteria in order of importance that best determines the driver's response to a imminent collision.

Criteria	**Respondents Rankings**				
	1	**2**	**3**	**4**	**5**
Driver alertness	36	9	2	0	0
Driver's use of required safety belts	5	2	2	3	35
Driver's head and eye movement	3	22	14	5	3
Driver's field of vision through the windshield	3	13	17	13	1
Driver's hand positions on the steering wheel	0	1	12	26	8