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Effectiveness of Mandatory Driver Training Programs for Fire Service Drivers

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EFFECTIVENESS OF MANDATORY DRIVER TRAINING PROGRAMS
FOR FIRE SERVICE DRIVERS

By

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By

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DEDICATION

This thesis is dedicated to my wife and daughter

Lee and Ellery Pietzsch

who have made so many sacrifices to

make this achievement possible

Thank you!

ACKNOWLEDGMENTS

I would like to thank the Chair of my committee, Dr. Terry Kline for his dedication to the education process and ensuring that I learn even after his formal retirement. I would also like to thank the other members of my committee, Dr. Sarah Morris for her guidance, expertise, and patients and James Pharr for his support through this long process. I would like to thank the Glatfelter Insurance Group for their dedication to education and Associate development.

ABSTRACT

This research attempts to measure the effectiveness of mandatory driver training programs for fire service drivers. Effectiveness is defined by a decrease in the number of crashes per number of runs. Two states were identified for comparison, one with mandatory driver training requirements, Washington State (WA) and the other with no requirements, Pennsylvania (PA). Data was collected from state Department of Transportation (DOT) databases and state National Fire Incident Reporting Systems (NFIRS). A cross-sectional study was conducted to compare crash rates calculated from state DOT crash numbers and NFPA run numbers. The WA effectiveness rate was then compared to the PA effectiveness rate which yielded the results.

It was found that reported public data did not provide for accurate evaluation of effectiveness of mandatory driver training programs. A procedure was established to calculate more accurate data for comparison. Calculating the estimated total runs for each state by using reported data and estimating for unreported data provides for more accurate data for comparison.

An independent sample t-test was conducted on state DOT reported crash data and NFIRS reported run data. There was a significant difference in the number of crashes per 100,000 runs between Pennsylvania (PA) and Washington (WA) for 2003-2012 ($t=3.48$, $p=.01$); the mean number of crashes per 100,000 runs for PA was 188 ($SD=162$) while the mean number of crashes per 100,000 runs for WA was 10 ($SD=2$).

A second independent sample t-test was conducted on state DOT reported crash data and NFIRS estimated total run data (determined by taking the total number of reported incidents divided by the total state reporting FDID's resulting in the number of runs per state FDID. The number of runs per state FDID was then multiplied by the total number of state FDIDs for each year resulting in the total estimated runs per year). This second test is important as it gives a better representation of the actual number of runs for both states.

Using estimated total runs in the second test instead of only reported runs as was done in the first test, results in less but still a significant difference in the number of crashes per 100,000 runs between PA and WA for 2003-2012 ($t=3.48$, $p=.01$); the mean number of crashes per 100,000 runs for PA was 65 (SD=35) while the mean number of crashes per 100,000 runs for WA was 7 (SD=1).

After reviewing the difference between the two tests, the PA mean crash rate went from 188 crashes per 100,000 runs to 64 crashes per 100,000 runs and the WA mean crash rate went from 10 crashes per 100,000 runs to 7 crashes per 100,000 runs between test one and test two respectively. Standard deviation decreased from 162 to 35 for the PA data, and 2 to 1 for the WA data between test one and test two respectively. The confidence limits (t-value) and the probability level (p-value) remained the same between the two tests (3.48 and .01 respectively). Test two results produced a more accurate representation of the actual number of crashes per 100,000 runs.

These results indicate that mandatory training as implemented through the Emergency Vehicle Accident Prevention (EVAP) program in Washington State was effective at reducing the number of crashes that fire apparatus were involved in over the study period. However, data analysis indicates that the program did not have a long-term impact beyond one or two years following its implementation or re-accreditation. Further, there is consistency of record high crash rates as time elapses following re-accreditation. If this trend continues, then the 2013 re-accreditation will have had a positive impact on the reduction of crash rates in 2013 and possibly into 2014, however a hypothesis can be made that there will be an increase in crash rates beginning in 2015 and beyond until the next re-accreditation occurs.

Due to the limitations in current available public data there is an opportunity to get a better understanding of crash exposure through future analysis of data from sources such as insurance companies that measure actual exposure to crashes including those that are non-reportable to state DOTs.

Further opportunities exist for research on the root causes of ERV crashes with specific focus on the effects of population and emergency services culture on fire department crash rates. Data for these types of studies is not easily accessible so original empirical data methods should be established.

Regardless of program content, the Washington EVAP program is effective at reducing crash rates. However, further studies are necessary to determine a more permanent method of reducing the number of crashes over a longer period of time. Focus should be given to program content that results in consistent and positive driver habits and choices.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Emergency response vehicle crashes have been the subject of many studies and literature since the passing of the Commercial Motor Vehicle Safety Act of 1986 with the most recent studies having been conducted since 2012. The focus of these studies included root cause analysis, lack of proper training, and driver distraction as main areas of crash concern.

1.1 Definition of Emergency Response Vehicle

An emergency response vehicle (ERV) is defined by each state in their motor vehicle code. The Washington State Motor Vehicle Code defines an authorized emergency vehicle as;

> “Authorized emergency vehicle" means any vehicle of any fire department, police department, sheriff's office, coroner, prosecuting attorney, Washington state patrol, ambulance service, public or private, which need not be classified, registered or authorized by the state patrol, or any other vehicle authorized in writing by the state patrol. (RCW 46.04.040, 1987)

The Commonwealth of Pennsylvania Motor Vehicle Code defines an emergency vehicle as;

> § 121.1. Definitions. Emergency vehicle —A fire, police or sheriff department vehicle, ambulance, blood-delivery vehicle, hazardous material response vehicle, armed forces emergency vehicle, one vehicle operated by a coroner or chief deputy coroner or deputy chief county medical examiner used for answering emergency calls. The term includes motor vehicles under 75 Pa.C.S. § 6106 (relating to designation of emergency vehicles by Pennsylvania State Police), or a privately-owned vehicle specified in 75 Pa.C.S. § 102 which is used in answering an emergency call by any of the following:
>
> (i) A police chief and assistant chief.

(ii) A fire chief, assistant chief and, when a fire company has three or more fire vehicles, a second or third assistant chief.

(iii) A fire police captain and fire police lieutenant.

(iv) An ambulance corps commander and assistant commander.

(v) A river rescue commander and assistant commander.

(vi) A county emergency management coordinator.

(vii) A fire marshall.

(viii) A rescue service chief and assistant chief. (35 P. S. § 4003)

Authorized ERVs, especially fire apparatus due to their size, are a special type of vehicle that poses special risks to both their occupants and to the motoring public. This includes their unique size and vehicle dynamics such as high center of gravity, dynamic loads, and custom chassis for performance and specialty use. Many fire apparatus such as most engines, aerial trucks, tankers and some special rescue trucks qualify as a commercial vehicle under the definition provided by the Washington Department of Licensing (2014): "Any single vehicle with a gross vehicle weight rating (GVWR) of 26,001 pounds or more (p.1-1).

Fire apparatus are similar only in weight to ordinary over-the-road vehicles. For example, fire apparatus rarely travel further than 20 miles in one trip, and more frequently travel less than 5 miles. According to the FEMA (2014) initiative, the goal of the Commercial Motor Vehicle Safety Act was to make highways safer by ensuring that drivers of large trucks and buses are qualified to operate the specific vehicle that they were expected to operate.

1.2 Federal Commercial Motor Vehicle Safety Act of 1986

The Federal Commercial Motor Vehicle Safety Act is enforced through the Federal Motor Carrier Safety Administration (FMCSA), a division of the United States Department of Transportation. The qualification and licensing of individual drivers is the responsibility of state government. According to FMCSA (2014), "States develop their own knowledge and skills tests, which must meet the minimum Federal standards in Subpart G and H of 49 C.F.R. Part 383."

If a driver of an ERV has a Commercial Driver's License (CDL), they are not required by Washington State law to have any further training to operate an ERV, however they are required to operate the class of vehicle during licensing for which they will be licensed. Once a commercial license is issued, it is up to the employer to ensure that proper training and orientation is provided to the driver for the specific vehicle that they will operate. Needing no further training on the operation of an ERV, Washington State law by abstaining from any further requirements presumes that CDL alone provides sufficient training to an ERV driver to reduce crash rates. In addition, an ERV operator in Washington State does not have to obtain a CDL. They may instead choose to obtain the minimum training required by the state's CDL exemption program as defined by the Revised Code of Washington (RCW 46.25.050 (1)(b)(i)).

1.3 Problem Statement

Operation of emergency response vehicles is often performed under stress where time is of the essence and lights and sirens are used to expedite response. All fifty states allow emergency response vehicle (ERV) operators various privileges beyond normal traffic laws with the intent of enabling assistance to be rendered in an expedited manner to the general public.

CHAPTER II

LITERATURE REVIEW

Studies involving root cause analysis of ERV crashes yielded statistics showing that intersections were not only the highest frequency, but also the most costly from loss of life and property damage. Abdelwanis, (2013) confirmed that although police cars accounted for nearly 80 percent of ERV crashes, ambulances were more than twice as likely to be associated with fatal crashes in North Carolina. This same study confirmed that intersections posed the greatest risk for ERV related fatalities. Other significant studies according to Abdelwanis, (2013) are classified into "…categories such as environmental factors, driver behavior, vehicle type, and crash description" (Abdelwanis, 2013, p.5). These classifications are also related to root cause analysis for crashes. According to Abdelwanis (2013) (as cited in Custalow and Gravitz, 2004) a study of ambulance crashes in the greater Denver, Colorado area from 1989 to 1997 found that 91 percent of ambulance crashes occurred during the emergency mode of operation. Custalow and Gravitz (2004) compared like-sized non-emergency type vehicles to ambulances which is significant because the similar non-emergency vehicles of like-size were more likely to be involved in rear-end collisions where ambulances were more likely to be involved in intersection collisions such as a T-bone style crash, suggesting that operating a vehicle the size of an ambulance in an emergency response mode changes the probable collision type.

A study by Ray and Kupas (2007) compared ambulance crashes in rural settings verses urban settings. This study compared data from the Pennsylvania Department of Transportation from 1997-2001 and found that driver error was the most common cause of ambulance crashes in Pennsylvania during this period. Ray and Kupas (2007) found that driver error was the cause of the collision in the urban setting 93 percent of the time and in the rural setting 75 percent of the time. Besides the number of incidents, the big difference between the urban setting and the rural setting according to Ray and Kupas (2007) was that ambulance crashes in the urban setting were more likely to occur in intersections and involve other vehicles, where vehicle or environmental conditions effected rural ambulance collisions and they were more likely to collide with a fixed object rather than another vehicle.

The Gkritza (2003) study was a dissertation focused on the effects of pre-emption devices in the Washington D.C. area on improved response time. This study showed that the use of pre-emption devices resulted not only in decreased response times, but also a reduction in the number and severity of emergency vehicle crashes. Becker, Zaloshnja, Levick, Li, and Miller (2003) studied the risk of injury and death of occupants in emergency vehicles from 1988-1997. This study found that “lack of restraint use and/or responding with ‘lights and siren’ characterized the vast majority of fatalities among fire truck occupants” (Becker, et. al., p.941). Becker, et.al. (2003) found that 73 percent of firefighter injuries from fire truck collisions occurred during the emergency operation of the vehicle; however only 55 percent of firefighter fatalities related to fire truck collisions occurred during the emergency operation of the vehicle. The findings in Becker, et.al. (2003) are significant to this study because it separates passenger vehicle crashes from fire truck crashes. It concluded that “emergency response is especially hazardous for firefighters” (Becker, et.al., p.946). Becker, et.al. (2003) recommend engineering controls be evaluated in ambulance restraint systems for rear patient compartments, as well as training emergency responders in the dangers associated with unrestrained occupants and equipment in ERV’s.

Driver inattention is also a common cause to many emergency vehicle involved crashes. Several studies focus on “Distracted Driving” such as Klauer, Guo, Simons-Morton, Ouimet, Lee, and Dingus (2014) who studied the risk of distracted driving, which they refer to as secondary tasks, using a sample group of experienced and novice drivers (16-17 years old) from June 2006 through September 2008. Examples of these secondary tasks include; dialing a cell phone, reaching for a cell phone, texting, reaching for an object other than a phone, looking at a roadside object, and eating. The study found that a novice driver’s risk increases significantly when actively engaged in many of these secondary tasks. However, experienced drivers were only at a higher risk of crash or near-miss when dialing a cell phone in this study. It was also found that as the study progressed, the novice driver increased their attention to secondary tasks. The report indicated development of high risk behavior acceptance in the novice drivers as the drivers gain more experience. The results of this study directly relate to overall driver behavior and the relation between experienced drivers and novice drivers which may be correlated to drivers of ERV's.

According to Regan, Hallett and Godon (2011) driving itself, is a distraction. In their study, they define and compare driver distraction and driver inattention. Driver distraction, which we have become familiar with and associate with such things as the use of mobile devices and in-cab interference such as passengers, is defined in Regan, et.al (2011) as; Driver Diverted Attention (DDA)-The diversion of attention away from activities critical for safe driving toward a competing activity, which may result in insufficient or no attention to activities critical for safe driving (Regan, et.al., p.1776).

According to research performed by Lonero (2008) "driver education is intended to mitigate novice driver risk factors" (p.S316). Lonero focused on the education of young drivers and found that educating drivers requires changing the "choices and habits that determine actual driving behavior" (p.S321). In his article entitled "Trends in Driver Education and Training", Lonero recommends focusing future driver education on individual, social, and cultural factors related to driving. Lonero suggests that "driver education needs to be more firmly based on driver skills, behavior, motivation, and risk and, at the same time, in the principles of effective behavior change" (p.S321-S322). Further, education and training alone do not effectively work to reduce crashes.

The California Commission on Peace Officer Standards and Training: Driver Training Study (2009) evaluated the effects of driver simulation on crash reduction as well as the importance of enforcing policy. This study found that driving skills are perishable, ongoing emergency vehicle driver training reduces the number of law enforcement collisions, and the addition of driving simulation with EVOC has the greatest effect on reducing law enforcement collisions. The recommendations provided within this study included in-service training every twenty four months as well as curriculum enhancements.

As illustrated by the above study, EVOC training is known to reduce the number of collisions; however most states do not require any type of specialized or ongoing training. For example, the Wisconsin State Patrol study as prepared by CTC & Associates LLC and the WisDOT Research & Library Unit (2010) provided state Emergency Vehicle Operator Course (EVOC) requirement inventory for Ambulance drivers. This inventory identified that eleven states require ambulance drivers to complete some type of EVOC training to operate an ambulance, however the large majority of jurisdictions to not require any special training or testing related to driving over and above a basic driver's license.

Contrary to the hypothesis that structured training programs would be more effective at reducing the number of crashes, Lonero found that more education is always a popular prescription for improving safety, but demonstrated effectiveness in improving safety performance solely through education of any form is relatively rare (Lonero, p.S317).

Driver training through the use of simulation has been studied. Dorn and Barker (2005) studied the effects of driver training amongst police officers in the United Kingdom (UK) through the use of a simulator. This study found that police drivers applied their learned defensive driving techniques and driving experience more successfully than the untrained driver. Importantly, this study suggests that age and driving experience are significantly correlated (Dorn & Barker, p.65).

Several studies, including the Abdelwanis, (2013) and Ray & Kupas (2007), have shown that intersections provide the greatest risk for EV crashes, both in frequency and in loss of life and property. They account for a majority of EV crashes and are the most dangerous for the motoring public. There have also been programs put in place to try to raise awareness to the emergency services community of the dangers of intersections with some limited success. Volunteer Fire Insurance Services (2006) has one such program called “Intersections: Operation Safe Arrival”. According to this video program, successful reduction of intersection incidents requires rules and regulations to be provided and enforced.

The United States Fire Administration recently published its updated Emergency Vehicle Safety Initiative (FEMA, 2014). The purpose of this document is to forward the results of many studies and best practices in emergency services to members of the United States Fire Service. Some of the more significant studies referenced include the FEMA (2009) study that researched best practices with regard to emergency lighting devices to alert other drivers of their presence, and retro-reflective vehicle marking such as the chevron now found on rear-facing surfaces of many ERV’s (p.6). The FEMA (2014) study cites NFPA 1002: Standard for Fire Apparatus Driver/ Operator Professional Qualifications and suggests that it “strongly urges fire departments to require apparatus drivers to obtain a Commercial Driver’s License (CDL) for their state” (p. 82) as the NFPA 1002 technical committee based the objectives of fire apparatus driver training standard on CDL requirements. However, this study does not offer any empirical data as evidence to support the theory of CDL effecting crash rates or severity.

Through this literature review, a gap has been identified with regard to measuring the impact of training programs such as CDL exemption programs. For example, according to the U.S. Department of Transportation Federal Motor Carrier Safety Administration; “The Commercial Motor Vehicle Safety Act of 1986 was signed into law on October 27, 1986. The goal of the Act is to improve highway safety by ensuring that drivers of large trucks [fire apparatus] and buses are qualified to operate those vehicles and to remove unsafe and unqualified drivers from the highways” (U.S. Department of Transportation, 1986). This Act was the birth of the Commercial Driver’s License Program (CDL) which can be found today under Title 49 of the Code of Federal Regulations (CFR), Part 383, Volume 5 (2011). The federal law “Establishes requirements for the commercial license documentation” (49 CFR 383.1(B)(11)). This resulted in various state exemptions which typically include farm related activities, firefighters and military. Commercial motor vehicle operation required a state-issued CDL after April 1, 1992. According to the U.S. Fire Administration initiative, lobbying by the fire service resulted in most states exempting emergency vehicles from CDL licensing (FEMA, 2014). Some states made certain members of emergency services qualify for CDL exemption through alternate forms of training such as the use of EVOC or similar programs; however a majority of the states do not require any special training to qualify for CDL exemption. There is no data or evaluation of the effects of CDL exemption or the effectiveness of emergency response vehicle driver training programs on reducing incidents as was the goal of the Commercial Motor Vehicle Safety Act of 1986.

2.1 Purpose of Research

The purpose of this study is to test the effectiveness of mandatory driver training programs for fire service drivers. This thesis would contribute to the literature related to transportation safety by testing the effectiveness of regulation on ERV crash rates. This study will evaluate the effectiveness of the CDL exemption program (EVAP) in Washington State which includes mandatory training for fire apparatus operators on topics such as those included in previous research including intersection safety (Abdelwanis, 2013), effects of emergency response (Custalow and Gravitz, 2004), vehicle dynamics/ driver error (Ray & Kupas, 2007), distracted driving (Keaur, et.al., 2014), and the requirements of NFPA 1002: Standard for Fire Apparatus Driver/Operator Professional Qualifications. This thesis attempts to address the question as to whether the Washington EVAP program has been effective in its goal of reducing ERV crashes since its effective date in comparison to a State without a structured EVAP program. The original purpose of the CDL program was to provide a safer driver behind commercial vehicles on the roadways. Emergency response vehicle crash data will be evaluated regardless of emergency response status. Available data will allow evaluation of fire apparatus crash data from 2003 to 2012.

The Washington State Emergency Vehicle Accident Prevention (EVAP) program uses three accredited programs for the purpose of CDL exemption. The purpose of this program is to reduce the number of emergency vehicle crashes, yet the focus of the program is through the licensing requirements for commercial vehicle exemption. The program focus is on operators of vehicles that qualify as commercial vehicles (over 26,000 pounds) and requires operators of such vehicles to either possess a CDL or show proof of training from one of the three accredited programs.

The three programs currently accredited by the Washington Department of Licensing and the State Police are: VFIS's Emergency Vehicle Driver Training (EVDT) program (2008), International Academy for Professional Driving (IAPD), and the Washington Fire Chiefs Emergency Vehicle Incident Prevention (EVIP) program. Each of these programs is required to be approved through the Washington State Patrol (WSP) standards and accreditation process. Per the Revised Code of Washington (RCW) these programs must be submitted for approval and resubmitted every five years.

Washington State Patrol standards and accreditation have an agreement with Washington State Department of Licensing, Commercial Drivers Licensing, to review and approve driver training programs for firefighters. According to the Program Coordinator at the Washington Office of the State Fire Marshal, the EVAP accreditation process includes evaluation of program materials to ensure that they meet or exceed NFPA 1002 requirements and some basic Washington CDL requirements as determined by the staff of the State Fire Marshal's office. No matrix or list of any kind was available for reference. Each of the programs is reviewed by a curriculum committee to ensure that the programs meet the standards (W. Slosson, personal communication, October 3, 2014).

Washington State and the Commonwealth of Pennsylvania have minor differences in their motor vehicle codes with regard to emergency vehicle exemptions. However, these laws have not changed over the period included in this research. Education practices need to be more firmly based on driver skills, behavior, motivation, and risk, and, at the same time, in the principles of effective behavior change (Lonero). Regardless of program content, CDL exemption programs may only be effective at reducing crash rates if the content is learned and driver choices and habits improve, resulting in behavior change.

2.2 Study Objectives

The primary goal of this study is to test the effectiveness of required training for fire department drivers. Effectiveness is defined by a decrease in the number of crashes per the number of runs. The Washington State Effectiveness Rate will be compared to the Commonwealth of Pennsylvania Effectiveness Rate.

CHAPTER III

METHODOLOGY

3.1 Design and Sample

This cross-sectional study compares crash rates calculated from state DOT crash numbers and National Fire Incident Reporting System (NFIRS) run numbers.

3.2 Measures

Pennsylvania does not have a training requirement; however, there are many departments that participate in risk management programs that provide driver training to fire apparatus operators. Some operators have CDL training and licensing, though not commonly attained with the use of a fire apparatus during testing. The three Washington EVAP programs were first accredited in 2002. Because data gathering was implemented at approximately the same time, it is appropriate to suggest that the EVAP program began in 2002.

When reviewing the number of crashes, it is important to consider exposure to the risk of a crash. This exposure is measured by the number of times a vehicle has the potential to be involved in a crash.

An estimated total number of runs were established using the number of Fire Department Identification (FDID) numbers as provided by state NFIRS databases. The FDID numbers represent the total number of organizations that could report using the system. The total number of reported runs divided by the total reporting FDID's produced the number of runs per FDID. The number of runs per FDID was then multiplied by the total number of FDIDs for each year. The resulting number is the estimated total runs for each state.

3.3 Analysis

NFIRS estimated total run data will be determined by taking the total number of reported incidents in each state each year, divided by the total reporting state FDID's for the respective year, resulting in the number of runs per state FDID each year. The number of runs per state FDID will then be multiplied by the total number of state FDIDs each year, resulting in state estimated total runs per year.

Independent sample t-tests will be used to compare the mean crash rates between PA and WA. The first t-test will use raw data rates. A second independent t-test will be conducted on the adjusted “estimated total” rates.

CHAPTER IV

RESULTS

4.1 Pennsylvania Data

Pennsylvania Department of Transportation (PennDOT) data was retrieved for the period beginning in 2003 through 2013. Analysis of this data showed a steady decline in the number of reported crashes involving at least one fire apparatus as seen in Figures 1.

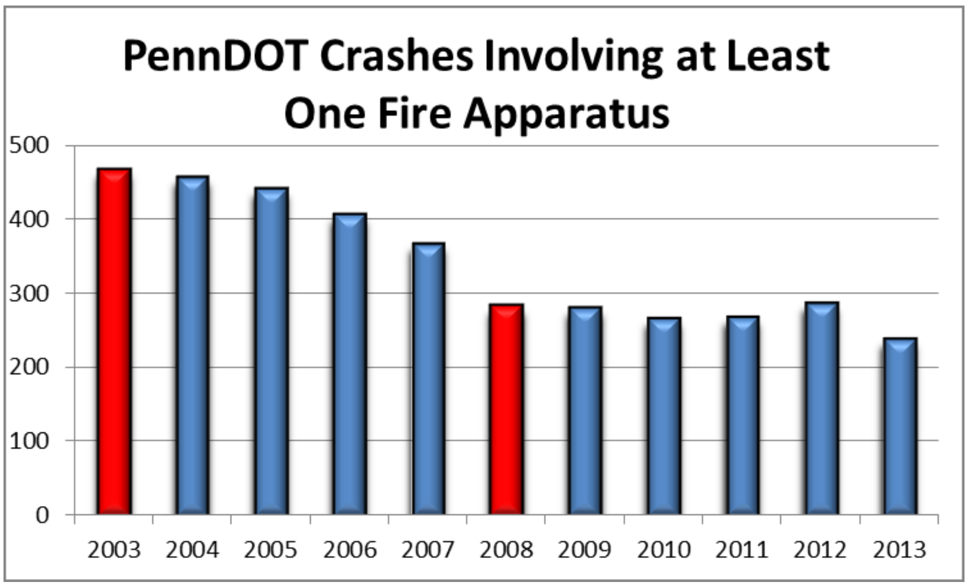

Figure 1 PennDOT Crashes Involving at Least One Fire Apparatus

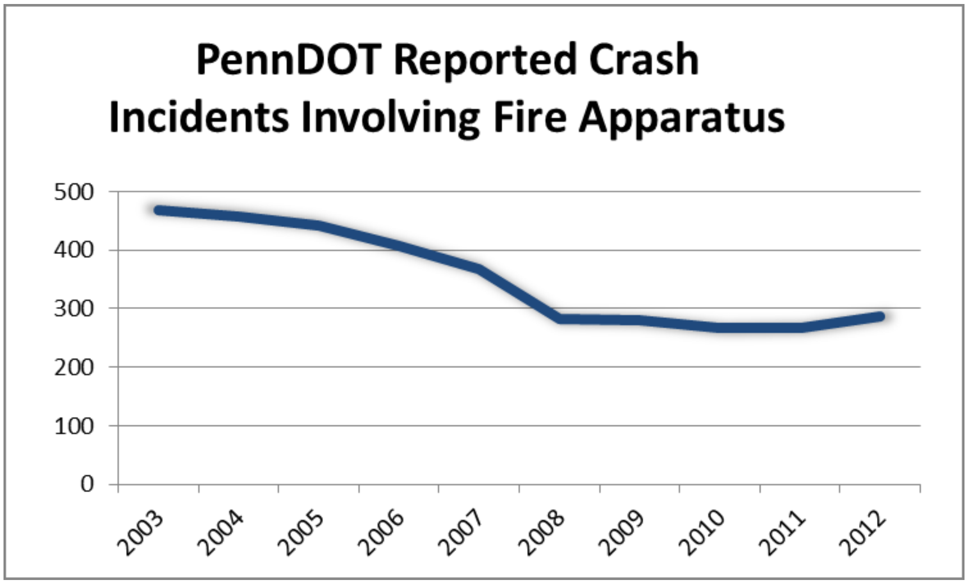

Figure 2 PennDOT Reported Crash Incidents Involving Fire Apparatus

When reviewing the number of crashes, it is important to consider exposure to the risk of a crash. This exposure is measured by the number of times a vehicle has the potential to be involved in a crash. Though it is not possible with the available data to measure every exposure to a crash, such as parades and duties other than call response (runs), we can measure the number of documented emergency response runs. To get a better understanding of crash exposure, we will evaluate the number of crashes per run involving fire apparatus. Figure 3 shows the number of reported runs from the Pennsylvania National Fire Incident Reporting System (PA-NFIRS) run data. Reported runs only account for those departments that report their runs to the PA-NFIRS system. The method of reporting has changed over the years from paper reporting to an online reporting system.

The number of runs that PA fire departments responded to increased steadily throughout the study period. The method of reporting has changed over the years represented in this study from paper reporting to an online reporting system. It was noted that fire department participation in the PA-NFIRS process was only 6 percent in 2002 and steadily increased through 2012 with the highest reporting rate being 66 percent of registered fire departments reporting in 2011. The median reporting percentage over the study period is 42 percent of Pennsylvania fire departments reporting run data to PA-NFIRS.

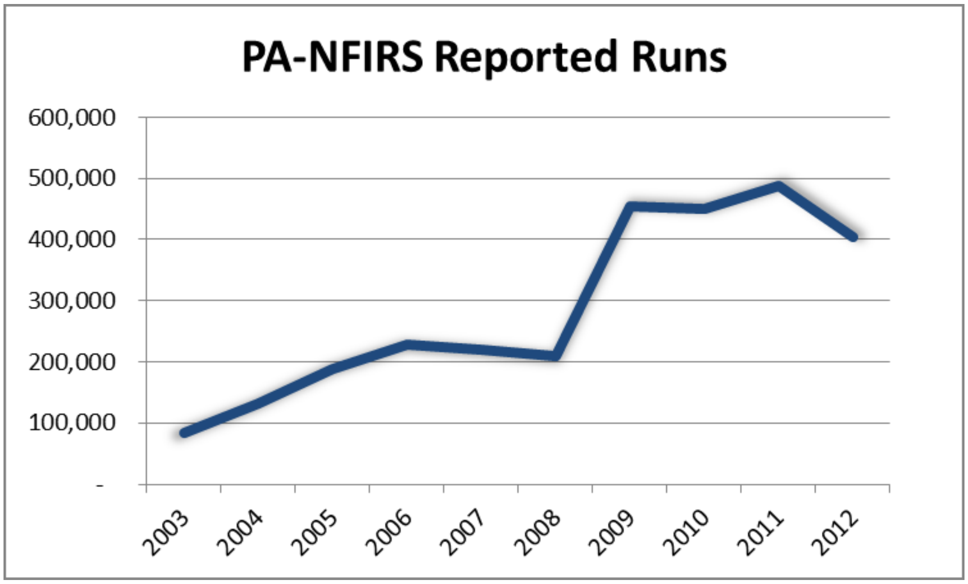

Figure 3 PA-NFIRS Reported Runs

A notable exception occurred in 2011 when the number of Pennsylvania Fire Department Identification Numbers (PA-FDID's) increased substantially from 2,003 in 2010 to 3,423 in 2011 and retreated to 2,016 in 2012 according to reported PA-NFIRS data. This inconstancy may be related to the implementation of statewide electronic reporting initiated by the state.

Figure 4 shows the number of PA-NFIRS reported runs per reported PennDOT crash. There is a steady increase over the study period with a significant increase from 2008 to 2009 and then a sudden decrease from 2011 to 2012.

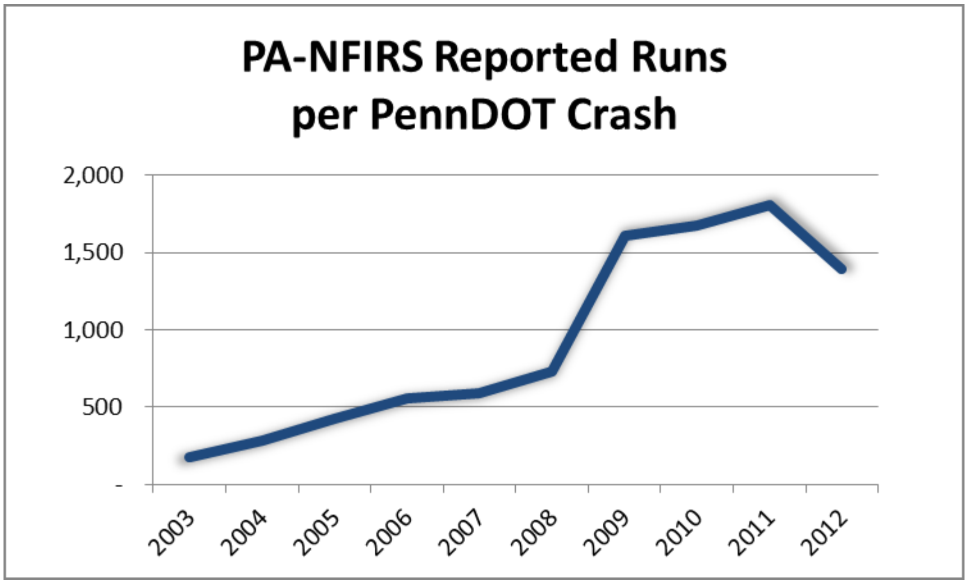

Figure 4 PA-NFIRS Reported Runs per PennDOT Crash

Figure 5 shows an estimated total number of runs based on the number of PA-FDID numbers. This calculation was determined by taking the total number of reported incidents divided by the total reporting PA-FDID's which produced the number of runs per reporting FDID. The number of runs per reporting PA-FDID was then multiplied by the total number of FDIDs for each year producing the total estimated runs for the Commonwealth of Pennsylvania as shown in Figure 5.

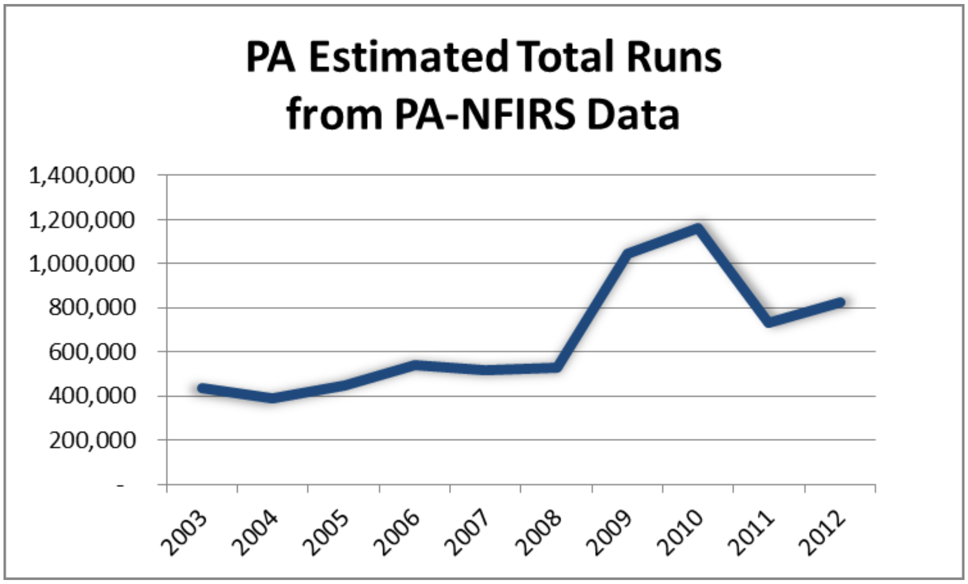

Figure 5 PA Estimated Total Runs from PA-NFIRS Data

Figure 6 shows the PA-NFIRS estimated total runs per reported PennDOT crash. Note the decrease from 2010 to 2011. This decrease shows up a full year before a similar decrease from 2011 to 2012 in the reported runs data as shown in Figure 4.

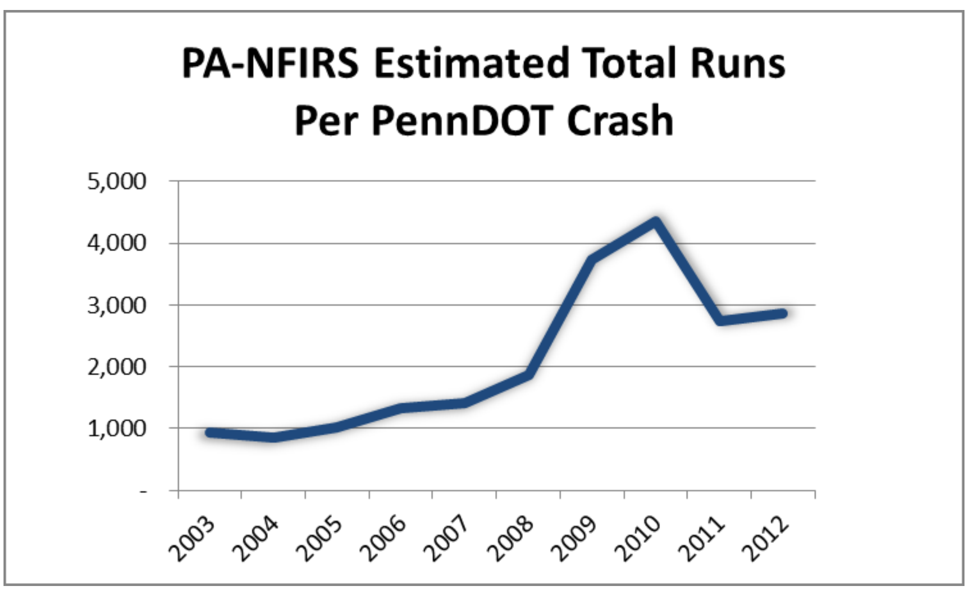

Figure 6 PA-NFIRS Estimated Total Runs per PennDOT Crash

4.2 Washington State Data

Washington State DOT (WSDOT) data was retrieved for a ten year period from 2003 through 2012. The data was sorted to include all crashes involving at least one fire apparatus. Figure 7 shows the results of the data collection with the years 2003 and 2008 highlighted in red showing EVAP program accreditation years.

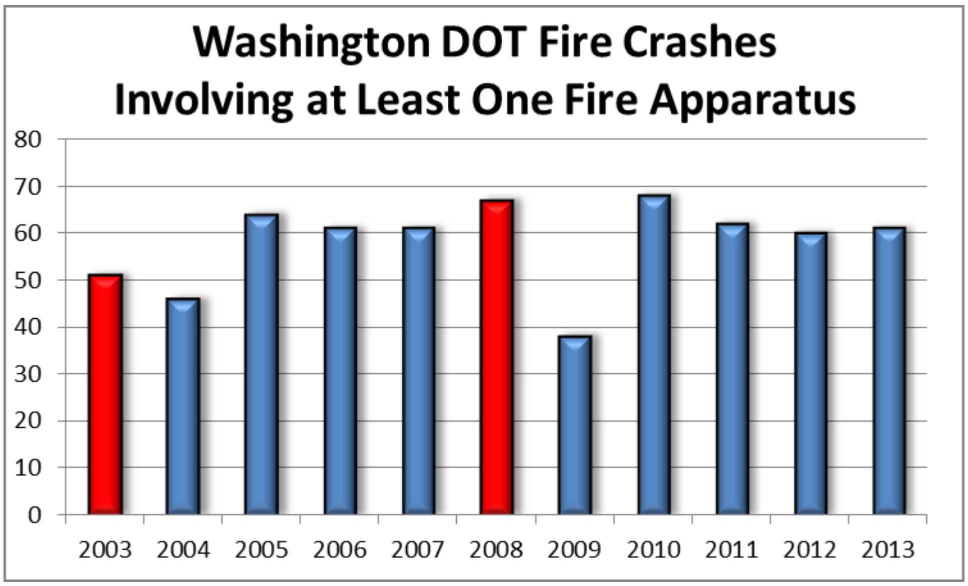

Figure 7 WSDOT Crashes Involving at Least One Fire Apparatus

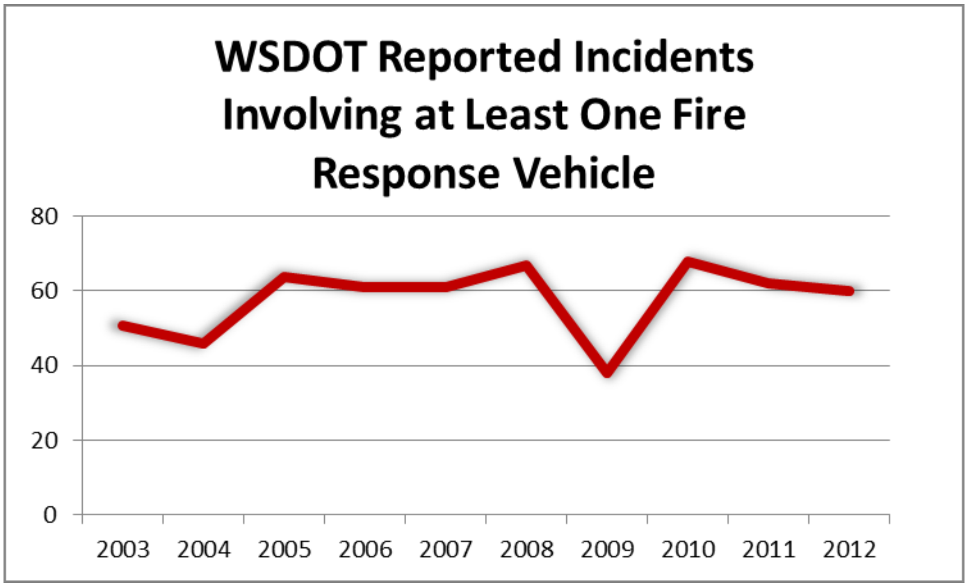

Figure 8 WSDOT Reported Incidents Involving at Least One Fire Response Vehicle

Overall, from 2003 through 2012 the number of crashes has increased. Only two years saw a reduction in crashes; the reductions from 2003 to 2004 was immediately following the EVAP program implementation. The only other year that saw significant reduction in crashes per year was 2009, which is one year after the first re-accreditation of the EVAP training programs.

When reviewing the number of crashes, it is important to consider exposure to the risk of a crash. This exposure is measured by the number of times a vehicle has the potential to be involved in a crash. Though it is not possible with the available data to measure every exposure to a crash, such as parades and duties other than call response, we can measure the number of documented emergency response runs. To get a better understanding of crash exposure, we will evaluate the number of crashes per run involving fire apparatus. Figure 9 shows the number of reported runs from the Washington National Fire Incident Reporting System (WA-NFIRS) run data. Reported runs only account for those departments that report their runs to the WA-NFIRS system.

The method of reporting has changed over the years from paper reporting to an online reporting system.

Fire Department participation in the WA-NFIRS process mostly increased over the study period with the highest reporting rate of 71 percent of registered fire departments reporting in 2009. Noted was the retreat in reporting rates in 2011 and 2012 from a prior steady increase. The median reporting percentage over the study period is 69 percent of WA fire departments reporting run data to NFIRS.

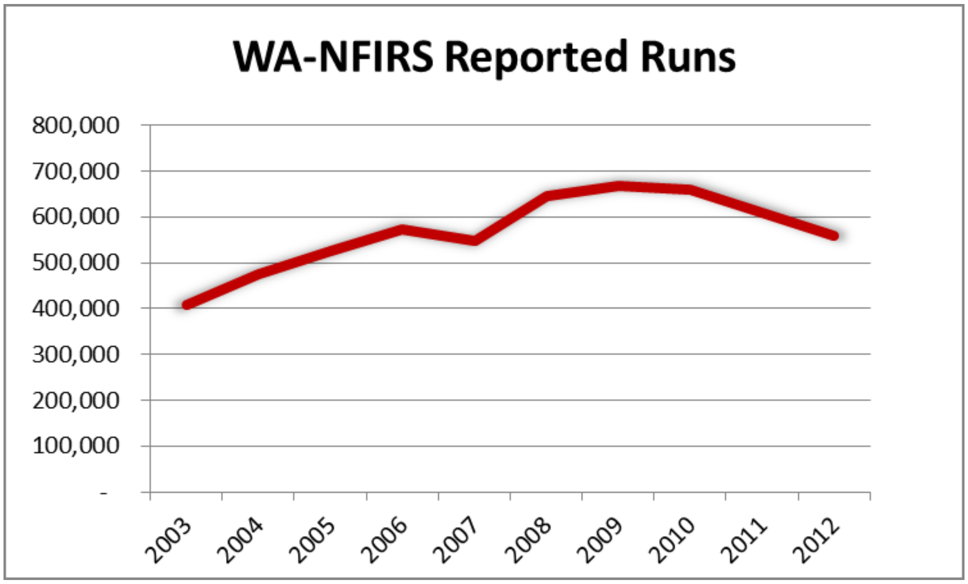

Figure 9 WA-NFIRS Reported Runs

Figure 10 shows the number of reported runs per crash using WSDOT data and WA-NFIRS run data. The number of reported crashes per run increased from 2003 through 2012 showing an improvement in exposure to crash risk with a significant increase in 2009 as shown in Figure 10.

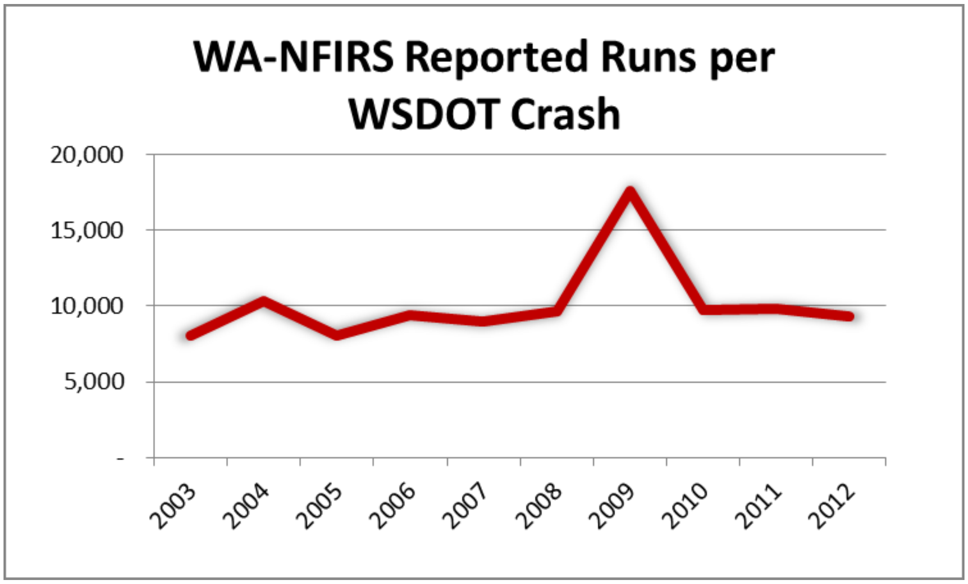

Figure 10 WA-NFIRS Reported Runs per WSDOT Crash

Figure 11 shows the estimated total number of runs based on the number of Washington Fire Department Identification (WA-FDID) numbers. This calculation was determined by taking the total number of reported runs divided by the number of reporting WA-FDID's which produced the number of runs per reporting WA-FDID. The number of runs per reporting WA-FDID was then multiplied by the total number of WA-FDIDs for each year producing the total estimated runs Washington State as shown in Figure 10.

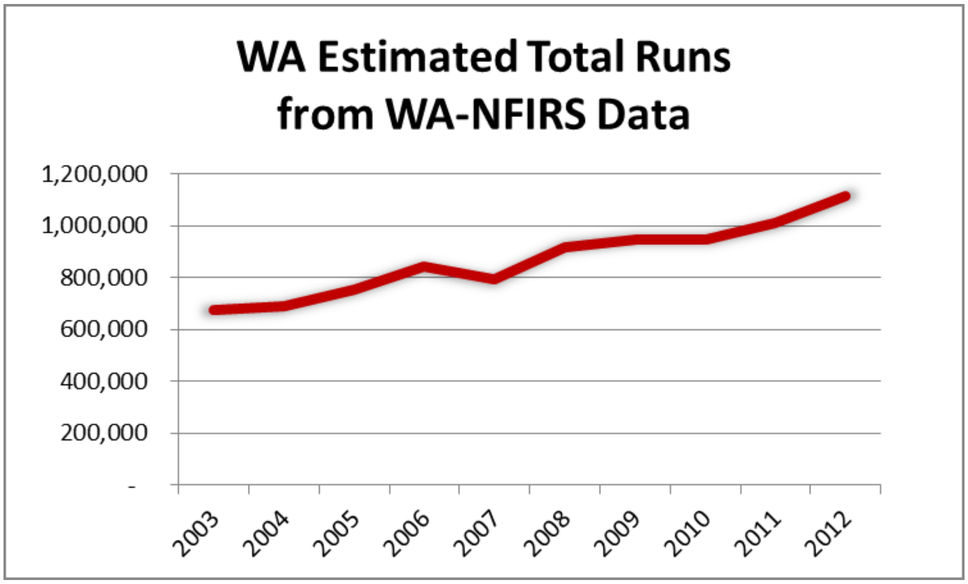

Figure 11 WA Estimated Total Runs from WA-NFIRS Data

Figure 12 shows the estimated total number of runs per crash using WSDOT data and WA-NFIRS run data. The estimated total number of runs per crash also increased from 2003 through 2012 with two notable differences. From 2003 to 2004 there was less impact on the risk exposure when looking at the estimated total number of runs per crash; however, this same comparison shows an improvement to risk exposure from 2010 to 2012. Comparing these two data sets verifies an improvement in exposure to crash risk.

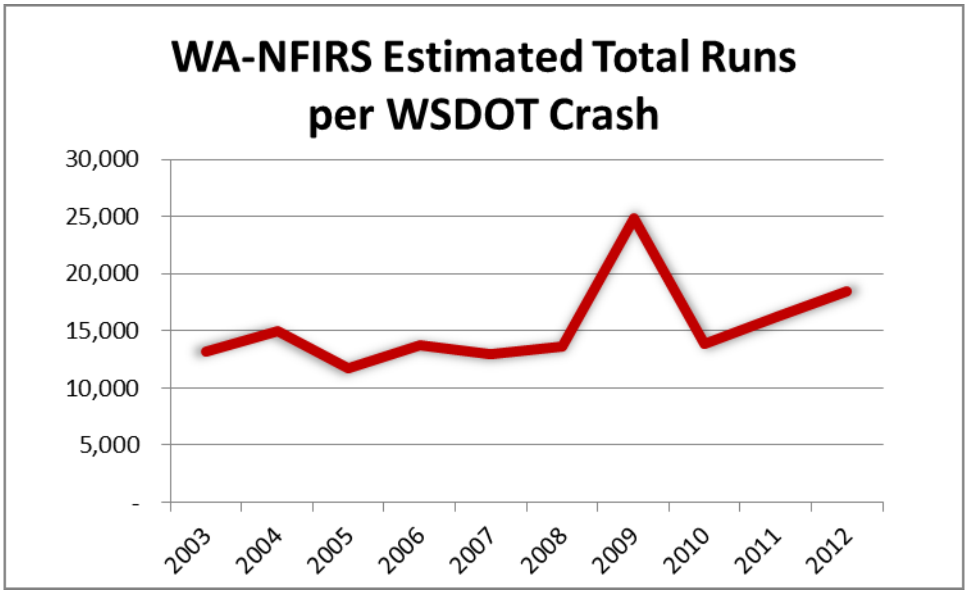

Figure 12 WA-NFIRS Estimated Total Runs per WSDOT Crash

The WA data shows that the implementation of the EVAP program was effective at reducing the number of crashes that fire apparatus were involved in. However, the program did not have a long-term impact beyond one or two years following its implementation and or re-accreditation. Further, there is consistency of record high crash rates as time elapses following re-accreditation. If this trend continues, then the 2013 re-accreditation will have had a positive impact on the reduction of crash rates in 2013 and possibly into 2014, however a hypothesis can be made that there will be an increase in crash rates beginning in 2015 and beyond until the next re-accreditation occurs.

4.3 Run Data Comparison

Figure 13 illustrates the comparison of run data for each state. It includes both NFIRS reported runs and estimated total runs for each state which was used for comparison. The estimated total runs illustrate the change after applying the calculation.

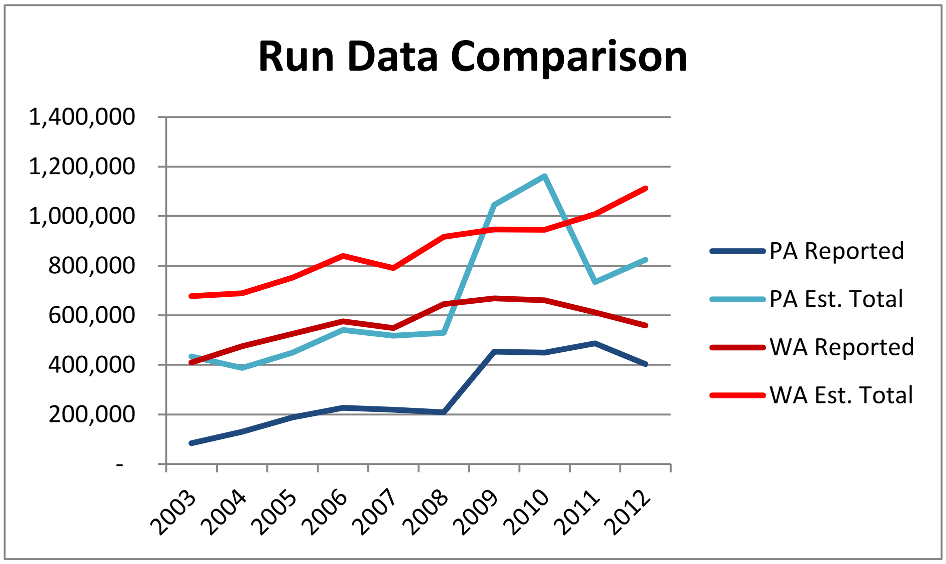

Figure 13 Run Data Comparison

Note the change in PA data in 2009. The estimated total data rises dramatically in PA which may be attributed to the change to electronic reporting. WA data is steadier than PA until 2010 when reported data began a decline and estimated total runs actually increased. When comparing the two state's estimated total data, it is important to note how relatively similar they are in the number of runs, especially in the latter years of this study which reflect more accurate reporting data. The similar number of runs reflects a similar crash exposure rate for comparison.

4.4 Test Results

An independent sample t-test was conducted on the DOT reported crash data and NFIRS reported run data. There was a significant difference in the number of crashes per 100,000 runs between PA and WA for 2003-2012 ($t=3.48$, $p=.01$); the mean number of crashes per 100,000 runs for PA was 188 ($SD=162$) while the mean number of crashes per 100,000 runs for WA was 10 ($SD=2$).

A second independent sample t-test was conducted on the DOT reported crash data and NFIRS estimated total run data (determined by taking the total number of reported incidents divided by the total reporting FDID's resulting in the number of runs per FDID. The number of runs per FDID was then multiplied by the total number of FDIDs for each year resulting in the total estimated runs per year). This second test is important as it gives a better representation of the actual number of runs for both states.

Using estimated total runs in the second test instead of only reported runs as was done in the first test, still results in a significant difference in the number of crashes per 100,000 runs between PA and WA for 2003-2012 (t=3.48, p=.01); the mean number of crashes per 100,000 runs for PA was 65 (SD=35) while the mean number of crashes per 100,000 runs for WA was 7 (SD=1).

After reviewing the difference between the two tests, the PA mean crash rate went from 188 to 64 and the WA mean crash rate went from 10 to 7 between test one and test two respectively. Standard deviation also went from 162 to 35 for the PA data, and 2 to 1 for the WA data between test one and test two respectively. The confidence limits (*t*-value) and the probability level (*p*-value) remained the same between the two tests (3.48 and .01 respectively). Test two results produced a more accurate representation of the actual number of crashes per 100,000 runs.

CHAPTER V

DISCUSSION

The Federal Motor Carrier Safety Administration has allowed for state exemption of Fire Departments from Commercial Driver's licensing requirements. Pennsylvania motor vehicle code allows for the exemption of fire department personnel from additional required training and licensing. The qualification of an ERV diver is left to the authority having jurisdiction (AHJ). Many organizations in the state have opted to use some form of ERV training as part of their risk management program, which is often influenced by their insurance carrier.

Washington State has implemented minimum training requirements for all commercial drivers and has implemented a special program for ERV's. The EVAP program was intended to provide specialized and focused training for emergency vehicle operators with the intent of reducing incidents associated with the operation of these large, specialty vehicles. Contrary to the program's title, the EVAP program is only used by the WA fire service and no program has been adopted by the Washington State Department of Health for EMS organizations. Law enforcement also lacks a training program for the larger specialty vehicles and most do not follow the recommendations of neither CDL nor EVAP.

Though not addressed by CDL and the EVAP program from Washington State, which put the focus for specialized training on the largest vehicles, some states have recently begun requiring special training for ambulance drivers. This effort is being driven from many state Health Departments who manage EMS programs in most states, rather than state Department of Transportations as was the case with the commercial vehicle program and CDL. According to a Dr. Douglas Kupas, Commonwealth EMS Director for the Bureau of Emergency Medical Services for the Pennsylvania Department of Health, the bureau desires to use training to improve the safety and ensure drivers of ambulances are qualified to operate these specialty vehicles (D. Kupas, personal communication, July 30, 2014). The Wisconsin State Patrol Transportation Synthesis Report provides a good inventory of state requirements for licensing of ambulance drivers. Though a small percentage of states actually required specialized training in 2010, VFIS has reported more recent efforts to encourage or require some form of emergency vehicle driver training to try to reduce the unacceptably high rate of ERV crashes (D. Bradley, personal communication, July 30, 2014).

The three accredited EVAP programs were first accredited in 2002. Because of this, and the implementation of data gathering at approximately the same time, it is appropriate to suggest that the EVAP program began in 2002. Some emergency responders were participating in risk management efforts similar to those provided by the EVAP program for many years prior to the employment of EVAP in 2002. Likewise, though PA does not have a training requirement, there are many departments that participate in risk management programs that provide driver training to fire apparatus operators and some operators have CDL training and licensing, though not commonly attained with the use of a fire apparatus during testing.

Pennsylvania DOT (PennDOT) staff providing the data used in this study indicated that if the data was to be used to compare other states, it was important to keep in mind that PA reporting criteria were different from other states. This reporting criterion include; damage over $5000, any severe injury or death, or a crash requiring one or more of the vehicles to be towed away. The data analysis used for this study concerns a cross sectional comparison which is concerned only with the consistent collection of data, and not the scope of the parameters. Since the same data within the same parameters was collected over the study period, the data can be analyzed to show trends.

When reviewing the number of crashes, it is important to consider exposure to the risk of a crash. This exposure is measured by the number of times a vehicle has the potential to be involved in a crash. Though it is not possible with available public data to measure every exposure to a crash, such as parades, and other duties other than calls for service, we can measure the number of calls for service that emergency response vehicles respond to that are documented. The NFIRS run data is limited to the number of reported incidents and only account for those departments that report their runs to the NFIRS system. The method of reporting has changed over the study period from paper reporting to an online reporting system.

According to the U.S. Census Bureau, the Commonwealth of Pennsylvania had a 2010 population of 12,702,379 and Washington State‘s population was 6,724,540. That same year, PA had 2,003 organizations with FDID’s and WA had 595 organizations with FDID’s. After calculating the number of estimated runs in each state, WA consistently had more estimated runs per year than PA.

Though the reason for the higher number of runs in WA is beyond the scope of this research, it does provide an opportunity for further research as to why WA, with nearly half of the population of PA and nearly one-fourth of the number of fire service organizations, consistently has more runs. Such research should focus on the effects of fire department response procedures, deployment models, target hazards such as wildland response, and reporting procedures. It is known from NFIRS data that WA fire departments report more EMS runs than PA fire departments. A hypothesis may be made that more fire departments in WA run EMS calls than fire departments in PA, which contribute to the higher number of runs in WA.

Though PA has statistically fewer responses than WA it has nearly twice the population and nearly nineteen times the ERV crash rate. This variance may be affected by but not necessarily limited to population density, roadway engineering controls as well as culture differences. Additional opportunities exist for research on the root causes of ERV crashes with specific focus on the effects of population and emergency services culture on fire department crash rates.

Due to limitations in current available public data there is an opportunity to get a better understanding of crash exposure through future analysis of data from sources such as insurance companies that measure actual exposure to crashes including parades and other non-reportable DOT incidents. This data was found to be very difficult to acquire as insurance companies are for profit organizations that protect this type of proprietary data from public access.

Fire department participation in the NFIRS reporting process was very weak in the earlier years of this study. The rate estimates for the earlier years will be unstable due to this underreporting. For example, it was noted that only 6 percent of the fire departments in PA reported to PA-NFIRS in 2012. The available 2012 data was not stable enough to be evaluated as part of this study. However, the reporting rates increased steadily through 2012 and were stable enough to begin evaluation beginning in 2003.

The data collected indicated the number of responses per vehicle in WA increased from 73.62 in 2004 to 99.92 in 2012. Despite the 35.7 % increase in responses per vehicle, the number of crashes has remained relatively unchanged during the same period with nearly 2% of vehicles involved in crashes every year. PA responses per vehicle also increased though not as substantially from 227.04 in 2004 to 292.77 in 2012 for a 29% increase.

This study affirms the hypothesis, supported by the literature review (Lonero) that structured training programs are more effective at reducing the number of ERV crashes. There is a significant difference in the number of crashes per 100,000 runs between PA and WA for 2003-2012 ($t=3.48$, $p=.01$); the mean number of crashes per 100,000 runs for PA was 188 ($SD=162$) while the mean number of crashes per 100,000 runs for WA was 10 ($SD=2$). This shows that the Washington EVAP program was more effective than PA with no training requirements during the study period.

The data for the number of crashes per run in PA did indicate a steady increase over the studied period from 595 in 2002 to 2,861 in 2012. That change resulted in an average of 11% increase in the number of ERV runs per year before incurring a crash in PA.

The WA data was much more volatile and in some cases saw a significant decrease in the number of runs per crash. For example, 2008 saw a 45% increase in the number of runs per crash, however the following year saw a 79% decrease. The average yearly increase in runs per crash in WA was 0.17% over the study period.

Regardless of program content, the Washington EVAP program is effective at reducing crash rates. However, further analysis is needed to evaluate how the Washington EVAP program may become more consistent in reducing the number of fire apparatus crashes. The EVAP program has contributed to the reduction in likelihood of a fire truck being involved in a crash. The data suggest more success for short periods of time following accreditation implementation (2002) and the program re-accreditation process/ retraining (2008). Further studies should focus on long-term and permanent methods of reducing the number of fire apparatus crashes. Focus should be given to program content that results in consistent and positive driver habits and choices as opposed to programs such as the EVAP program that result in checking off a box to meet stated requirements by third party organizations such as the Washington State Department of Licensing.

REFERENCES

1. Abdelwanis, N. (January, 2013). Characteristics and Contributing Factors of Emergency Vehicle Crashes (Doctoral Dissertation). Retrieved from Clemson University Tiger Prints (All Dissertations, Paper 1224). Clemson University, Clemson, SC.
2. Becker, L.R., Zaloshnja, E., Levick, N., Li, Guohua, Miller, Ted. (2003). Relative risk of injury and death in ambulances and other emergency vehicles. (Accident Analysis and Prevention Publication No. 35 941-948). Elsevier Science Ltd. Available at: www.elsevier.com/locate/aap.
3. California Commission on Peace Officer Standards and Training. (February, 2009). POST Driver Training Study, (POST2008 TPS-0396, Vol.1). Retrieved from http://lib.post.ca.gov/Publications/driver_training.pdf on September 13, 2014.
4. Commercial Driver's License Standards; Requirements and Penalties. 49 C.F.R. §383 (2011). Subtitle B - Other Regulations Relating to Transportation, Chapter III - Federal Motor Carrier Safety Administration, Department of Transportation, Subchapter B – Federal Motor Carrier Safety Regulations. (Vol. 5). Retrieved from http://www.gpo.gov/fdsys/pkg/CFR-2011-title49-vol5/xml/CFR-2011-title49-vol5-part383.xml#seqnum383.1 on September 8, 2014.
5. Custalow, C.B., and Gravitz, C.S. (2004). Emergency medical vehicle collisions and potential for preventative intervention. (Vol. 8, No 2) Informa Healthcare, Prehospital Emergency Care. Retrieved from http://informahealthcare.com/doi/abs/10.1080/31270300279X on Septebmer 10, 2014.
6. Dorn, Lisa and Barker, David. (2004). The effects of driver training on simulated driving performance. Accident Analysis and Prevention, 2005, Vol 37, p. 63–69. Elsevier, Ltd.

7. FEMA. (2009). Emergency Vehicle Visibility and Conspicuity Study. U.S. Fire Administration Publication No. FA-323. Emmetsburg, MD. Retrieved from http://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf on September 10, 2014.

8. FEMA. (February, 2014). Emergency Vehicle Safety Initiative. U.S. Fire Administration Publication No. FA-336. Emmetsburg, MD. Retrieved from https://www.usfa.fema.gov/fireservice/firefighter_health_safety/safety/vehicle_safety/ on April 18, 2014.

9. Federal Motor Carrier Safety Administration. (n.d.). Commercial Driver's License; States; Overview. Retrieved from http://www.fmcsa.dot.gov/registration/commercial-drivers-license/states on September 8, 2014.

10. Gkritza, K. (2003). Analysis of the Characteristics of Emergency Vehicle Operations in the Washington D.C. Region (Unpublished Maser's Thesis). Virginia Polytechnic Institute and State University, Falls Church, VA.

11. Klauer, S. G., Guo, F, Simons-Morton, B.G., Ouimet, M.C., Lee, S.E., and Dingus, T.A. (2014). Distracted Driving and Risk of Road Crashes among Novice and Experienced Drivers. The New England Journal of Medicine, Vol 370, p.54-59, January 2, 2014.

12. Lonero, Lawrence P. (2008). Trends in Driver Education and Training. American Journal of Preventive Medicine, Vol 35(3S), p.S316–S323, Elsevier Inc.

13. National Fire Protection Association. (2014). NFPA 1002; Standard for Fire Apparatus Driver/Operator Professional Qualifications. Quincy, MA.

14. Pennsylvania Department of Transportation (PennDOT). (2014). Crashes Involving at Least One Fire Vehicle. PennDOT Bureau of Maintenance and Operations, Harrisburg, PA.

15. Pennsylvania Office of the State Fire Commissioner. (2014). Pennsylvania National Fire Incident Reporting System (NFIRS). Harrisburg, PA.

16. Pennsylvania State Legislature. Title 75 Chapter 01 Section 121.1 Emergency Vehicle. Retrieved from; http://www.legis.state.pa.us on August 23, 2014.

17. Ray, A.M., and Kupas, D.F. (2007). Comparison of Rural and Urban Ambulance Crashes in Pennsylvania. Informa Healthcare, Prehospital Emergency Care, Vol 11 (No 4). Retrieved from http://informahealthcare.com/doi/abs/10.1080/10903120701536966 on September 10, 2014.

18. U.S. Census Bureau. (2014). Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014. Retrieved from http://www.census.gov/popest/data/state/totals/2014/index.html on November 3, 2015.

19. U.S. Department of Transportation. (n.d.). Commercial Driver's License Program. Retrieved from http://www.fmcsa.dot.gov/registration-licensing/cdl/cdl.htm on November 22, 2013.

20. Volunteer Fire Insurance Services. (2008). Emergency Vehicle Driver Training (EVDT). Volunteer Fire Insurance Services, York, PA.

21. Volunteer Fire Insurance Service. (2006). Intersections: Operation Safe Arrival. Volunteer Fire Insurance Services, York, PA.

22. Washington Fire Chiefs. (n.d.). Emergency Vehicle Incident Prevention (EVIP). Washington Fire Chiefs Association, Olympia, WA.

23. Washington Fire Chiefs Association. (2014). Washington National Fire Incident Reporting System (NFIRS). Washington Fire Chiefs Association, Olympia, WA.

24. Washington State Department of Transportation (WSDOT). (2014). Crash Data. WSDOT Crash Data and Reporting Branch, Olympia, WA

25. Washington State Legislature. Title 46 Chapter 04 Section 040 Authorized Emergency Vehicle. Retrieved from; http://app.leg.wa.gov/rcw/default.aspx?cite=46.04.040 on August 23, 2014.

26. Wisconsin Department of Transportation. (2010). State Requirements for Licensing of Ambulance Drivers (Transportation Synthesis Report). WisDOT Research & Library Unit, Retrieved fromhttp://wisdotresearch.wi.gov/ wpcontent/uploads/tsrambulancedrivers1.pdf on May, 2014.