U.S. Fire Administration

Emergency Vehicle Safety Initiative

FA-336/February 2014

FEMA

U.S. Fire Administration

Mission Statement

We provide national leadership to foster a solid foundation for our fire and emergency services stakeholders in prevention, preparedness, and response.

U.S. DEPARTMENT OF HOMELAND SECURITY FEMA

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Preface

This project was supported by Interagency Agreement No. 2009-DE-R-103 and awarded by the National Institute of Justice (NIJ), Office of Justice Programs (OJP), U.S. Department of Justice (DOJ) to the U.S. Fire Administration (USFA). The opinions, findings, and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect those of the DOJ.

The USFA made a cooperative research agreement with the International Fire Service Training Association (IFSTA) at Oklahoma State University (OSU) to develop this report. IFSTA and its partner, OSU Fire Protection Publications, have been a major publisher of fire service training materials since 1934. Through its association with the OSU College of Engineering, Architecture, and Technology, it also conducts a variety of funded, technical research on fire service, fire prevention and life safety issues. Special thanks are due to USFA Fire Program Specialist William Troup for his particular efforts toward improving emergency responder safety related to emergency vehicle response and roadway safety.

The extensive information provided within this report would not have been possible without the dedication and efforts of the following people assigned to this project:

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The USFA and IFSTA would also like to thank the following individuals who reviewed and commented on the draft version of this report:

Steve Austin, Cumberland Valley Volunteer Firemen's Association

Sharon Baroncelli, International Association of Fire Chiefs

Brian Montgomery, Officer Safety and Protective Technologies Program Manager, U.S. Department of Justice, National Institute of Justice

Larry McKenna, U.S. Fire Administration Fire Program Specialist


DO NOT CROSS CENTER LINE

Chapter 1
Introduction

If you polled the public and asked people during which portion of a firefighter's job would that firefighter have the greatest chance of being killed, most would likely respond that this would be when firefighters are actually fighting a fire. Incidents in which firefighters are severely injured or killed while conducting tactical operations tend to draw more attention and news coverage. The truth is that firefighters are more likely to die in a motor vehicle-related incident than during the course of a firefighting operation.

The same situation is true for law enforcement officers. Most people would likely assume that gunshots are the most common cause of fatal injuries to law enforcement officers. However, at the time of this report, vehicle-related fatalities were the leading cause of death to law enforcement officers in the United States for 11 of the 12 previous years.

A review of injuries and fatalities in other professions related to emergency response, or other duties associated with responding to incidents on or near roadways, will mirror those described in the preceding paragraphs. This includes Emergency Medical Services (EMS), towing and highway department personnel.

To some extent, this is also true for the general public. Mass shooting events, such as those in a Colorado movie theater and a Connecticut elementary school, are rightfully given large amounts of media/public exposure and capture the public's attention. These horrific tragedies cause everyone to personally and organizationally relate to these situations and re-examine how to avoid them. They cause business owners and school officials to examine their safety and security measures and make immediate changes if they identify any deficiencies or vulnerabilities, as they should.

These single incidents make an impact and cause change, often in a swift and decisive manner. However, the reality of the overall situation is that exponentially greater numbers of children and adults are injured or killed each year while traveling to a movie theater or school than those who die from gunshot wounds in one of those locations. These injuries and deaths commonly result from passengers in the vehicle not being properly seated or belted while the vehicle is in motion. Interestingly, the same is true for emergency responders riding in personally owned or emergency vehicles. In virtually every function of daily life, people are at a much greater risk of harm while traveling to and from a particular location than they are while at that location.

A review of USFA firefighter fatality statistics over the years reveals that 75 percent of line-of-duty deaths (LODDs) are the result of either cardiac-related causes or vehicle-related causes. In particular, vehicle-related deaths account for 25 percent of all fire service fatalities. According to the National Law Enforcement Officer's Fund, for the period of 2002 through 2011, 39 percent of law enforcement officer fatalities were vehicle-related. Gunshot fatalities accounted for 36 percent of fatalities during the same period. These figures reinforce the concept that traveling to an incident is often more hazardous than what you do once you arrive at the scene.

Early Efforts to Address This Issue

The USFA embarked on an ambitious mission in 2000. This mission was to reduce the number of annual firefighter fatalities by 25 percent within five years and 50 percent within 10 years. The USFA planned to do this, at least in part, by providing funding for research on the issues that were leading to injuries and deaths, which might lead to transforming the way emergency responders operate. This research would then be published and made available to fire and emergency services. Other federal government agencies, including the U.S. Department of Transportation (DOT), DOJ, and the Department of Homeland Security (DHS), also provided funding and assistance to the USFA for a number of these projects. Because medical and vehicle-related issues accounted for nearly three-quarters of firefighter fatalities, these were the first areas addressed with research efforts. The National Fallen Firefighters Foundation (NFFF) also adopted the 25/50 percent goal in 2005.

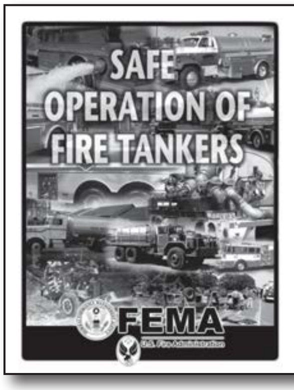


Figure 1.1 — USFA "Safe Operation of Fire Tankers" report.

Safe Operation of Tankers

An initial examination of firefighter vehicle-related fatalities showed that the largest percentage of these (40 percent) were volunteer firefighters who crashed their personally owned vehicles (POVs) during the course of their service to the fire department. The type of fire apparatus most commonly involved in fatal crashes were water tanker/tenders. Water tanker/tenders were involved in 25 percent of the fatal crashes, despite the fact that they account for only 3 percent of the total fire apparatus in the U.S. This was more than pumpers and aerial apparatus combined.

In 2002, the USFA released a publication titled "Safe Operation of Fire Tankers" (FA-248) **(Figure 1.1)**. This document remains the definitive source on the safety issues related to safe driving practices for tankers. The publication includes case studies on previous collisions, information on the impact of vehicle design on operational safety and safe driving practices for tankers. This document may be viewed and downloaded, free of charge, from the following Web link: http://www.usfa.fema.gov/downloads/pdf/publications/fa-248.pdf.

Emergency Vehicle Safety Initiative

The next step for the USFA was the launch of the Emergency Vehicle Safety Initiative (EVSI) in 2002. This partnership included the DOT National Highway Transportation Safety Administration (NHTSA) and the DOT Intelligent Transportation Systems (ITS) Joint Program Office. There were two primary goals for this initiative:

1. Identify the major issues related to firefighter and emergency responder fatalities that occur while responding to or returning from incidents and while operating on roadway emergency scenes **(Figure 1.2)**.

2. Develop and obtain consensus among major national-level fire and emergency service trade associations on draft "best practices" guidelines, mitigation techniques, and technologies to reduce firefighter response and roadway scene fatalities.

Figure 1.2 — Reduction of emergency vehicle crashes is a major goal. (Photo/Ron Jeffers, Union City, New Jersey)

The USFA established a committee of subject-matter experts (SMEs) to examine the critical issues that needed to be addressed in order to improve emergency vehicle safety. This committee held several landmark meetings and developed an extensive list of recommendations. The committee was comprised of a wide array of people, organizations and government agencies, including:

- American Ambulance Association (AAA).
- Congressional Fire Service Institute (CFSI).
- Cumberland Valley Volunteer Firemen's Association (CVVFA).
- CVVFA Emergency Responder Safety Institute (ERSI).
- Federal Aviation Administration (FAA) Technical Center.
- Federal Highway Administration (FHWA)
- Fire Apparatus Manufacturers Association (FAMA).
- Fire Department of New York (FDNY).
- Firehouse Magazine.
- Fire Department Safety Officers Association (FDSOA).
- General Services Administration (GSA).
- International Association of Fire Chiefs (IAFC).
- International Association of Fire Fighters (IAFF).
- International Fire Service Training Association (IFSTA).
- IOCAD Emergency Services Group.
- Medical Transportation Insurance Professionals.
- Mitretek Systems (supporting FHWA DOT-ITS).
- National Association of Emergency Vehicle Technicians (NAEVT).
- National Fire Protection Association (NFPA).
- National Institute for Occupational Safety & Health (NIOSH).
- National Institute of Standards & Technology (NIST).
- National Safety Council (NSC).
- National Truck Equipment Association (NTEA).
- National Volunteer Fire Council (NVFC).
- North American Fire Training Directors (NAFTD).
- Plano, Texas, Fire Department.
- Training Resources and Data Exchange (TRADE).
- U.S. Army Tank-Automotive and Armaments Command (TACOM).
- U.S. Department of Transportation/National Highway Traffic Safety Administration (DOT/NHTSA).
- U.S. Fire Administration (USFA).
- Volunteer Fireman's Insurance Services (VFIS).

The USFA published the results of these meetings in "Emergency Vehicle Safety Initiative" (FA-272) in August 2004 **(Figure 1.3)**. The report identified the committee's recommendations to improve safety related to response and highway operations. This document may be viewed and downloaded, free of charge, from the following Web link: http://www.usfa.fema.gov/downloads/pdf/publications/fa-272.pdf.

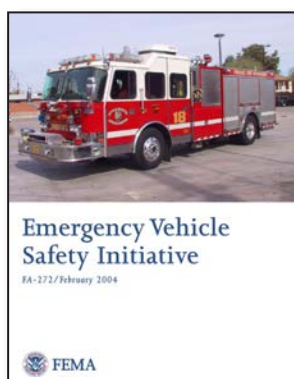


Figure 1.3 — The "Emergency Vehicle Safety Initiative" was first published in 2004.

Multiple Fire Service Association Projects

As a follow-up to the EVSI, the USFA initiated partnerships with the IAFC, the IAFF, and the NVFC to reduce the number

of firefighters killed while responding to or returning from the emergency scene or while working at roadway emergency scenes. Each of these agencies was asked to focus their work on the particular issues facing their constituencies.

The USFA and the NVFC developed the "Emergency Vehicle Safe Operations for Volunteer and Small Combination Emergency Service Organizations" program. This Web-based educational program includes an emergency vehicle safety best practices self-assessment, standard operating guideline (SOG) examples, and behavioral motivation techniques to enhance emergency vehicle safety. It also discusses critical safety issues of volunteer firefighting. This information can be viewed at http://www.nvfc.org/files/documents/EVSO_2009.pdf.

The USFA and IAFF developed a similar Web- and computer-based training and educational program — "Improving Apparatus Response and Roadway Operations Safety in the Career Fire Service." The program addresses critical emergency vehicle safety issues such as seatbelt use, intersection safety, roadway operations safety on crowded interstates and local roads, and driver training. Instructor and participant guides and PowerPoint™ slides are included in the package. While the focus of this project was career fire departments, most other emergency response agencies will find this information helpful. It can be downloaded at http://www.iaff.org/hs/EVSP/guides.html.

The USFA and the IAFC developed "IAFC Policies & Procedures for Emergency Vehicle Safety." It is a Web-based document providing guidance for the development of basic policies and procedures required to support the safe and effective operation of all fire and emergency vehicles, including fire apparatus, rescue vehicles, ambulances, command and support units, POVs, and any other vehicles operated by fire department members in the performance of their duties. This information is found at http://www.iafc.org/Operations/content.cfm?ItemNumber=1374.

In 2010, the IAFF also released a report titled "Best Practices for Emergency Vehicle and Roadway Operations Safety in the Emergency Services" **(Figure 1.4)**. This report was funded by the NIJ, part of the DOJ, and was produced under a Cooperative Agreement with the USFA. It provides the latest information on all aspects of response and roadway scene management for many emergency response agencies, including police, fire and EMS, and can be downloaded at http://www.iaff.org/hs/EVSP/guides.html.

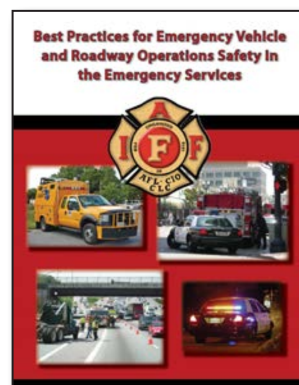


Figure 1.4 — IAFF "Best Practices for Emergency Vehicle and Roadway Operations Safety in the Emergency Services" report.

The USFA also developed another resource related to response and roadway safety titled "Alive on Arrival." This two-page flyer provides tips for safe emergency vehicle operations. It focuses specifically on the roles of the apparatus operator and apparatus passengers. The complete document may be reviewed at http://www.usfa.fema.gov/downloads/pdf/publications/fa_255f.pdf.

Additional Research on Vehicle and Roadway Safety

Following the initial burst of research generated by the first EVSI project, the USFA continued to work with its partner agencies to do further, more focused research on specific issues affecting emergency vehicle response and roadway scene safety.

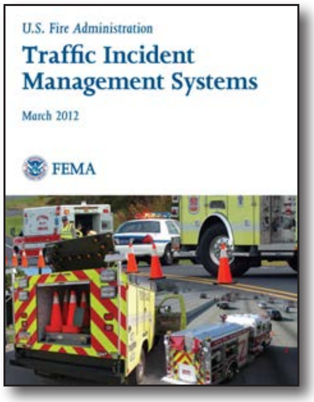


Figure 1.5 — USFA/IFSTA developed the "Traffic Incident Management Systems" report.

Traffic Incident Management Systems

The USFA and the U.S. Department of Transportation's Federal Highway Administration (DOT/FHWA) worked in partnership with the IFSTA at OSU on a traffic incident management study. The original edition of this "Traffic Incident Management Systems" report was released in 2008. This project examined the latest technologies, training and operational practices for effective traffic incident management. It is downloadable at http://www.usfa.fema.gov/downloads/pdf/publications/tims_0408.pdf.

The DOT/FHWA released a new edition of "Manual on Uniform Traffic Control Devices" (MUTCD) in 2009. The USFA and DOT/FHWA again engaged IFSTA to do an updated version of the "Traffic Incident Management Systems" report so that it would be compliant with the latest edition of the MUTCD and other advances since the release of the first edition **(Figure 1.5)**. The new edition was released in 2012. It provides technical and training program information for fire and emergency service providers and includes case studies of roadway incidents that have taken the lives of firefighters, highway scene safety survival basics, incident command for roadway incidents, and examples of effective Traffic Incident Management System (TIMS) programs. The report also provides information on the American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) Standard 207, High Visibility Public Safety Vests. This report is found at http://www.usfa.fema.gov/downloads/pdf/publications/fa_330.pdf.

Technology and Incident Reporting Research

The ResponderSafety.Com — Roadway Safety Initiative for Emergency Responders examines the development of advanced technology and systems that will permit nationwide sharing of lessons learned among transportation, public safety, and emergency personnel, enabling them to respond to roadway incidents more effectively and safely. USFA is working with the CVVFA ERSI on this project. The USFA also received support for this initiative from the DOT/FHWA and DOJ/NIJ OJP. The project brings together advocacy for effective highway incident management and training of emergency response personnel.

Technologies to improve highway incident management and responder safety are also being studied as part of the project. This ongoing effort has resulted in the development of:

- A white paper titled "Protecting Emergency Responders on the Highways."
- Support for the ResponderSafety.com website.
- A task analysis of those who control traffic at incident scenes to aid in the development of performance standards for temporary traffic control personnel.
- Educational outreach to the motoring public on how to react to firefighters, law enforcement officers and other responders on the roadway.

Emergency Vehicle Visibility and Lighting Research

IFSTA also completed a separate cooperative agreement with the USFA for the development of the "Emergency Vehicle Visibility and Conspicuity Study" (FA-323) that was released in August of 2009 **(Figure 1.6)**. This report, funded by the NIJ, part of the DOJ, provides detailed information on effective types of emergency lighting devices and retroreflective markings used on emergency vehicles. The report experimentally demonstrates the connection between effective conspicuity and improved responder safety. The report can be found at http://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf.

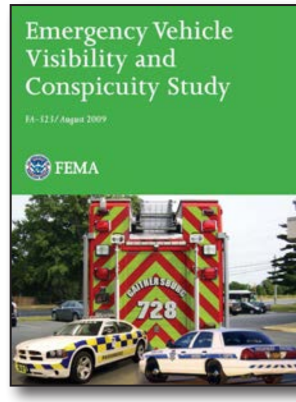


Figure 1.6 — USFA/IFSTA developed the "Emergency Vehicle Visibility and Conspicuity Study."

"Vehicle Marking and Technology for Increased Highway Visibility — A Reference Guide for Decision-Makers" provides information on best practices in the application of various arrangements of emergency warning devices, creative use of retroreflective decal markings and other innovative designs, all with the intent of increasing the visibility of emergency vehicles to motorists approaching them **(Figure 1.7)**. It focuses on emergency vehicles not covered by existing standards in this area. The guide was created by the USFA and the CVVFA Emergency Responder Safety Institute; it is supported by the DOJ/NIJ and can be downloaded at http://www.usfa.fema.gov/fireservice/firefighter_health_safety/safety/roadway_safety/.

Figure 1.7 — Increased visibility techniques are used on all types of emergency vehicles. (Photo/Mike Wieder)

One of the key issues discovered from the USFA EVSI was the disorientation of motorists caused by the daytime and nighttime use of emergency warning lights. This finding led USFA to enter into a research partnership with the Society of Automotive Engineers (SAE) on nonblinding emergency vehicle warning lighting system recommendations. Their study examined disorientation caused by emergency warning lighting and lighting effects on normal, impaired and drowsy drivers (also known as the "moth effect"). The actual research was performed by the University of Michigan Transportation Research Institute (UMTRI). "Inferences about Emergency Vehicle Warning Lighting Systems from Crash Data" is the first report released in this project.

The second phase of the project continued to research effective mitigation of, through design, technology and operating practices, the disorientation of motorists caused by emergency warning lights. Researchers looked at issues such as lighting design, color, flash rate and emergency vehicle visibility/conspicuity, as well as operational mitigation (i.e., reducing the amount of lighting used). Lighting color issues included the "traditional" red and white color lighting used by the fire service and EMS, as well as the use of yellow (typically used for construction and tow vehicle warning), blue and other colors. This project discovered that:

- Detection distances for pedestrians and emergency responders operating on the roadway at night wearing typical clothing are very short, even shorter than typically required stopping distances.

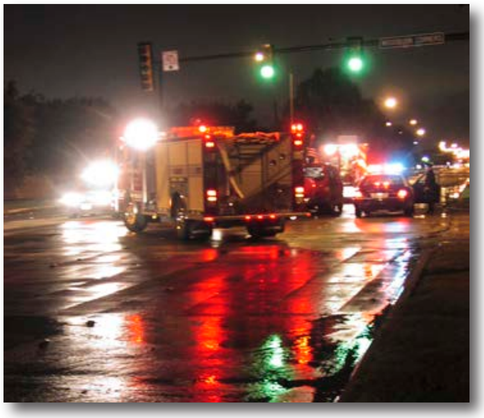


Figure 1.8 — Proper roadway lighting at night operations is crucial. (Photo/Ron Moore, Plano, Texas)

Figure 1.9 — Incident scenes must be made as safe as possible. (Photo/Ron Jeffers, Union City, New Jersey)

- In contrast, detection distances for pedestrians and emergency responders operating on the roadway at night with retroreflective markings are very long.

Results of this research are shown in a chart illustrating motorist seeing and stopping distances, available at http://www.usfa.fema.gov/downloads/pdf/research/SAEpedslide.pdf.

From this research, UMTRI researchers conducted a nighttime field study of emergency warning lighting **(Figure 1.8)**. Researchers examined colors, intensity and flash patterns of warning lamps and documented the resulting desirable (conspicuity) and undesirable (glare) effects. Findings from this operational study are detailed in the April 2007 report from the SAE, "Effects of Warning Lamps on Pedestrian Visibility and Driver Behavior." This report is found at http://www.sae.org/standardsdev/tsb/cooperative/nblighting.pdf.

The next phase of the study enhanced previous research to examine colors and intensities of warning lamps that influence both positive (intended) and negative (unintended) effects of such lamps in both daytime and nighttime lighting conditions. Research focused on how to design emergency warning lamps to provide the most benefit for the safety of emergency vehicle operations. Findings are detailed in the October 2008 report from the SAE, "Effects of Warning Lamp Color and Intensity on Driver Vision" at http://www.sae.org/standardsdev/tsb/cooperative/warninglamp0810.pdf.

Other Government Initiatives for Roadway Safety

In addition to the various USFA-based programs that address roadway response and roadway incident safety, numerous other programs and standards at the federal level are having a major, positive impact on this issue. A few of these are described below.

National Traffic Incident Management Coalition

Launched in 2004, the National Traffic Incident Management Coalition (NTIMC) is a multidisciplinary partnership forum linking public safety and transportation communities to coordinate experiences, knowledge, practices and ideas. NTIMC is committed to safer and more efficient management of all incidents that occur on, or substantially affect, the nation's roadways in order to:

- Enhance the safety of on-scene responders and of motorists passing or approaching a roadway incident **(Figure 1.9)**.
- Strengthen services to incident victims and stranded motorists.
- Reduce incident delay and costs to the traveling public and commercial carriers.

One of the products developed by the NTIMC is the "National Unified Goal (NUG) for Traffic Incident Management: Working Together for Improved Safety, Clearance, and Communications." The goal of the NTIMC is to achieve three major objectives of the NUG through 18 strategies. Key strategies include recommended practices for multidisciplinary traffic incident management (TIM) operations and communications, multidisciplinary TIM training, goals for performance and progress, promotion of beneficial technologies, and partnerships to promote driver awareness. More information on the NTIMC can be found at http://ntimc.transportation.org/Pages/default.aspx. Additional information on the NUG can be located at http://ntimc.transportation.org/Pages/NationalUnifiedGoal(NUG).aspx.

Federal Highway Administration Traffic Incident Management Website

The FHWA Office of Operations operates an Emergency Transportation Operations (ETO) website, featuring information on the ETO for disasters, traffic planning for special events (PSE) and TIM programs. The FHWA, through the ETO programs, provides tools, guidance, capacity building and good practices that aid local and state DOTs and their partners in their efforts to improve transportation network efficiency and public and responder safety when a **nonrecurring** event either interrupts or overwhelms transportation operations. Nonrecurring events may range from traffic incidents to traffic PSE to Disaster ETO. Work in ETO program areas focuses on using highway operational tools to enhance mobility and motorist and responder safety. Partnerships in ETO program areas involve nontraditional transportation stakeholders since ETO programs involve transportation, public safety (fire, rescue, EMS, law enforcement) and emergency management communities. ETO, as a discipline, spans a full range of activities: from transportation-based (e.g., fender benders) to those where transportation is a critical response component (e.g., hurricane evacuations). This website can be viewed at http://ops.fhwa.dot.gov/eto_tim_pse/about/tim.htm.

Federal Highway Administration "Traffic Incident Management Handbook"

The FHWA released a new edition of their "Traffic Incident Management Handbook" in 2010. This text includes the latest advances in TIM programs and practices across the U.S. and the latest innovations in TIM tools and technologies. This new edition supersedes the 2000 edition of the same title. It can be downloaded at no charge from http://ops.fhwa.dot.gov/eto_tim_pse/publications/timhandbook/tim_handbook.pdf.

"Manual on Uniform Traffic Control Devices"

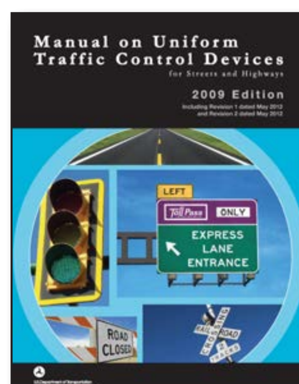


Figure 1.10 — The "Manual on Uniform Traffic Control Devices."

Throughout this report, you will see references to the MUTCD. Title 23 of the United States Code of Federal Regulations charges the DOT FHWA with developing a manual on uniform traffic control standards and requires each state to adopt these standards. The MUTCD is the document that contains these standards **(Figure 1.10)**. Historically, most emergency response agencies have failed to recognize the existence of this document and have not abided by its requirements. This may have been due, at least in part, to the fact that the MUTCD never clearly provided standards specific to emergency incidents. The types of incidents that emergency responders handle on roadways did loosely fall into the category of

Figure 1.11 — Apply the MUTCD requirements to every incident. (Photo/Ron Jeffers, Union City, New Jersey

temporary work zones, but most people viewed these as requirements for small road maintenance operations and failed to implement them for emergency incidents.

In the 2003 edition of the MUTCD, the DOT made its first direct effort at developing requirements specifically for roadway emergency incidents. They reinforced these requirements in the new 2009 edition of the MUTCD. Section 6I (that is the number six and the letter "i") is dedicated to "The Control of Traffic Through Incident Management Areas." The MUTCD defines a traffic incident as "an emergency road user occurrence, a natural disaster, or other **unplanned** event that affects or impedes the normal flow of traffic."

Emergency response agencies, including fire, EMS and police departments, need to understand that unlike documents such as NFPA standards, which are voluntary unless formally adopted, the requirements of the MUTCD are federal law. Emergency response organizations' standard operating procedures (SOPs) must reflect the requirements of the MUTCD or their equivalent state document. Some states have chosen to modify the MUTCD and make some sections more stringent. Responders should be familiar with the version of the MUTCD recognized in their state and apply these principles to every roadway emergency **(Figure 1.11)**. Failure to follow these requirements subjects the responders and their agencies to both civil liabilities and reduced federal funding.

The basic purpose of the information contained in MUTCD Section 6I is to provide direction on temporary traffic control (TTC). TTC is defined as controlling traffic close to or around an incident or emergency scene. There are three basic goals of TTC:

- Improving responder safety on the incident scene.
- Keeping traffic flowing as smoothly as possible.
- Preventing the occurrence of secondary crashes.

(Note: See http://mutcd.fhwa.dot.gov/htm/2003r1r2/part6/part6i.htm for details.)

Secondary crashes are those crashes that occur as a result of traffic backups or lane closures related to an initial roadway incident. DOT statistics show that approximately 18 percent of all highway fatalities result from secondary crashes.

It is impossible to fully explain all the requirements contained in Section 6I of the MUTCD in a document of this length. However, this section will highlight the major

topics and points to provide an idea of the information this useful document contains. Section 6I contains five major parts:

1. **General** — This part contains requirements for interagency coordination, training, visibility, estimating incident scope and length, TTC sign colors, and use of initial control devices, such as road flares and traffic cones.
2. **Major Traffic Incidents** — These are incidents whose duration will exceed two hours. If the incident will exceed 24 hours, full MUTCD work zone requirements will need to be implemented **(Figure 1.12)**.
3. **Intermediate Traffic Incidents** — These incidents range from 30 minutes to two hours in duration. They typically require lane closures. Typical vehicle collisions with injuries fall into this category **(Figure 1.13)**.
4. **Minor Traffic Incidents** — These are incidents whose duration is less than 30 minutes. Simple actions, such as the use of initial control devices, will be sufficient to handle the incident. Minor, noninjury collisions and stalled vehicles are examples of minor traffic incidents **(Figure 1.14)**.
5. **Use of Emergency Vehicle Lighting** — This part provides direction on the appropriate types of lighting for use at nighttime roadway incidents. Because excessive lighting has been proven to increase the risk of secondary crashes, this section focuses on the establishment of proper work zones so that emergency vehicle lighting can be minimized.

Figure 1.12 — This roadway incident may exceed two hours in duration. (Photo/Ron Jeffers, Union City, New Jersey)

Figure 1.13 — This roadway incident may be complete within two hours. (Photo/Mike Wieder)

Figure 1.14 — This roadway incident may be complete in less than 30 minutes. (Photo/Mike Wieder)

As mentioned earlier in this section, the MUTCD places a significant amount of emphasis on doing a proper estimation of the scope and severity of the incident within 15 minutes of the arrival of the first emergency responder. The MUTCD also provides detailed information on setting up an effective Traffic Incident Management Area (TIMA). The TIMA includes the **advance warning area** that tells motorists of the situation ahead, the **transition area** where lane changes and closures are made, the **activity area** where responders are operating, and the **incident termination area** where normal flow of traffic resumes. These are covered in greater detail later in this report. Note that the distances for the advance warning and transition areas will differ depending on the speed limit in the area of the incident. Higher speed limits require longer advance warning and transition areas. These distances are detailed in a chart in the MUTCD.

The MUTCD also provides direction on the types of flares, traffic cones, flags, signs and barriers that may be used for TTC operations **(Figures 1.15a and 1.15b)**. In addition to specifying the requirements for these devices, the document also provides detailed information on their deployment and placement. Training requirements for flaggers and other personnel who will be directing traffic are also highlighted.

Figure 1.15a — Typical traffic control devices. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

All roadway incident response agencies should obtain a copy of the MUTCD and/or their own state equivalent documents and use them to refine their SOP for roadway incidents. For more information on the MUTCD document and to download a free copy, go to http://mutcd.fhwa.dot.gov.

Figure 1.15b — Typical traffic control devices. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

About This Report

The information provided up to this point in the chapter shows the enormous amount of work and effort that has been put in toward improving emergency responder safety-related vehicle operations and roadway incident scenes since the initial "Emergency Vehicle Safety Initiative" (FA-272) was released in 2004. Because this information was scattered in a variety of places, in 2011 the USFA signed a cooperative agreement with IFSTA to develop this updated version of the EVSI. This updated version serves several purposes:

- It details the magnitude of injuries and deaths related to emergency vehicle and roadway scene operations.
- It makes emergency responders aware of all of the research conducted regarding emergency vehicle response and roadway incident safety over the past decade.
- It highlights various situations in which the research information applies to emergency operations.

This report includes eight chapters in addition to this introductory chapter. These chapters include:

- Chapter 2 — Statistics and Case Studies
- Chapter 3 — Common Crash Causes and Their Prevention
- Chapter 4 — The Impact of Vehicle Design and Maintenance on Safety
- Chapter 5 — Improving Response-related Safety: Internal Factors
- Chapter 6 — Improving Response-related Safety: External Factors
- Chapter 7 — Regulating Emergency Vehicle Response and Roadway Scene Safety
- Chapter 8 — Roadway Incident Scene Safety
- Chapter 9 — Summary and Recommendations

Following the last chapter, a list of resources is included. The USFA and all of the partners involved in this project are hopeful that this work will be used as intended, and make a positive impact on both emergency responders and the public they serve.


DO NOT CROSS CENTER LINE

Chapter 2
Statistics and Case Studies

Introduction

The original "Emergency Vehicle Safety Initiative" report (2004) reviewed fatality data related to fire departments. This report expands the data to include injuries and fatalities for fire departments, law enforcement and EMS and covers data available for the years 1992 to 2012, where available.

Limitations

As with the original report, it must be stressed that there are two major limiting factors to the statistical findings presented in this report:

- There are no comprehensive databases for fire, law enforcement or EMS to identify factors involved in vehicle crashes, worker injuries or fatalities.
- The databases that do exist may or may not include information related to volunteer responders.

Because of these limitations, the reader must keep in mind that the analyses are simple because they use percentages, are based on multiple sources and are anecdotal. Although anecdotal in nature, they do provide a relatively clear-cut picture of the major causes of injuries and fatalities. In the case of the fire service, the major findings of the first report related to fire department fatalities compare with this report with a fair degree of reliability.

Fire Department Statistics

Injuries Responding To and From an Alarm

The "Multi-Discipline Response and Roadway Safety" report included a table showing the summary of firefighter injuries occurring during response and return from 1990 through 2006. **Table 2.1 p. 14** includes that data and updated data to include the reports through 2010.

These numbers suggest that while vehicle-related deaths are the second leading overall cause of firefighter deaths, they actually account for only a small percentage of overall firefighter injuries. However, while vehicle-related events tend to be lower in frequency, when they do occur, they are serious events.

Cause and Location of Incidents Resulting in Injuries

For this report, 500 incidents of firefighter injuries were reviewed. There were 432 injuries reported in the 500 incidents reviewed. The reader should be aware that very little data is available for the years prior to 2005. Of all the causes identified, 135 injuries occurred as the result of a rollover. Collisions with other vehicles accounted for the majority of injuries with 327 injuries being reported. Of those collisions, 122 occurred at intersections. **Figure 2.1 p. 15** graphically illustrates the causes of all of the firefighter injuries reported in the database from 1996-2012.

Collisions result in not only injuries to firefighters and economic loss to fire departments, but also injuries, fatalities and economic losses to the civilian population, since collisions usually occur with civilian vehicles. In addition to the firefighters injured,

the collisions reviewed resulted in civilian injuries, and in some cases fatalities. There were 228 civilian injuries, which could be even higher since 34 reports did not include data related to civilians **(Figure 2.2)**. In addition to the injuries, these collisions resulted in 137 civilian fatalities.

Table 2.1. Firefighter Injuries Responding to/Returning From Incidents, 1995-2010

Year	Fire Apparatus Collisions	Fire Apparatus Collisions Injuries	Privately Owned Vehicle Collision Injuries	Privately Owned Vehicle Collisions	Crash Injuries as a Percent of All Firefighter Injuries
1992	11,500	1,050	1,575	150	N/A
1993	12,250	900	1,675	200	N/A
1994	13,755	1,035	1,610	285	N/A
1995	14,670	950	1,690	190	1.2
1996	14,200	910	1,400	240	1.3
1997	14,950	1,350	1,300	180	1.8
1998	14,650	1,050	1,350	315	1.6
1999	15,450	875	1,080	90	1.1
2000	15,300	990	1,160	170	1.4
2001	14,900	960	1,325	140	1.3
2002	15,550	1,040	1,030	210	1.5
2003	15,900	850	980	85	1.2
2004	15,420	980	1,150	220	1.6
2005	15,885	1,120	1,080	125	1.7
2006	16,020	1,250	1,070	210	1.5
2007	14,650	915	665	120	
2008	14,950	670	1,000	70	
2009	15,100	820	870	100	
2010	14,200	775	1,000	75	1.0

Source: NFPA Survey of Fire Departments for U.S. Fire Experience.

Figure 2.1. Firefighter Injuries in Nonfatal Vehicular Incidents, 1996-2012

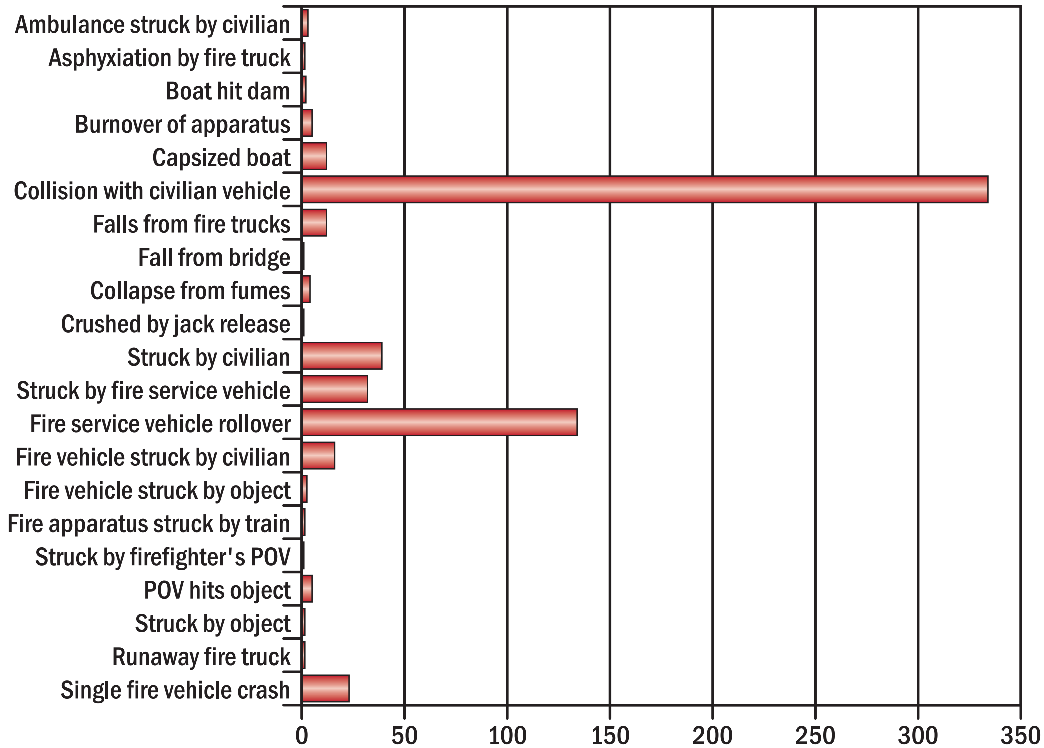
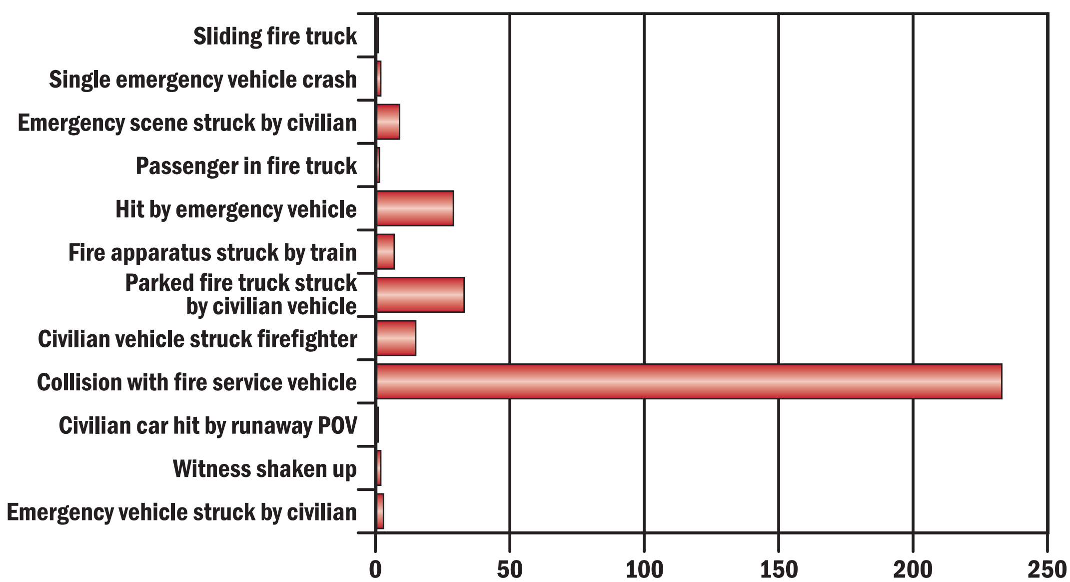


Figure 2.2. Civilian Injuries Due to Fire Service Vehicle Incidents, 1996-2012



Firefighter Fatalities

At the time of this report, for the third year in a row, firefighter fatalities were less than 100, with 2011 having the lowest number of firefighter losses on record (an 11 percent reduction from 2010). Although this is significant in total fatalities, that reduction is not reflected to the same degree of decrease in vehicular fatalities, as seen in **Table 2.2**.

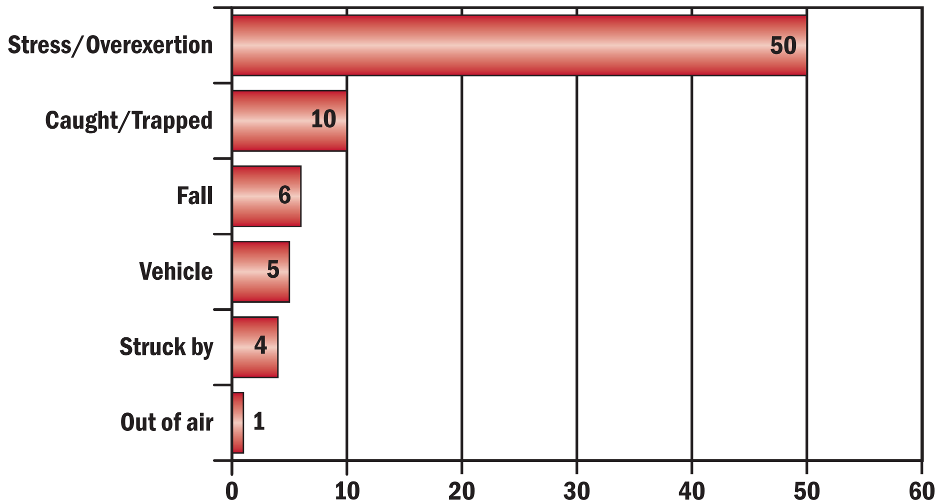
Table 2.2. Vehicular-related Firefighter Fatalities, 1994-2011

Year	Total Firefighter Fatalities	Total Vehicular Fatalities	Fire Apparatus Collision Fatalities	Privately Owned Vehicle Collisions Fatalities	Struck at Vehicle Collision Scene	Fatalities as a Percent of All Firefighter Fatalities
1994	104	13	10	1	2	13
1995	97	14	7	5	2	14
1996	95	20	8	8	4	21
1997	96	17	7	5	5	18
1998	91	16	8	4	4	18
1999	113	15	9	2	4	13
2000	103	20	12	3	5	19
2001	103*	15	7	5	3	15
2002	100	11	2	5	4	11
2003	111**	28	18	6	4	25
2004	108**	13	5	5	3	12
2005	99**	15	11	3	1	15
2006	92**	8	4	2	2	9
2007	106**	20	9	10	1	19
2008	108**	14	6	7	1	13
2009	78**	14	10	3	1	18
2010	72**	9	3	3	3	13
2011	64	6	1	3	2	9

*Firefighters lost in the World Trade Center not included.
** Firefighters under the inclusion criteria of Hometown Heroes Survivors Benefit Act not included.
Source: USFA Firefighter Fatality Reports 1994-2011.

This report reviews vehicular fatalities in a different format from the initial "Emergency Vehicle Safety Initiative" report. This report pulls out the fatalities responding to and from an alarm that are specific to vehicular collisions and adds in those that result from being struck by a vehicle at the scene. For the first time in several years, vehicle collision has dropped from the second leading cause of firefighter fatalities to the fourth **(Figure 2.3 p. 17)**. Although this is encouraging, several more years of data are necessary to determine if this is truly a trend.

Figure 2.3. Firefighter Fatalities by Cause, 2011



Source: USFA Firefighter Fatality Report 2011.

Law Enforcement Statistics

Injuries and Cause

Unlike the records on firefighter fatalities kept by several organizations, finding long-term data on police injuries resulting from vehicle crashes or being struck by vehicles is not so simple.

The Federal Bureau of Investigation (FBI) does track injuries to law enforcement officers, but it only separates out assaults and related injuries. **Table 2.3** shows a breakdown of reported assaults and injuries for 2001-2010 as reported to the FBI.

A 2007 report issued by the National Safety Council (NSC) provides some knowledge of injuries related to law enforcement vehicles. The report analyzed law enforcement data for the three-year period of 2004 to 2006. During that period, there were 81,707 documented total crashes involving law enforcement vehicles. This averaged out to about 27,235 per year. During that three-year period, approximately 37,655 law enforcement officer injuries were reported.

Table 2.3. Law Enforcement Officer Assaults and Injuries, 2001-2010

Year	Assaults	Injuries
2001	57,258	16,328
2002	58,440	16,626
2003	58,278	16,412
2004	60,054	16,737
2005	59,428	16,072
2006	59,907	15,916
2007	60,851	15,736
2008	60,139	15,554
2009	57,268	14,985
2010	53,469	13,962
Total	585,092	158,328

Source: Federal Bureau of Investigation

The report also noted that police vehicles were in 3.4 times more crashes than fire and EMS vehicles during that period. Although this may seem an extraordinarily high figure, police vehicles spend a significantly greater amount of time on the road than do most fire and EMS vehicles. Thus, their potential for being involved in collisions is greatly increased simply due to the greater amount of exposure to potential hazards. Although numbers were not reported, this report did emphasize that the majority of police vehicle crashes were during regular patrol activities and at speeds of less than 40 miles per hour (mph). Costs from nonemergency response crashes were four times higher than pursuit and emergency response combined.

Fatalities

According to statistics kept by the National Law Enforcement Officers Memorial Fund, 2011 was the first year since 1996 that firearms-related fatalities once again outnumbered traffic-related fatalities. From 1997 to 2010, traffic-related fatalities were the leading cause of law enforcement officer fatalities. The preliminary data through June 25, 2012, shows 21 traffic-related fatalities and 18 firearms-related fatalities for the 2012 calendar year. One will have to review the final 2012 statistics to see if this begins a trend of vehicle-related fatalities being the second leading cause for law enforcement officer LODDs.

Over the 10-year period from 2002-2011, there were 1,559 law enforcement officer fatalities. Of that total, 687 (44 percent) were vehicle-related. Automobile collisions accounted for 30 percent; motorcycles accounted for 5 percent and struck by vehicles accounted for 9 percent. **Table 2.4** shows the breakdown of vehicle-related law enforcement officer deaths from 1992-2012.

Similarly, the data in the FBI's Law Enforcement Officers Killed and Assaulted (LEOKA) database reveals that over a 10-year period from 2003-2012 there were 1202 law enforcement fatalities, and 593 (49 percent) of that total were vehicle-related. Of these vehicle-related fatalities, 6 percent were feloniously killed, and the remaining 94 percent were considered accidental.

In August 2011, the National Law Enforcement Officers Memorial Fund and the NHTSA initiated an innovative partnership to promote law enforcement officer safety on the roadways and reduce vehicle-related fatalities.

Table 2.4. Sites of Vehicle-Related Law Enforcement Officer Fatalities, 1992-2012

Interstates	210	20%
Intersections	187	18%
State highways, single surface	136	13%
Roads, single surface, unspecified	109	10%
U.S. highways, single surface	103	10%
Divided roadways, open access	82	8%
City streets, single surface	80	7%
Miscellaneous areas	48	4%
Natural areas	44	4%
County roads, single surface	29	3%
Freeway/Tollway/Turnpikes	23	2%
Highways, unspecified	19	1%

Emergency Medical Services Statistics

Depending on the location, the local or volunteer fire department, a separate "third service" public agency, a hospital or group of hospitals, a private company, or a combination of these organizations may provide EMS. Because of the diversity among EMS organizations, no reliable counts of the number of EMS personnel exist, and there is no organized data collection system to track illness, injuries and fatalities.

According to the Bureau of Labor Statistics, in 2009, there were about 218,000 emergency medical technicians (EMTs) and paramedics employed. There are also an estimated 500,000 and 800,000 additional volunteer EMTs and paramedics. These numbers did not include the firefighters who cross-trained in EMS.

According to the report, "Considerations for Toward Zero Deaths: A National Strategy on Highway Safety," prepared by the National Association of State Emergency Medical Services Officials in 2010, EMS providers are at greater risk of death on the job than their police and firefighter counterparts, with 74 percent of EMS fatalities being transportation-related. This and other studies have estimated the fatality rate for EMS personnel at more than twice the national average.

Based on information provided by the American Ambulance Association (AAA) that was collected through insurance organizations protecting ambulance services, an estimated 10,000 or more ambulance-related collisions occur annually, with many of these resulting in injury or death. The following databases collect information on EMS responder injuries and fatalities; however, all are limited and/or inconsistent in data sets collected.

- The Fatality Analysis Reporting System (FARS) focuses on fatalities, and the National Automotive Sampling System General Estimates System (NASS GES) focuses on injuries. The NHTSA administrates both of these and collects information regarding adverse motor vehicular traffic events on the national level. Despite the breadth and depth on ambulance crashes, there are statistical details that are not available.
- The National EMS Information System (NEMSIS) was established to promote the unification of EMS data. It focuses on establishing a framework for the evolution of effective national EMS data that includes coordination with state-based data collection efforts.
- The National EMS Memorial Service (NEMSMS) Database is the only database specific to EMS. It keeps a database of LODDs, broken down by cause of death, and contains some narrative about the circumstances. This database depends entirely on nominations from the responder community to identify fatalities, so it is impossible to know if the numbers are complete or just representative of the EMS population.
- The Model Minimum Uniform Crash Criteria (MMUCC) coordinates state-based data addressing ambulance crashes and related topics. The program provides a minimum recommended standardized data set for describing motor vehicle crashes and the vehicles, people and environment involved in the event. Contribution to the MMUCC program is voluntary.

Table 2.5. State Reported Ambulance Crash Injury and Fatality Data, 2000-2010

Year	Number of States Reporting	Injuries	Fatalities
2000	9	137	5
2001	13	262	7
2002	17	357	7
2003	21	461	14
2004	23	670	20
2005	23	719	28
2006	26	702	8
2007	27	809	18
2008	26	783	21
2009	24	735	19
2010	23	680	19

Source: Analysis of Ambulance Crash Data; NFPA 2011.

Injuries

NFPA published a report, "Analysis of Ambulance Crash Data," in September 2011. **Table 2.5** summarizes those findings by state from 2000-2010.

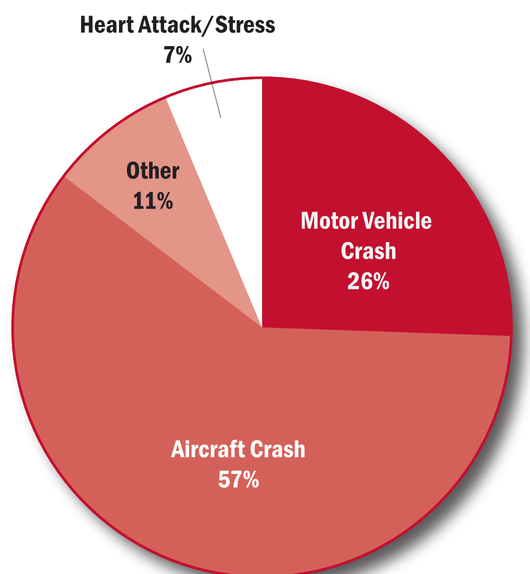
Although the data expand as more states report, it is still not possible to determine with any certainty the numbers of injuries or fatalities that occur in ambulance crashes, since less than half the states report, and the reporting states varied over the years.

Fatalities

An analysis of EMS line-of-duty fatalities using data from the Census of Fatal Occupational Injuries and NEMSMS revealed an average of 19 EMS responder deaths per year from 1992 to 1997. The latest information available on causes of fatalities indicates that emergency medical responders are most often killed in aircraft and motor vehicle accidents (**Figure 2.4**).

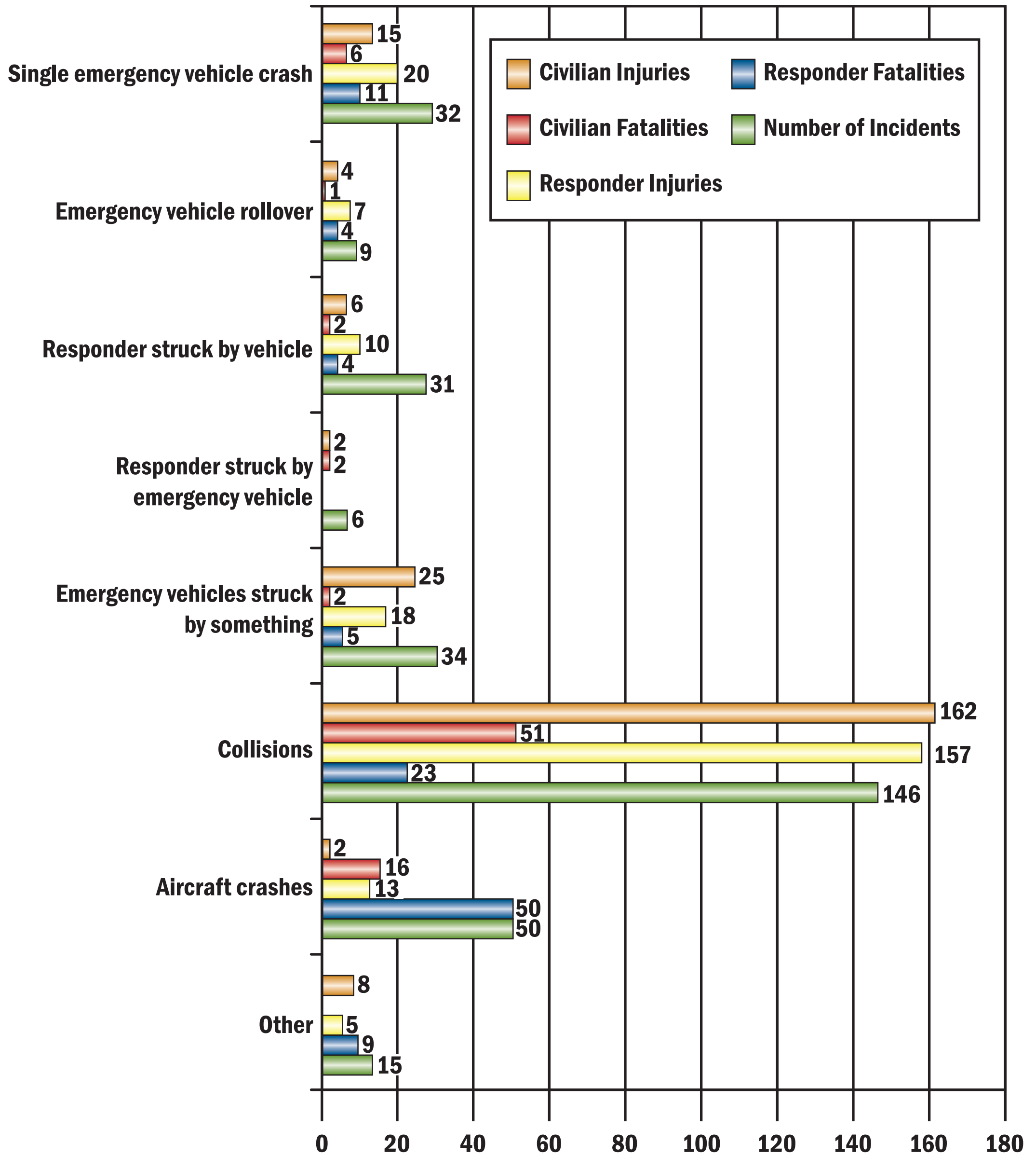
There were 325 fatal incidents reviewed for this report to determine incident type spanning the years 1996 to 2012. The most common incident type was a collision. Note that although the number of responder and civilian injuries was almost the same, the number of civilian fatalities was almost twice the number of responder fatalities. The entire findings of this review are found in **Figure 2.5 p. 21**.

Figure 2.4. EMS Fatalities by Cause, 1998-2001



Source: National EMS Memorial Service (2002)

Figure 2.5. Emergency Medical Services Fatalities by Incident Type, 1996-2012



Case Studies

The numerical data and statistics on injuries and fatalities related to response and roadway scene operations give a sense of the magnitude of the problem. However, it is also important to review specific incidents in order to identify factors involved and show the personal side of these tragedies. This chapter presents selected cases on firefighter and law enforcement fatalities identified through the data obtained from the firefighter fatality studies and police reports over the past several years.

Firefighter Fatalities

Case Study 1

On Feb. 10, 2010, at 3:40 p.m., a 69-year-old male fire chief died after being crushed between a parked tanker and a pumper being backed into the fire station. The firefighter reported that he observed the fire chief outside of the station as he was backing the pumper into the station. The firefighter, realizing he had backed the pumper too close

to the tanker parked inside of the station, pulled forward to reposition the pumper and then finished backing it into the station. The firefighter exited the pumper and yelled for the chief. The chief did not respond. When the firefighter searched for the chief, he found him unconscious and unresponsive on the station floor next to the pump panel of the tanker. The firefighter called 911 and started CPR. Although EMS responded, the chief was pronounced dead by the coroner at the scene.

Contributing Factors for the Incident

- Inadequate policies for backing apparatus.
- Inadequate facility space for the number of apparatus.
- Inoperative backup warning system and possible obscured side view mirror.

Additional information on this incident is available in the National Institute for Occupational Safety and Health (NIOSH) "Fire Fighter Fatality Investigation and Prevention Program," report number 2010-07. The report is available for review at www.cdc.gov/niosh/fire/reports/face201007.html.

Case Study 2

On July 26, 2010, at 4:30 p.m., a 59-year-old male volunteer fire chief (Victim 1) and a 67-year-old male volunteer firefighter (Victim 2) died from injuries sustained after they were ejected when their engine was involved in a crash and rolled over. The engine, with its lights and siren activated, was responding to a mutual-aid residential structure fire. The crash occurred when the engine entered an intersection with a red light and was struck by a sport utility vehicle (SUV). The engine rolled over and ejected both victims. Victim 1 was pronounced dead after being transported to a local hospital. Victim 2 was pronounced dead at the scene. Both victims were not wearing their seatbelts.

Contributing Factors for the Incident

- Nonuse of seatbelts.
- Failure of the motorist to yield the right-of-way to an approaching emergency vehicle with audible and visual signals in use.
- Failure to ensure that all approaching vehicles had yielded the right-of-way before advancing through an intersection.
- Failure to come to a complete stop at a red traffic signal.
- Lack of intersection control device on emergency vehicle and traffic light.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2010-19. The report is available for review at www.cdc.gov/niosh/fire/reports/face201019.html.

Case Study 3

On Jan. 2, 2009, at 2:13 a.m., a 57-year-old male career firefighter was fatally injured when he was backed over while spotting an apparatus on the fire scene. The victim was the acting captain on the night of the incident and responded in an engine with a crew of three to a reported working structure fire.

While en route, the engine had received a radio message to perform a forward hose lay and supply water for an elevated master stream. Due to the location of the fire structure and hydrant, the crew had to lay the supply line beneath a highway overpass.

Upon arrival, the engine driver had to drive around a police cruiser and tow truck in order to position the engine at an available hydrant. The engine then dropped off a firefighter at the hydrant to prepare a forward lay when the Incident Commander (IC) advised them to do a reverse lay.

The acting captain then exited the engine to guide the driver while he backed the engine around the police cruiser and tow truck. He walked down the officer's side of the engine and positioned himself at the rear on the officer's (right) side. The firefighter positioned himself at the driver's side front bumper. The driver was able to negotiate the engine around the police cruiser and tow truck without incident before straightening up to position a supply line into the scene.

The acting captain walked backward, keeping eye contact with the driver via the officer's side mirror. While backing, the driver noticed the tow truck drive past him toward the scene. He focused his attention on the tow truck momentarily when he felt the truck run over something. A police officer yelled to the driver to stop the engine because something or someone was just run over.

They found the acting captain underneath the engine just in front of the officer's side rear wheels. He was transported to a local metropolitan hospital where he was pronounced dead. The driver was not cited in the fatal incident.

Contributing Factors for the Incident

- Loss of direct communications between driver and spotter.
- Driver distractions.
- Possible loss of footing by the victim.
- Possible failure of the automatic reverse braking system.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2009-10. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200910.html.

Case Study 4

On Feb. 23, 2009, at 3:59 p.m., a 34-year-old male volunteer/paid on-call firefighter was the front seat passenger in a 1964 "Fire Knocker" engine responding to a wildland fire on a two-lane paved road with a posted speed limit of 55 mph. As the engine responded, it approached a split intersection with another highway. As the apparatus approached the intersection, the driver tried to apply the brakes and found that he was unable to stop. The apparatus traveled through the first part of the intersection and then swerved to avoid traffic in the second part of the intersection. The apparatus overturned and came to rest on a utility pole. The passenger was ejected from the vehicle during the crash and sustained fatal injuries. The cause of death was listed as trauma to the head. Neither the driver of the engine nor the passenger was wearing a seatbelt at the time of the crash.

Contributing Factors for the Incident

- Nonuse of seatbelts.
- Inadequate driver training and inexperience with the specific apparatus.
- Lights and siren response with an apparatus not designed for higher speed on-road emergency response.
- Lack of maintenance on the vehicle.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2009-08. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200908.html.

Case Study 5

On April 15, 2009, at 7:45 p.m., a 41-year-old male volunteer fire chief was fatally injured when the vehicle he was driving skidded off the highway and struck a tree. He was driving the fire department's response vehicle (pickup truck) to a fire alarm when a car pulled out of an intersecting roadway to his left and across the path of his vehicle. The victim tried to maneuver his vehicle around the car, but his vehicle turned sideways and skidded down the highway. The vehicle then went off the highway and struck a tree. An eyewitness to the incident called 911 and reported the crash. EMS arrived shortly thereafter and evaluated the victim's condition. He was pronounced dead at the scene as a result of multiple trauma. He was wearing his seatbelt at the time of the crash.

Contributing Factors for the Incident

- Excessive speed.
- Wet roadways.
- Operating the vehicle without the use of a siren.
- Obstructed view at the intersecting roadway.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2009-12. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200912.html.

Case Study 6

On June 5, 2009, at 12:53 a.m., an 18-year-old volunteer firefighter was responding to a car fire in his personal vehicle when he lost control of the vehicle, crossed the center line, left the roadway and struck a tree. He was killed as a result of massive head trauma sustained during the crash. He was not wearing a seatbelt at the time of the crash.

Contributing Factors for the Incident

- Nonuse of seatbelt.
- Excessive speed.
- Wet roadways.

Case Study 7

On March 28, 2008, at 9:30 a.m., a volunteer firefighter was responding as the driver of a 3,000-gallon water tanker (tender) to a structure fire in a neighboring fire district. The vehicle entered a 90 degree curve with a posted cautionary speed of 10 mph. The apparatus failed to negotiate the turn and left the roadway. The apparatus rolled onto the driver's side and struck a large pine tree.

The firefighter was trapped in the apparatus. Arriving firefighters were unable to extricate him until a tow truck was used to pull the truck off the tree, which took approximately 45 minutes. He was flown by medical helicopter to the hospital, where he was pronounced dead. He was wearing his seatbelt at the time of the crash.

Contributing Factors for the Incident

- Excessive speed to negotiate the turn.
- Lack of familiarity with the area and roadways.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2008-10. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200810.html.

Case Study 8

On July 7, 2008, at 8:08 p.m., firefighters were dispatched to a vehicle fire that was later updated to a garage fire. The volunteer driver of a 1991 commercial chassis pumper with a 1,000-gallon water tank came upon a farm tractor with implements approaching from the opposite direction. The tractor pulled as far to the side of the road as possible and stopped. The driver pulled the pumper to the right and passenger side wheels of the apparatus left the roadway. He steered left to bring the truck back on the road and then steered to the right when the apparatus jumped toward the opposing lanes. The rear of the apparatus came around and the apparatus rolled several times.

The driver was not wearing his seatbelt and was ejected during the crash. A front seat passenger in the apparatus was also not wearing a seatbelt but remained inside of the vehicle. The driver suffered fatal traumatic injuries. The passenger firefighter received nonlife-threatening injuries. The speed of the apparatus prior to the crash was estimated by a witness to be 55 to 60 mph.

Contributing Factors for the Incident

- Nonuse of seatbelts.
- Excessive speed.
- Loss of vehicle control.
- Failure to keep all of the wheels of the apparatus on the road surface.

Case Study 9

On July 8, 2008, a 25-year-old male volunteer firefighter died after being ejected in a fire truck rollover. This was his first emergency call driving this apparatus. The crash occurred as the fire truck was returning to the station after a call for a propane gas fire.

The fire truck was traveling down a winding, steep grade. The paved road had a posted speed limit of 45 mph with a curve warning sign and recommended safe speed of 20 mph through the S-curve. The driver lost control of the fire truck, swerved off the left side of the road, returned to the pavement and overturned on the right side of the road.

The victim was not wearing a seatbelt and was ejected out of the driver's side window. The pumper's 725-gallon water tank detached from the truck body and landed on top of the victim in the street. The victim was pinned underneath the water tank and died from multiple trauma and crush injuries sustained in the crash.

Contributing Factors for the Incident

- Nonuse of seatbelt.
- Inadequate driver training.
- Driver inexperience with this specific apparatus.

- Potentially incorrect installation of a replacement water tank.
- Difficult road conditions.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2008-25. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200825.html.

Law Enforcement Officer Fatalities

Case Study 10

On Sept. 8, 2008, around 1:30 p.m., a 43-year-old state trooper was responding with his emergency lights and siren in operation to a motor vehicle accident. The trooper went around a curve on wet pavement and lost control of his cruiser. He briefly crossed the center line of the highway and then steered hard to the right to return to his lane. The cruiser spun around to the right, slid sideways, and was hit by an oncoming garbage truck. Excessive speed was not noted as an issue in this collision.

The truck driver tried to avoid the cruiser but was not successful. The truck struck the cruiser on the driver's side. The trooper was trapped in the vehicle and required extrication. He died in the ambulance on the way or shortly after arrival at the hospital as the result of head and chest injuries.

Contributing Factors for the Incident

- Potential nonuse of seatbelt, since this is not noted in the report.
- Wet roadway.
- Loss of vehicle control.

Case Study 11

On April 29, 2007, at approximately 10:19 a.m., a 23-year-old police officer was dispatched to a call for a robbery in progress at an ATM at a local bank. He responded to the incident utilizing his vehicle's emergency lights and siren. As he entered an intersection with the traffic signal displaying red in his direction, an SUV hit the cruiser on the driver's side door.

He was wearing his seatbelt, but he sustained severe head trauma. He was treated at the scene and eventually flown by medical helicopter to a regional trauma care facility where he died of his injuries.

Contributing Factors for the Incident

- Failure of the motorist to yield the right-of-way to an approaching emergency vehicle with audible and visual signals in use.
- Failure to ensure that all approaching vehicles had yielded the right-of-way before advancing through an intersection.
- Failure to come to a complete stop before traversing a negative right-of-way (red light) intersection.

Case Study 12

On Oct. 28, 2007, at approximately 2:40 a.m., a 24-year-old state trooper was dispatched to assist sheriff's deputies in breaking up a fight outside a bar. As the trooper drove south, a northbound vehicle crossed the center line into the path of his cruiser.

The trooper attempted to avoid collision but could not. Both the cruiser and the vehicle that hit it spun around; the cruiser was then hit on the driver's door by a third vehicle, and the latter two erupted in fire. A fourth vehicle went off the road to avoid the two vehicles on fire.

The trooper was declared dead at the scene as the result of blunt force trauma. The driver of the vehicle that first hit the trooper was charged with aggravated drunken driving, reckless homicide and failure to yield to an emergency vehicle. The driver of the second vehicle was also charged with aggravated drunken driving. In addition to having a blood alcohol level above the legal limit, the driver of the second vehicle had ecstasy and horse tranquilizers in his system.

Contributing Factors for the Incident

- Failure of the motorist to yield the right-of-way to an approaching emergency vehicle with audible and visual signals in use.
- Motorist driving under the influence and impaired.

Case Study 13

On May 4, 2005, at around 4 p.m., a 26-year-old deputy operating a marked Chevrolet Camaro was following another deputy trying to find and identify the driver of a dump truck who had earlier committed an assault. The deputy was operating with emergency lights but not his siren.

When they crossed into the neighboring county, the interstate narrowed from three lanes to two. While attempting to pass a slower pickup truck on the left, the deputy lost control of his vehicle. He overcorrected and swerved across the median and under the cable barrier. The vehicle ended up in the opposing lanes of traffic, where a 2000 Infiniti SUV hit his cruiser almost head-on. The two vehicles were then hit by a 2002 Volkswagen Jetta. The Jetta burst into flames and caused the cruiser to burn.

The State Highway Patrol estimated that the deputy's cruiser was traveling at least 87 mph when the crash occurred. Although he was wearing his seatbelt, he was declared dead at the scene; the cause of death was listed as physical trauma.

Contributing Factors for the Incident

- Excessive speed combined with the narrowing of the interstate.
- Loss of vehicle control.
- Overcorrecting to regain control of the vehicle.
- Operating the vehicle without the use of a siren.

Case Study 14

On Nov. 3, 2006, at around 10:30 a.m., a 38-year-old deputy was performing normal patrol duties. Another deputy radioed for backup assistance with a driver he had stopped on the interstate. This driver was suspected to be intoxicated and had become combative.

The deputy drove east on the interstate toward this situation. Encountering merging traffic at an interchange, according to witnesses, he initially tried to pass merging cars on the right but appeared to change his mind at the last moment. He swerved and lost control of his cruiser, which spun off the right side of the interstate and hit a split-rail fence and sheet metal around a signpost before coming to rest. The State Patrol investigators estimated that the cruiser was traveling about 110 mph when the deputy lost control.

The deputy was not wearing a seatbelt. He was treated at the scene and transported to the hospital. He was pronounced dead at the hospital of traumatic injuries.

Contributing Factors for the Incident

- Excessive speed.
- Loss of vehicle control.
- Failure to ensure that all merging vehicles had yielded the right-of-way.
- Nonuse of seatbelt, although a State Patrol investigator was quoted as saying that the crash might not have been survivable even if a seatbelt had been worn.

Case Study 15

On Nov. 9, 2006, just after 6 a.m., a law enforcement investigator observed a deer carcass in the middle of the left lane, northbound of State Route 309. He pulled his cruiser to the right shoulder, activated his emergency lights and got out. He radioed for backup assistance, but as he attempted to move the carcass, he was struck by a passenger van.

The assisting officer arrived at the scene approximately two minutes after the request. The investigator was treated at the scene and flown by medical helicopter to a regional hospital. He was pronounced dead at 6:54 a.m.

The investigation of the incident concluded that the driver of the van was not speeding and was traveling at 40 mph at the time of the impact. State Police investigators determined that the van driver could not have seen the investigator due to the darkness of the hour and the dark blue uniform that he was wearing. No charges were filed. A witness to the crash commented that it was pitch dark at the time of the incident.

Contributing Factors for the Incident

- Inability to establish traffic control in affected highway lanes.
- Inadequate lighting.
- Failure to wear retroreflective personal protective equipment (PPE).

Case Study 16

On Aug. 17, 2007, at approximately 7 a.m., a 32-year-old police corporal was driving to work in an unmarked patrol car. A call was dispatched for an armed robbery in progress. Multiple units responded.

The corporal was traveling northbound on the outside lane of a four-lane street and needed to turn around and head southbound toward the dispatched call. The officer attempted a U-turn from the outside lane and was struck at the driver's door of his vehicle by another vehicle that was traveling in the same direction in the inside lane.

The force of the collision snapped the officer's seatbelt, and he was knocked into the back seat of his vehicle. The officer was treated on the scene by paramedics and transported to the hospital, where he was treated for massive head trauma and died about one half-hour after the collision.

Contributing Factors for the Incident

- Not checking the location of approaching traffic before making a lane change and change of direction.
- Attempting a U-turn on a busy, multilane street rather than going around a block or turning in a location outside the flow of traffic.

Case Study 17

On Oct. 22, 2006, at 10:05 a.m., a 29-year-old police officer was dispatched to a traffic crash on U.S. Highway 20, a two-lane road running east and west. The initial crash involved an SUV with a trailer. The temperature was 21 F and the road was wet and icy in spots.

The officer responded to the crash in his marked SUV and activated his emergency lights. He was traveling west on a section of road that is straight and level. As he passed two vehicles, he lost control of his vehicle. The SUV went into a skid, rolled 1 1/2 times, and hit a tree on the south side of the road. He was not wearing his seatbelt. He was declared dead at the scene due to severe head trauma.

Contributing Factors for the Incident

- Nonuse of seatbelt.
- Icy roadway.
- Operating the vehicle without the use of a siren.

Case Study 18

On April 21, 2007, at approximately 11 p.m., a 21-year-old sheriff's deputy was driving eastbound on a divided interstate highway returning from an incident when his cruiser left the road, turned over several times and came to rest 100 feet off the highway.

The deputy was likely not wearing his seatbelt. He was ejected from the vehicle during the crash. He was pronounced dead at the scene. Excessive speed was likely a factor in the crash.

Contributing Factors for the Incident

- Excessive speed, especially in a nonresponse mode.
- Loss of vehicle control.
- Nonuse of seatbelt.

Case Study 19

On June 16, 2007, at approximately 2 p.m., three police officers were conducting a speed enforcement detail on eastbound State Route 32.

A 31-year-old officer, who was working overtime for the detail, tracked a Nissan Sentra traveling 71 mph in a 55 mph zone. He stepped into the lane of travel, as per department procedure, and motioned to the driver to move left onto the shoulder.

The driver failed to notice him until the last moment, applied the brakes, and swerved right. In doing so, she struck the officer. He was vaulted to the top of the vehicle and then thrown 153 feet from the point of impact. The officer was wearing a retroreflective traffic safety vest at the time he was struck.

He was airlifted to the Trauma Center, where he died of his injuries two days later. The cause of death was multiple traumatic injuries.

Contributing Factors for the Incident

- Excessive speed of the oncoming motorist.
- Stepping into the lane of travel of a speeding vehicle.

It should be noted that the policy of stepping out to direct speeding vehicles to stop has been dropped by this particular police department but continues to be used in other agencies.

Case Study 20

On May 12, 2006, around 4:40 p.m., a 40-year-old state patrol officer was traveling home when he accidentally ran a stop sign. He locked his brakes in an attempt to stop but skidded into the intersection, where his covert (unmarked) police vehicle collided with a pickup truck.

His vehicle was hit on the passenger side in the intersection by a pickup truck. Because of the collision, the patrol officer's vehicle struck a utility pole and came to rest in a ditch on the side of the road. The pickup turned over and came to rest in the field near the roadway. The driver of the pickup was not seriously injured. Despite wearing his seatbelt, the patrol officer was pronounced dead at the scene as the result of blunt force trauma.

Although the patrol officer's normal shift was eight hours, the previous day he had worked from 8 a.m. to almost 2 a.m. on the morning of May 12, in response to a SWAT incident with the city police department. He returned to the office by 7:40 a.m. on May 12 to continue work on that incident. Before he left his office at 4:30 p.m., he indicated in an email that he was fatigued. He told a friend he was working on about 2 1/2 hours of sleep. At the time of the collision, the patrol officer was talking with a friend on his cellphone and noted that he had inadvertently run a stop sign. Then the call was abruptly terminated.

Contributing Factors for the Incident

- Fatigue resulting in decreased concentration and slower reaction time.
- Talking on a cellphone may have contributed to not seeing the stop sign.

Case Study 21

On the night of July 30-31, 2005, a 34-year-old police officer was on routine patrol. Around midnight, a call was dispatched for a burglary in progress involving juveniles at a school facility.

The officer responded and utilized his emergency lights and siren. His cruiser was traveling at a high rate of speed as he responded on a state highway. A car started to pull onto the highway at an intersection. The officer swerved to avoid a collision, overcorrected and lost control of the vehicle. The cruiser veered left and overturned in a ditch, hitting a culvert. The impact was so significant that the cruiser's rear seat was pushed into the front seat.

Although the officer was wearing a seatbelt, he was ejected from the vehicle. He was transported to the hospital by medical helicopter but was pronounced dead a few hours later.

His father was participating in an authorized ride along program at the time of the crash and was also killed.

Contributing Factors for the Incident

- Excessive speed.
- Failure to ensure that all merging vehicles had yielded the right-of-way.

Case Study 22

On June 14, 2008, a 51-year-old male volunteer assistant chief and a sheriff's deputy were fatally injured.

A fire in an inaccessible area of a military base firing range had been burning for over two months. The fire was contained by means of a firebreak line that had been created using heavy equipment. On the morning of June 14, smoke from the fire mixed with fog had created zero visibility conditions on a highway near the military base.

A series of vehicle crashes occurred in the smoky area, and the volunteer fire department was dispatched to assist. The assistant chief arrived on the first engine company and reported heavy smoke and poor visibility conditions.

As law enforcement officials arrived on the scene, additional crashes occurred, at least one involving a law enforcement vehicle. The roadway was in the process of being shut down by law enforcement officers.

The assistant chief was outside of the engine, wearing full turnout gear and a reflective vest, when he was struck by a tractor-trailer truck that entered the scene. A sheriff's deputy was also struck and killed, and another deputy was injured. The report on the incident estimated the speed of the tractor-trailer at 55 mph when it entered the scene.

Contributing Factors for the Incident

- Inability to establish traffic control on both sides of a divided highway.
- Ineffective coordination of the multiple agencies involved in the response.
- Unsafe vehicle operation of motorists during inclement weather/environmental conditions.

Additional information on this incident is available in NIOSH "Fire Fighter Fatality Investigation and Prevention Program," report number 2008-17. The report is available for review at http://www.cdc.gov/niosh/fire/reports/face200817.html.

Chapter 3
Common Crash Causes and Their Prevention

When looking at vehicle response crash data, statistics and case histories for fire, law enforcement and EMS, it quickly becomes evident that the causes of vehicle crashes across these disciplines are, for the most part, notably similar. This section will examine the common causes for all emergency vehicle crashes, with emphasis on issues that tend to affect one discipline more than others.

Intersections

The most common place where vehicles of all emergency disciplines are involved in a collision with another vehicle is intersections. Intersections are the most likely location for emergency vehicles to come into contact with other vehicles that are directly in their path of travel. The most common reason that emergency vehicles collide with civilian vehicles is drivers who fail to yield to the emergency vehicle **(Figure 3.1)**. Intersection collisions also result from the driver of the emergency vehicle disregarding safe practice and the laws dictating the manner in which they are supposed to traverse an intersection, especially in a negative right-of-way situation. On occasion, two emergency vehicles will collide with each other in the intersection. In some cases, the emergency vehicles are responding to the same incident, and in other cases they are responding to separate incidents.

Figure 3.1 — Intersections are the most common places for collisions to occur. (Photo/Ron Jeffers, Union City, New Jersey)

When responding to a call, emergency vehicles are given the option of proceeding through a red traffic signal or stop sign (after coming to a complete stop) because of the perceived urgency of the event. Too often, emergency vehicles proceed through negative right-of-ways without stopping and, in some cases, barely slowing down. Yet, many calls do not require an urgent response. The differences between slowing the vehicle and rolling through an intersection versus coming to a complete stop at an intersection will probably only extend the response time by two to three seconds per intersection in fire apparatus and ambulances. This figure may even be less in police vehicles, as they tend to have quicker stopping and acceleration capabilities than do larger apparatus. Rarely, if ever, could it be shown that an additional 15 to 20 seconds during a response had a significant impact on the outcome of the incident.

SOPs and training must reinforce safe procedures for getting through intersections. Police and fire departments must have established policies for negotiating intersections, and all drivers must be thoroughly trained in these procedures. In the fire service, this is a requirement of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program* (Objective 6.2.7). Negotiating intersections for ambulances is covered in the Emergency Vehicle Operator Course (EVOC) for Ambulances through NHTSA. Most local law enforcement agencies have similar policies.

When the vehicle has two members riding in the front, such as with two police officers, two EMTs/paramedics or a fire apparatus driver/operator and a company officer, both the occupants must work together to ensure safe passage through intersections. When approaching an intersection, the driver must slow the vehicle to a speed that allows a stop at the intersection if necessary. Even if faced with a green signal light or no signal at all, slow the vehicle to a speed that would allow for an expedient stop. Situations where an expedient stop may be required include obstructions, such as buildings or trucks, that block the driver's view of the intersection or when the driver cannot ensure that all other vehicles have stopped to give the vehicle the right-of-way.

At busy intersections, the foot should be placed on the brake pedal, so there will be no delay if a stop is necessary. This technique is often referred to as "covering the brake pedal," and it is widely taught in both the fire and law enforcement communities. Depending on the speed at which the vehicle is moving at the time, this technique can save anywhere from 30 to 60 feet of travel/stopping distance and may be the difference between being involved in a collision and not.

Depending on the motor vehicle statutes and departmental SOPs within a particular jurisdiction, fire apparatus and ambulances on an emergency response may proceed through a red traffic signal or stop sign after coming to a complete stop according to NFPA 1500 and EVOC. Local SOPs on this issue for law enforcement agencies may differ from jurisdiction to jurisdiction.

A driver should never proceed into the intersection until certain that every other driver sees the emergency vehicle and is allowing it to proceed. Slowing when approaching the intersection, then coasting through, is not an acceptable substitute for coming to a complete stop. When proceeding through the intersection, an attempt to make eye contact with each of the other drivers should be made to ensure that they know the emergency vehicle is there and about to proceed. The only sure way to safely ensure passage through an intersection is to visually confirm that all other vehicles have come to a complete stop.

Figure 3.2 — Use caution when proceeding into opposing lanes of traffic. (Photo/Mike Wieder)

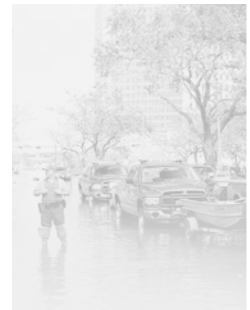
In situations where all lanes of traffic at an intersection in the same direction as the responding emergency vehicles are blocked, the driver should move the vehicle into the opposing lane of traffic and proceed through the intersection at an extremely reduced speed **(Figure 3.2)**. Oncoming traffic must be able to see the approaching vehicle. Full use of warning devices is essential. Driving in the oncoming lane is not recommended in situations where oncoming traffic is unable to see the emergency vehicle, such as on a freeway underpass. Be alert for traffic that may enter from access roads and driveways, approaching traffic on the crest of a hill, slow-moving traffic, and other emergency vehicles.

When approaching a green signal, the driver must also try to note if it has been in that position for a considerable amount of time. This could mean that it is ready to change to yellow at any moment. Anticipate this change and be prepared to stop if the change occurs as the vehicle nears the intersection. Another indicator of an impending signal change would be the presence of flashing "Do Not Walk" signs at pedestrian crossings.

These lights typically begin flashing about 15 to 30 seconds or so before the green signal turns to yellow.

Some jurisdictions use traffic signal control devices to assist emergency vehicles in negotiating intersections during their response. (These will be discussed in detail in Chapter 6.) Drivers must be aware of the traffic signal control devices used in their jurisdiction and how they operate. Traffic signal control devices are not substitutes for using proper defensive driving techniques. When traversing an intersection with a green signal, the driver must maintain a speed that will allow for evasive actions in the event that another vehicle enters the intersection. If, for any reason, the emergency vehicle does not get a green signal, the driver must bring the vehicle to a complete stop at a red signal. Keep in mind that if two emergency vehicles equipped with signal control devices approach the same traffic signal from different directions, only the vehicle whose sensor affects the signal first will get a green light. The later approaching vehicle gets a red signal. Do not assume that just because you did not get a green light that the system is not working. Approach the intersection with caution and come to a complete stop.

In cases where multiple vehicles will be leaving the same location en route to a call, all vehicles should take the same route of travel. This policy reduces the chances of the emergency vehicles encountering each other in an intersection near the incident scene. Vehicles must maintain a distance of 300 to 500 feet between vehicles. In many cases, civilian drivers clear the way for the first vehicle, but then pull back into the travel path because they are unaware that multiple emergency vehicles are approaching them. By maintaining this safe distance, the subsequent emergency vehicles traveling behind the lead vehicle will have a chance to react and avoid a collision should civilian traffic move back into the lane of travel.



Excessive Speed

In reviewing the records and reports on police vehicle and fire apparatus crashes that have occurred over the years, a large percentage of these reports cite excessive speed of the vehicle as one of the primary contributing factors to the cause of the crash. Although EMS data is limited, it would seem logical that excessive speed would also be a factor in many ambulance crashes since they respond in the same way as fire and police units. The old sports adage, "speed kills," certainly seems to be the case when applied to emergency vehicle crashes. There is a direct correlation between increased speed and decreased safety when operating any vehicle and emergency vehicles are **not** exempt. The problems associated with excessive speed manifest themselves in a number of ways:

- The vehicle is unable to negotiate a curve in the road **(Figure 3.3)**.
- The vehicle is unable to stop before hitting another vehicle or object **(Figure 3.4)**.
- The vehicle is unable to stop before entering an intersection or railroad crossing.

Figure 3.3 — Excessive speed may result in loss of vehicle control when entering a curve in the road. (Photo/Mike Mallory, Tulsa, Oklahoma Fire Department)

Figure 3.4 — Excessive speed may result in the inability to stop before hitting another object. (Photo/Mike Mallory, Tulsa, Oklahoma Fire Department)

- A weight shift occurs when the vehicle is slowed, causing it to skid or overturn.
- Control of the vehicle is lost after hitting a pothole, speed bump or similar defect in the driving surface.
- Control of the vehicle is lost as a result of swaying outside the lane of travel and striking a median or curb, or the tires on one side of the vehicle (usually the right side) leaving the road surface **(Figure 3.5)**.
- Tire traction is lost on wet, icy, snowy or unpaved road surfaces.

Figure 3.5 — Loss of control may occur when the wheels leave the road surface. (Photo/ Robert Tutterow, Charlotte, North Carolina, Fire Department)

Emergency disciplines must develop and **enforce** policies that establish maximum speed criteria for all types of vehicles, conditions and situations. Drivers must be familiar with these policies and also understand that they are maximums. The policy must contain a provision that allows a riding company officer or superior to demand that drivers slow down, but **never** gives them the right to force the driver to go faster than the driver's comfort level allows.

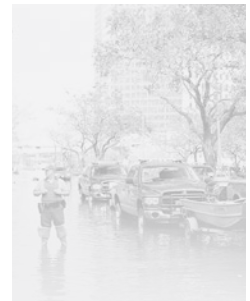
The potential for any of these scenarios to occur may be increased by road surfaces that are wet, icy, unpaved, contain loose materials, or are banked in one direction or the other. Drivers must recognize these dangerous conditions and adjust for them accordingly. The vehicle must always be driven at a speed that allows control on the roadway and the ability to stop within a reasonable distance. Speed needs to be reduced if the road is wet, icy or unpaved.

Driver training must begin at low speeds and increase only as the driver becomes more comfortable driving/handling the vehicle. The driver must develop a sense of what the safest maximum speed for operating the vehicle is under a variety of conditions. Difficult routes of travel within the response district must be included in road testing so that the driver will understand how the vehicle will handle when making an emergency response in that area.

There is little tactical advantage for fire and EMS responders by increasing the apparatus speed by 10-15 mph. At a constant speed, the difference between 40 mph and 50 mph on a two-mile response is only about 25 seconds. When you take into account acceleration and deceleration times, weaving through traffic, and stopping at intersections, this difference is almost negated. On the other hand, the chances of becoming involved in a collision at the higher speed grow at a much higher rate. Improving dispatch handling times, station turnout times and other factors will contribute more to decreasing response time than increasing the speed of the apparatus.

Much of the same can also be applied to law enforcement agencies. Law enforcement agencies tend to have less restrictive policies on vehicle response speeds than the fire service and EMS agencies. This is most likely due to the wider range of emergencies to which police officers respond. Individual officers operating in the field have much more discretion on speed. On every response, the officer must make a risk versus gain judgment on whether there exists a need to make a high-speed response. If officers are honest with themselves, they will determine that many of the calls that they have rushed to in the past ended up not being time-crucial and did not justify the higher rate of speed.

Many law enforcement driving instructors liken the judgment on whether to use a more rapid response to that of determining the need to apply use-of-force. Each case requires an evaluation of the situation and then the application of appropriate techniques.



Regardless of the agency or vehicle being driven, the faster a vehicle is driven, the more likely the driver is to lose control of it for one reason or another. The loss of control may be due to an issue with the driving surface, driver distraction, people or vehicles entering the travel path, vehicle malfunction, and any number of other reasons. Increased speed reduces the reaction time to adjust for these situations: the faster the speed, the longer the stopping distance. As a rule of thumb, doubling the speed of a vehicle **quadruples** the distance it takes to stop on a dry surface. This distance is further increased on wet, snowy or icy roads. An increased stopping distance increases the likelihood of running into some other object before the vehicle can be brought to a stop.

Excessive speed is the true culprit in many of the other issues discussed in this section of the document. The importance of speed management cannot be overstated when discussing the reduction of vehicle response-related incidents.

Keeping the Vehicle’s Wheels on the Road Surface

A significant number of emergency vehicle crashes have occurred as a result of the vehicle drifting off the right side of the road surface **(Figure 3.6)**. This has occurred both on straight sections of road as well as curves. This situation develops when, for whatever reason, the vehicle drifts too far to the right, and the front, rear or both sets of tires leave the paved surface. This is particularly important in the fire service where the most likely type of fire apparatus to be involved in a fatal collision is a water tanker or tender. Approximately two-thirds of all fatal tender/tanker crashes are a result of the vehicle’s right side wheel leaving the road surface. A review of case studies on all fire apparatus shows this to be a similarly frequent cause of serious collisions. Numerous reports on the causes of police vehicle crashes also cite this as a common cause for collisions.

Figure 3.6 — This crash occurred as a result of the right side vehicle wheels leaving the road surface. (Photo/Robert Tutterow, Charlotte, North Carolina, Fire Department)

Figure 3.7 — These tire marks indicate that the vehicle’s wheels left the road surface.

It is possible that if the shoulder is very soft, it could throw the vehicle toward the right into an object along the roadway or perhaps into a rollover situation **(Figure 3.7)**. However, most crashes that occur when the right side wheels leave the paved surface are the result of an “overcorrection” and the resultant panic by the driver when attempting to bring the right side wheel(s) back onto the paved surface. Often, there will be a lip of 4 to 8 inches where the paving drops off onto the soft shoulder. When the driver attempts to bring the right-side tires over this lip back onto the paved surface at too high of a speed, the common reaction is for the vehicle to shoot quickly (in some cases, violently) toward the left. This could cause the vehicle to enter opposing lanes of traffic, go completely off the left side of the road, or to begin a rocking motion that results in loss

Figure 3.8 — The tire marks indicate the path of the vehicle after it was brought back to the road surface. (Photo/Robert Tutterow, Charlotte, North Carolina, Fire Department)

of control of the vehicle **(Figure 3.8)**. In other cases, the vehicle may stay on the roadway, but the jerking action of jumping back onto the paved surface, along with the driver steering the vehicle toward the right, causes the rear end of the vehicle to swing out in a counterclockwise motion, causing the vehicle to slide and/or overturn.

The best way to avoid these collisions is to simply keep all the wheels on the road surface at all times; although, this may be easier said than done. During a response, the driver may be faced with unpredictable civilian drivers, debris or potholes in the roadway, narrow roads, or other conditions that may force the vehicle toward the right edge of the road. The following actions will help the driver keep the vehicle from drifting off the right side of the road:

- First and foremost, operate the vehicle at a safe and reasonable speed. This will minimize swaying and drifting. It will also avoid loss of control on curves in the road.
- Do not operate warning devices, read map books or computer monitors, or perform other activities while driving the vehicle, as that may result in drifting due to lack of attention.
- Never pass slowed or stopped vehicles on the right side.

Although the goal is to keep the vehicle on the road, drivers must be trained in how to react should the wheels drift off the right side. When either or both of the right-side wheels/tires drift off of the paved surface, the driver must gradually slow the vehicle to a safe speed before attempting to bring the wheel(s) back onto the paved surface. There is no defined speed at which this is always safe, as it will depend on many factors, including the size of the lip, the characteristics of the vehicle, and driver's skill level. However, most experts agree that the appropriate speed to remount the paved surface is 20 mph or less, especially for larger vehicles such as fire apparatus, ambulances or law enforcement tactical vehicles. By significantly slowing or stopping the vehicle prior to bringing the wheel(s) back onto the road surface, the driver will avoid the violent reaction that often occurs when trying to do this at a higher speed.

Safely Negotiating Curves

After intersections, curves may be the next most dangerous place to drive an emergency vehicle. The reasons that the vehicle fails to make it through the curve are typically a combination of two of the previously discussed causal factors: excessive speed and failure to keep the vehicle's wheels on the road surface.

This is a particularly important issue for the fire service and box type ambulances, as entering a curve at an excessive speed is particularly dangerous due to the vehicles' inherent large size and high center of gravity. The forces of gravity and inertia will work against the driver and make the apparatus uncontrollable. Even if the driver is able to keep the apparatus wheels on the road surface, these forces may cause the apparatus to slide and/or roll over once in the curve. In order to keep the vehicle under control, the driver may drift into an opposing lane of traffic and strike another vehicle.

More commonly, when the emergency vehicle enters the curve at too great a speed, either the vehicle's right side wheels or, in severe cases, the entire vehicle will leave the road surface. It is important to realize that the vehicle must be slowed down prior to entering the curve. Trying to slow the vehicle down once it is already in the curve is too late, too dangerous and may add more instability to the situation.

Figure 3.9 — This shows the suggested speed for passenger vehicles on a dry road surface. (Photo/Mike Wieder)

In most cases, highway departments post yellow signs that warn drivers of an approaching sharp curve. A smaller sign that lists a suggested reduced speed through the curve is often located beneath the primary sign **(Figure 3.9)**. The suggested speed on these signs is intended for **passenger cars** under ideal, dry road conditions. The speeds on these signs may be too high for safe negotiation by larger vehicles. Drivers of any emergency vehicles, including police patrol cars, must consider these "suggested" speeds as the maximum for negotiating these curves under even the best of conditions. Speeds will have to be reduced if the road conditions are less than dry and clear.

Passing Other Vehicles Safely

In a perfect world, all civilian traffic would pull over to the right shoulder or side of the road and come to a complete stop as an emergency vehicle with warning devices activated approached them from the rear. Even though this is required by law in virtually all jurisdictions, on almost every response a substantial portion of the vehicles in the travel path of the emergency vehicle do not clear the way. If all of the other vehicles moving in the same direction as the emergency vehicle are moving at the same or a higher speed, this is not much of an issue. It becomes a serious issue when approaching a slower vehicle who fails to yield, requiring the emergency vehicle to overtake that vehicle for the purpose of making an expedient response.

There are a number of reasons why traffic may fail to yield. Most commonly, the driver is not paying attention and may not be aware of an approaching emergency vehicle because of a tightly enclosed, noise-insulated passenger compartment; loud music; or other distractions, such as cellphone use. When becoming aware of the emergency vehicle, the civilian driver may panic and make an unpredictable movement or freeze and come to a complete stop wherever he or she is. Some drivers are simply obstinate and refuse to move. In some cases, the amount of traffic present does not allow all of the vehicles to move to the right.

Whatever the case, overtaking and passing other vehicles is one of the most dangerous maneuvers that an emergency vehicle driver can make. Passing other vehicles often requires moving into opposing lanes of traffic, which is always a risky move. Whenever possible, avoid passing other vehicles by moving into opposing lanes of traffic and do it only if no other safer option exists. The situations in which passing another vehicle should never be attempted include:

- Negotiating a curve.
- Traveling through an intersection.
- Crossing railroad tracks.
- When you cannot see or account for approaching vehicles in the opposing lane of traffic, especially at night.

Before passing another vehicle, there are several considerations to evaluate.

- **Is the vehicle you are approaching aware you are closing in?** In most cases, the driver of the other vehicle notices your presence and reacts appropriately. However, there are other times when this is not the case and the other driver either makes a panicked reaction at the last second or continues on with what they were doing.
- **Are there intersections, driveways, side roads, parking lots, or other locations where a vehicle may be ready to turn into your path?** These are particularly dangerous if the intervening roadway is not visible to the approaching emergency vehicle. If you cannot account for these, passing another vehicle may be ill-advised.
- **Is there enough room to make the pass safely?** Being able to make the pass safely and get back in the proper lane before encountering other vehicles coming in the opposite direction depends on the speed and handling characteristics of all the vehicles involved in the scenario. For example, a police patrol vehicle is able to make a pass and return to the correct lane in a shorter amount of time than is an ambulance or fire department aerial apparatus. The driver must know the capabilities of the vehicle he or she is operating and use his or her judgment and experience in these situations.

It is important that drivers be aware of both the speed of their vehicle and that of the vehicle they are trying to pass to help estimate the time required to be in the opposing lane of traffic. Start the pass from a safe following distance; do not pull up directly on the rear bumper of the vehicle to be passed. This eliminates the need for quick, jerky steering movements that could result in a loss of control, especially in high center of gravity vehicles. It also allows for better vision of what may be in front of the vehicle that is about to be overtaken. It is typically safe to move back to the original travel lane once you can see the vehicle you have passed in your rearview mirror.

When responding in the same direction to the same call, there is a temptation for a faster moving emergency vehicle, such as a police vehicle or ambulance, to want to pass the slower vehicle, such as a large fire truck. In most cases, this type of passing is not advisable, particularly if all vehicles are going to the same place. However, in the case of a violent incident where police must secure the scene before other responders can perform their work, it may be advisable. In these cases, if radio contact cannot be made between the two vehicles, the lead vehicle should recognize that the approaching vehicle wants to go by and move over to the right as any civilian vehicle is supposed to and allow the faster vehicle to pass. When moving to the right, take care not to allow the vehicle's tires to leave the road surface. This may result in loss of control of the vehicle.

Vehicle Unfamiliarity

A review of case studies of crashes reveals that driver unfamiliarity with a vehicle is often cited as a possible cause of a collision. Case studies reveal the following scenarios where this situation can occur:

- Lacking a qualified driver, an untrained member attempts to drive a vehicle to an incident.

Figures 3.10a and 3.10b — Drivers may operate vehicles of varying size, often in the same station. (Photo/Mike Wieder)

Figure 3.11 — Drivers must be trained on a new apparatus before it is placed in service. (Photo/Ron Jeffers, Union City, New Jersey)

- A driver who is trained on smaller vehicles, in a pinch, tries to drive a larger vehicle, such as a tender/tanker or police tactical vehicle, to an incident **(Figures 3.10a and 3.10b)**.
- A driver trainee is placed in an over-the-road training situation without being sufficiently familiar with the handling characteristics of the vehicle.
- A company receives a new piece of apparatus and some drivers are insufficiently trained on it before it is placed in service **(Figure 3.11)**.
- A driver is rotated into a new station or assignment with unfamiliar kinds of vehicles.

Figures 3.12a and 3.12b — Ambulances may vary widely in size. (Photo/Ron Jeffers, Union City, New Jersey)

Similar scenarios have been known to occur in EMS and the law enforcement community as well. Different types of ambulances each have different handling characteristics **(Figures 3.12a and 3.12b)**. You must be familiar with the handing characteristics of the type(s) of ambulance(s) that you will drive.

Figure 3.13a — Police departments may operate standard patrol or high-performance vehicles. This illustrates a four-door marked patrol unit commonly used throughout the U.S.

In many cases, police officers are not permanently assigned to a particular vehicle. Even if the officer is assigned to the same type of vehicle each shift, there may be minor differences in the handling characteristics of each car that could become an issue in a crucial situation. Other situations that have been noted in the past include:

- Officers switching from a standard patrol car (such as a Crown Victoria or Chevrolet Impala) to a high-performance patrol/traffic enforcement vehicle (such as a Chevrolet Camaro, Dodge Charger or Ford Mustang) **(Figures 3.13a and 3.13b)**.
- Officers switching from a standard patrol vehicle to an SUV or a special tactical vehicle without sufficient training **(Figures 3.14a and 3.14b)**.

Figure 3.13b — Police departments may operate standard patrol or high-performance vehicles. This illustrates a two-door marked patrol unit that may be viewed for specialized functions such as traffic enforcement duties.

Figures 3.14a and 3.14b — Police departments may operate vehicles larger than standard patrol vehicles. (a) (Photo/Mike Wieder) (b) (Photo/Ron Jeffers, Union City, New Jersey)

Different vehicle types have different blind spots and sight lines. For example, switching from a vehicle with a higher profile, such as an SUV, to a lower profile, such as a high-performance patrol vehicle, will lower the driver's field of vision and may make it more difficult to see over objects such as concrete median barriers. These differences must be accounted for in vehicle familiarity training.

Reducing the occurrence of these types of incidents comes down to training. Members who have insufficient training should not be allowed to operate vehicles under any circumstances. There is no scenario that justifies placing untrained drivers into an unfamiliar vehicle and asking them to drive it somewhere, especially under emergency response conditions. All drivers must be trained on the vehicle they are expected to drive before being allowed to drive the vehicle in the performance of field duties. In the fire service, this is a requirement contained in NFPA 1500.

Although not a national requirement, the EVOC for ambulance drivers provides training necessary to safely drive an ambulance. Although some states and many individual departments require driver training, there is also not a national standard or requirement for law enforcement officers to complete any kind of driver training, especially at high speeds under stressful conditions. The Law Enforcement Driver Instructor Training Program (LEDITP) does train instructors employed with federal, state and local law enforcement agencies in the principles, philosophies and techniques of teaching law enforcement driver training curriculum.

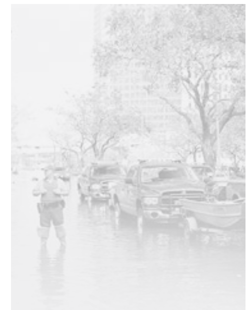
Driving in Inclement Weather

Conditions that reduce the driver's vision or the amount of traction provided by the road surface are some of the most dangerous conditions for operating emergency vehicles **(Figures 3.15 a and b)**. However, call volume may actually increase during inclement weather conditions. Police often see an increase in domestic incidents when people have been shut in for long periods of time. EMS agencies may see a greater demand for service as civilians are unwilling to drive themselves to seek medical treatment for minor illnesses and instead call EMS to take them. Lightning strikes, wires down, wind damage, traffic incidents, structural collapses and similar situations tend to increase the demand for the fire service. Weather that results in extended power outages for the public can also increase the level of fire activity. Fires started by alternative heating methods, use of candles, and similar actions can result in greater fire losses.

Figures 3.15a and 3.15b — Poor road conditions impair safe vehicle operation. (Photo/ Chris Mickal, New Orleans, Louisiana Fire Department Photo Unit)

Common inclement weather conditions that affect vehicle operation include fog, wind, rain, ice and snow. Hazards associated with these conditions include:

- Reduced visibility.
- Reduced steering control.
- Reduced speed and frequent braking.
- Civilian drivers who are not driving cautiously.



Safe driving during inclement weather conditions starts with making sure that the vehicle is in good mechanical condition. Personnel should check the fluid levels of their vehicles, particularly windshield washer fluid and antifreeze, to make sure that they are at adequate levels. Tires are the single most important mechanical component to safe driving. Tires should be inspected to ensure that they are properly inflated and have sufficient tread depth. The ability to control the vehicle is based upon friction with the ground beneath the wheels. The only surface contact is through the tires. Under normal conditions, the contact patch is about the size of the palm of a hand. Under heavy cornering, that patch may shrink to the size of a thumbprint. Therefore, the condition of the tires is critical, and even more so during inclement weather.

If they have been parked out in the weather, vehicles must be completely cleared of snow and ice prior to driving. This enhances the safety of all motorists by providing an unobstructed view for the driver and prevents snow and ice from flying off vehicles at high speeds and posing a hazard to others on the road. Visibility is a key factor in operating the vehicle during poor weather conditions. In addition to cleaning the vehicle off, it is important for items such as the defroster and wipers to be in good working condition.

Speed must be adjusted relative to the degree of visibility so that the vehicle can be stopped if another vehicle or object appears in the travel path. It may be necessary to pull a little further than normal into intersections to increase visibility. Use the vehicle's headlights in the low beam mode when driving under these conditions at night to provide the best visibility. Do not use wigwag (alternating) headlights under these conditions.

Perhaps the two biggest keys to safe driving in slippery road conditions are reducing speed and increasing the following distance behind other vehicles. Most winter weather-related crashes are caused by "spin-outs" and vehicles sliding off the road due to excessive speeds for the road and weather conditions. Speed limits are set for driving under optimal, dry conditions. If road and weather conditions are adverse, it may be more reasonable to operate at a speed that is well below the posted limit. It is better to take a little longer to arrive at a call than not arrive at all.

Under optimal driving conditions, drivers should leave at least one car length for every 10 mph between them and the vehicle in front of them. If the road and weather conditions are adverse, that distance should be significantly increased in order to allow for increased stopping distances.

Slippery road conditions require smoother steering, acceleration and braking. Any actions by the driver result in a weight shift that decreases the stability of the vehicle. The harsher the action, the more weight shift that occurs and the harder it is to control. Jerking the wheel or stabbing the brakes increases the likelihood of losing traction and beginning to slide. Small mistakes can become big problems.

Use the following guidelines in adverse weather driving situations:

- Reduce speed, keep the tires at proper inflation and maintain sufficient tread depth to reduce instances of hydroplaning on standing water.
- Increase the stopping distance between you and other vehicles.
- Use extra caution in shaded areas during the winter, since they remain icy when open areas have melted.
- Remember that bridges will freeze before other road surface areas due to their elevation above the ground.

- Be aware that "black ice" on asphalt roads can't be seen but makes the road slippery.
- Do not use brake retarders or other auxiliary braking systems when driving on slippery surfaces.
- Use care when driving just after rain begins because the water will mix with oil on the entire road surface.
- Avoid driving into deep-water puddles, if possible. If it is impossible to avoid deep puddles, slow down before entering the puddle, keep a firm grip on the wheel and do not brake.
- Avoid using cruise control in wet weather driving conditions.
- Look farther ahead and pay particular attention to "hot spots" such as bridges, culverts, on- and off-ramps, and elevated highways.
- Avoid unusual driving maneuvers that could induce a skid.

Avoiding and Combating Skids

The most common causes of skids involve driver error, including:

- Driving too fast for road conditions.
- Failing to properly appreciate weight shifts, particularly in larger vehicles.
- Failing to anticipate obstacles. (These range from other vehicles to animals.)
- Improper use of auxiliary braking devices.
- Improper maintenance of tire air pressure and adequate tread depth.

Tires that are overinflated or lack reasonable tread depth make the vehicle more susceptible to skids. On passenger-type vehicles, it is acceptable to use the suggested pressure on the sidewall of the tire. On larger vehicles, obtain the proper tire pressure from the "Tire and Rim Year Book" published by the Tire and Rim Association, not from the sidewall of the tire.

Most new vehicles are equipped with an all-wheel, anti-lock braking system (ABS). On larger trucks, this system is powered by air pressure. These systems minimize the chance of the vehicle being put into a skid when the brakes are applied forcefully. An onboard computer that monitors each wheel controls air pressure to the brakes, maintaining optimal braking ability. A sensing device monitors the speed of each wheel. When a wheel begins to lock up, the sensing device sends a signal to the computer that the wheel is not turning. The computer analyzes this signal against the signals from the other wheels to determine if this particular wheel should still be turning. If it is determined that it should be turning, a signal is sent to the air modulation valve at that wheel, reducing the air brake pressure and allowing the wheel to turn. Once the wheel turns, it is braked again. The computer makes these decisions many times a second, until the vehicle is brought to a halt. Because of this mechanical capability, maintain a steady pressure on the brake pedal (rather than pumping the pedal) until the apparatus is brought to a complete halt.

Most fire apparatus and police tactical vehicles are equipped with both ABS and an auxiliary braking system. NFPA 1917, *Standard for Automotive Ambulances* recommends auxiliary braking systems on ambulances because of the repeated stops from high speeds that can cause rapid brake lining wear and fade.

Examples of auxiliary braking systems include:

- Engine retarders.
- Transmission retarders.
- Driveline retarders.
- Exhaust retarders.

The computer controlling the **ABS** will shut off the **auxiliary** braking system during a skid condition. This will also help reduce the vehicle's tendency to continue the skid. If a vehicle **not** equipped with ABS goes into a skid, the driver should release the brakes and allow the wheels to rotate freely. Turn the steering wheel so that the front wheels face in the direction of the skid. If using a standard transmission, do not push in the clutch pedal until the vehicle is under control and just before stopping the vehicle. Once the skid is controllable, gradually apply power to the wheels to further control the vehicle by giving traction.

Hydroplaning can occur in wet weather. Driving through even a very shallow one-quarter inch puddle of water at a high speed can "hydroplane" a vehicle right off the road. Partial hydroplaning typically begins at about 35 mph and increases with speed. At about 55 mph, the tires may rest on top of the layer of water and not be in contact with the pavement at all. When this occurs, there is no road-tire friction and a gust of wind, change of road grade, or a slight turn can cause a skid.

To regain control if partial hydroplaning and skidding occurs, the driver must compensate by countersteering, turning the wheel in the direction of the skid, and removing the foot from the accelerator. Good tires with deep tread help prevent hydroplaning. The deep tread forces the water to escape from under the tires and tends to prevent complete hydroplaning at normal highway speeds.

Figure 3.16 — Skid pads provide realistic wet driving surface training. (Photo/Mike Wieder)

Skid control skills may be learned through practice on skid pads. These are specially designed, smooth surface, driving areas that have water directed onto them to make skids likely **(Figure 3.16)**. All training should be done at slow speeds to avoid damaging the vehicle or injuring participants. Some jurisdictions use reserve or older vehicles for this part of the training process.

Safe Vehicle Spacing

The importance of maintaining safe spacing between the emergency vehicle and other traffic in all conditions cannot be overemphasized. Appropriate spacing between vehicles allows for a margin of error if a civilian driver makes an unexpected move. Spacing increases visibility and provides time to react, avoid a collision and stop. A four-second following distance is recommended in ideal conditions. If conditions are not ideal, such as wet roads or during emergency responses, that distance should be increased. The easiest way to determine the following distance is to look at a fixed object that the car ahead passes and count the seconds it takes you to pass the same object.

Vehicle Backing Operations

While collisions that occur when an emergency vehicle is being driven in reverse are noteworthy in the overall number of emergency vehicle collisions, they are less likely to result in serious injury or death, although numerous examples of backing-related injuries and deaths were cited in Chapter 2 of this report. However, they do account for a high percentage of emergency vehicle crash repair costs. All emergency services departments must have firmly established procedures for backing the vehicle, and these procedures must always be followed by the driver. NFPA 1500 contains specific information on safe backing of fire apparatus and should be consulted when developing a departmental backing policy. This policy could also serve as the basis for EMS and law enforcement policies.

Figure 3.17 — Always use at least one backer when operating the vehicle in reverse. (Photo/Mike Wieder)

The easiest way to prevent a problem is to avoid the conditions that lead up to it. Whenever possible, avoid backing the vehicle. It is normally safer and sometimes quicker to drive around the block and start again. It is also advantageous to design new fire stations with drive-through apparatus bays that negate the necessity to back in the apparatus.

When it is necessary to back fire apparatus, it must be performed very carefully. There must be at least one firefighter — and preferably two — with a portable radio assigned to clear the way and to warn the driver of any obstacles obscured by blind spots (**Figure 3.17**). If portable radios are not available, flashlights may be used at night to signal (but not blind) the driver. The department must establish preset signals for using the flashlights. If two spotters are used, only one shall communicate with the driver. The second spotter must assist the first one. This very simple procedure can prevent a large percentage of the crashes that occur during backing operations. Very simply, if you are the driver and you do not have or cannot see the spotters behind you, **do not back the vehicle!** All fire apparatus and ambulances must be equipped with an audible alarm system that warns others when the apparatus is backing up.


Figure 3.18 — Many apparatus are equipped with rearview cameras. (Photo/Mike Wieder)

There are several devices that may be attached to the apparatus to make backing operations safer. Some departments place a mirror at the rear of the apparatus that is visible through the driver's rearview mirror. The second mirror is angled toward the rear step area of the vehicle and allows the driver to see if the end of the tailboard is approaching an object. Some apparatus are equipped with a camera that is mounted on the rear of the apparatus **(Figure 3.18)**. This camera transmits a significant view of the area behind the apparatus to a monitor in the cab. This allows the driver/operator to view the rear of the apparatus while the apparatus is backing up **(Figure 3.19)**.


Figure 3.19 — The image captured by the rearview camera is displayed on a monitor inside the cab. (Photo/Mike Wieder)

Some newer fire apparatus may be equipped with automatic sensing devices, often referred to as backstops, which will cause the vehicle's brakes to lock up and stop the apparatus when the device senses contact with an object. Backstop devices minimize the damage to the apparatus when it strikes an object. They do not prevent the crash. If the object being struck is a person, that person is still likely to be injured or killed. All of these devices improve safety during backing operations **but none are substitutes for having spotters.**

Police vehicles are typically not nearly as large as a fire apparatus or ambulance, and the driver's vision of the area behind the vehicle is likely to be better than that for the driver of a fire or EMS vehicle. However, it is still a good idea to get out of the vehicle and check behind the vehicle if it is not clearly visible from the driver's position. Other personnel should be used to guide the driver backward if there are extremely tight clearances behind the backing vehicle.

Driver Distractions

Driver distractions are a major factor in the causes of collisions involving all vehicles, both emergency response and general public. David Strickland, Administrator of NHTSA, provided interesting facts on driver distraction during his 2012 speech at the Verizon Policy Breakfast. He stated, "One of our greatest highway safety challenges today is the epidemic of distraction." He provided the following statistics:

- Cellphones, texting and accessing the Internet are huge distractions and are used frequently and primarily by young people while driving. All of these actions divert eyes, hands and focus from driving.
- In 2010, more than 3,000 fatalities occurred in crashes where distraction was a factor.
- Drivers using hand-held devices are four times more likely to get into a crash serious enough to cause injury.
- Texting drivers are 23 times more likely to be involved in a crash.
- Sending or reading a text takes an average of 4.6 seconds. At 55 mph, that is like driving the length of a football field blindfolded.

Driver distractions have always been a particular problem for the fire, EMS and law enforcement services. Warning device controls, mobile computers, map books, preincident plan documentation, emergency radios, and standard radio/CD players are common to the vehicles of all of the disciplines **(Figure 3.20)**.

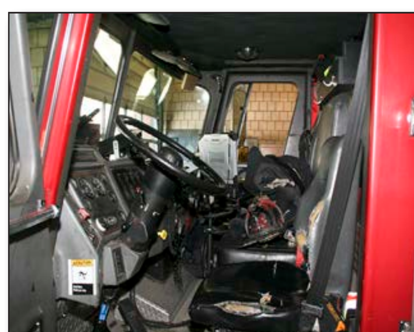


Figure 3.20 — Try to avoid driver distractions and loose equipment inside the cab. (Photo/Mike Wieder)

Whenever possible, the driver should refrain from operating other devices, including reading map books or utilizing mobile computers while driving the vehicle. If a second person is riding in the front of the vehicle, they should be the one performing these functions. In many cases, law enforcement officers do not have the luxury of having a second person riding with them. In these cases, the officer should limit distractions to absolutely essential functions, such as initial activation of the warning devices and necessary radio transmissions. Police officers also must use extreme caution when they are involved in activities such as searching for a suspect who is on foot from the patrol car. The officer must balance the amount of time they are scanning the immediate area with the amount of time they are watching the roadway.

Although EMS vehicles are staffed with at least two people, the portion of the response involving transport of the patient to the hospital typically leaves only one emergency provider in the front seat. Noise and movement from the patient compartment can contribute additional distractions to those already identified.

In the case of the fire service, a fire apparatus that is occupied by a single individual is not really going to be of much use at an emergency scene. Departments that allow single drivers to take an apparatus to a reported emergency should consider a policy that requires them to do so at a reduced, nonemergency response rate.

Siren Syndrome

Many operators of emergency vehicles have been known to fall prey to "siren syndrome" or "sirencide." These terms are used to describe the tendency to drive faster and more aggressively when operating under emergency conditions with the siren activated. In some cases, this may result in an adrenaline rush that offers the driver a false sense of invincibility that can lead to serious danger if it is not controlled.

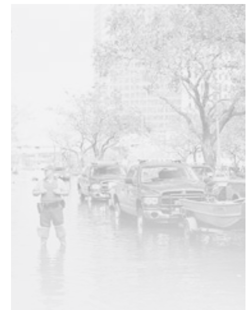
This condition becomes particularly dangerous when the driver assumes that every motorist encountered will hear and react appropriately to the siren. As noted earlier in this chapter, motorists do not always hear the siren for a variety of reasons. If the emergency vehicle driver does not remember this fact and is "overdriving" the vehicle, problems could occur when encountering an unaware motorist. Even if encounters with other vehicles do not occur, the increase in adrenaline caused by the situation can result in vehicle operation beyond the real capabilities of the driver, leading to a loss of control of the vehicle and a likely crash scenario.

The primary way of combating this problem is through effective training. Whenever possible, driver training exercises should be conducted with the siren activated. Experiencing these conditions in a training environment will help make an impression on the drivers.

Fatigue

Fatigue has always been an issue in the law enforcement, EMS and fire service communities. Unique and changing shift schedules, long shift schedules, interrupted sleep patterns, and extended periods of physical activities are but a few of the numerous causes of fatigue. Fatigue poses a significant hazard to drivers because it lowers visual efficiency and increases reaction time. Fatigue most frequently manifests itself in the form of drowsiness. This causes reflexes to slow, the mind to wander, and the eyelids to become heavy and close for a longer period of time than is safe. Although fatigue is prevalent during the night shifts, when normal sleeping habits are interrupted, potential danger may appear anytime the member reports for duty without being well-rested.

The only real "cure" for fatigue is a sufficient amount of rest and sleep. The effect may be offset temporarily by changes in the activity level, such as police officers talking aloud, if alone, making frequent stops to conduct security checks of businesses and homes, or inspecting known trouble spots. Firefighters and EMS personnel may try to engage in some type of physical exercise to "wake themselves up." These types of actions have a very limited amount of effectiveness. The real solution is rest and sleep.



Today's society is saturated with a variety of stimulant products that are supposed to increase energy and fight the effects of drowsiness. These come in the form of pills, tablets, herbal supplements, and energy drinks. Most of these simply provide high, and potentially unsafe, quantities of either sugar or caffeine to provide a very short "burst" of energy. These concoctions only treat the symptoms and not the actual causes of fatigue, and their use is not recommended.

All emergency responders must be aware of the effect that fatigue may have on not only their performance, but also their health and safety. There are reports on the effect of fatigue on the health and performance of firefighters, EMS workers and law enforcement personnel. These include:

- A report developed by the USFA and the IAFC. It can be downloaded from the IAFC website at www.iafc.org/Operations/content.cfm?ItemNumber=1331.
- A 2000 report on fatigue issues in the law enforcement community can be found through the National Criminal Justice Reference Service at www.ncjrs.gov/pdffiles1/nij/grants/184188.pdf.

Seatbelt Usage

Some crash reconstruction specialists have speculated that particular incidents may have occurred after an unrestrained driver was bounced out of an effective driving position following the initial contact with a bump in the road or another object. In other cases, the driver came out of the seat after an overcorrection to return the vehicle to the roadway after the right side wheels had slipped off the edge. However, these instances are very rare. While the failure of the vehicle driver and/or occupants to wear seatbelts is rarely established to be the **cause** of a crash, it is often a mitigating factor in the severity of the **outcome** of the crash.

Despite the fact that information and studies on the benefits of wearing seatbelts have been available for more than 30 years, drivers and/or occupants being seriously injured or killed after being partially or totally ejected from the vehicle following a crash when not wearing a seatbelt remains a common theme.

The DOT and the NHTSA 2011 report on seatbelt use shows the use of seatbelts has increased from 58 percent in 1994 to 84 percent in 2011 and a steady decline in the percentage of unrestrained passenger vehicle occupant fatalities during the daytime from 57 percent in 1994 to 44 percent in 2009. Even with this decline in overall percentages, USFA Firefighter Fatality Reports continue to identify firefighter fatalities in vehicular accidents resulting from no seatbelt usage leading to vehicle ejection every year. Similar information has been reported in the EMS and law enforcement communities. In some of the cases reviewed, not only were the occupants not wearing seatbelts, but the vehicles were found to have the seatbelts removed or tucked away beneath the seat cushions. Given the proven benefits of seatbelts, these omissions are unforgivable.

Emergency vehicle occupants, both driver and other personnel, should remember:

- Three out of four people who are ejected from a vehicle will die.
- Eight out of 10 fatalities in rollover crashes involve occupant ejection from the vehicle.
- Occupants are 22 times more likely to be thrown from the vehicle in a rollover crash when they are not wearing their seatbelts.

Several standards and laws direct the use of seatbelts by firefighters. NFPA 1901, *Standard for Automotive Fire Apparatus* requires all new fire apparatus to be equipped with a proper seatbelt for each riding position. Many states that have vehicle inspection programs for fire apparatus also require seatbelts to be present. Furthermore, since its first adoption in 1987, NFPA 1500 has required all riders on fire apparatus to be seated and belted prior to the movement of the apparatus. Again, many states have enacted mandatory seatbelt usage laws in recent years, and in some cases, they apply to fire apparatus and law enforcement vehicles as well as civilian vehicles.

Even with these requirements, firefighters often do not wear their seatbelts, citing that they are restrictive and uncomfortable over their personal protective gear. There is a relatively new seatbelt on the market that has gained acceptance by firefighters. Research on more functional seatbelts for firefighters has resulted in the installation of this new style of seatbelts on all New York City fire apparatus and testing at the College Park Station of Prince George's County, Maryland. An extender arm places the seatbelt d-loop closer in an easy-to-reach location, allowing easy buckling of the belt over the personal protective gear. In addition, the belts are florescent orange, making it easy for the driver to ensure that all personnel are wearing a seatbelt before the apparatus moves. One concern is that some manufacturers' equipment would require extensive retrofitting.

All fire departments must have SOPs in place that require all members riding on the apparatus to be seated and belted any time the vehicle is ready to begin road travel. The driver should not proceed until this fact has been verified. These policies must be enforced strictly.

The NHTSA analyzed 733 law enforcement crashes from 1980 through 2008 and found that at least 42 percent of police officers killed in vehicle crashes were not wearing seatbelts or other safety restraints. In addition to the 42 percent who were not wearing restraints during the course of the review, the study found that seatbelt use could not be determined in nearly 13 percent of the fatalities, suggesting that noncompliance could be higher. According to the NHTSA report, 28 percent of officers killed in vehicle crashes in the 1980s used some kind of restraint. While usage increased to 56 percent in the 1990s, it has recently declined to about 50 percent.

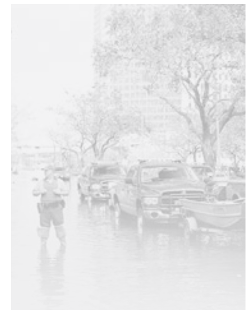
Some officers resist wearing seatbelts because the restraints slow their movement in and out of the cars. Others complain that the straps get tangled in utility and gun belts. Still others suggest that seatbelts are not appropriate for patrol driving and making frequent stops. Many personnel fear the restriction of a seatbelt makes them vulnerable to assault when stopped. This fear is unfounded. It takes a second to either fasten or unbuckle a seatbelt. Conversely, an officer on patrol, and especially one who must suddenly respond to an emergency call, without a fastened seatbelt endangers himself or herself needlessly.

Simply put, in most states and local jurisdictions, law enforcement personnel routinely enforce seatbelt laws that have been enacted by those political entities. Law enforcement officers must set a good example and wear the same devices that they require the motoring public to wear.

Summary

This chapter has focused on the more common causes of crashes in the emergency services disciplines and reviewing methods to prevent or minimize the severity of those causes. Many of the methods that will prevent crashes are easy to apply and are dependent on good training and good judgment.

Although failure to wear a seatbelt is rarely identified as the cause of a crash, it is often a mitigating factor in the severity of the outcome of the crash. Emergency providers are well aware of the consequences of the public not wearing seatbelts as seen through multiple responses to civilian crashes. Emergency responders must remember they are not immune to the same consequences.



Chapter 4
The Impact of Vehicle Design and Maintenance on Safety

Introduction

Safety begins with the vehicle itself. It is incumbent on agencies in all the disciplines to procure and maintain safe and effective vehicles from which their members can do their jobs. While the vehicles will typically vary significantly between the services, the basic factors that go into their selection and use are generally similar in nature. Agencies must seek to select vehicles that maximize service delivery, are as safe as possible, and balance with the fiscal capabilities of the organization.

First and foremost, design vehicles in accordance with the motor vehicle codes that apply to the jurisdiction in which they will be operated. Specific requirements for things such as weight limits, vehicle sizes and warning light colors will vary somewhat from state to state. Emergency service organizations should not consider themselves exempt from these regulations.

NFPA standards are referenced throughout this and upcoming chapters. The reader should be aware that all NFPA standards are voluntary national standards developed through a consensus-based process involving multiple stakeholders such as manufacturers, users, installers/maintainers, labor, applied research/testing laboratories, enforcing authorities, insurers, consumers and special experts in relevant fields. While compliance with NFPA standards is voluntary unless adopted as a code/ordinance/regulation by the authority having jurisdiction (AHJ), manufacturers typically comply with the latest version of the relevant standard(s) to limit legal liability and ensure product marketability.

Vehicle Design

Fire Apparatus

In the fire service, most new fire apparatus are designed to meet the requirements of NFPA Standard 1901 **(Figure 4.1)**. This standard specifies the minimum design and performance requirements for most types of fire apparatus.

Figure 4.1 — Drivers must be sufficiently trained to drive new apparatus, especially larger vehicles. (Photo/Ron Jeffers, Union City, New Jersey)

Similar requirements for wildland fire apparatus are found in NFPA 1906, *Standard for Wildland Apparatus.* While law does not generally require compliance with these standards, it is important for two other reasons. First, it provides a baseline from which departments can develop appropriate specifications when purchasing new apparatus. Second, apparatus that meet this standard are less likely to be liable in a civil case involving the design or the operation of that apparatus.

Law Enforcement Vehicles

Standard police patrol vehicles do not have a national standard for their design and performance comparable to that for fire apparatus **(Figure 4.2)**. These requirements are typically determined by the agency

Figure 4.2 — A standard police patrol vehicle. (Photo/Denis Desmond)

purchasing the vehicle and usually involve modified versions of standard passenger vehicles and SUVs. The typical modifications include upgraded driveline components and braking systems. Warning devices, protective barriers between the front and rear seats, and the addition of various types of communications equipment are also common modifications. Agencies should ensure that modifications and vehicles are in general compliance with applicable state motor vehicle codes and SAE recommendations.

The law enforcement agency should also evaluate the types of vehicles that constitute its fleet and determine which are acceptable to be operated at high speeds under conditions such as vehicle pursuits. Officers assigned to vehicles should follow the departmental guidelines for how each type of vehicle may be operated under specific conditions. Vehicles that are not approved by the department for high-speed maneuvers must not be operated in that manner.

Figure 4.3 — Law enforcement agencies may operate larger-than-standard vehicles. (Photo/Mike Wieder)

Some law enforcement agencies operate vehicles that are larger than standard patrol-type vehicles **(Figure 4.3)**. These may include Special Weapons and Tactics (SWAT) vehicles, rescue apparatus, command post vehicles, bomb squad vehicles, and other similar types of apparatus. The NFPA 1901 standard serves as an excellent reference for the design and specifications for these types of vehicles.

Figure 4.4 — A typical ambulance. (Photo/Ron Jeffers, Union City, New Jersey)

Ambulances

Ambulances are a part of the transportation system that is largely exempt from most of the Federal Motor Vehicle Safety Standards (FMVSS), particularly the rear passenger compartment **(Figure 4.4)**. EMS is also not covered by other national transportation system safety oversight.

In 2007, the NIOSH collaborated with the Ambulance Manufacturers Division of the National Truck Equipment Association (AMD-NTEA) and the General Services Administration (GSA) to revise the GSA ambulance purchase specification and the companion AMD-NTEA test standards. This included increasing the head clearance for EMS workers above the seating positions, eliminating a significant source of head injury. NIOSH also worked with AMD-NTEA to establish a new crash test methodology technical committee. The committee used NIOSH research to develop a cost-effective test procedure to evaluate how components (seats, cot, equipment mounts) in a patient compartment would withstand a 30 mph frontal impact. The SAE published this test procedure in May of 2010 as a recommended practice, and it is currently being used within the industry to improve ambulance seating and restraints. The team also developed a companion document covering vehicle response in side impact events, which SAE published in 2011.

As NIOSH was working with AMD-NTEA, the federal government's GSA announced in 2008 that it would no longer maintain the "Triple-K" specification for ambulance design. In response, the NFPA put together a technical committee and in June of 2012 passed NFPA 1917, *Standard for Automotive Ambulances.* This new standard contains the minimum design specifics for both the chassis and patient compartment and performance requirements for both large and small ambulances. Note that ambulances ordered before January 2013 are not required to meet this standard.

Restraints

Keeping personnel relatively safe while riding in a patrol car, fire apparatus or even the front cab of an ambulance is a fairly simple concept. There is no real need to do anything other than stay seated and belted while the vehicle is in motion. Passengers on a fire apparatus should never be performing any function that requires them to move from the seated and belted position.

This issue is not so clear-cut for personnel providing care to patients in the rear (patient compartment) of an ambulance. EMS responders are often not able to remain seated and belted when patient care is required while the ambulance is moving. This places them in an extremely vulnerable, and potentially lethal, position in the event that the ambulance is in a collision.

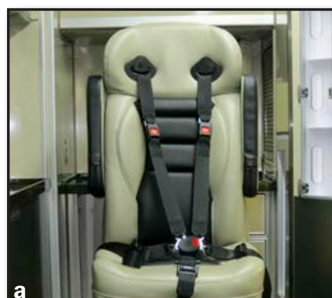
According to a 2003 report issued by the Centers for Disease Control and Prevention (CDC), the patient compartment was the most deadly location on the ambulance in a collision situation. The CDC study covered the period from 1991 through 2000. During that decade, collisions resulted in the deaths of 82 ambulance occupants. The locations of the fatally injured occupants were as follows:

- Left front (driver's) seat — 14 fatalities — 17.1 percent.
- Right front (passenger's) seat — 10 fatalities — 12.2 percent.
- Patient compartment — 48 fatalities — 58.5 percent.
- Other/Unknown — 10 fatalities — 12.2 percent.

The patient compartment also accounted for similarly high percentages of nonincapacitating and incapacitating injuries.

In recent years, there has been work done by ambulance manufacturers, in conjunction with EMS providers, to develop effective restraint systems for patient compartment passengers **(Figures 4.5a and 4.5b)**. These include both active and passive restraint systems. Active restraints are those that include a harness-type restraint used to restrict the movement of the wearer while moving within the patient compartment. Passive restraints typically consist of webbed nets designed to catch responders hurled toward the front of the patient compartment during a crash.

Numerous patients have also received severe or fatal injuries because they were improperly secured to the cot when a collision occurred. Simply securing the patient with the cross straps on the cot will not prevent the patient from being thrown toward the front of the passenger compartment during a crash. In order to properly secure the victim, the cot must be equipped with upper body safety restraints that cross each shoulder and prevent the passenger from being ejected off the front of the cot. These restraints must be used every time a patient is transported on the cot.



Figures 4.5a and 4.5b — Ambulance passenger compartments may be equipped with a variety of passenger restraint devices. (Photo/Mike Wieder)

NIOSH has done a considerable amount of research into ambulance collisions and safety. The institute recommends that ambulance providers and response agencies continue to work toward the development of more effective restraint systems that will increase the crash survivability of both the EMS providers in the patient compartment and the patients who are being transported.

Although NFPA 1917 does not address patient restraints on the cot, sections 6.21.3.2, 6.21.3.8 and 6.21.10 address ambulance personnel restraint and seatbelt warning systems in detail as follows:

- Each seating position shall be provided with a seatbelt.
- The length for lap and shoulder harnesses for ambulances above 19,500 pounds shall meet specific requirements.
- Seats in the patient compartment shall be adjustable both at the head and the side for the delivery of patient care while remaining restrained.
- An occupant restraint warning system shall be provided for each designated seating position in the patient compartment that indicates if an occupant is not belted or restrained.
- The warning system shall be both audible and visual. It should be audible and visible to the driver and visible to the occupants in the patient compartment.
- A warning shall be activated when the parking brake is released and the transmission is not in neutral or park.

Loose Equipment Storage

Agencies must establish policies regarding the storage of loose equipment within the passenger riding and patient compartments of vehicles. In recent years, it has become increasingly common to mount and store a variety of tools and equipment within fire apparatus cabs, ambulances and police car passenger compartments. This is typically done with the intent of making frequently used items more readily accessible to personnel as they leave the vehicle. The theory is that this will markedly speed delivery of services. Equipment commonly found in the fire apparatus cab includes protective breathing apparatus, forcible entry tools, portable lights, EMS equipment, and other commonly used tools and equipment **(Figure 4.6)**. Equipment found in ambulances may include monitor/defibrillators, drug boxes, mobile computers, clipboards and other medical equipment. Equipment found in the police car passenger compartment may include firearms, mobile computers, flashlights, clipboards and similar equipment.

Figure 4.6 — Loose equipment must not be stored inside the apparatus cab. (Photo/ Mike Wieder)

For fire service concerns, the reality is that the availability of this equipment in the cab makes little difference in the speed of service delivery compared with retrieving the same equipment from a well-planned apparatus body compartment. On the other hand, the risk posed to crew members by this equipment coming loose and flying about the cab during a sudden stop or collision is significant. Numerous cases have been noted where loose tools and equipment have struck firefighters who would otherwise have been uninjured in relatively minor collisions.

It is highly recommended that fire departments establish and enforce policies that minimize the storage of tools and equipment in the apparatus passenger compartment, including self-contained breathing apparatus (SCBA). Breathing apparatus cannot be properly donned while wearing a seatbelt — wearing the seatbelt must take precedence. Safety-conscious fire departments are now ordering new apparatus without SCBAs in the cabs and are mounting the units in quick-mount brackets in exterior compartments **(Figure 4.7)**. Firefighters who are seated and belted may don the SCBA face piece while the apparatus is en route to the scene. They can then dismount the apparatus and quickly don the rest of the unit while attack lines are being laid out and other preparations are being made for the fire attack. This procedure causes little, if any, delay to the fire attack and will greatly increase firefighter safety while responding to the emergency. It should be noted that some agencies discourage even the donning of SCBA masks en route, as it may increase the likelihood of slips, trips and falls when exiting the apparatus. Each jurisdiction should establish policies that best suit its organization.

Figure 4.7 — SCBAs should be mounted in exterior compartments. (Photo/Mike Wieder)

Figure 4.8 — Ambulance passenger compartments have ample room for equipment storage. (Photo/Mike Wieder)

Figure 4.9 — Police vehicles are commonly equipped with equipment in their passenger compartments. (Photo/Mike Wieder)

While initial delivery of service may not be adversely affected by storing EMS equipment in outside compartments, the use of that equipment in patient care necessitates that much of this equipment be contained in the patient compartment during transport **(Figure 4.8)**. NFPA 1917, Section 6.16 describes the requirements for interior storage. Section 6.18 specifies:

- Supplies, devices, tools, etc. shall be stored in enclosed compartments or fastened to secure them during vehicle motion.
- Equipment weighing three pounds or more, mounted or stored in driving or patient areas, shall be contained in an enclosed compartment capable of containing the contents when a 10G force is applied in the longitudinal, lateral or vertical axis of the vehicle, or such equipment shall be secured in a bracket(s) or mount that can contain the equipment when the equipment is subjected to those same forces.

Obviously, police patrol vehicles do not have the outside storage space of most fire and EMS apparatus. They typically only have a trunk. Equipment that absolutely must be ready at hand in the passenger compartment shall be mounted in such a manner that it will not become a flying hazard during a sudden stop or collision **(Figure 4.9)**. Consider moving larger, less frequently used items to the trunk. Equipment that is stored in the trunk must also be stowed or secured properly according to departmental policies or manufacturer's recommendations.

Emergency Vehicle Lighting

Emergency vehicle lighting conveys to other motorists the urgent nature of a response, provides warning of a hazard when stationary, and for police officers, signals a civilian driver to pull over. Emergency vehicle lighting is in addition to the standard lighting, such as headlights and hazard flashers, that are required on all motor vehicles.

The first modern fire apparatus lighting standard was tested for use in upcoming NFPA standards, at the Fire Department Instructors Conference (FDIC) in Cincinnati in 1992 and 1993. Changes in automobiles, society and the size of emergency vehicles makes emergency vehicle lighting all the more important today. Sirens are often useless with soundproof cars and drivers focused on more than just driving, their cellphones and other hand-held devices drawing their attention away from the road.

Most state vehicle codes have provisions that exempt emergency vehicles from certain provisions of the code when responding to an emergency with activated warning lights. This may include situations such as exceeding the posted speed limit and passage through intersections against a red light or stop sign. The motor vehicle codes typically also require civilian motorists to pull to the side of the road and yield right-of-way to emergency vehicles who are displaying activated warning lights.

Emergency vehicle lighting is also important from the standpoint of providing protection for emergency workers positioned along the roadway. In these instances, warning lights must provide notice to approaching motorists of the presence of emergency responders and some basic guidance on how to safely approach and navigate around the work area.

Warning Light Colors

There are a variety of warning light colors that are available for use by emergency response agencies. In most cases, the color of lights that may be used on specific types of emergency vehicles is generally regulated by state motor vehicle codes. Although there is a lack of consistency regarding the colors of warning lights that are used on specific types of emergency vehicles in the U.S., the following five colors, or any combination of these five, are used most commonly on emergency vehicles.

Red Lights

Red is the most common color used in the U.S. to denote an emergency vehicle. With the exception of law enforcement vehicles in certain states, red lights are commonly used on police, fire, and EMS vehicles **(Figure 4.10)**. The only other permissible use for red warning lights in most states is on school buses for the loading and unloading mode. Most other nonemergency service vehicles are prohibited from displaying red flashing lights. Motor vehicle codes usually require motorists to yield or come to a complete stop for vehicles displaying red warning lights.

Figure 4.10 — Red warning lights are common on many types of emergency vehicles. (Photo/Ron Jeffers, Union City, New Jersey)

Amber Lights

Amber or yellow lights typically have the broadest range of acceptable use in most motor vehicle codes. They are typically considered cautionary warning lights, and other motorists are not required to yield or stop for them. They are most commonly used on construction vehicles such as tow trucks, funeral escorts, security patrol vehicles, snowplows, utility vehicles, or other vehicles that may be stopped or moving slower than the flow of traffic. Emergency vehicles may be equipped with yellow warning lights as a secondary, contrasting light to the primary lighting color used for that vehicle when it is in motion. Some fire apparatus warning light systems are designed to switch to all amber lighting when stationary **(Figure 4.11)**.

Figure 4.11 – Amber warning lights may be used on any vehicle. (Photo/Mike Wieder)

White Lights

White is typically used as a contrasting color to other colors of lights used on an emergency vehicle. No emergency vehicles should be equipped with only white lights. NFPA 1901 prohibits white lights from being used on the rear of fire apparatus or when parked in the blocking mode. NFPA 1917 identifies four zones on an ambulance **(see Figure 4.12)**, identifies placement of optical warning devices for both large and small ambulances, and specifies the use of the following colors as shown in **Table 4.1**.

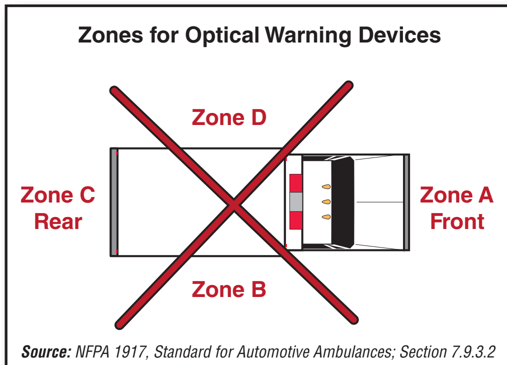


Figure 4.12 – Zones for Optical Warning Devices on Ambulances. Source: NFPA 1917, *Standard for Automotive Ambulances*; Section 7.9.3.2

Table 4.1. Ambulance Zone Colors

Color	Calling for Right-of-way	Blocking Right-of-way
Red	Any zone	Any zone
Blue	Any zone	Any zone
Yellow	Any zone except A	Any zone
White	Any zone except C	Not permitted

Green Lights

Green lights are typically limited to fire service or emergency management applications. They are most commonly used to signal the dedicated position of an Incident Command Post (ICP) **(Figure 4.13)**. This use was derived from the practice of using a green flag to denote the Command Post (CP) in early versions of the Incident Command System (ICS). In some states, green lights are also used on volunteer firefighter or EMS personnel's POVs or on private security guard vehicles. In the Chicago, Illinois, area, they are also commonly used as a contrasting color to red lights on fire apparatus.

Figure 4.13 – Green warning lights are commonly used to designate a mobile Command Post vehicle. (Photo/Mike Wieder)

Blue Lights

Blue lights probably have the widest variety of uses in the U.S. In many states, they are used as a contrasting color with red and/or other colors of lights on all types of emergency vehicles **(Figure 4.14)**. In a small number of states, all blue lighting is used for law enforcement vehicles. In other states, blue lights are used on POVs operated by volunteer firefighters and EMS personnel. In these cases, the lights are often considered a courtesy light, and other motorists are not required to yield to vehicles displaying all blue lights. In other states, tow trucks, snowplows and other public utility vehicles have blue lights.

Figure 4.14 — Blue warning lights may be used on a variety of emergency vehicles. (Photo/Mike Wieder)

Types of Warning Lights

In general, there are four main types of emergency lights that are used on emergency vehicles in the U.S. Some vehicles are equipped with only one type of light, but more commonly, vehicles are equipped with a combination of two or more types. Combining the types and colors of lights is a preferred practice, as different lights are more effective in different conditions. The four primary types of warning lights are:

- Rotating lights.
- Fixed flashers.
- Strobe lights.
- Light-emitting diode (LED) lights.

Rotating Lights

Rotating lights are among the oldest type of warning lights in use on emergency vehicles **(Figure 4.15)**. They catch people's attention because of the flashing sensation that is created as the light beacon(s) rotates within the light housing. These lights provide coverage over the full 360 degrees surrounding the vehicle on which they are mounted. Depending on the design, a rotating light may have anywhere from one to four lights within the unit. Single-light rotating lights typically remain lit constantly, and the sensation of flashing is created by a curved mirror that rotates around the bulb.

Figure 4.15 — A rotating warning light. (Photo/Mike Wieder)

Other rotating lights contain two to four quartz-halogen or conventional incandescent sealed-beam lights that rotate as an assembly around an electrically driven hub. Less common are rotating lights using LED lights. The assembly is protected by a plastic dome. Depending on the design, these lights can be all clear lights contained within a colored housing or colored lamps within a clear housing.

Rotating lights may be in the form of a single unit or multiple rotators contained within an enclosed light bar arrangement **(Figure 4.16)**. Enclosed light bars often contain angled or diamond-shaped mirrors between the lamps to give the effect of multiple flashing lights for each individual light.

Figure 4.16 — A warning light bar. (Photo/Mike Wieder)

Fixed Flashing Lights

Figure 4.17 — A fixed flasher warning light. (Photo/Mike Wieder)

Fixed flashing lights, also referred to as fixed flashers, provide a beam of light that is projected in a single direction **(Figure 4.17)**. These lights create attention by flashing on and off. They may be mounted to a flat surface outside the vehicle, attached to vehicle accessories such as bumper guards, or mounted on the rear inside deck of a passenger-type vehicle. Older designs of these devices utilized quartz-halogen or conventional incandescent sealed-beam lamps that were usually white in color. The housing over the lights could be any color desired. Modern versions use LED lamps as described below. In most cases, these types of lights are used as supplemental lighting on the middle to lower portions of the vehicle to augment the larger lighting system on the top of the vehicle. In some cases, newer ambulance designs solely use fixed flashing lights around the perimeter of the vehicle.

Strobe Lights

Figure 4.18 — A strobe warning light. (Photo/Mike Wieder)

Strobe lights were the first new addition to emergency vehicle lighting capabilities following the era of rotating lights. Strobe lights work in much the same way a flash unit does on a camera. Xenon gas flash lamps put out a very quick, but very bright, flash by ionizing and then discharging an electrical current through the gas. This does not make them ideal for any kind of programmed flash pattern. Strobes are fixed lights that flash in only one direction. They may be used in single fixed flashers or in combination within a light bar arrangement **(Figure 4.18)**.

The actual light produced by a xenon strobe is not perfectly white. It tends to be in the blue spectrum. Thus, when used in conjunction with red flasher covers or dome covers on light bars, the light emitted may have a pinkish or purplish tint.

Light-emitting Diode Lighting

Figure 4.19 — An LED warning light. (Photo/Mike Wieder)

In many places, warning lights comprised of multiple LEDs are the standard in emergency lighting and are becoming the standard as vehicles are replaced **(Figure 4.19)**. Each individual LED is a nickel- to quarter-sized solid-state light that has no filament to burn out. LEDs emit a powerful beam of light, yet use a minimal amount of electrical energy. They have exceptionally long life spans. Colors for LED lights can be intrinsically designed into each individual light, thus many LED warning devices are covered with a clear dome. In addition to their brightness and high level of visibility, they create an exceptionally low level of draw on the vehicle's electrical system as compared to strobes or traditional flashing lights. This reduces the amount of electrical overload problems that were common when vehicles were equipped with older styles of lighting.

LED lights can be used in the same applications discussed above for strobe lights. However, their use possibilities are much more flexible than those of conventional strobe lights. LED lights are controlled by electronics. This allows them to be programmed in an almost endless variety of operating patterns. The warning lights on an individual emergency vehicle can be programmed for a variety of patterns that can easily be selected by the vehicle operator based on the conditions in which the vehicle is being operated.

Other Types of Warning Lights

Law enforcement vehicle and ambulance warning lights are typically limited to one or a combination of the types described previously. This is in some part due to tradition, but more likely due to the smaller size of law enforcement vehicles and the limited capacity of the vehicles' electrical systems.

Fire apparatus are typically larger vehicles with a greater electrical capacity than police vehicles. Through the years, many fire apparatus have been equipped with two types of warning lights that are not usually found on other types of emergency vehicles: oscillating lights and rotary beacon lights. Both of these types of lights are typically located on the front of the apparatus, below the bottom of the center of the windshield. While both are effective in a number of ways, it is believed that their greatest value is in attracting the attention of motorists through their rearview mirrors.

Oscillating lights use one of several means to produce a light that moves up, down and horizontally, most typically in a pattern described as a figure eight **(Figure 4.20)**. These lights are commonly known as "Mars" lights in deference to their inventor and popular brand name. The most common colors used for oscillating lights are red and white. They are still often specified on modern day apparatus.

Rotary beacon lights, or Roto Ray lights, are warning light units made up of three sealed-beam lights that rotate in a vertical plane at 200 revolutions per minute (RPM). The plane of rotation is perpendicular to the longitudinal axis of the vehicle. The most common light combinations in Roto Ray units are three red lamps or two red lamps and one white lamp, although other variations can be found. Because the sweeping patterns on a roof-mounted unit tended to interfere with visibility through the windshield, modern apparatus have these lights mounted just below the center of the windshield **(Figure 4.21)**.

Figure 4.20 — An oscillating warning light. (Photo/Mike Wieder)

Figure 4.21 — A rotary beacon light. (Photo/Mike Wieder)

Available Research on Emergency Vehicle Lighting

For agencies seeking information on the topic of effective emergency vehicle lighting, there are many reputable sources. Research on this topic has been conducted by a variety of agencies, including fire and police departments, manufacturers, academic institutions, and governmental agencies. This section summarizes the results of some of the more commonly known and most recent research projects that have been conducted.

It should be noted when reading the summaries that there may be some discrepancies and contradictions among the results of various projects. Different circumstances, variables and goals used for the respective research projects may account for these differences. It is not the purpose of this document to validate or evaluate any of these studies, but simply to report them. Individuals and agencies should attempt to find those studies that most suit their needs and then investigate them in more detail than is possible in this report.

Phoenix Fire Department Study

In 1994, the Phoenix, Arizona, Fire Department had a firefighter killed in the line of duty when an impaired driver crashed into the back of an ambulance while the firefighter was assisting in loading a patient. The department conducted an internal lighting study that suggested that a reduced level of all-amber (yellow) lighting was less likely to blind drivers and less likely to draw the interest and attention of passing drivers.

As a result, all new Phoenix apparatus are now configured for all nonamber warning lights (clear, red and blue) to turn off when the apparatus parking brake is engaged. Amber lights on all four sides of the apparatus are the only functioning lights in the "blocking right of way" mode, although there is an override switch that is sometimes used when the apparatus is parked in bright sunlight **(Figures 4.22a and 4.22b)**. Many other fire departments in the U.S. have also adopted this practice.

Loughborough University Study

One well-known study, "Motor Vehicle and Pedal Cycle Conspicuity: Part 3, Vehicle-Mounted Warning Beacons," was conducted at Loughborough University in the U.K. in 1999. The study favored the use of traditional strobe lighting on emergency vehicles; however, LED lights were not widely used in the emergency service at the time this study was conducted. LEDs have replaced strobe lighting as the preferred lighting in later research studies.

Figures 4.22a and 4.22b — Amber lights may be positioned around the vehicle. (Photo/Mike Wieder)

Flash Rate

The study showed that the faster the flash, the greater the sense of urgency that was interpreted by the receiver. It was felt that this might help the emergency vehicle proceed more efficiently through traffic. This study also reported that the flash pattern that was used was important. Simultaneously flashing lights attracted attention far faster than alternating versions. The report also noted that brighter lights and greater numbers of lights also sped up gaining attention. On the downside, these changes did result in increased uncomfortable glare to the receiver and some potential health issues discussed below.

Light Color

The study looked at different light colors for the purpose of measuring glare and detection time under both daylight and nighttime conditions. The research noted that both red and blue lights compared favorably with amber for the level of glare under a variety of conditions. However, the tests for detection time results were not so even. Given an equal intensity, amber lights had the poorest detection time during both daytime and nighttime.

Hazards to Motorists

- **Photosensitive epilepsy —** Some people who are afflicted with photosensitive epilepsy may experience a reaction when exposed to certain types of strobe lights. This reaction can range in severity from an unusual feeling, involuntary twitch or a full-blown seizure. Studies have shown that such reactions can be triggered by any color of light flashing in the 10-20 hertz frequency range. Strobe lights used on emergency vehicles typically have much lower flash rates than this level. However, light manufacturers and departments specifying these lights should be sensitive to this issue and avoid developing or using lights that may approach this frequency.
- **Glare —** Glare can be caused by a bright light source in a person's field of view, and it can significantly reduce the person's ability to see other objects. When operating a vehicle, glare can be increased by rain, windshields or eyeglasses. The study distinguished between "disability" glare and "discomfort" glare. Disability glare is a condition where the driver may be temporarily blinded and unable to see hazards in the road even when looking directly toward them. Discomfort glare is a more general effect that may cause motorists to avert their eyes. During this time, they may fail to see obstacles in front of them soon enough to avoid them. The report noted that the worst disability glare occurred with amber beacons, strobe beacons and especially bright lights.
- **Phototaxis —** Phototaxis is the scientific term for the condition that is commonly referred to as the "moth-to-flame" effect. This theory is based on the idea that some drivers may be so distracted by the beacons that they are "drawn" to them. This is a commonly held belief in the emergency services, and many experts also report that this condition is increased if the driver is under the influence of alcohol or drugs. While this information has been widely spread throughout the emergency services, the authors of the Loughborough study were unable to locate any supporting scientific research that proved this theory at the time that their study was conducted.

Arizona Blue Ribbon Panel Study and Report

In June 2002, a Blue Ribbon Panel (BRP) was formed as a joint effort between the Arizona Attorney General and Ford Motor Company to improve police officer safety. The panel was formed in response to four crashes involving Ford Crown Victoria Police Interceptors (CVPI) that resulted in the deaths of three Arizona police officers and serious injury to a fourth officer. All four vehicles caught fire following the collisions.

The obvious primary emphasis of this review was the noted tendency for CVPIs to burst into flame following being struck in or near the rear of the vehicle; however, the panel did not limit their attention to simply addressing the fire issue. The group looked at the hazards as they applied to stationary vehicles and officers operating inside or outside parked vehicles. The study did not address moving police vehicles.

One of the aims of the panel was to identify ways to make stopped emergency vehicles more conspicuous to oncoming drivers so as to reduce the number of rear-end crashes into those vehicles. It was realized early on that the level of vehicle lighting that is effective during an emergency response may not be the same as safe vehicle lighting when parked at a roadway scene. The type of lighting needed for stationary operations must convey to the approaching driver that an emergency vehicle is present and the vehicle is not currently moving, as well as indicate the safe way to negotiate the scene.

The panel identified four key factors that affect the visual conspicuity of warning lights on emergency vehicles:

Light Output

Light output refers to the brightness of the light. Too little light may not provide an early enough signal to approaching drivers. At very high output levels, the resultant glare may impair drivers and reduce the level of safety. Determining an acceptable level must take into consideration the prevailing illumination, other light sources in the visual field and the driver's ability to adapt.

Light Color

From a scientific standpoint, given a halogen light and a set of the four most common lens colors, a white lens allows almost all of the light to pass through the lens, while amber (60 percent), red (25 percent) and blue (15 percent) allow lesser amounts of light to pass through. However, human eyes are not science experiments. Tests showed that the human eye is more sensitive to blue lights at night and red lights during daylights hours.

Flash Rates

Motion is a very effective way to gain attention. In general, the higher the number of flashes, the greater the level of conspicuity to the observer. However, excessive flash rates may cause glare and distraction or annoyance.

In their 1996 handbook, the SAE recommends flash rates ranging from 2.2 to 8 hertz, which are about one to two flashes per second. While strobes can be used to trigger seizures in some people, the strobe needs to be in the 6 to 40 hertz range, which far exceeds typical emergency vehicle strobe lights. NFPA 1901, section 13.8.1 and NFPA 1917, section 7.9.11 specify the minimum flash rate of any optical source on a fire apparatus or an ambulance shall be 75 flashes per minute, and the maximum number of flashes at any measurement point shall be 150 flashes per minute.

Ramp Times

This is the time that it takes for the light to go from off to fully on. It is believed that the quicker ramping occurs, the greater the conspicuity of the light.

Florida Highway Patrol Study

The Florida Highway Patrol (FHP) conducted its own study of effective police vehicle emergency lighting in 2003 and 2004. The test concluded in March 2004 with the FHP sponsoring a prototype lighting evaluation in which three lightbar manufacturers participated. Each prototype included two different lighting patterns to assist approaching motorists in determining whether the police vehicle was moving or stopped. Only LEDs were used to reduce both the electrical load and the required maintenance. Findings included:

Light Color

Red LEDs are more visible in daylight than either blue LEDs or blue halogen lights. This is a combined effect of the red LEDs having more light output than blue and the red light being more readily detectable in bright environments. With the advent of LEDs, blue has become a much more intense and visible color, appearing to be the best color to use at night because it is more conspicuous in the dark environment. Blue also gives a truer perception of the vehicle's motion than red. It stands out against the predominately red background provided by other vehicles; thus, it needs less intensity to achieve the same perceived brightness. This helps reduce the likelihood of night blindness. In addition, at night in dimly lit areas, red lights are seen as either farther away or moving away from an observer while blue to violet lights are seen as closer or approaching the observer. Overall, the study determined that red LED lights were the most visible during daylight conditions and blue LEDs or blue halogen lights were most visible at night.

Flash Rate and Pattern

The worst lights for signaling movement of the patrol vehicle were lights that alternated flashes from side to side. Quickly and randomly flashing all the modules in the light bar as a multiflash "dancing" pattern was the best configuration for moving apparatus, regardless of whether it was day or night. When stopped, the entire light bar flashes as one complete unit at 90 flashes per minute in the color chosen according to the ambient light (red during the day, blue at night). Also, the lights will not flash in the rear window when the vehicle is moving unless specifically activated by the operator, such as when accompanying a disabled vehicle from the roadway.

U.S. Fire Administration/Federal Emergency Management Agency Sponsored Research

The USFA, a unit within FEMA, coordinates a variety of research on issues related to firefighter health and safety. In recent years, USFA has paid particular attention to issues surrounding emergency vehicle response and roadway scene safety, prompted by the fact that these account for 25 percent of all firefighter fatalities on an annual basis and an equally significant number of injuries. Many of the projects that have come out of this effort were covered in Chapter 1 of this document. It should be noted here that although the percentage of firefighter fatalities from collisions and roadway incidents has decreased in the past two years, there is not enough data to determine if this trend will continue.

As mentioned in Chapter 1, the USFA, in partnership with the DOJ's OJP, entered into a cooperative agreement with the SAE to look at the issue of nonblinding emergency vehicle lighting in 2001. The SAE worked with the University of Michigan Transportation Research Institute (UMTRI) to conduct this research. The results were published in a USFA report titled "Effects of Warning Light Color and Intensity on Driver Vision" (SAE J595) in October 2008.

This report was part of a research program on how warning lights affect driver vision and how those lights can be designed to provide the most benefit for the safety of emergency vehicle operations. In order to understand the overall effects of warning lights on safety, it is necessary to know about the positive (intended) effects of the lights on vehicle conspicuity, as well as any negative (unintended) effects that the lights may have, such as glare and driver distraction. The report also provides information about how the colors and intensities of warning lights influence their positive and negative effects in both daytime and nighttime lighting. Color and intensity received considerable attention in standards covering warning lights at the local, state and national levels. Interest in these variables increased because of the new options provided by the growing use of LED sources in warning lamps.

Participants in this study were selected to be reasonably representative of the driving public. Two groups, based on age, were chosen to ensure that some estimate could be made of how warning light effects might change with driver age. A static field setting was used to simulate the most important visual circumstances of situations in which drivers respond to warning lights in actual traffic. Two vehicles with experimental warning lights were placed so that they would appear 90 degrees apart in a simulated traffic scene as viewed by an experimental participant who was seated in a third vehicle. The four most commonly used colors of warning lights in the emergency services were used (white, yellow, red, blue) and all four colors were presented at two levels of intensity. All intensity levels were high relative to current minimum requirements, since the greatest interest was in measuring potential benefits of high intensity lamps in the day and possible problems with high intensity lamps at night. Participants performed three tasks, under both daytime and nighttime conditions:

- Lamp search, in which the participant had to indicate as quickly as possible whether a flashing lamp was present on the right or left simulated emergency vehicle. This task was designed to capture the kind of visual performance that would be important when a driver tries to locate an emergency vehicle approaching an intersection from one of two possible paths. Faster performance for a certain type of lamp can be taken to mean that the lamp provides better conspicuity.
- Pedestrian responder search, in which the participant had to indicate as quickly as possible whether a pedestrian responder wearing turnout gear was present near the right or left simulated emergency vehicle. This was designed to capture negative effects of the warning lamps on seeing pedestrian responders near an emergency vehicle. Slower performance for a certain type of lamp can be taken to mean that the lamp causes more interference with driver vision (e.g., glare or distraction).
- Numerical rating of the subjective conspicuity of warning lamps. This task was designed to provide a subjective measure of the visual effects of lamps, which may or may not show the same effects of color and intensity that are provided by the objective search tasks.

The results of all three tasks showed major differences between daytime and nighttime conditions. Search for lights was easier during the night, and search for pedestrians was easier during the day. The large differences in performance between night and day add support, and some level of quantification, to the idea that the most significant improvement to be made in warning lights may be adopting different light levels for night and day.

Over the range of light intensities that were used, there were improvements in the daytime light search task with higher intensities of light, but performance on light search at night was uniformly very good and did not improve with greater light intensity. The lights showed little effect on the pedestrian search task during either day or night.

Color affected both the objective light search task during the day and the rating of subjective conspicuity during both day and night. The photopic (vision in bright light mediated by the cones of the retina) photometric values for different colors that are currently specified by the SAE are approximately consistent with these findings, but there appear to be some discrepancies, particularly at night. More data on color may be useful in reviewing those specifications.

Although the original report provides much more detail on this issue, it can be summarized in three basic recommendations based on the results of the experiment and on previous results in the existing literature:

- Use different intensity levels for day and night.
- Make more use of blue overall, for both day and night.
- Use color coding to indicate whether or not vehicles are blocking the path of traffic.

The strongest findings in research concern the differences between night and day in performance on the light and pedestrian responder search tasks. These effects are consistent with the common experience that emergency warning lights are far more visually impressive in the generally dark context of night than against the much brighter context encountered during the day. However, in order to make the best use of warning lights under all conditions, it is important to quantify these differences. Current research results at least begin that effort. For the range of intensities and the flash pattern used in the report, nighttime performance in locating the warning lights was not affected by intensity. Although the older participants made a large number of errors, all participants appeared to be performing as well as possible. Greater stimulus intensities would not have helped. In the daytime, however, the higher intensity level of each of the four colors led to improved performance, indicating that even for the very high range of intensities used in this experiment, visual performance in the search task can still improve. The large overall difference in performance between day and night on the light search task (853 versus 473 milliseconds) is consistent with that finding, although the very high ambient light levels encountered in the daytime probably make it impossible for any practical warning light to achieve in daytime anything close to the conspicuity levels that most warning lights have at night.

Conversely, reaction times and error rates for the pedestrian search task at night were substantially worse than during the day. However, the lighting situation was unfavorable to the retroreflective markings, both in terms of the amount of light on the markings and in terms of observation angles. Different situations might result in near-daytime levels of performance for pedestrian responder search. For at least the older group of participants, there appeared to be a measurable negative effect of the flashing warning lights on their ability to search for pedestrian responders at night. During the day, performance on the pedestrian responder search task appeared to be unaffected by the warning lights, as was expected given the relatively reduced effectiveness of the warning lights in daylight.

There was no difference in performance for the black versus yellow turnout gear either in the day or night. This was expected at night because under the nighttime lighting conditions, only the retroreflective markings were relevant, and the only difference between the black and yellow turnout gear was in the background material. In the daytime, the yellow turnout gear had considerably higher luminance, although, at least for the conditions of this experiment, the difference did not affect visual search for the pedestrian responder.

As was expected, color had effects on both objective search performance and subjective rating of conspicuity. During the daytime, there were marked differences in light search performance for the different colors beyond the effects that could be attributed to intensity. Researchers interpolated results to determine intensity levels of each of the four colors that corresponded to a single value of reaction time. They found that those levels were at least in rough correspondence to the photometric requirements currently specified in SAE J595. The main exception was that red was less effective in the search task than would be expected based on the SAE requirements. The reaction time data suggested that blue was very effective in aiding the search task, even in the daytime. This is consistent with the SAE requirements, but goes against some statements that have been made about the effectiveness of blue in the daytime. It has often been said that blue is very effective at night (consistent with the idea that the blue-sensitive rod photoreceptors are strong contributors to driver vision at night), but that blue lights provide weak stimuli in daytime.

Subjective ratings of conspicuity were also affected by color, beyond the differences that could be accounted for by differences in intensity. Researchers modeled the effects of color on subjective ratings by determining the levels of intensity for each color that corresponded to a single response level (in this case, a certain value for conspicuity rating). The daytime results are consistent with the SAE J595 requirements, but are inconsistent with the results from the search task. The main discrepancy is that red is subjectively rated as more effective relative to the other three colors than it appears to be in the search data. However, there is a reasonably high overall similarity between the effects of color on subjective ratings of conspicuity and the objective effects on reaction time in the light search task in daytime. The nighttime subjective ratings show a strong difference between red and blue, with red being rated less conspicuous than white and far less conspicuous than blue. These results are qualitatively consistent with a shift from photopic toward scotopic (vision in dim light involving only the retinal rods as light receptors) vision between the daytime and nighttime conditions. They are inconsistent with the current SAE recommendations that are meant to apply to both nighttime and daytime conditions. However, the new results are from a limited range of conditions, and it was not possible to quantify the effect of color on the objective search task at night.

To view and download the entire "Effects of Warning Light Color and Intensity on Driver Vision" report, go to the SAE website at http://www.sae.org/standardsdev/tsb/cooperative/warninglamp0810.pdf.

Conspicuity

Conspicuity refers to the ability of a vehicle to draw attention to its presence, even when other road users are not actively looking for it. Emergency warning lights are the predominant method for making emergency vehicles conspicuous. However, studies conducted in the U.S. and other countries suggest that emergency vehicle conspicuity can be increased using passive treatments. The purpose of making any vehicle conspicuous goes further than simply enhancing its visibility. Catching the eye of another driver is the first thing, but the larger goal is to help provide other drivers with information about a vehicle's presence, size, position, speed and direction of travel.

Retroreflectivity

Although of limited benefit during daylight hours, it seems clear that properly applied and maintained retroreflective sheeting materials can effectively increase the nighttime visibility and conspicuity of treated objects. Retroreflective material is used in a wide range of traffic control applications. Research in this area prompted the 1992 addition of retroreflective conspicuity standards for U.S. trucks in the FMVSS, Chapter 108 (US CFR, 2004). A 2001 research study performed by NHTSA following the addition of this standard suggests that retroreflective conspicuity treatments applied to U.S. heavy truck trailers have been "quite effective" at reducing side- and rear-impact crashes at night.

For materials to exhibit their retroreflective properties, an external light source is needed. While emergency vehicles carry their own light sources in the form of headlamps, marker lamps and emergency warning lights, they also depend on light from other vehicles' headlamps for visibility. The degree to which a retroreflective object (including an emergency vehicle treated with retroreflective striping) reflects light back to its origin depends on the amount of incoming light hitting the retroreflective surface(s).

The efficiency of a retroreflector is also related to a specific viewing geometry. The viewing geometry of a retroreflector is a function of two angles: the angle that incoming light strikes the target (such as a traffic sign, vehicle, person or other object), called the entrance angle (ß), and the angle where light reflected back from the target is observed, called the observation angle (α). The viewing geometry of a fixed object such as a traffic sign is much different than the changing angles at which a retroreflective target accepts incoming light and reflects it back to the viewer as he or she moves through an emergency scene. Unlike a fixed traffic sign where the expected viewing geometry is largely predictable, in a vehicle-mounted application, the relative positions of target and observer are continually changing, thus changing the viewing geometry.

Factors Affecting Visibility and Recognition

Several factors affect the visibility and recognition of emergency vehicles. The lettering used to mark emergency vehicles almost certainly affects the ability of surrounding drivers to recognize them. Multiple studies have demonstrated that retroreflective sheeting type, font style/size, word count, and color are meaningful factors in determining the legibility of traffic signs and vehicle markings (Schmidt-Clausen, 2000; Chrysler et al., 2002; Gates and Hawkins, 2004; Amjadi, 2008). It seems likely that these results extend to emergency vehicles.

Visibility and recognizability are also likely influenced by the color scheme(s) in which emergency vehicles are painted. However, there has been no single particular color identified as the optimal choice for enhancing emergency vehicle visibility/conspicuity under every possible scenario.

Figures 4.23a through 4.23c — Contour markings on police vehicles.

Different marking patterns can also change driver responses. The association of the down-and-away chevron pattern with a "danger" or "slow down" message probably has something to do with its widespread use on traffic barriers, as specified in the U.S. Manual on Uniform Traffic Control Devices (FHWA, 2009).

Contrast

The use of contrasting colors can positively affect conspicuity by assisting drivers in locating a hazard amid the visual clutter of the roadway. There are basically two types of contrast: luminance contrast, the degree to which an object is brighter than its background, and color contrast, the difference in an object's color(s) and those found in its background (Cook et al., 1999). Contrast is enhanced by using colors not normally found in the environment, including fluorescents.

Fluorescent Colors

The effectiveness of fluorescent colors for enhancing daytime visibility/conspicuity in traffic safety applications is well-established in the literature (Schieber et al., 2003; Buonarosa and Sayer, 2007). Since fluorescence relies on ultraviolet radiation, fluorescent colors offer no additional benefit at night.

Research Findings Related to Conspicuity

The consensus among the research studies cited in this chapter suggests there are a number of practical things that law enforcement agencies, EMS providers and fire departments can do to enhance the ability of drivers to see and recognize emergency vehicles during all phases of an incident.

Contour Markings

Outlining vehicle boundaries with "contour" or "edge" markings using retroreflective material should help enhance emergency vehicle visibility/conspicuity. The potential value of outlining a vehicle is supported by research going back to 1984 (Henderson et al. 1984). In an extensive study of various marking schemes for large trucks, Darmstadt University of Technology researchers found contour markings useful for improving both side and rear visibility (Schmidt-Clausen, 2000). Langham and Rillie (2002) explained the benefits of marking a vehicle to project its entire shape, a recommendation echoed by Tijerina et al. (2003) for improving the safety of the Ford CVPI. **Figures 4.23a through 4.23c** illustrate the contour and edge marking techniques, respectively. Ready-to-install packages of retroreflective material for applying edge markings are commercially available at a relatively low cost.

Placement

Newer versions of vehicle headlamps used in passenger and commercial vehicles change the way the road ahead is illuminated, including traffic signs, people and emergency vehicles. Studies (Chrysler et al., 2002; Sivak et al., 2006) of recent changes in headlamp illumination suggest that it might be effective to concentrate retroreflective material lower on emergency vehicles to optimize interaction with approaching vehicles' headlamps. This opportunity complements the anticipated positive effects of contour markings outlining an emergency vehicle's overall size and shape. For law enforcement vehicles, retroreflective material can be concentrated on the sides and rear to maintain stealth when facing traffic or patrolling. Retroreflective tape matched to the vehicle's base color also can be used to maintain an unmarked appearance during the day, but enhance visibility/conspicuity at night.

Fluorescent Colors

Fluorescent retroreflective materials, especially yellow and orange, have superior conspicuity properties and are particularly useful where a high degree of daytime visibility is desired (Zwahlen and Vel, 1994). The increasing use of fluorescent colors will likely prove beneficial for providing 24/7/365 high conspicuity on fire apparatus and ambulances. Mission requirements for law enforcement vehicles should drive decisions about whether to incorporate fluorescent colors. For example, a traffic enforcement vehicle designed to be inconspicuous will probably not use fluorescent colors to enhance its daytime visibility.

Efficiency

Using high-efficiency retroreflective material can improve conspicuity while reducing the amount of vehicle surface area requiring treatment. Some studies of retroreflective sheeting types in traffic control applications suggest that the cost increase to specify higher-efficiency retroreflective material can be reasonably expected to pay off by reducing crashes under some scenarios (Gates and Hawkins, 2004; Amjadi, 2008). However, as noted by Chrysler and others (2002), all visual performance factors must be considered; performance should be evaluated for all lighting and weather conditions; and durability, ease of fabrication and cost must be weighed against the benefits of each product.

Additional research specific to emergency vehicle visibility and conspicuity is critically needed in the U.S., particularly since vehicle recognition is such a crucial facet of understanding how to improve responders' safety along the roadside.

Standards Related to Emergency Vehicle Visibility and Conspicuity

Standards related to vehicle visibility and conspicuity have been determined by various entities over time. Some consistency may be evident between fire apparatus and ambulances now that NFPA has developed standards for both.

Fire Standards

Effective Jan. 1, 2009, section 15.9.3 et seq. of the NFPA 1901, 2009 edition (NFPA, 2009), requires retroreflective striping in multiple locations, including at least:

- 50 percent of the cab and body length on each side (excluding pump panels) with 4-inch wide striping.
- 25 percent of the front width of the apparatus with four-inch wide striping.
- 50 percent of rear-facing vertical surfaces (excluding pump panels not covered by a door) in a 45 degree down-and-away "chevron" pattern of six-inch stripes alternating between red and either yellow, fluorescent yellow or fluorescent yellow-green.

(NFPA 1901, 2009, p. 47)

Beyond its design stipulations, NFPA 1901 cites section 6.1.1 of "ASTM D4956–Standard Specification for Retroreflective Sheeting for Traffic Control" (ASTM International, 2007) in detailing the performance/colors of retroreflective materials used for the required conspicuity treatment **(Figure 4.24)**.

Figure 4.24 — New fire apparatus are required to have reflective markings on various parts of the vehicle. (Photo/Mike Wieder)

Law Enforcement Standards

There is currently no U.S. industry standard on the color or markings for the visibility/conspicuity of law enforcement vehicles. The choice of vehicle exterior designs and warning equipment remains squarely within the discretion of each individual local, regional, state or federal agency.

The demands of the law enforcement profession also create unique visibility issues. Sometimes personnel do not want their cars to be readily detectable. Officers may want to be almost invisible to other drivers under certain circumstances. The need for high visibility at certain times must be balanced against a need for stealth at other times. As a best practice, however, many U.S. law enforcement agencies apply retroreflective treatments to patrol cars, motorcycles and other vehicles **(Figure 4.25)**.

Figure 4.25 — Police vehicles may be equipped with reflective markings.

Emergency Medical Services Ambulance Standards

The earliest known effort at trying to develop standard markings for emergency vehicles in the U.S. occurred in the late 1960s and early 1970s when the federal government attempted to standardize ambulance markings. At that time, they published the Triple-K ambulance purchasing specification (KKK-A-1922-A), which became the requirement for all ambulances purchased by agencies receiving federal monies. The standard required all ambulances to be primarily white in color with a 12-inch, midline "Omaha orange" stripe circling the vehicle. Use of the blue Star of Life emblems and the word "AMBULANCE" in reverse lettering on the front of the vehicle was also required. Many states and local jurisdictions adopted those requirements into their specifications or requirements, even if the ambulances were not federally funded. Although these specifications were never based on any research or citable references, they remained the requirements for federally purchased ambulances.

Figure 4.26 — NFPA 1917 requires reflective markings on new ambulance. (Photo/Mike Wieder)

In 2008, the GSA announced it would no longer maintain the Triple-K standards. As a result, NFPA released NFPA 1917, a voluntary standard that replaced the Triple-K and addresses a variety of issues related to ambulances. NFPA 1917, Section 6.25 does not specify an exterior color but requires a retroreflective stripe or combination of stripes in the following proportions **(Figure 4.26)**:

- 25 percent of the width of the front of the ambulance visible when approached from the front.
- 50 percent of the overall ambulance length visible when approached from each side.
- Stripes shall be a minimum of 4 inches in total vertical width, and the full stripe must be conspicuous as the ambulance is approached.
- Vertically hinged doors shall have at least 60 inches of retroreflective material on the inside of the door.
- At least 50 percent of the rear-facing vertical surfaces visible from the rear of the ambulance shall have retroreflective striping in a chevron pattern.
- Each strip in the chevron shall be a single color, alternating between red and either yellow, fluorescent yellow or fluorescent yellow-green.
- All retroreflective material shall conform to the requirements of ASTM D4956, Section 6.1.1.

Vehicle Inspection and Maintenance

All agencies should have and enforce SOPs for vehicle maintenance procedures. The primary goal of the maintenance program is to keep all vehicles in a safe and operable condition. Responsibilities of the vehicle operators, command officers and maintenance personnel relative to vehicle maintenance must be identified.

Routine Inspection and Maintenance

SOPs must specify timetables and procedures for performing regular, routine vehicle maintenance and include specific information on the frequency of inspections, the items to be inspected, procedures for recording the inspection, and procedures for making necessary repairs.

Career police officers, fire apparatus driver/operators and ambulance drivers should perform a basic vehicle operational and safety inspection prior to each tour of duty. Volunteer agencies may require these checks on a weekly or monthly basis.

Making sure that tires are in good condition and properly inflated is particularly important for emergency vehicles. These vehicles frequently make quick maneuvers that require optimum contact with the road surface in order to ensure safe operation. They also must be expected to operate in a wide variety of adverse weather conditions. Tires that are in good condition are perhaps the most important safety factor in these situations.

SOPs should dictate which conditions may be corrected by the member and which require the attention of a designated mechanic. Repairs may be made by a maintenance division of the organization or by private service companies contracted by the agency.

In the fire service, NFPA 1915, *Standard for Fire Apparatus Preventive Maintenance Program* can be used as the basis for developing SOPs relative to vehicle maintenance. While there is no comparable national standard for EMS or police vehicle maintenance, those agencies may find the information contained in NFPA 1915 a useful guideline for formalizing a program.

Removing a Vehicle From Service

There must be an agreed upon list of conditions that warrant the removal of a vehicle from service when it is deemed unsafe. **Once deemed unsafe, or even potentially unsafe, the vehicle must be removed from service until appropriate repairs have been made.** Members of the organization should refuse to operate or ride in any vehicle that is in an unsafe or potentially unsafe condition.

Applicable federal and state regulations, standards, manufacturer's recommendations, or other guidelines shall be used as the basis for creating the list of conditions that warrant a vehicle's removal from service. Examples of these conditions include:

- Excessive leakage of vehicle fluids.
- Braking or steering defects.
- Missing or inoperable seatbelts.
- Inoperable wiper blades.
- Poor tire condition.

Only personnel with appropriate automotive repair training and certifications should perform repairs. Major components of a vehicle being repaired should be thoroughly tested before the vehicle is placed back in service.

Summary

This chapter has focused on aspects of emergency vehicle design and maintenance. Although the characteristics of design differ among fire apparatus, law enforcement vehicles and ambulances, ensuring the safety of responders is a common concern that begins with vehicle design. However, even the most well-designed, safe and high-performance vehicles will quickly become ineffective and potentially dangerous if not properly maintained for the duration of their service lifetime. All agencies should have and enforce SOPs for vehicle maintenance procedures.

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Chapter 5
Improving Response-related Safety: Internal Factors

Introduction

All employers have an obligation to provide the safest working conditions possible. However, once emergency personnel leave the stations and go on the streets, they are exposed to a considerable array of hazards. That said, significant reductions in hazards could be made if there is a commitment from both the organization and the individuals serving within it.

Agency Vehicle Response Policies

Standard Operating Procedures

One of the primary means by which agencies establish consistent operations and manage risk is through the adoption and enforcement of SOPs, sometimes referred to as standard operating guidelines (SOGs). SOPs allow agencies and their personnel to operate in a predictable and efficient manner. Developing and enforcing SOPs related to emergency vehicle response procedures and roadway incident scene operations are particularly important due to the hazards these operations pose for responders. The agency administration is responsible for developing the SOPs, but it is strongly recommended that members from all levels of the organization, including organized labor organizations, be involved in the development and periodic review and revision of the SOPs.

When developing SOPs for emergency vehicle responses and roadway incidents, it is important to ensure that they conform to applicable laws and standards. These include state and federal laws, national consensus standards, state and federal requirements, and the DOT's MUTCD. SOPs that conflict with these regulations can place a significant amount of liability and risk on the agency and its members.

Developing, maintaining and revising SOPs is only half the equation. If the agency fails to educate the members and/or consistently enforce these procedures, the best SOPs in the world are worthless. Agencies must hold members accountable for following the SOPs. Lacking accountability, SOPs often are disregarded, leading to unsafe behaviors, unnecessary damage, injuries and deaths.

It is not the purpose of this report to cover the full range of necessary policies relative to vehicle operations. This report focuses on the importance of examining policies and practices related to emergency (lights and siren) responses to determine if they are appropriate from a risk-benefit standpoint.

Prioritizing Dispatch

The use of warning lights and sirens on emergency vehicles is a basic component of emergency response and patient transport in the U.S. It is expected by not only emergency responders, but also by the public. Without question, emergency personnel are most vulnerable when they are responding to a reported emergency or transporting a patient with lights and siren activated.

If we are going to make significant reductions in the number of injuries and deaths to personnel of all emergency disciplines, a major cultural shift is required. One of these shifts is the realization that using an honest risk-benefit analysis, many calls do not really justify a lights and siren response.

Sound priority dispatching relies on trained dispatchers and preset, algorithmic questions. There are commercial programs with preset questions available for all the emergency disciplines (fire, EMS, law enforcement). Many departments have also developed their own preset questions.

Probably the best-known commercial priority dispatch system is the Medical Priority Dispatch System® (MPDS), originally developed by Dr. Jeff Clawson 30 years ago. It is now controlled by the National Academies of Emergency Dispatch. The MPDS is, in part, based on published standards by the National Association of EMS Physicians (NAEMSP), the ASTM, the American College of Emergency Physicians (ACEP), the DOT, the National Institutes of Health (NIH), and the American Medical Association (AMA).

This system of dispatch instruction has evolved into three separate protocols — the MPDS, the Fire Priority Dispatch System® (FPDS), and the Police Priority Dispatch System® (PPDS). The systems use a protocol (series of scripted questions designed to gather specific information) to determine a priority response level. Any of the above response modes may be upgraded or downgraded as new information is received. More specific information regarding these three systems is available on the National Academies of Emergency Dispatch website at http://www.naemd.org/ResourcesEDS.

Response Matrix

A response matrix serves as a guide for the dispatch for emergency vehicles based on the incident type **(Figure 5.1)**. Having the response matrix readily available for dispatch allows for a rapid and appropriate deployment of emergency vehicles for a given incident.

Example of Salt Lake Valley Fire Response Matrix

CODE	BDALE	COUNTY	MIDVALE	MURRAY	SANDY	S JORDAN	SOSL	W JORDAN	W VALLEY
ALARM	1E	1E	1E	1E	1E	1E,1A	1E	1E	1E
ALRMCO	1E	1E	1E	1E	1E	1E	1E	1E	1E
ALRMR	1E	1E	1E, CS	1E	1E	1E, 1A	1E	1E	1E
ALRMW	1E, 1T	1E, 1T	1E, 1T	1E, 1T	1E, 1T	1E, 1T, 1A	1E, 1T	1E, 1T	1E, 1T

Figure 5.1 — A typical response matrix.

Alternative Response Policies for Fire Departments

Historically, fire departments treated virtually every response as an emergency and sent all apparatus with lights and sirens activated. In many cases, fire apparatus were involved in serious collisions while responding to calls that had a very low probability of requiring true emergency assistance. By considering and implementing policies that reduce the number of lights and siren responses made by fire companies, departments reduce the level of risk to their members (and the public) created by these responses.

The reduction in lights and siren responses is accomplished by performing a realistic review of the types of responses the department makes and determining which ones truly constitute an emergency condition. The goal is to identify types of incidents in which the few extra seconds created by a nonemergency response will have little or no impact on life safety or property damage. Use this information to modify dispatch procedures and SOPs for apparatus response. Though the results of this type of study vary from jurisdiction to jurisdiction, the following are types of calls that many departments are now treating as nonemergency responses:

- Activated fire alarm, without an additional call reporting fire conditions.
- Trash fire.
- Wires down/hanging.
- Smoke/Gas odor in the vicinity.
- Carbon monoxide detector activation without reported patient symptoms.
- Basic life support (BLS) EMS calls.
- Company relocations.
- Water leaks.
- Investigating a controlled burn or extinguished fire.

Numerous fire departments, including Saint Louis, Virginia Beach, Salt Lake City and Phoenix have instituted these "on-the-quiet" policies and have noted dramatic reductions in apparatus collisions when responding to incidents. In particular, St. Louis noted a greater than 90 percent reduction in apparatus collisions within the first couple of years of implementing this policy. It should also be noted that none of these jurisdictions have noted a reduction in their service delivery, higher fire losses or reduced patient care/mortality rates on EMS calls because of these policies.

In jurisdictions where there is significant resistance to responding all apparatus in a nonemergency mode on certain types of calls, it is highly recommended to revise SOPs so that only the closest unit to a reported incident scene responds with lights and siren, while all other responding units start toward the incident operating under nonemergency conditions. If the first unit on the scene finds an emergency situation, the other units can be upgraded to an emergency response status.

In a study of fire department responses to activated fire alarms without a secondary call reporting fire conditions, the New York State Office of Fire Prevention and Control found that only 1 percent of responses required the services of more than the first-arriving company to mitigate the incident. It is safe to assume that those figures would probably hold true in almost any jurisdiction. Based on that information, it is difficult to justify the response of a full first-alarm assignment, with all companies operating under emergency conditions, to every activated fire alarm. The odds of a third- or fourth-due apparatus being involved in a collision are probably greater than the chance that they will be needed to control an incident at the property with the activated alarm.

Figure 5.2 — Exercise extreme caution when operating in heavy traffic conditions. (Photo/Ron Jeffers, Union City, New Jersey)

While reducing the number of lights and siren responses undoubtedly reduces the chances of the apparatus being involved in a collision, this policy may not be practical in some situations. In particular, companies that operate in extremely congested urban settings may need to operate their lights and sirens to clear slow or stopped traffic in order to prevent long out-of-service times while responding to minor incidents **(Figure 5.2)**. In these cases, although the incident may not necessarily warrant an emergency response, excessive out-of-service times might prevent them from being available to respond to a true emergency. In these situations, drivers should use a modified emergency response. Use warning devices to clear a reasonable path to the incident, but do not operate the apparatus with the sense of urgency used when responding to a true emergency.

Alternative Response Policies for Emergency Medical Services

Since the 1970s, arriving within eight minutes 90 percent of the time has been the gold standard for determining the quality of an EMS system. Response times are how EMS providers compete for contracts, and prove to the community that they are providing quality service. According to NFPA 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, first responders and BLS units must arrive on-scene within a four-minute time frame 90 percent of the time for all incidents, and the advanced life support (ALS) crew must respond within eight minutes. This requirement is based on experience, expert consensus and science. Many studies note the role of time and the delivery of early defibrillation in patient survival due to heart attacks and cardiac arrest, which are the most time-critical, resource-intensive medical emergency events to which fire departments respond.

Figure 5.3 — AEDs are found in many public buildings. (Photo/Mike Wieder)

It is important to point out here that those times were set before the advent of the automated external defibrillator (AED) and, as noted in NFPA 1710, were based on delivery of early defibrillation, which at the time, was only available from ALS crews. Since then, AEDs have become commonplace, not only on BLS units, but in shopping malls, airports, schools and, in many areas, in police vehicles **(Figure 5.3)**.

There exist multiple studies comparing ambulance response times with and without the use of lights and sirens. The majority of these have demonstrated that although response times are faster with lights and siren, the time saved had no significant impact on patient outcome, except in cardiac arrest and obstructed airway cases. The Emergency Medical Services Outcomes Project (EMSOP) identified seven clinical conditions that account for 65 percent of all adult EMS transports and seven that account for 85 percent of all pediatric transports. Of these conditions, only cardiac arrest — the second least frequent of all the conditions — appears to require rapid EMS response (Sword RA, Cone DC., 2002).

In 1999, all police vehicles in Miami-Dade County, Florida, were equipped with AEDs, and police officers received a four-hour training session. They developed a dual-dispatch response system in which police and conventional EMS were simultaneously deployed to assist cardiac arrest victims. This system translated to a statistically significant improvement in the percentage of those who survived "shockable" ventricular arrhythmias: 17.2 percent survival rate, compared with a 9 percent survival rate in the historical control (Joglar, J. and Page, R. 2002).

A number of municipal police agencies around the nation have started AED programs. It is evident that there is benefit in survival from shockable cardiac arrest afforded by simultaneous deployment of AED-equipped police. This substantially increases the overall number of AEDs; and in most communities, police cars are usually already on the road at the time of an emergency call. However, a key factor to success is a satisfactory commitment by the police force to the concept of, and comfort with, the process.

Alternative Response Policies for Law Enforcement Agencies

The need to review emergency response policies is just as critical for law enforcement agencies as it is for fire and EMS. Although the percentage of calls that police officers historically have responded to using lights and siren is significantly less than with fire and EMS, there still are many calls in which the risk-benefit analysis probably does not justify an emergency response.

Much attention is often paid to incidents where police officers are injured or killed during the course of a vehicle pursuit. This is typically because of the high-profile media attention focused on these events. The reality is that on average, only about 5 percent of all vehicle-related officer fatalities occur during pursuits. A review of case histories that were listed as automobile crashes indicates that the majority of these occurred (driving with or without lights and siren) at a high rate of speed.

Officials who study these issues, and who assist law enforcement agencies in developing driving policies, typically look at this issue from the same risk-benefit perspective as discussed above in the fire department and EMS sections. Certainly, the vast majority of police vehicle crashes occur during routine driving situations, and they tend to be low in severity. Although the number of crashes that occur during pursuits is relatively low, they are often quite severe. Crashes that occur during emergency responses happen much more frequently than pursuit crashes and tend to be significantly more serious than those that occur during routine driving.

As in the fire and EMS services, there exists no national standard or regulations for police agencies about when or when not to respond to calls using emergency driving procedures. While there may be some direction from applicable state motor vehicle codes, most policies that exist on this topic are agency-developed and highly dependent on the culture of each individual department. In many cases, the policies that are in place are not highly specific on when and when not to drive in an emergency response mode. This is because of the perception that every call is a different situation and certain variables may or may not justify an emergency response.

In reality, all law enforcement agencies should have relatively firm polices on what justifies an emergency response and what does not. There must be some flexibility in these policies to account for conditions such as inclement weather, heavy traffic conditions and other factors that may influence the response time. However, in establishing these policies, law enforcement agencies should use a risk versus benefit perspective to determine when emergency driving is appropriate.

One of the critical factors to consider when developing this type of policy is whether there is any likelihood that a slightly faster arrival on the scene of call is likely to make a difference in the outcome of that incident. Many, if not most, incidents that police officers respond to are actually over before the caller even talks to the 911 dispatcher. In those incidents, an emergency response versus a nonemergency response will make no difference in the outcome.

Another policy issue is the perception by many officers that a rapid emergency response to a location without using warning lights and siren is safer and more effective than a true emergency response. They base this on the observation that civilians may react unpredictably to approaching emergency vehicles with activated lights and sirens. The truth of the matter is that this type of response is not really any safer than a true emergency response. While it does negate the unpredictable reaction to the approaching lights and siren, it may present a different set of challenges. For example, a civilian driver may be unaware of the police vehicle approaching quickly from the rear and turn into its path.

An additional concern with this type of response is the issue of liability. Most state motor vehicle codes that allow emergency vehicles to exceed speed limits and bypass other traffic regulations do so with the understanding that the vehicle will be operating with its warning devices activated. Should the officer be involved in a collision while making a high-speed response without using the appropriate warning devices, it would expose the officer to criminal liability and both the officer and the department to civil liability. Make every effort within department policy, training and enforcement to prohibit these types of responses.

The International Association of Chiefs of Police (IACP) has developed a set of model policies and procedures that can be adapted by local police agencies for use in their jurisdictions. "The Manual Police Traffic Services Model Policies and Procedures" can be downloaded from the Internet at no charge from http://www.theiacp.org/PublicationsGuides/TopicalIndex/tabid/216/Default.aspx?id=1047&v=1.

Training

It is important that all agencies appropriately train their personnel for the duties that they perform. Specific minimum training requirements for each of the emergency response disciplines are spelled out within state and local laws, jurisdiction policies, and the various professional qualifications standards.

Training Requirements

There is an enormous difference between operating a two-ton utility vehicle and a 25-ton aerial or rescue apparatus **(Figures 5.4a and 5.4b)**. NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications* identifies the minimum job performance requirements for career and volunteer firefighters who drive and operate various types of fire apparatus. This standard states that all driver/operators must complete a formal training program on the exact types of apparatus that they will drive in the field.

Figures 5.4a and 5.4b — Fire departments operate vehicles of widely varying sizes. (Photo/Ron Jeffers, Union City, New Jersey)

The training course needs to meet state and federal requirements for operators of heavy trucks and must lead to the driver meeting the certification requirements contained in NFPA 1002. Note that NFPA 1002 has separate requirements for drivers of different types of fire apparatus. A driver who has only received training on a standard pumper must not be expected to drive a large water tanker/tender or aerial apparatus without additional training. If a driver feels that he or she has not been adequately trained on a particular piece of apparatus, he or she must **refuse to drive the vehicle** until sufficient training has taken place.

Though not required by NFPA 1002, the standard strongly urges fire departments to require apparatus drivers to obtain a Commercial Driver's License (CDL) for their state. Requirements for CDLs in the U.S. are outlined in The Commercial Motor Vehicle Safety Act that was signed into law on Oct. 27, 1986. The goal of the act was to improve highway safety by ensuring that drivers of large trucks and buses are qualified to operate those vehicles and to remove unsafe and unqualified drivers from the highways. The act retained the state's right to issue a driver's license, but established minimum national standards that states must meet when licensing large vehicle drivers.

Most heavy truck drivers have been required since April 1, 1992, to have a CDL in order to drive a commercial motor vehicle. Using the provisions of the act, the FHWA developed and issued standards for testing and licensing large-truck drivers. Among other things, the standards require states to issue CDLs to their large-truck drivers only after drivers pass knowledge and skills tests administered by the state related to the type of vehicle they wish to operate. Drivers need CDLs if they are in interstate, intrastate or foreign commerce and drive a vehicle that meets one of the definitions of a commercial motor vehicle. Clearly, fire apparatus meet the definitions of large trucks as defined in this standard.

One of the important provisions of the Commercial Motor Vehicle Safety Act of 1986 allowed a state, at its discretion, to waive firefighters, emergency response vehicle drivers, farmers, and drivers removing snow and ice in small communities from the CDL requirements, subject to certain conditions. Constituents of these excluded groups who felt it would be unreasonable to require their members to meet the CDL requirements lobbied for this provision. Virtually all of the individual state motor vehicle divisions ultimately waived fire and emergency vehicle drivers from the need to obtain CDLs.

In hindsight, one must question the logic of the fire service's desire for exemption from CDL licensing requirements. Given the hazards posed by emergency response driving conditions and our poor driving safety record, it would seem that fire service driver/operators would be perfect candidates for CDL licensing **(Figure 5.5)**.

Figure 5.5 — This collision resulted in the fatal ejection of a front seat occupant.

The process of obtaining a CDL includes passing a written test of at least 30 questions (with a grade of at least 80 percent) and passing a skills test. The skills test must include the following elements:

- Basic vehicle control skills, including demonstrating the ability to start, to stop, and to move the vehicle forward and backward in a safe manner.
- Safe driving skills, including demonstrating proper visual search methods, appropriate use of signals, speed control for weather and traffic conditions, and ability to position the motor vehicle correctly when changing lanes or turning.
- Perform a pre-trip inspection to ensure that the vehicle is in a safe, operable condition.
- Regular physical examinations and drug testing are required to maintain a CDL.

Fire departments that have a reasonable driver training program are probably covering most, if not all, of the items required to pass the CDL test. In fact, when the NFPA 1002 committee developed basic requirements for all fire apparatus drivers in their standard, they based their objectives on the CDL requirements. It should not be a significant burden on most departments, which train their personnel according to the NFPA 1002 standard, to take the next step and require their drivers to obtain the CDL.

In the long run, this is another way of ensuring members of the public and the fire department of the driver's preparation and qualification. It will also reduce liability concerns should the driver be involved in a collision.

In 2010, the Wisconsin State Patrol requested a report focused on training or testing required to operate an ambulance. The report contained information from 47 states, the District of Columbia, and six Canadian provinces. Forty-three of 54 jurisdictions identified did not require EVOC training to operate an ambulance, with a large majority of those states and provinces not requiring any special training or certification to operate an ambulance beyond a basic driver's license. Only 11 states required ambulance drivers to complete some form of EVOC training. However, only four of those states required that an on-the-road driving component be part of the course. No state provided information indicating that retraining or recertification was required once an individual had taken the course. The entire report is available online at http://wisdotresearch.wi.gov/wp-content/uploads/tsrambulancedrivers1.pdf.

While ambulances are not as large as fire apparatus, they carry the additional liability of transporting trusting civilians **(Figure 5.6)**. It would appear to be inexcusable that very few states require nothing more than 18 years of age and a normal driver's license.

Figure 5.6 — Responders may be vulnerable to approaching traffic while loading a patient in an ambulance. (Photo/Mike Wieder)

Minimum driver training requirements in the law enforcement community are generally addressed in state-level requirements for peace officer training.

In addition to the specific training requirements identified for each of the emergency response disciplines through laws, standards and policies, the MUTCD requires anyone functioning as a flagger on the roadway to have the following abilities:

Figure 5.7 — Emergency responders must be trained properly if they are expected to perform traffic control duties. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

- Receive and communicate specific instructions.
- Move and maneuver quickly.
- Control signaling devices to provide clear and positive guidance to drivers.
- Understand and apply safe traffic control practices.
- Recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.

Any fire, EMS or law enforcement person may need to function as a flagger and direct traffic at a roadway scene **(Figure 5.7)**. Teaching these skills should be a basic part of the entry-level training program of members in any emergency response discipline and reinforced regularly through in-service training.

Identifying the Need for Additional Training

The driver training provided at the recruit-level is not sufficient to cover a responder's entire career. Regular refresher and in-service training is critical in these high-risk areas.

Some agencies go so far as to require periodic recertification of emergency vehicle drivers to ensure their skills are maintained and to determine if additional training is warranted.

In addition to requiring refresher training on a specified time schedule, there are other indicators for the need for training that may occur in between regularly scheduled sessions. The first may be an identified rash of incidents that follow the same general pattern. This may require an immediate need to deliver training to address this specific situation so that the pattern may be broken.

Figure 5.8 — Provide adequate training for the appropriate-sized vehicle that is to be driven. (Photo/Ron Jeffers, Union City, New Jersey)

Another common and crucial indicator for required in-service training is when an emergency vehicle driver is expected to drive a new or different type of vehicle **(Figure 5.8)**. Examples of this situation include:

- A police officer switching from a standard patrol cruiser such as an Impala or Crown Victoria to a high-performance vehicle such as a Dodge Charger or Ford Mustang.
- A police officer switching from a standard patrol cruiser to an SUV or pickup truck.
- A police or fire officer switching from a front-wheel drive to rear-wheel drive vehicle or vice versa.
- A police officer or fire apparatus driver/operator assigned for the first time to a vehicle with an anti-lock or auxiliary braking system.
- A fire company, EMS crew or police officer receiving a new vehicle to replace an older model.
- A fire company, EMS crew or police officer receiving a reserve vehicle while the primary vehicle is being repaired or otherwise serviced.
- A fire apparatus driver assigned to a different vehicle from the one trained on. For example, the addition of a water tanker/tender or aerial apparatus to a fleet that previously had none.

Training Program Components

In addition to any classroom component, members must be provided ample opportunity to practice driving the apparatus. One effective tool used in driver training programs across all of the emergency fields is computer-operated driving simulators. These simulators provide the trainee with a relatively realistic experience of operating in a variety of traffic locations, conditions and weather. Perhaps the best thing about these devices is their ability to put the driver in a variety of critical situations to see how they react, without placing the driver or anyone else in any danger.

Computer driving simulators, when available, are just one tool in an overall driver training program. Simply learning proper techniques in the simulated environment does not replace the need for extensive training in actual emergency vehicles within controlled driving ranges and open road conditions. Give members the opportunity to practice in the actual apparatus under different environmental conditions (e.g., dark, wet pavement).

The California Commission on Peace Officer Standards and Training (POST) conducted a study of police officer driver training that concluded that blended training including both traditional EVOC training and the use of computer simulators results in the fewest collisions for peace officers upon completion of their initial training. The study also noted that overall, in-service driver training via driving simulators provides better results for experienced officers than in-service training via traditional EVOC training. The study also determined that computer simulator training about every two years is an optimal time frame to reinforce decision-making to prevent collisions. The POST report also noted the following findings:

- Driver training technologies such as the Skid-Car and driving simulators allow for situational training that cannot (safely) be undertaken in a "real" setting **(Figure 5.9)**.
- Training at speeds equivalent to emergency operating speeds is an effective way to prepare officers for the demands of high-speed driving.
- Use of interference vehicles is an effective way to prepare officers for the challenges of emergency operations in traffic.
- Use of training vehicles that are similar in make and model, equipment, and weight distribution is an effective way to achieve realistic behind-the-wheel training.
- Driver training during hours of darkness is an effective way to achieve realistic training.

Figure 5.9 — Driving simulators are effective training tools. (Photo/Mike Wieder)

Available Training Programs and Resources

Training provided at both the recruit level and in ongoing training programs must meet all applicable recognized standards and protocols. Training is acceptable from in-house personnel or through other organizations such as community colleges, driving schools, and private- or state-run training agencies. Only appropriately trained and agency-certified instructors and programs should be used for this important training.

Emergency Vehicle Occupant Safety

There is no dispatched emergency incident that justifies driving any other way than the safest manner possible. Always follow applicable traffic laws, departmental SOPs and rules of common sense. Adding 10 seconds to a response time is better than not arriving at all because of a collision caused by indiscretion and/or foolishness.

Figure 5.10 — Drivers are responsible for safe operation of the vehicle. (Photo/Jeff Fortney, Stillwater, Oklahoma)

Although vehicle types are dramatically different between law enforcement, fire apparatus and ambulances, the drivers of each of these vehicle types share common responsibilities related to ensuring occupant safety. These include inspecting the vehicle at the beginning of each tour of duty and ensuring that all occupants are wearing seatbelts before the vehicle moves.

Responsibilities of the Driver

Unquestionably, the individual who has the greatest impact on the safety of the occupants of any apparatus, as well as civilian motorists, is the vehicle driver **(Figure 5.10)**.

While all responders who drive any type of emergency apparatus have a wide range of duties and responsibilities, none is more basic or important than safely driving to and from the incident scene. Failure to drive the vehicle to and from the scene safely often results in that vehicle and its occupant(s) becoming an additional emergency incident to address.

Safety Inspection

The driver must perform an operational and safety inspection of the vehicle/apparatus at the beginning of each tour of duty to ensure that the apparatus is in a safe operational condition and that all apparatus systems are operating as designed and intended before driving the apparatus.

The driver, if allowed by departmental procedures, may correct minor problems, such as low fluid levels and burned-out light bulbs. More significant mechanical issues must be referred to department maintenance personnel for attention. If the driver has a genuine concern that an obvious or otherwise potential mechanical problem might affect the safe operation of the apparatus, **that driver must notify his or her superior of the concern and refuse to operate the apparatus until the problem is corrected or a replacement apparatus is obtained.**

Seatbelt Usage in Fire Apparatus

Firefighter death statistics show that approximately 80 percent of firefighters killed in apparatus collisions are not wearing their seatbelts at the time. **This is inexcusable** and is one of the easiest ways in which firefighter injuries and deaths can be reduced **(Figure 5.11)**.

Figure 5.11 — Occupants must wear seatbelts at all times when the vehicle is in motion. (Photo/ Mike Wieder)

NFPA 1500 specifically places this responsibility on the driver (Requirement 6.2.5). If a firefighter is injured or killed while trying to board or dismount a moving apparatus, while riding on the outside of an apparatus (including while operating at wildland fires), during a collision, or by falling out while the apparatus is driving down the street, it is as much the driver's fault as it is the company officer's and the person who gets hurt or killed. Ensuring that all members are seated and belted before moving the apparatus will prevent these losses.

By its nature, the delivery of EMS and law enforcement provide their own sets of issues and problems related to seatbelts. These are addressed in detail in Chapter 4.

Responsibilities of the Company/Lead Officer

The ultimate responsibility for the actions of the driver and the vehicle passengers lies with the company/lead officer of that vehicle. For the fire service, this is spelled out in NFPA 1500 6.2.4.1. The driver and the company/lead officer must work as a team to ensure safe operation of the vehicle at all times. The company/lead officer serves as a second set of eyes during the response and must constantly assist the driver by providing information that assists in the safe operation of the vehicle.

The company/lead officer must constantly observe the actions of the driver and provide direction when observing potential hazards or poor driving practices. The company/

Figure 5.12 — Fire apparatus are equipped with speedometers on the officer's side of the vehicle. (Photo/Mike Wieder)

Figure 5.13 — High-visibility seatbelts are now required in NFPA standards. (Photo/Mike Wieder)

Figure 5.14 — This rearview mirror allows the officer to view occupants in the rear of the cab without having to turn around. (Photo/Mike Wieder)

lead officer may order a driver to slow down if the vehicle is operating at an unsafe speed. Some fire departments equip apparatus with a second speedometer located on the company officer's side of the dashboard so that the officer can watch the speed **(Figure 5.12)**. The officer must never order a driver to speed up a response beyond the driver's comfort level for operating the vehicle. The driver shall refuse such an order.

The company/lead officer must also ensure that all passengers are seated and belted within the vehicle riding compartment before the vehicle is moved. One of the best ways to achieve this is to set a good example and always wear a seatbelt. In the fire service, experience shows that if the company officer says the truck is dirty, it gets washed. If the company officer says the station is messy, it gets cleaned. If the company officer says, "We are going to wear our seatbelts at all times" and sets a good example, the crew follows suit.

Most new vehicles are equipped with seatbelt monitors that send a signal if a belt is not buckled. These are not foolproof, as insubordinate members may buckle them and sit on top of them. There is no substitute for visually ensuring that every passenger is seated and belted. Visually checking in a fire apparatus is augmented by the use of high-visibility seatbelts that contrast from turnout clothing and equipment **(Figure 5.13)**. Furthermore, some fire departments equip apparatus with a rearview mirror above the officer's seat that allows the officer to observe the crew positions without having to turn around constantly **(Figure 5.14)**. **The company officer must not allow a vehicle to move unless every member is seated and belted.**

During the response, the company/lead officer, front seat passenger in an ambulance, or second officer in a law enforcement vehicle must constantly observe traffic conditions, road conditions, incident radio traffic, and other factors to assist the driver in ensuring safe travel. In many cases, pending hazards or helpful information becomes apparent while the driver is otherwise busy trying to negotiate through traffic or other attention-consuming conditions. By having the company officer, ambulance passenger, or second law enforcement officer act as a "co-pilot," focusing on the operation of the vehicle, hazards not initially noticed by the driver may be avoided before they lead to a collision.

Responsibilities of the Passenger

Passenger responsibility begins by remaining seated, with the seatbelt fastened, whenever the vehicle is in motion. NFPA 1500 (6.3.2) states that the seatbelt must not be loosened or removed for any reason, including the donning of respiratory equipment or protective clothing. The few extra seconds gained by having breathing apparatus pre-donned when arriving at the emergency scene do not warrant the level of risk imposed on the firefighters by not wearing their seatbelts while the apparatus is en route.

NFPA 1500 provides only three exceptions for the always seated and belted rule. These are:

- Aggressive patient care in the rear of an ambulance.
- Low speed hose loading activities.
- Tiller driver/operator training.

With the release of NFPA 1917, side seating in ambulances must be adjustable to allow for delivery of patient care while remaining restrained. Once all ambulances are replaced with this type of seating, there will be no reason for caregivers on side seats to be unrestrained during patient transport.

If a passenger is assigned to an apparatus/vehicle that does not have proper seating equipped with a seatbelt, **the passenger must refuse to ride in the vehicle.** In these cases, the department must provide an alternative response vehicle that allows all passengers to ride in a seated, belted position.

Many fire departments continue to operate fire apparatus that do not have fully enclosed cabs. NFPA 1500 requires firefighters riding in the unenclosed positions to wear both helmets and eye protection. Helmets will provide additional protection in the event the apparatus is involved in a collision. Eye protection will prevent bugs and other foreign objects from entering the firefighters' eyes while the vehicle is in motion. Regardless of whether the cab is enclosed or not, firefighters exposed to noise levels in excess of 90 decibels (dB) must also wear approved hearing protection while in those riding positions.

Department/Agency Responsibilities

Departments/Agencies must develop and **consistently enforce** effective SOPs for all areas related to vehicle and roadway safety. These SOPs must ensure that personnel operate in compliance with applicable laws and standards such as NFPA 1500 and 1917, state and federal motor vehicle codes, and the DOT's MUTCD for roadway operations. Finally, departments/agencies must ensure that personnel understand their responsibilities within these SOPs.

The list of issues to be covered in the SOPs can be rather lengthy. Many of those issues are covered earlier in this manual. However, there are issues that bear repeating in this section. The first is the department's obligation to maintain an effective vehicle maintenance and repair program. For fire departments, that means a program in compliance with NFPA 1915. The primary goal of this program is to keep vehicles in a safe and operable condition. The SOP must dictate the responsibilities of the driver, company/lead officers, supervisors and maintenance personnel relative to vehicle maintenance. There must be an agreed upon list of conditions that warrant the removal of apparatus from service when they are deemed to be unsafe. **Once deemed unsafe, or even potentially unsafe, remove the apparatus from service until appropriate repairs are made.**

Personnel with appropriate training and certifications must perform repairs. NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, is one source of direction on requirements for fire apparatus mechanics. Test major components of fire apparatus, such as fire pumps or aerial devices, according to the appropriate NFPA standard before placing them back in service.

Figure 5.15 — Investigate all collisions thoroughly. (Photo/Mike Mallory, Tulsa, Oklahoma Fire Department)

Departments/Agencies should conduct a formal review of all collisions **(Figure 5.15)**. Much can be learned from reviewing previous incidents with incurred losses. A department/agency must be diligent in thoroughly investigating all crashes and struck-by incidents that involve their vehicles to identify the circumstances and causes surrounding these incidents.

Departments/Agencies should have formal procedures for handling these investigations. There are a number of important things to consider. First is the associated liability. Conduct investigative procedures with consideration for the protection of the department/agency and individuals involved. Another issue is objectivity, as seen both from within and outside the organization. Even the appearance of nonobjectivity can have major consequences for all those involved. Therefore, it is common in many jurisdictions to involve or have an outside entity take the lead in the investigation. For example, fire departments and EMS agencies should allow the appropriate law enforcement agencies to perform their duties as required by statute. Consider asking representatives from outside the involved fire department/EMS agency to provide an objective review of the incident.

Each law enforcement agency should have a policy on how it handles crashes involving its vehicles. While some agencies handle these investigations internally, others seek outside law enforcement assistance to conduct the formal investigation. For example, if a municipal or county law enforcement officer is involved in an incident, the state police may be asked to take over the investigation. Even if an outside agency is assigned to formally investigate a collision, an internal review is still needed to identify any corrective measures that must be undertaken. Appropriately review and store data collected from any investigation. It can be invaluable in identifying addressable patterns or issues to reduce the chances of future similar incidents.

It is also important to document poor driving performance on an individual basis. In many cases, the behavior was most likely exhibited in the past. Supervisors must observe, document and correct deficiencies; discipline policy violations; and be held accountable if they do not.

It is important that the department/agency establish a culture and send a message that reckless behaviors and failure to follow safety procedures are not acceptable and will not be overlooked or tolerated. Avoidable crashes are not acceptable and members will be held accountable as such. There can be no compromise when it comes to issues of safety.

Personal Responsibilities

All of the response and roadway scene safety policies and SOPs in the world will be of little use or help if personnel fail to abide by them. The most basic responsibility of any emergency responder is to first account for his or her own safety and well-being. Failing to operate within the manner trained and within established SOPs of the department/agency is counteractive to personal safety.

Each member must hold himself or herself and the members he or she works directly with accountable for following established safety procedures at all times. If everyone does the right thing all of the time, there is little else to do. However, when someone begins to operate beyond the bounds of safe practice, the other members who observe this behavior must seek to bring the member back in line. The "good old boy" way of overlooking, or even validating, unsafe behavior is a culture that can no longer be tolerated. Members must have the courage (and the backing of their department/agency) to stand up and stop unsafe behaviors that they observe.

It cannot be overemphasized that the level of personal wellness and fitness plays an important role in this issue. Many cases can be cited where a responder suffered a medical emergency, such as a cardiac event, while operating the vehicle that led to a serious crash. Personnel who are in poor physical condition are less apt to move well in critical situations to avoid hazards when working on the roadway. It is every responder's personal responsibility to maintain an acceptable level of wellness for the job he or she is performing. While some medical emergencies may occur regardless of the level of fitness and wellness, those chances are greatly reduced when the responder is healthy and fit. All emergency personnel must take responsibility for living a healthy lifestyle and maintaining an appropriate level of fitness.

Summary

Using safe procedures for operating emergency vehicles and working at roadway incident scenes is everyone's responsibility. The department/agency administration and each individual member play important parts in this overall responsibility. The failure of any of those parts to function responsibly by operating outside the bounds of safe practice is unacceptable and intolerable. All must work together to ensure maximum member safety.

Chapter 6
Improving Response-related Safety: External Factors

Introduction

This chapter focuses on aspects related to response safety that are external to the daily workings of a department. The topics of this chapter are the DOT ITS, traffic signal pre-emption systems, Traffic Management Centers (TMCs), and the use of private vehicles to respond in an emergency mode.

DOT Intelligent Transportation Systems Program

For several years, the DOT has been engaged in a program titled ITS. The goal of ITS is to improve transportation safety and mobility and enhance productivity through the use of advanced communications technologies. There are nine major initiatives within the ITS program. They include:

- Vehicle Infrastructure Integration (VII).
- Next Generation 9-1-1 (NG9-1-1).
- Cooperative Intersection Collision Avoidance Systems.
- Integrated Vehicle Based Safety Systems.
- Integrated Corridor Management Systems.
- Clarus, the Nationwide Surface Transportation Weather Observing and Forecasting System.
- Emergency Transportation Operations.
- Mobility Services for All Americans.
- Universal Electronic Freight Manifest.

Much work has been done within the ETO section of ITS relative to the safety of firefighters and other first responders who are working on the roadway. One of the concepts being studied in this part of the project is the use of TIMS to reduce the effects of incident-related traffic congestion by decreasing the time necessary to detect incidents, the time for responding vehicles to arrive and the time required for traffic to return to normal conditions. TIMS contributes to increasing emergency responders' safety at an incident scene both directly and indirectly.

Though many of the findings and features of the overall ITS project are not directly related to issues that emergency responders will work with or even be concerned about, they have a direct, positive impact on the safety of emergency responders who work on the roadway. The first portion of this chapter discusses some of these projects. This information is based on the FHWA's "Intelligent Transportation Systems Benefits and Costs, Deployment, and Lessons Learned Desk Reference: 2011 Update" (http://www.itskr.its.dot.gov/its/benecost.nsf/files/BCLLDepl2011Update/$File/Ben_Cost_Less_Depl_2011%20Update.pdf).

Much of what emergency responders need to know about traffic control and safe operations on the highway is contained in a DOT document titled MUTCD. The relevant contents of this manual will be covered in detail in Chapter 7.

Traffic Surveillance Technology

Figure 6.1 — Traffic control centers have myriad equipment used to monitor traffic and road conditions. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

A variety of surveillance and detection technologies that can help identify incidents quickly include inductive loop, microwave, acoustic vehicle detectors and camera systems providing video surveillance of roadways monitored by operators **(Figure 6.1)**. These technologies monitor traffic flow, detect deviations in traffic patterns, feed information to a traffic management center, and notify responders of traffic conditions along the way or the best route to approach the scene.

Information from wireless enhanced 911 systems, Mayday and automated collision notification (ACN) systems, as well as roadside call boxes can also help incident management personnel identify incidents quickly. Mobilization and response may include automated vehicle location (AVL) and computer-aided dispatch systems, as well as response routing systems to help incident response teams arrive swiftly. According to the FHWA, in 2011, 80 percent of emergency response vehicles in major metropolitan areas operate within a computer-aided dispatch system.

Mayday and Automatic Collision Notification Systems

Collision notification systems detect and report the location and severity of incidents to agencies and services responsible for coordinating appropriate emergency response actions. These systems can be activated manually (Mayday) or automatically with ACN to establish wireless data and voice communications with call centers that relay information to emergency response services. Data transmitted typically include vehicle location and the description and nature of the emergency. More advanced ACN systems use in-vehicle crash sensors, Global Positioning System (GPS) technology and wireless communication systems to automatically determine the severity, location, condition and orientation of vehicles involved in a crash, and communicate this information to emergency responders. With advanced ACN, responders can determine the type of equipment needed in an emergency (basic services or ALS), mode of transport (air or ground), and the location of the nearest trauma center.

Currently, over a dozen commercial Mayday/ACN products are available. Many of these products are available as factory-installed options on high-end luxury cars; others are installed as after-market products. The typical Mayday/ACN product utilizes location technology, wireless communication and a third-party response center to notify the closest public safety answering point (PSAP) for emergency response. The cost of ACN devices ranges from approximately $400 to $1,900. These units appear to hold a great deal of promise in improving incident reporting and thus emergency response. However, there is a fee for the service, ranging from $10 to $27 per month. If the fee has not been paid, the ACN will be inactive.

Studies estimate that ACN systems can reduce road traffic deaths by 1.5 to 15 percent. In trauma care, seriously injured patients who arrive at an operating room of a trauma center within the first 60 minutes after a crash have a much greater chance of survivability compared to those who arrive within 90 minutes. In rural areas, timely notification, response and decisions regarding medical care prior to transport can save lives.

A study of the population with BMWs in service in Florida from 2006-2008 involved in crashes severe enough to trigger the ACN found that the ACN provided an initial crash notification and also transmitted data on the severity of the event. The ACN data correctly identified 75.9 percent of seriously injured occupants as seriously injured. Extrapolating the findings to population-based statistics indicates that implementing an enhanced ACN in all passenger vehicles in the U.S. would improve outcomes for 15,200 drivers involved in moderate to severe crashes each year.

Intelligent Vehicles

In-vehicle applications of ITS use vehicle-mounted sensors and communications devices to assist with the safe operation of vehicles, prevent crashes and mitigate the consequences of crashes that do occur. Collision avoidance systems monitor a vehicle's surroundings and provide warnings to the driver regarding dangerous conditions that may lead to a collision. Driver assistance systems provide information and, in some cases, assume partial control of the vehicle to assist with the safe operation of the vehicle. With the aim of speeding aid to victims after a crash occurs, collision notification systems alert responders when a crash occurs, with more advanced systems providing additional information on crash characteristics that can aid medical personnel.

Freeway Service Patrols

Service patrols, which preceded the emergence of ITS technologies, are now frequently incorporated into TIM programs. The patrol vehicles and staff, supported by an array of other ITS components, enable significant reductions in response time and incident clearing time. Freeway service patrols operate in many major metropolitan areas, as well as some suburban and rural areas. These are often state DOT programs and consist of a fleet of light-duty trucks that have two-way radio communication with a traffic management center and are usually equipped with motorist assist supplies, traffic cones, a lighted vehicle arrow board, and, in some cases, extendable floodlights **(Figure 6.2)**.

Figure 6.2 — Many transportation agencies operate motorist assist patrol vehicles to lessen the risks to disabled motorists. (Photo/Jack Sullivan)

While the primary focus of these units is to monitor roadway conditions and assist disabled motorists, they are also typically dispatched to roadway emergency incidents to assist other emergency responders with traffic control. Depending on local protocols, dispatch of these units may be automatic or by request of the IC or law enforcement personnel.

State DOT representatives should be included as part of the TIM team. They are critical to identifying criteria and SOPs for incorporating DOT resources into roadway scene responses. Including service patrols in responses, where available, not only aids in traffic control, but also helps reduce incident-related traffic delays.

Next Generation 9-1-1

The current 911 system is designed around telephone technology and cannot handle the text, data, images and video that are increasingly common in personal communications and critical to future transportation safety. Although this system has been an unqualified success for over 40 years, the growing market for wireless and Voice over Internet Protocol (VoIP) telephony and the increasingly nomadic world they reflect are contributing to greater expectations for connections than the existing 911 system can deliver.

Next Generation 9-1-1 (NG9-1-1) systems can offer broader coverage and increased functionality using an Internet Protocol (IP) based approach. A wide variety of communication devices (wired, wireless or Internet) can be supported by NG9-1-1 enabling voice, data and video to be transmitted to public safety answering point (PSAP) dispatch centers and trauma centers simultaneously. With real-time detailed information available on crash characteristics, emergency responders and trauma centers can prioritize response actions and promptly transport victims to prepared medical facilities.

To date, the NG9-1-1 initiative has:

- Developed a next-generation 911 engineering architecture that allows for connections to a wide range of new technologies.
- Developed emergency call center receiving software and software screens for operators to record information in files that can be easily distributed to and accessed by other stakeholders involved in the emergency response.
- Developed a set of point of contact (POC) test scenarios for laboratory tests for the most complex aspects of the NG9-1-1 architecture and the new call technologies as well as for PSAP tests for demonstrating the ability to receive, process and send calls. The sites are:
  - King County E-911 System, Seattle, Washington.
  - Montana Public Safety Services Bureau, Helena, Montana.
  - Rochester, New York Emergency Communications Department.
  - Ramsey County Metropolitan Emergency Services Board, St. Paul, Minnesota.
  - Indiana Office of the State Treasurer, Indiana Wireless 911 Board, Kosciusko County, Indiana.
  - Coordinated engagement on standards across the nation and with other emergency service network providers within North America (Canada and Mexico).
  - Tested transmission and receipt of calls under real-world conditions, sending test 911 calls through PSAPs.

Transition to NG9-1-1 is expected to be an evolutionary process, involving technological, economic and institutional change. In some cases, NG9-1-1 implementation will depend on the underlying infrastructure and state of the PSAP and 911 authority. In other cases, the transition may depend on the ability of service networks to deliver NG9-1-1 calls via IP-based infrastructure. The Final Transition Plan identifies the potential for multiple approaches to nationwide deployment. Most deployments of NG9-1-1 will probably fall between the two extremes identified in the plan:

- **Coordinated, Intergovernmental Approach:** Planned and coordinated deployments of NG9-1-1 capabilities that are governed by statewide or regional 911 authorities or by informal mechanisms that enable a cooperative deployment.
- **Independent, Unilateral Approach:** Decentralized deployments by local jurisdictions through independent initiatives.

The cost, value and risk of implementing NG9-1-1 have been evaluated by the DOT on a national scale and published in a series of reports. For more information, please visit the ITS Joint Program Office's (JPO's) website: http://www.its.dot.gov/NG911/index.htm. The NG9-1-1 initiative end-products, including the Final System Design, Final Transition Plan, and Procurement Toolkit, are being transitioned to the National 9-1-1 Office housed within NHTSA.

Dynamic (Changeable) Message Signs

Dynamic Message Signs (DMS) are permanent **(Figure 6.3)** or portable electronic traffic signs that allow operators to give travelers information on traffic conditions, incidents, weather, construction, safety and special events. DMS are becoming more common on the nation's freeways and extending to arterial systems. For example, the percentage of arterial management agencies that deployed video imaging detector systems (VIDS) and Dynamic Message Systems from 2007 to 2010 more than doubled. According to the DOT RITA, DMS are second only to collision avoidance technology in the number of safety benefits.

Figure 6.3 — Changeable message signs give specific directions to approaching motorists. (Photo/Ron Moore, Plano, Texas)

DMS provide a versatile means of communicating information to drivers and can be invaluable in alerting oncoming traffic to an emergency incident. In some locations, incident management personnel can directly post incident-related information to roadside traveler information devices such as DMS or highway advisory radios (HARs). On-site or transportation management center-based personnel can also relay messages to traveler information, freeway management, or arterial management systems, providing incident information to travelers via additional means, including 511 systems and traveler information websites. When transportation management center-based personnel are not on-site, emergency responders should be familiar with the procedures for contacting the agency that controls those technologies within their jurisdiction.

For DMS to be useful, the message must be concise and clear. DMS used on roadways with speed limits of 55 mph or higher should be visible from 1/2 mile under both day and night conditions **(Figure 6.4)**. The message should be designed to be legible from a minimum distance of 600 feet for nighttime conditions and 800 feet for normal daylight conditions. When environmental conditions that reduce visibility and legibility are present, or when the legibility distances stated in the previous sentences in this paragraph cannot be practically achieved, messages composed of fewer units of information should be used and consideration should be given to limiting the message to a single phase.

Figure 6.4 — Changeable message signs alert motorists to hazardous road conditions.

Each message shall consist of no more than two phases. Each phase shall consist of no more than three lines of text. The minimum time that an individual phase is displayed should be based on one second per word or two seconds per unit of information, whichever produces a lesser value. The display time for a phase should never be less than two seconds. The maximum cycle time of a two-phase message should be eight seconds.

Messages should be concise and clear and provide relevant information. All messages are printed in capital letters. The average driver traveling at a high rate of speed can handle eight-word messages of four to eight characters per word at two to four seconds per message. The message should consist of at least the problem and action and may contain an effect. For example, let us say that the problem is an accident two miles ahead in the right lane. Drivers should expect delays and merge left. A two-panel changeable message sign might read:

> Panel 1: Accident AHEAD two miles
> Panel 2: Merge Left Expect Delays

> A one-panel sign might read: ACCIDENT TWO MILES MERGE LEFT

Portable changeable message signs should be visible from 0.5 miles under both daytime and nighttime conditions. Letter height should be a minimum of 18 inches and legible from at least 650 feet if the sign is mounted on a trailer or large truck. If mounted on service patrol trucks, letter height should be a minimum of 10 inches and visible from at least 330 feet **(Figures 6.5a and 6.5b)**.

Figures 6.5a and 6.5b — A vehicle-mounted changeable message sign. (Photo/Ron Moore, Plano, Texas)

Traffic Signal Pre-emption Systems

Traffic signal pre-emption is a system that allows the normal operation of traffic lights to be pre-empted. When activated, the traffic signal pre-emption device will cause properly equipped traffic lights in the path of the vehicle to cycle immediately to grant right-of-way in the desired direction after allowing for normal programmed time delays for signal changes and pedestrian crosswalks to clear. Providing the right-of-way to emergency vehicles helps reduce response times and enhances traffic safety. Traffic signal pre-emption devices are frequently integrated with the vehicle's emergency warning lights.

Implementation

Traffic signal pre-emption devices are implemented in a variety of ways. They can be installed on the vehicles or operated by remote control from a fixed location, such as a fire station, or by a 911 dispatcher at an emergency call center. To be controlled by any system, traffic lights must be equipped to receive an activation signal. A traffic signal not equipped to receive a traffic pre-emption signal will not recognize activation and will continue to operate in its normal cycle.

Fixed-location systems can vary widely, but a typical implementation is a single traffic signal in front of or near a fire station to stop traffic and allow emergency vehicles to exit the station unimpeded. Alternatively, an entire corridor of traffic signals along a street may be operated from a fixed location to allow fire apparatus to quickly respond through a crowded downtown area or to allow an ambulance faster access when transporting a critical patient to a hospital in an area with dense traffic.

Traffic signal pre-emption systems sometimes include a method for communicating to the operator of the vehicle that requested the pre-emption (as well as other drivers) that a traffic signal is under control of a pre-emption device. This notifier device is almost always an additional light located near the traffic signals. It may be a single light bulb visible to all, which flashes or stays on, or there may be a light aimed in each direction from which traffic approaches the intersection. In the case of multiple notifier lights at a controllable intersection, they will either flash or stay on, depending on the local configuration, to communicate to all drivers from which direction a pre-empting signal is being received. This informs civilian drivers which direction may need to be cleared, and informs activating vehicle drivers if they have control of the light. This is especially important when multiple emergency vehicles attempting to activate signal pre-emption approach the same intersection from different directions. There are variations of notification methods in use, which may include one or more colored lights in varying configurations. However, a typical installation would provide a flashing notifier to indicate that an activating vehicle is approaching from ahead or behind, while a solid notifier would indicate that the emergency vehicle is approaching laterally.

Vehicular Device Types

Acoustic

Some systems use an acoustic sensor linked to the pre-emption system. This can be used by itself or in conjunction with other systems. Systems of this type override the traffic signal when a specific pattern of tweets or wails from the siren of an emergency vehicle is picked up. This type of system is fairly inexpensive to integrate into existing traffic signals and allows the use of siren equipment already installed in emergency vehicles. A major disadvantage is that sound waves can easily be reflected by buildings or other large vehicles present at or near an intersection, causing the "reflected" wave to trigger a pre-emption event in the wrong direction. Reflected waves can also create unnecessary collateral pre-emption events along side streets near the emergency vehicle's route and acoustic sensors can sometimes be sensitive enough to activate the pre-emption in response to a siren from too far away.

Line-of-sight

A vehicle that utilizes a line-of-sight traffic signal pre-emption system is equipped with an emitter that typically sends a narrowly directed signal forward, toward traffic lights in front of the vehicle, to attempt to obtain right-of-way through controllable intersections before arriving at the intersection **(Figure 6.6)**. These line-of-sight systems generally utilize an invisible infrared signal, or a visible strobe light. Line-of-sight emitters can use infrared diodes. They are pulsed with a low-priority signal (10 hertz) or a high-priority signal (14 hertz).

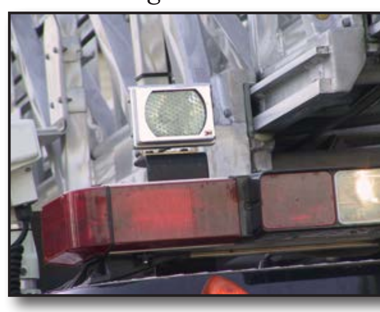


Figure 6.6 — Emergency vehicle may be equipped with emitting devices that trigger a sensor on approaching traffic signals to grant the emergency vehicle the right-of-way. (Photo/Mike Wieder)

The emitter transmits visible flashes of light or invisible infrared pulses at a specified frequency. Traffic lights must be equipped with a compatible traffic signal pre-emption receiver to respond. Once the vehicle with the active emitter has passed the intersection, the receiving device no longer senses the emitter's signal, and normal operation resumes. Some systems can be implemented with varying frequencies assigned to specific types of uses, which would then allow an intersection's pre-emption equipment to differentiate between a fire engine, ambulance or law enforcement vehicle sending a signal simultaneously, while others respond only to the first vehicle to activate the pre-emption device. Therefore, an emergency vehicle should not assume that just because a green light was not activated that the system is not working. Approach the intersection with caution and come to a complete stop.

Drawbacks of line-of-sight systems include:

- Obstructions.
- Lighting and atmospheric conditions.
- Undesired activations.

Buildings on a curving road block visual contact with a traffic signal until very close, or a large truck in front of a police car can block the traffic signal from receiving the emitter's signal from the police car. Direct sunlight into a receiver may prevent it from detecting an emitter or severe atmospheric conditions, such as heavy rain or snow, can reduce the distance at which a line-of-sight system will function. Undesired activations may occur if an emitter's signal is picked up by many traffic lights along a stretch of road, all directed to change to green in that direction, prior to the activating vehicle turning off the road, or being parked without its emitter being deactivated.

Global Positioning System

GPS requires software and a communications platform to determine where the activating vehicle is located, in which direction it is heading, and which traffic lights will be pre-empted, as well as for the central application to be able to activate the desired traffic lights promptly.

Drawbacks of GPS systems include:

- Obstructions.
- Single point of failure exposure.
- Atmospheric conditions.
- GPS satellite availability.

In dense cities with tall buildings, GPS receivers may have difficulty obtaining the required GPS satellite signals for triangulation to determine location. If the primary application is not installed with redundant hardware, a single failure on the primary system controller can disable all traffic pre-emption functions within the entire traffic network covered by the GPS-based system. Extremely heavy cloud cover or severe weather can also adversely impact the ability of the GPS receiver from obtaining the required satellites. Additionally, recent concerns about the health of the GPS satellite network raise the possibility that the reliability of the GPS satellite system may degrade in the future.

Localized Radio Signal

Radio-based traffic pre-emption systems using a local, short-range radio signal in the 900 megahertz (MHz) band can usually avoid the weaknesses of line-of-sight systems as well as GPS systems. A radio-based system still utilizes a directional signal transmitted from an emitter, but being radio-based, its signal is not blocked by visual obstructions, lighting or weather conditions.

Radio-based systems offer the additional benefits of adjustable range and collision avoidance. The operating range can be adjusted by varying the radio signal strength so that traffic lights are activated only nearby or at greater distances. The hardware utilized by radio-based systems and installed on a vehicle is also capable of interacting with other equipped vehicles, primarily for the purpose of providing collision avoidance warnings when two or more vehicles approach each other while operating their pre-emption systems.

Traffic Management Centers

Figure 6.7 — Many transportation agencies operate sophisticated traffic management control centers, such as this one for the Pennsylvania Turnpike Commission. (Photo/Pennsylvania Turnpike Commission)

TMCs monitor traffic signals, intersections and roads, and proactively deploy traffic management strategies to reduce congestion and coordinate state and local authorities during special events, emergencies, or daily stop and go traffic. TMCs are the nerve centers of highway monitoring and operations **(Figure 6.7)**. TMCs operate 24 hours a day. Operators monitor cameras, sensors and other technology to alert the proper authorities and approaching drivers about problem areas, reducing crashes and saving drivers' time, money and fuel. TMCs also:

- Coordinate activities with state DOT incident response teams which help stranded drivers, move disabled vehicles and keep traffic moving safely, while emergency responders help people involved in accidents.
- Coordinate highway incident response with law enforcement and other emergency response crews.
- Are often a critical component of a coordinated response to emergencies and disasters anywhere in the state.

In some areas, TMCs reach across city boundaries in a large urban area to collect information on the entire road network. Representatives of law enforcement, fire and EMS, and local transit agencies may also be collocated at TMCs in order to improve multiagency response. TMCs use a variety of technologies to monitor traffic conditions, alert authorities and drivers, and respond to a variety of conditions.

Closed Circuit Television Camera Surveillance

Closed Circuit Television (CCTV) surveillance allows real-time monitoring and evaluation of traffic conditions and can confirm data from other modes of monitoring, such as sensors, to verify incidents and monitor congestion.

Roadway Weather Information System

Roadway Weather Information System (RWIS) is a collection of pavement and atmospheric sensors that monitors and identifies weather-related events that could affect roadway traffic conditions. This sophisticated system can respond automatically by applying anti-icing chemicals to the roadway and activate other information devices (DMS, etc.).

Reversible Lane Systems

Reversible lanes maximize the use of roadways by changing the direction of individual lanes of traffic in response to traffic demands. Lane control signs are displayed well in advance of merging lanes and control the opening and closing of lanes to adapt to increasing and decreasing traffic volume.

Dynamic Message Signs

These programmable road signs provide current traffic information and assist law enforcement as part of the Amber Alert System. The signs alert motorists of incidents, providing information on what happened, where it happened and what to expect. This increases safety and allows the option for motorists to take alternative routes, if available.

Safe Operation of Privately Owned Vehicles

Many states allow volunteer emergency responders to equip their POVs with emergency lights or emergency lights and sirens to be used when responding to the station or an incident location. While many states allow this practice, there is no consistency or standardization of rules regarding this practice, past the requirement of permission from some authority (e.g., mayor, police chief, fire chief).

Acceptable color for emergency lights varies from state to state. Some states allow only red, some allow only blue and some allow both. Some departments may specify the color based on the rank held by the individual. For example, some departments allow only chief officers to use red lights, and other personnel use blue lights. In addition to different colors, states vary on placement of the lights (e.g., roof, grill) and type (e.g., rotating, wigwag, solid), as well as the use of sirens (e.g., sirens not allowed, sirens must be operating when lights are in use).

Table 6.1 provides an anecdotal breakdown of some known state requirements. The reader must keep in mind that this table was compiled from forum threads with information provided by members of different departments.

Each state determines specific licensing requirements for drivers. Most states do not require any special licensing or training to operate a POV under emergency response conditions. Some state laws do allow POVs responding to an incident to travel 5 to 10 mph over the posted limit. No state allows POVs to traverse an intersection in a negative right-of-way situation without coming to a complete stop.

Insurance is another factor that varies from state to state. Some states require private insurers to carry volunteer emergency workers, while some departments cover them when they are responding to or returning from a call. In other areas, insurance companies will cancel coverage if they find out a volunteer is using a POV equipped with warning devices.

With the lack of standardized requirements for operating POVs under emergency response conditions, it is not surprising that the only types of vehicles that account for more firefighter deaths than tankers/tenders are POVs. POV crashes are most common among volunteer firefighters and account for about 40 percent of all firefighter vehicle-related fatalities on an annual basis. It is incumbent on departments who allow members to respond in POVs with lights/sirens to ensure that SOPs address the manner in which that response must occur and the necessary training requirements.

The "Guide to IAFC Model Policies and Procedures for Emergency Vehicle Safety" suggests that before being allowed to operate a POV during emergency responses, department members must hold a current state-issued driver's license valid for the type/class of the member's POV and complete a state-approved EVOC. It is also critical that department SOPs specify and enforce that response in a POV follows all traffic laws, including speed limits and stopping at intersections. One only has to review the case histories to see the preponderance of speed and negative right-of-way incidents related to POVs.

Table 6.1. Lights and Siren Use on Privately Owned Vehicles by State

State	Firefighter Lights	Firefighter Sirens	EMS Light	EMS Siren
AL	N/A	N/A	N/A	N/A
AK	Blue	N/A	Blue	N/A
AR	Red, White, Yellow	Yes		
CA	Red	N/A		
CO	Red, Red/Clear	N/A		
CT	Blue, Red — Chief	N/A, Yes — Chief	Blue, Red — Chief	N/A, Yes — Chief
FL	Red/White	PA system	N/A	N/A
GA	Red, Red/Clear	Yes		
IL	Blue	N/A	N/A	N/A
IN	Blue	N/A	Green	N/A
IA	Red/Blue	N/A	Clear, White	N/A
KY	Red	Yes		
LA	Red	N/A		
MD	N/A	N/A	N/A	N/A
MA	Red	N/A		
MI	Red, Red/White	Yes	Red, Red/White	Yes
MS	Red, White	Yes		
MO	Blue	Yes		
MT	Red	N/A	Red	N/A
NE	Red/Blue	Yes		
NH	Red, Red/White	N/A		
NJ	Blue, Red — Chief	Yes — Chief		
NY	Blue, Red — Chief	Yes — Chief	Green	
NC	Red, Red/White	Yes — Chief		
OH	Red, Red/White	Yes		
OK	N/A	N/A	N/A	N/A
PA	Blue, Red — Chiefs	Yes — Chiefs	Blue, Red — Chiefs	Yes — Chiefs
SC	Red, Yellow/White			
TN	Red, Red/White	Yes	Red	Yes
TX	Red, Red/Blue	Yes		
UT	N/A	N/A		
VT	Red	Yes	Red	Yes
VA	Red	N/A		
WA	Green	N/A	Green	N/A
WV	Red/White	N/A	Blue/White	N/A
WI	Red, Red/White	Yes		
WY	Red	Yes		

www.firehouse.com/forums/t113094/ www.firehouse.com/forums/t33044/

Summary

The ITS has done a great deal to improve the safety of all drivers and to assist emergency responders in arriving both safely and expeditiously at an incident. TMCs are an excellent resource for helping to control traffic and expedite emergency responses. Departments/Agencies in areas with TMCs should establish a strong working relationship to develop coordinated, multiagency responses. Traffic pre-emption devices can provide an additional safety factor during emergency responses but must never be considered a replacement for approaching an intersection with caution and coming to a complete stop.

There is no standardization of laws regarding emergency response in a private vehicle. Although these responses occur primarily in volunteer services, all emergency agencies, including volunteer and career fire, EMS and law enforcement, should support the development of specific guidelines for emergency response in a private vehicle. In the interim, despite having no direct control of driving habits in private vehicles, departments must develop and enforce SOPs addressing the use of private vehicles in an emergency response mode, and provide training to improve driving skills in the private vehicle when responding with lights or lights and siren.

Chapter 7
Regulating Emergency Vehicle Response and Roadway Scene Safety

Introduction

In addition to the necessary department SOPs discussed in earlier chapters and state and local requirements, departments/agencies need to be aware of and conform to relevant standards related to emergency vehicle response and roadway scene safety. This chapter will focus on NFPA standards related to the fire service and the DOT MUTCD, which applies to all emergency disciplines.

National Fire Protection Association Standards

There are several NFPA standards that contain sections relevant to vehicle response and roadway safety. These standards are summarized as follows.

NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications*

This standard identifies the minimum job performance requirements for career and volunteer firefighters and fire brigade members who drive and operate fire apparatus. Requirements for all personnel include, but are not limited to:

- Being licensed to drive all vehicles that they are expected to operate.
- Having complete medical evaluations required by NFPA 1500 and NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments.*
- Remaining current with technology, practices, laws and standards.
- Successfully completing a road driving test specified by the standard, including turning, straightaways, intersections, railroad crossings, curves, limited access roadway and ramps, downgrade with downshifting, and upgrade with shifting.
- Demonstrating knowledge of laws, weight and height limits, control of liquid surge, brakes, and high center of gravity.
- Demonstrating the following driving skills:
  - Turning 180 degrees in a confined space.
  - Traversing a low overhead obstruction.
  - Backing.
  - Maneuvering in restricted spaces.
  - Turning 90 degrees into tight spaces.
  - Spotter signaling.
  - Avoiding obstructions **(Figure 7.1)**.
  - Defensive driving while maintaining control.
  - Operating all systems on vehicle, including passenger restraint devices.
- Demonstrating a knowledge of:
  - Operation under adverse weather conditions.
  - Other environmental or driving surface conditions.
  - Use of gauges and controls.
  - Skid control.
  - Night driving.

Figure 7.1 — A driver/operator must be able to maneuver around obstructions. (Photo/Jeff Fortney, Stillwater, Oklahoma)

- Passing a test on each specific type of apparatus that personnel will be driving during the course of their work.

The standard includes suggested exercises, practices, curricula, training design and evaluation suggestions. There are also examples of lesson plan construction along with step-by-step directions for performing and evaluating job performance requirements (JPRs).

NFPA 1091, *Standard for Traffic Control Incident Management Professional Qualifications*

This new standard was under development at the time of this report and is slated for release in 2015. The standard identifies the minimum JPRs to execute traffic control incident management activities. The requirements for personnel who respond to roadway incident to this new standard will likely include, but not be limited to:

- Demonstrate the appropriate use of:
  - PPE.
  - Warning signals.
  - Temporary traffic control devices **(Figure 7.2)**.
  - Flagging operations.
  - Sign placement.
  - Vehicle lighting.
- Conduct an initial size-up and establish command of a roadway incident, identifying incident location, potential hazards and needed resources, and communicate these specifics to responders and dispatch.
- Safely position vehicles on-scene to:
  - Protect responders and civilians **(Figure 7.3)**.
  - Not excessively impede traffic flow.
  - Provide access for later arriving vehicles.
  - Reduce the likelihood of secondary incidents.
- Establish a traffic incident management area that will protect responders and move traffic through and around the incident.
- Establish adequate warning for vehicles approaching the traffic queue to prevent secondary incidents **(Figure 7.4)**.
- Operate in the traffic incident management area so personnel can enter or exit emergency vehicles and work safely within the area with due regard for moving traffic as assigned tasks are performed.
- Operate as a member of a team within an ICS/Unified Command structure.

Figure 7.2 — Use extreme care when placing traffic control devices on an active roadway. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.3 — Use emergency vehicles to block incident activities from approaching traffic. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.4 — The advanced warning area provides a measure of security for the incident work area. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

- Identify, deny access to, and direct to a safe location nonauthorized people found near or within a traffic incident management area.
- Assess the effectiveness of ongoing temporary traffic control measures and report through the chain of command.
- Adapt the traffic incident management area in response to a special hazard.
- Perform traffic control incident management area demobilization functions, ensuring that all TTC devices are removed and all resources and personnel are cleared from the scene.

This standard stresses the need for ongoing training and continuing education to ensure that responsible personnel remain current in the ever-changing field of traffic control incident management.

NFPA 1451, *Standard for a Fire and Emergency Services Vehicle Operations Training Program*

This standard outlines the minimum requirements for a fire service vehicle operations training program. Requirements of this standard include, but are not limited to:

- Members shall be trained to operate specific vehicles or classes of vehicles before being authorized to drive or operate such vehicles.
- Training:
  - Frequency shall be at least twice a year.
  - Must be hands-on.
  - Must formally address all changes in procedures or technology.
  - Must formally introduce new or unfamiliar vehicles with manufacturer information, technical limitations and differences from former apparatus.
  - Must emphasize defensive driving in all conditions.
  - Instills SOPs, limits and laws for responses to nonemergency incidents.
  - Covers standards for off-road driving **(Figure 7.5)**.
  - Demonstrates hazards of special units.
  - Clarifies auxiliary braking devices.
  - Explains hazards of retarders.
- Instructors shall meet qualifications for Instructor I NFPA 1041, Standard for Fire Service Instructor Professional Qualifications.
- All aspects of the training must be monitored to ensure safety, including:
  - A lesson plan and field training area review prior to training.
  - Safety officer monitoring during an exercise to alert instructors or halt exercises.
  - A qualified driving instructor supervising each vehicle.
  - Securing the area, ensuring that it is free from nonparticipating vehicles, observers and nonparticipants **(Figure 7.6)**.

Figure 7.5 — Use extra caution when operating a vehicle off the road surface. (Photo/Mike Wieder)

Figure 7.6 — Perform driver training in a safe and secure area. (Photo/Mike Wieder)

- All drivers must:
  - Meet NFPA 1002 standards.
  - Demonstrate knowledge of Commercial Motor Vehicle Safety Act 49 CFR 383, 2003.
  - Have a CDL, if required.
  - Know all applicable laws.
- Drivers/Operators under the influence of alcohol or drugs are not permitted to drive or operate under any circumstances.
- Department/Agencies maintain complete training records and driving/operating records.
- Department/Agencies must have proper insurance for loss and liability for both training and operation.
- Department/Agencies must inform individuals of personal limits and liabilities.
- Department/Agencies must have a member assistance program.
- Department/Agencies must have written SOPs for vehicle operations and driver/operator requirement.

This standard also identifies requirements during emergency response, responsibilities of personnel on the apparatus, crash review procedure and vehicle and apparatus care. These include, but are not limited to:

- At no time shall driving regulations be less restrictive than state motor vehicle laws.
- Must-stop situations include:
  - Any "stop" signal, sign, light, traffic officer **(Figure 7.7)**.
  - Blind intersections.
  - Intersections where the operator cannot see all lanes of traffic.
  - School bus flashing lights.
  - Unguarded railroad crossings, gates, warning lights **(Figure 7.8)**.
- Maintain a safe driving distance.
- Pass with extreme caution.
- Move-ups or filling an empty station should be done in a nonemergency mode.
- Identify responses that should be nonemergency mode.
- Emergency response considerations balance:
  - Minimal travel time.
  - Optimal safety.
  - Minimal chance of emergency vehicles meeting at intersections.
  - Coordinating routes with other locations.
- Correct unsafe conditions immediately; document risk completely with safety officer.
- Driver/Operators shall not move fire department vehicles until all people on the vehicle are seated and secured with seatbelts in approved riding positions, except as specifically allowed in NFPA 1451, 8.3.3.

Figure 7.7 — Consider an unguarded railroad crossing sign and a signal to stop. (Photo/Mike Wieder)

Figure 7.8 — Use caution when approaching any railroad crossing, with or without crossing gates. (Photo/Mike Wieder)

- Exposed positions and standing are prohibited; all passengers must have a seat and seatbelt and remain secured until coming to a complete stop; unbelting or standing to don or doff clothing or equipment is not allowed.
- Members actively performing necessary emergency medical care while the vehicle is in motion shall be secured to the vehicle by a seatbelt, or by a safety harness designed for occupant restraint, to the extent consistent with the efficient provision of such emergency care.
- All agencies must have a crash investigation procedure that includes:
  - All rule/law/regulation violations being investigated and documented.
  - Action(s) taken to correct or prevent repetition.
  - Ensuring all information is covered in training.
  - Maintaining records.
- New equipment must meet standards for regular inspections, maintenance and repair, and complete records of all maintenance and repairs must be current.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*

First released in 1987, this standard outlines the minimum requirements for a fire department occupational safety and health program. Requirements in NFPA 1500 related to vehicle response and roadway scene safety include, but are not limited to:

- Fire department apparatus.
  - The fire department shall specify restraint devices for fire apparatus, including those restraint devices for EMS members operating in the patient compartment of the ambulance. NOTE: This is now addressed in NFPA 1917, and NFPA 1500 will no doubt be revised to match the requirements of NFPA 1917 **(Figure 7.9)**.
  - New fire apparatus shall meet specifications of NFPA 1901.
  - Apparatus are operated only with approved, trained drivers.
- Drivers/Operators of fire department apparatus.
  - Drivers/Operators are trained in compliance with NFPA 1451.
  - The AHJ posted a maximum speed limit on a placard on the dashboard, or manufacturer specified a maximum speed for tires that should be followed **(Figure 7.10)**.
  - The driver must possess a valid license for the class of vehicle being driven.
  - Fire department vehicles shall be operated in compliance with all applicable traffic laws, including special provisions pertaining to emergency vehicles as established by the AHJ, as well as specific rules, regulations and procedures adopted by the fire department.

Figure 7.9 — Use ambulance restraint systems when provided. (Photo/Mike Wieder)

Figure 7.10 — Post the speed limit on the dashboard or a plate elsewhere in the cab near the driver seat. (Photo/Mike Wieder)

- Pumpers and mobile water supply apparatus that do not have ABS and carry over 999 gallons of on-board water supply shall be operated in nonemergency mode at all times **(Figure 7.11)**.

Figure 7.11 — Older fire apparatus are not equipped with ABS. (Photo/Perkins, Oklahoma Fire Department)

- Drivers are responsible for safe and prudent operation; officers assume responsibility for the driver's actions.
- The driver/operator shall not move a fire apparatus until all people in the vehicle are seated and secured with seatbelts in approved riding positions, unless specifically allowed otherwise by the standard.
- Drivers of fire apparatus shall obey all traffic control signals and signs and all laws and rules of the road of the jurisdiction.
- The department shall develop SOPs for safely driving apparatus during nonemergency travel and emergency response and shall include specific criteria for vehicle speed, crossing intersections, traversing railroad grade crossings, the use of emergency warning devices and the backing of apparatus **(Figure 7.12)**.

Figure 7.12 — Use at least one backer when the apparatus is being moved in reverse. (Photo/Ron Jeffers, Union City, New Jersey)

- Bring the vehicle to a complete stop when required to by the standard. These situations include:
  - When directed by a law enforcement officer.
  - At red traffic lights.
  - At stop signs.
  - At negative right-of-way intersections.
  - At blind intersections.
  - When the driver cannot account for all lanes of traffic in the intersection.
  - When other intersection hazards are present.
  - When encountering a stopped school bus with flashing warning lights.
  - Unguarded railroad crossings **(Figure 7.13)**.

Figure 7.13 — A typical unguarded rail crossing, often found in rural areas. (Photo/Mike Wieder)

- Drivers shall proceed through intersections only when the driver can account for all lanes of traffic in the intersection.
- SOPs for POVs shall be at least equal to regulations for fire department vehicles, including use of lights and warning devices.
- Rules and regulations specify SOPs for emergency lighting and audible warning devices on POVs in compliance with laws of the jurisdiction.

- Riding in fire apparatus.
  - All occupants must be seated and belted the entire time the vehicle is in motion **(Figure 7.14)**.

Figure 7.14 — Occupants must be seated and belted when the vehicle is in motion. (Photo/Mike Wieder)

Figure 7.15 – Apparatus shall be placed to upstream side of the incident in a manner that reduces the chance of a vehicle being struck by oncoming traffic. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.16 – Place the first blocking vehicle about 50 feet behind the work area. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.17 – Traffic cones assist in guiding motorists away from the incident area. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.18 – Temporary traffic control signs should be pink in color. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 7.19 – Flares are highly visible at nighttime incident scenes. (Photo/Ron Moore, Plano, Texas)

  - Riders in unenclosed jump seats or tiller operator areas must also wear helmets and hearing and eye protection.
- Traffic incidents.
  - Each department shall establish, implement and enforce SOPs regarding emergency operations for traffic incidents.
  - Apparatus and warning devices shall be placed to take advantage of topography and weather conditions (uphill/upwind) and to protect firefighters from traffic.
  - Apparatus shall be placed to upstream side of the incident in a manner that reduces the chance of a vehicle being struck by oncoming traffic **(Figure 7.15)**.
  - When acting as a shield, apparatus warning lights shall remain on.
  - All additional responding vehicles, when arriving on the scene, shall be positioned beyond the traffic barrier unless their function requires placement before the barrier.
  - Apparatus shall be placed at an angle to the incident that maximizes safety.
  - The blocking apparatus shall be placed at least 50 feet downstream of the first operating unit to create a safe working area **(Figure 7.16)**.
  - One or more of the following warning devices shall be used to warn oncoming traffic of the emergency operations and the hazards to members operating at the incident:
    - Fluorescent and retroreflective warning devices such as traffic cones **(Figure 7.17)**.
    - FHWA-approved 48 inch by 48 inch retroreflective signs stating "Emergency Scene Ahead" (with directional arrow overlay) **(Figure 7.18)**.
    - Illuminated warning devices such as highway flares **(Figure 7.19)**.
    - Other warning devices appropriate to warn oncoming traffic of the emergency operations.
  - Warning devices shall be placed and utilized with proper considerations given to visual obstruction such as hills, curves, blind spots, or unusual localized weather conditions such as fog or rain.

- The first arriving unit shall ensure that traffic is controlled before addressing the emergency operations.
- Members shall position themselves and any victims in a secure area.
- Members shall park or stage unneeded fire apparatus and personal vehicles off the roadway whenever possible.
- When members are operating at a traffic incident and their assignment places them in potential conflict with motor vehicle traffic, they shall wear a garment that is constructed with high-visibility fluorescent and retroreflective material that is visible from all directions **(Figure 7.20)**.
- Members used for traffic control purposes shall receive training that is commensurate with their duties and in accordance with any applicable state and local laws and regulations.

Figure 7.20 — All responders working on or near the roadway must wear appropriate retroreflective vests or garments. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

NFPA 1917, *Standard for Automotive Ambulances*

This standard defines the requirements for new automotive ambulances designed to be used under emergency conditions to provide medical treatment and transportation of sick or injured people to appropriate medical facilities. The only requirements of this standard that apply directly to vehicle response safety are related to seatbelt application. They are:

- Seating at both the head of the cot and side seats must be adjustable to allow providers to deliver patient care while wearing seatbelts.
- Signs that read "Occupants Must be Seated and Belted When Ambulance is in Motion" shall be visible from each seated position.
- An occupant restraint warning system shall be provided for each designated seating position in the patient compartment.
- The warning system shall indicate if an occupant in the patient compartment is not belted or restrained.
- The warning system shall consist of an audible and visual warning device that can be heard and seen by the driver and seen by the occupants of the patient compartment.
- The warning shall be activated when the parking brake is released and the transmission is not in neutral or park.
- The warning system shall not show an affirmative indication unless it has determined that the seat was occupied before the seatbelt or restraint was buckled.

DOT "Manual on Uniform Traffic Control Devices"

The effective use of approved traffic control devices promotes highway safety and efficiency by providing for orderly movement of all road users. The MUTCD contains the basic principles that govern the design and use of traffic control devices for all streets and highways, regardless of the public agency having jurisdiction.

Temporary Traffic Control Zones

The MUTCD defines a TTC zone as:

> " … an area of a highway where road user conditions are changed because of a work zone, an incident zone, or a planned special event through the use of TTC devices, uniformed law enforcement officers, or other authorized personnel.

A work zone is an area of a highway with construction, maintenance, or utility work activities. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last TTC device.

An incident zone is an area of a highway where temporary traffic controls are imposed by authorized officials in response to a traffic incident. It extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where road users return to the original lane alignment and are clear of the incident.

A planned special event often creates the need to establish altered traffic patterns to handle the increased traffic volumes generated by the event. The size of the TTC zone associated with a planned special event can be small, such as closing a street for a festival, or can extend throughout a municipality for larger events. The duration of the TTC zone is determined by the duration of the planned special event."

The MUTCD refers to emergency scenes on the roadway as traffic incident management areas (TIMAs). That is, emergency responders need to be familiar with the MUTCD procedures for establishing TTC at TIMAs.

Advanced Warning Area

Most TTC/TIMAs are divided into four areas **(Figure 7.21)**. The advanced warning area is the section of highway where drivers are informed of the upcoming incident area. Because drivers on freeways are assuming uninterrupted traffic flow, the advance warning sign should be placed further back from the incident scene than on two-lane roads or urban streets. **Table 7.1** shows the stopping sight distance as a function of speed.

Table 7.1. Stopping Sight Distance as a Function of Speed

Speed (mph)	Distance (ft)
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
75	820

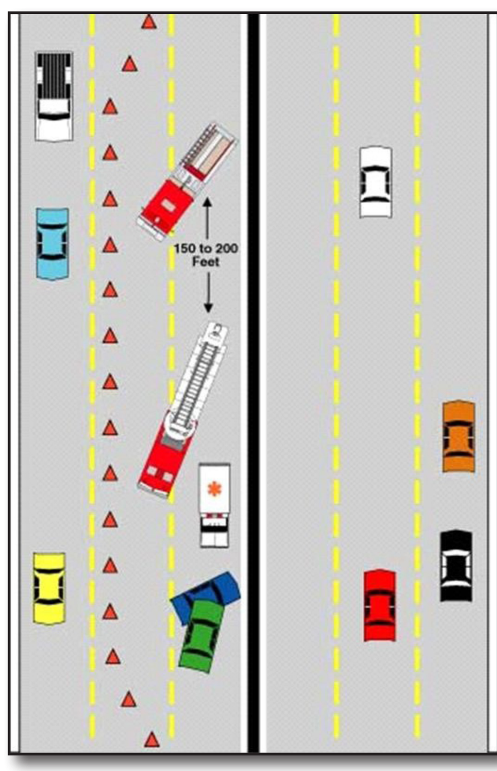


Figure 7.21 — The parts of a TTC zone.

Transition Area

The transition area is the section of the TTC zone where drivers are redirected from their normal path. This usually involves the creation of tapers using channelizing devices. Tapers may be used in both the transition and termination areas. The MUTCD designates the distance of cone placement to form the tapers based on the speed limit multiplied by the width of the lanes being closed off. This can be shown mathematically as follows:

TL = (LW x the number of lanes) x PSL

Where: TL = Taper length in feet

LW = Lane width in feet

PSL = Posted Speed Limit in mph

For example, suppose you are closing two lanes of an interstate highway whose speed limit is 75 mph. The lanes are 12 feet wide. In this example, the taper length would be calculated as follows:

TL = (LW x the number of lanes) x PSL

TL = (12 feet x 2 lanes) x 75 mph

TL = (24)(75)

TL = 1,800 feet

Activity Area

The activity area is the section of highway where the work activity or incident takes place **(Figure 7.22)**. It is made up of the work space, the traffic space, and the buffer space. The work space is where the actual work activity occurs. The traffic space is the portion of the roadway used to route traffic through the incident area. The buffer space is the lateral and/or longitudinal area that separates traffic flow from the work area. The buffer space may provide some recovery space for an errant vehicle. The MUTCD (Section 6C.06) specifically states that "neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space."

Figure 7.22 — Incident actions take place in the incident work zone. (Photo/Mike Wieder)

Termination Area

The termination area is used to return drivers to their normal path. It ends at the last TTC device. Conditions and safety considerations may dictate the need for a longitudinal buffer space between the work area and the start of the downstream taper.

Channelizing Devices

Channelizing devices are used to warn drivers of conditions created by incident activities in or near the roadway and to guide drivers around the incident. Channelizing devices used during an emergency incident can include signs, cones, tubular markers, flares, directional arrows and flaggers.

Signs

The MUTCD establishes specific color requirements for signs that will be used in different situations. The MUTCD (Section 6I.01) states that the required colors for warning signs used for TTC in TIMAs is fluorescent pink with black letters and border **(Figure 7.23)**. In emergency situations where fluorescent pink signs are not available, older style signs with yellow backgrounds may be used (Section 6F.16). However, it is recommended that as fire departments and other emergency response agencies replace old signs or purchase new signs, the new signs be of the pink with black letter type.

Figure 7.23 — An MUTCD-compliant temporary incident traffic sign. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

The MUTCD gives minimum direction on the required sizes for TTC signage. Where roadway or road user conditions require greater emphasis, larger than standard size warning signs should be used, with the symbol or legend enlarged approximately in proportion to the outside dimensions of the overall sign. Departments with limited resources are advised to acquire larger signs, such as 48 inches by 48 inches, as they are suitable for most any situation. When a series of two or more advance warning signs is used, the closest sign to the TTC zone should be approximately 100 feet off the ground for low-speed urban streets to 1,000 feet or more for freeways and expressways (Section 6F.17).

NFPA Standard 1500, which applies to fire service agencies, also requires that a retroreflective fluorescent pink highway safety sign be deployed as advance warning anytime a fire department vehicle is used in a blocking mode at a highway incident. NFPA requires the wording "Emergency Scene Ahead" for the sign **(Figure 7.24)**. This mirrors the MUTCD requirement.

Figure 7.24 — An Emergency Scene Ahead sign. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Cones

Traffic cones are perhaps the most commonly used channelizing devices. Cones must be predominantly orange and made of a material that can be struck without causing damage to the impacting vehicle. Cones should be weighted enough that they will not be blown over or displaced by wind or moving traffic. It is important to understand that MUTCD (Section 6F.64) requirements for traffic cones used during the day and on low-speed roadways (less than or equal to 40 mph) are different than for cones used at night and/or on freeways or high-speed roadways (greater than or equal to 45 mph).

For daytime and low-speed roadways, cones shall not be fewer than 18 inches in height. When used on freeways and other high-speed highways or at night on all highways, cones shall be a minimum of 28 inches in height. For nighttime use, cones shall be retroreflectorized or equipped with lighting devices for maximum visibility. Retroreflectorization of cones that are 28 to 36 inches in height shall be provided with a white band 6 inches wide located 3 to 4 inches from the top of the cone and an additional white band 4 inches wide located approximately 2 inches below the 6-inch band (Figure 7.25, p. 111).

Figure 7.25 — MUTCD-compliant traffic cones in use. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Retroreflectorization of cones that are more than 36 inches in height shall be provided by horizontal, circumferential and alternating orange and white retroreflective stripes that are 4 to 6 inches wide. Each cone shall have a minimum of two orange and two white stripes, with the top stripe being orange. Any nonretroreflective spaces between the orange and white stripes shall not exceed 3 inches in width.

Figure 7.26 – There are many locations on a vehicle for storage of traffic cones. (Photo/Mike Wieder)

The MUTCD does not specify whether the cones need to be of the solid or collapsible styles. Departments/Agencies may choose to equip their vehicles with collapsible cones, as they reduce the amount of required storage space. Some fire departments find unique, easily accessible locations to carry cones on the apparatus **(Figure 7.26)**. There are a variety of options that can be used to increase the effectiveness of the cones, particularly in low-light situations. Cones are available that illuminate from within or are equipped with light strips that encircle them. Cones may also be equipped with flashers attached to the tops **(Figure 7.27)**.

Figure 7.27 – Some traffic cones are equipped with battery-operated flashers. (Photo/Mike Wieder)

Flares

There are three basic types of flare devices that may be used in TTC zones.

Incendiary Flares

Some form of incendiary road flare has been used to alert drivers to dangerous conditions for almost 100 years **(Figure 7.28)**. Incendiary flares are self-sustaining. There are no concerns about battery life or corroding electrical parts. Incendiary flares burn at approximately 70 candela. By comparison, chemiluminescent light sticks are approximately 10 candela, and a typical flashlight is 5 candela.

Figure 7.28 – Incendiary flares are effective at nighttime operations. (Photo/Ron Moore, Plano, Texas)

There are several concerns with the use of incendiary flares. Incendiary flares are classified as a flammable solid and must be stored according to specific guidelines. The chemicals in standard incendiary road flares (strontium nitrate, potassium perchlorate and sulfur with a sawdust/oil binder) are hazardous substances. Exposure to the chemicals causes corrosive injury to the eyes and irritation to the skin and respiratory tract. Lit flares can cause skin burns and destroy clothing and vehicle tires. Incendiary flares cannot be used at scenes with fuel spills, hazardous materials, high-fire risk conditions, or during high-wind conditions. Cleanup is often required after use. Emergency personnel must ensure that all flares that may pose a continuing ignition source or traffic hazard are removed from the scene before responders depart.

Chemical Light Sticks

Chemical light sticks generate chemiluminescence in an enclosed container, making them suitable for use in hazardous environments. Two different types of chemicals (usually luminal and oxalate) are stored within two tubes, an outer one and an inner glass vial. These two tubes are stored in a transparent plastic container. The glass vial floats in the outer tube's chemical. When the outer tube is bent or broken and shaken, the chemicals combine and start to glow. Glow time is between six to 12 hours.

Chemical light sticks are inexpensive and easy to store and use. However, once they are activated, they cannot be reused. LED light sticks are a reusable alternative to chemical light sticks. They are battery-operated and will last about 20 hours if left on continuously, longer if turned on and off intermittently. Light sticks are not as bright as incendiary fuses or LED flares.

Light-emitting Diode Flare

These devices use LEDs to project an extremely bright light, visible 360 degrees from great distances. Depending on the manufacturer, the lights may be adjusted between a steady, flashing or rotating mode. One manufacturer has a mode that emulates the flicker of an incendiary flare. The rotating and flashing signals put out by these units are nonhypnotic and nondisorienting. These units come in a variety of configurations — some lie flat on the ground, some can sit on stands, and some come with a bracket that attaches them to the top of a traffic cone **(Figures 7.29a and 7.29b)**. Most use disposable or rechargeable AA or AAA batteries.

Figures 7.29a and 7.29b — LED flares do not present the fire hazard associated with incendiary flares. (Photo/Mike Wieder)

These units average approximately 90-100 hours of running time. They are sturdy, standing up to the weight of vehicle traffic, and weather proof.

Directional Arrow Boards

An arrow board is a sign with a matrix of elements capable of either flashing or sequential displays. Directional arrow boards can provide additional warning and directional information for merging and controlling drivers through or around a TTC zone. Directional arrow boards must be used in conjunction with other TTC devices such as channelizing equipment. There are four types of arrow boards. Type A is used on low-speed urban streets. Type B is used on intermediate-speed roadways and for maintenance or mobile operations on high-speed roadways. Type C is used in areas of high-speed, high-volume motor vehicle traffic. Type D is used on vehicles authorized by state or local authorities. Type A, B and C arrow panels shall be a solid rectangle. Type D shall conform to the shape of the arrow. All arrow panel boards shall be finished in nonreflective black. The minimum mounting height of an arrow is 7 feet from the roadway to the bottom of the board, except for vehicle-mounted boards, which should be as high as is practical.

Figure 7.30 — Some fire apparatus are equipped with lighted directional arrow or message signs. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

It is becoming increasingly common for fire departments to mount directional arrow boards on apparatus **(Figure 7.30)**. When contemplating this, it is important to review the MUTCD requirements in Section 6F.61 to ensure that the arrow boards are compliant. Arrow boards should be capable of operating in all of three modes:

- Flashing arrow, sequential arrow or sequential chevron.
- Flashing double arrow.
- Flashing caution or alternating diamond mode.

Figure 7.31 shows these modes. The board must be capable of at least a 50 percent dimming from full brilliance for use during nighttime operation in order not to adversely affect oncoming driver vision. The length of the arrow on apparatus-mounted boards must be 48 inches, and the width of the arrowhead must be 24 inches and must be visible at a minimum of 0.5 miles. It should be noted that many of the arrow boards and directional light bars currently located on apparatus do not meet this standard. If the arrowhead is not obvious to approaching traffic, it simply becomes another blinking yellow light. Although there is no specified height, vehicle-mounted arrow boards should be as high as is practical and have remote controls, and the vehicle must have high-intensity rotating, flashing, oscillating or strobe lights.

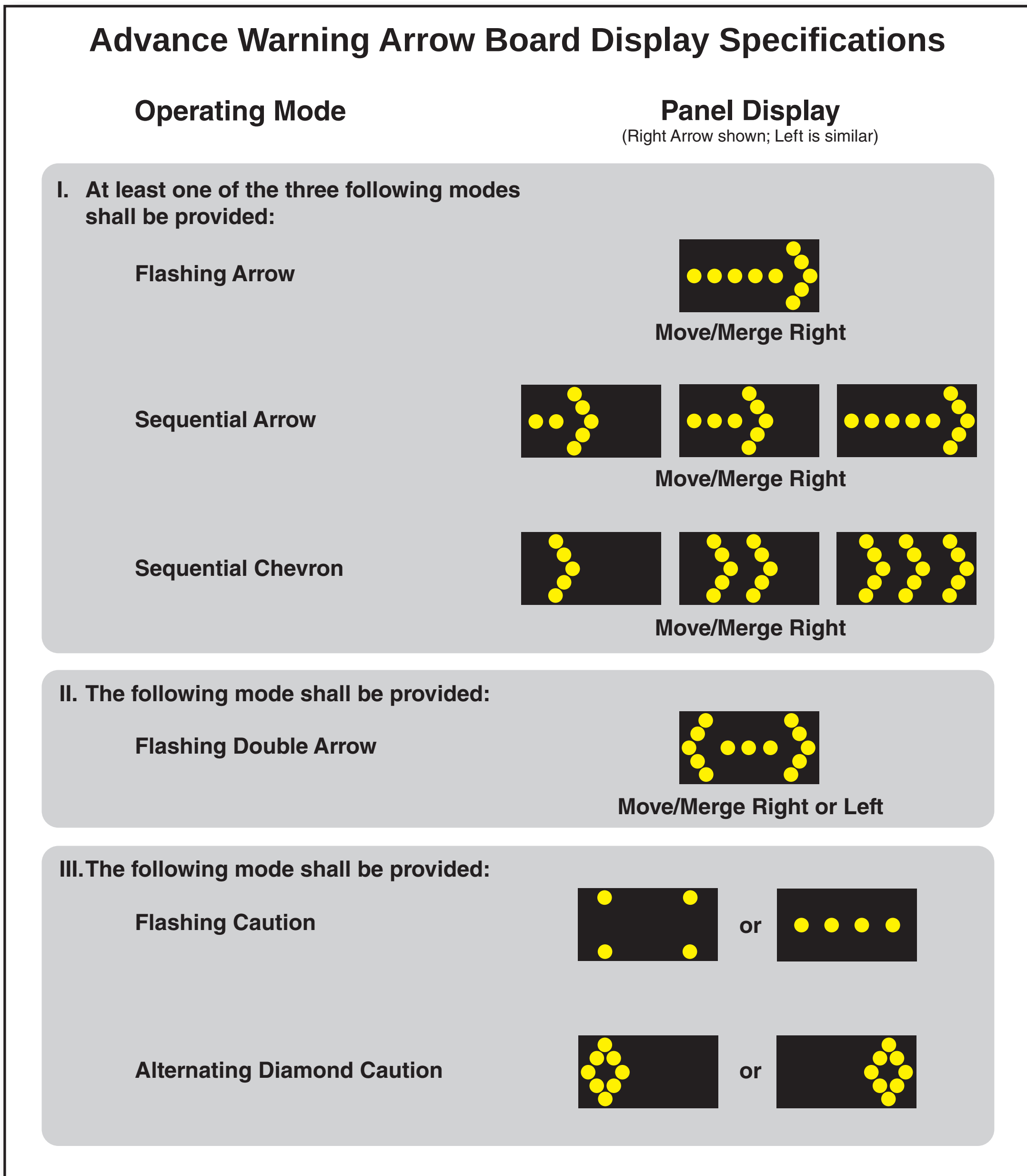
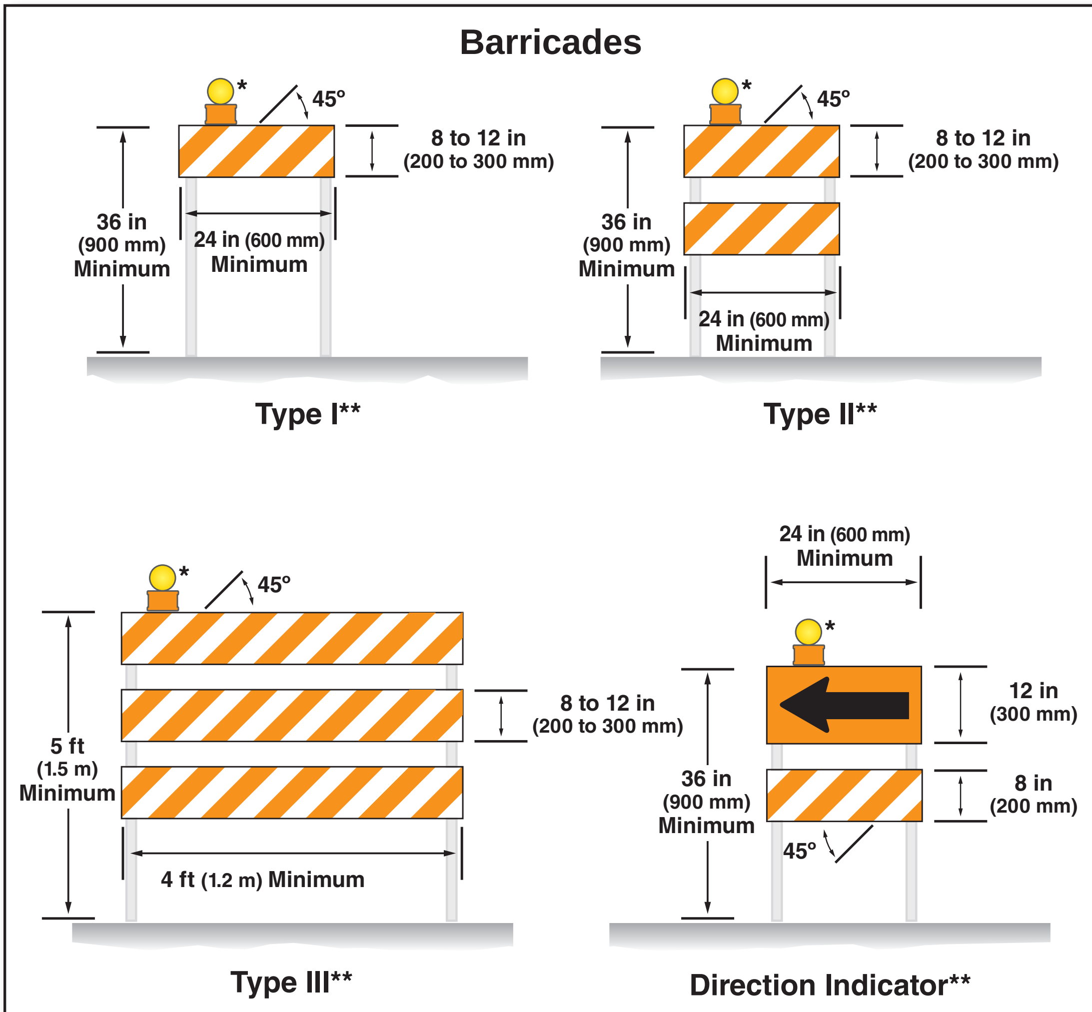


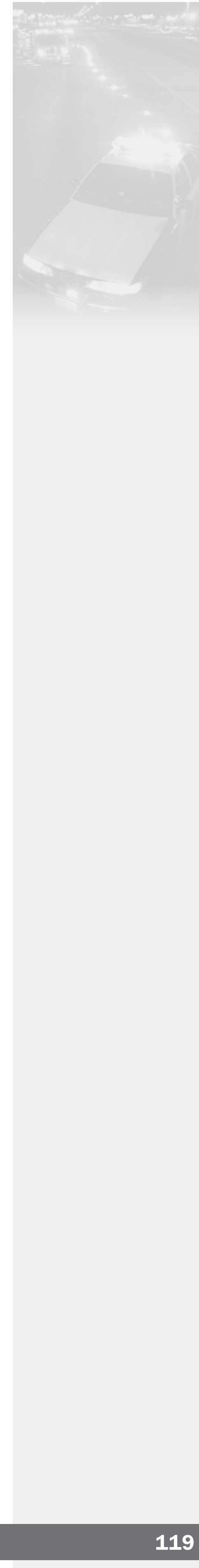
Figure 7.31 — This diagram shows various advanced directional arrow positions.



* Warning lights (optional)

** Rail stripe widths shall be 6 in (150 mm), except that 4 in (100 mm) wide stripes may be used if rail lengths are less than 36 in (900 mm). The sides of barricades facing traffic shall have retroreflective rail faces.

Figure 7.32 – The four types of barricades.



Barricades

Collisions involving multiple vehicles, collisions resulting in fatalities, or hazardous material spills may require a road closure. As part of an overall incident management plan, this type of incident would most likely involve the state DOT. Freeway patrol units would be able to provide initial traffic control, if available. Neither law enforcement vehicles, fire apparatus nor the freeway patrol units normally carry barricades. Thus, DOT resources would need to be dispatched to place barricades and other appropriate portable signs and TTC devices.

The MUTCD, Section 6F identifies four types of barricades **(Figure 7.32)**. Rail stripe width on all barricades 36 inches wide or over must be 6 inches. For barricades that are less than 36 inches wide, the rail stripe may be 4 inches. The side of the barricade facing traffic must have retroreflective rail faces. Warning lights on barricades are optional.

Flagger Control

In many situations, it will be necessary to use emergency personnel to assist in directing traffic at a roadway incident, especially early in the incident. A flagger is a person who manually provides TTC. According to the MUTCD Section 6E, a flagger is responsible for the safety of both emergency workers and the motoring public. Any person, including an emergency responder, who is assigned to direct traffic is considered a flagger and therefore must be trained and meet the MUTCD flagger requirements.

Figure 7.33 — Some fire departments operate fire police units that have vehicles designed specifically for traffic management functions. (Photo/Ron Jeffers, Union City, New Jersey)

Many volunteer departments on the East Coast of the U.S. use fire police to direct traffic at incident scenes. Fire police are members of the fire department who focus on providing roadway scene safety protection functions and crowd control at incidents. This includes directing traffic, setting up signs and other blocking equipment, and securing incident scenes. In some jurisdictions, they are formally sworn in by the municipality as reserve police officers. Occasionally, they operate apparatus specially equipped for traffic control **(Figure 7.33)**. In other jurisdictions, firefighters may be assigned traffic control duties. Regardless of who is assigned to direct traffic, it is important to review the MUTCD qualifications for flaggers. Flaggers should have the following abilities:

- Receive and communicate specific instructions.
- Move and maneuver quickly.
- Control signaling devices to provide clear and positive guidance to drivers.
- Understand and apply safe traffic control practices.
- Recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.

For daytime and nighttime activity, flaggers shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication titled "American National Standard for High-Visibility Apparel and Headwear" (see Section 1A.11) and labeled as meeting the ANSI 107-2004 standard performance for Class 2 or 3 risk exposure. The apparel background (outer) material color shall be fluorescent orange-red, fluorescent yellow-green or a combination of the two, as defined in the ANSI standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green or a fluorescent version of these colors, and shall be visible at a minimum distance of 1,000 feet. The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

In lieu of ANSI/ISEA 107-2004 apparel, public safety (law, fire, EMS) personnel within the TTC zone may wear high-visibility safety apparel that meets the performance requirements of the ANSI/ISEA 207-2006 publication titled "American National Standard for High-Visibility Public Safety Vest" and labeled as ANSI 207-2006.

Departments that require personnel to perform flagger duties should ensure that those personnel complete a MUTCD-compliant flagger course. It may be helpful to consult local transportation officials for information on these courses within their jurisdiction.

Hand-signaling Devices

Hand-signaling devices, such as STOP/SLOW paddles, flashlights/wands, and red flags, are used by flaggers to control drivers. The STOP/SLOW paddle **(Figure 7.34)** is the MUTCD-preferred hand-signaling device because it provides more positive guidance for drivers. The paddle is octagonal on a rigid handle. It must be at least 18 inches wide with letters at least 6 inches high. The background of the STOP side must be red with white letters and border, while the SLOW side must be orange with black letters and border. When used at night, the paddle must be retroreflectorized (MUTCD Section 6E.03).

Figure 7.34 — A typical lighted hand paddle. (Photo/Mike Wieder)

Flagger Location

Flaggers must be located so that approaching drivers have sufficient distance to stop at the intended stopping point or slow to merge lanes. Refer back to Table 7.1 to review the stopping sight distance as a function of speed and thus determine the flagger location. The flagger should be far enough in advance of workers to warn them of approaching danger by out-of-control vehicles. The flagger should wear proper protective equipment as described below and always stand alone.

Figure 7.35 — The flagger should be in the lane adjacent to flowing traffic. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Flaggers should stand either on the shoulder adjacent to the lane being controlled or in the closed lane prior to stopping drivers **(Figure 7.35**). The flagger should only stand in the lane being used by moving traffic after traffic has been halted. The flagger should be clearly visible to the first approaching driver at all times, as well as being visible to other drivers. Flaggers at emergency incidents must use extreme vigilance since there may not be an advance warning sign before traffic reaches the flagger. The use of hand movements alone without a paddle, flag or other approved devices to control road users shall be prohibited except for law enforcement personnel or emergency responders at incident scenes.

The following methods of signaling with paddles shall be used:

- To stop road users, the flagger shall face road users and aim the STOP paddle with the face toward road users in a stationary position with the arm extended horizontally away from the body. The free arm shall be held with the palm of the hand above shoulder level toward approaching traffic.
- To direct stopped road users to proceed, the flagger shall face road users with the SLOW paddle face aimed toward road users in a stationary position with the arm extended horizontally away from the body. The flagger shall motion with the free hand for road users to proceed.
- To alert or slow traffic, the flagger shall face road users with the SLOW paddle face aimed toward road users in a stationary position with the arm extended horizontally away from the body.

Audible Warning Signals

The MUTCD suggests equipping flaggers with a horn or whistle to provide an audible warning to workers of oncoming danger. An air horn or compressed-gas horn would work well. If a whistle is used, make sure the necklace has a break-away attachment, allowing it to pull loose if caught on an object or moving vehicle.

The device used to warn workers of dangers when working at a traffic incident should be loud enough to be heard above the noise of traffic and any equipment being used by emergency workers. Relying on a radio call may not be sufficient during highway operations. The radio channel may be busy, not everyone on the scene may have a radio, or not everyone may be on the same channel.

High Visibility Safety Apparel

Every year traffic increases, leading to more congestion and greater risk to emergency response personnel. Conditions at dawn, dusk, night and during inclement weather increase the risk. Personnel visibility is imperative to responder safety. Note: Although all firefighter turnout clothing includes the use of retroreflective markings per NFPA 1971, Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting requirements, these requirements fall very short of meeting MUTCD requirements for safety garments to be worn on the roadway. Firefighters must wear additional protective garments when working on roadway emergency scenes. With the exception of DOT workers, the normal clothing of most other responders to roadway incidents has no reflective markings whatsoever.

The ANSI/ISEA "American National Standard for High-Visibility Apparel" (ANSI 107) set the requirements for high-visibility garments worn by public safety personnel (and all other highway workers) for many years, and much of the equipment in use today was designed according to this document. In 2007, ANSI/ISEA released a new standard, ANSI/ISEA 207-2006, "American National Standard for High-Visibility Public Safety Vests." This document has more specific requirements for safety apparel that should be worn by public safety personnel who work on the highway.

American National Standards Institute/International Safety Equipment Association 107

Figure 7.36 — ANSI Class 2 and Class 3 garments. (Photo/Jack Sullivan)

The MUTCD specifies that safety apparel should "meet the requirements of ANSI/ISEA *American National Standard for High-Visibility Apparel* and it must be labeled as meeting the ANSI 107-1999 standard performance for Class 2 risk exposure. The apparel background (outer) material color shall be either fluorescent orange-red or fluorescent yellow-green as defined in the standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 1,000 feet. The retroreflective safety apparel shall be designed to clearly identify the wearer as a person. (This is particularly important for emergency workers among the flashing lights and other apparatus markings at the scene.) For nighttime activity, Class 3 risk exposure should be considered for flaggers" (Section 6E.02). **Figure 7.36** shows ANSI Class 2- and Class 3-compliant garments.

After five years, ANSI/ISEA revised this standard and released ANSI/ISEA 107-2004. The new standard sets performance criteria and guidelines for the selection, design and wearing of high-visibility safety clothing. It defines three protective classes based on background material, retroreflective material, and design and usage requirements. It also provides criteria to assist in determining the appropriate garment based on roadway hazards, work tasks, complexity of the work environment, and vehicular traffic and speed. **Table 7.2** summarizes the classes.

Fabric

ANSI/ISEA 107-2004 specifies that the fabric must be tightly knit or woven for background coverage. Therefore, open mesh fabrics are not in compliance, since they do not provide the background coverage or brightness to meet the standard. The fabric must also be stain- and water-repellent. The standard also requires retesting the chromaticity (brightness and purity of color) of fabrics after a laboratory light exposure test.

Fluorescence

Fluorescent fabrics absorb ultraviolet (UV) light of a certain wavelength and emit it at lower energy in longer wavelengths, making it visible. This property makes the garments especially bright on cloudy days and at dawn and dusk, when UV radiation is high. Fluorescent fabric does not glow in the dark. The new standard requires certification of the fluorescent background fabric to specific chromaticity minimums. Although several colors are available, the most popular safety colors are lime/yellow and orange.

Table 7.2. ANSI/ISEA Garment Classifications

Class	Intended Use	Worker Example
1	Activities that permit the wearer's full and undivided attention to approaching traffic. There should be ample separation of the worker from traffic, which should be traveling no faster than 25 mph.	• Parking lot attendants • Warehouse workers • Roadside "right-of-way" or sidewalk maintenance workers
2	Activities where greater visibility is necessary during inclement weather conditions or in work environments with risks that exceed those for Class 1. Garments in this class also cover workers who perform tasks that divert their attention from approaching traffic or are in close proximity to passing vehicles traveling at 25 mph or higher.	• Forestry operations • Roadway construction, utility and railway workers • School crossing guards • Delivery vehicle drivers • Emergency response and law enforcement personnel
3	Activities of workers who face serious hazards and often have high task loads that require attention away from their surroundings. Garments should provide enhanced visibility to more of the body, such as the arms and legs.	• Roadway construction personnel and flaggers • Utility workers • Survey crews • Emergency response personnel

Table 7.3. 107-2004 ANSI/ISEA Garment Class Requirement

Requirement	Class 1	Class 2	Class 3
Background material minimum area	217 in^2 (0.14 m^2)	775 in^2(0.5 m^2)	1240 in^2 (0.80 m^2)
Retroreflective or combined-performance material used with background material	155 in^2 (0.10 m^2)	201 in^2 (0.13 m^2)	310 in^2 (0.20 m^2)
Minimum width of retroreflective bands	310 in^2 (0.20 m^2)	N/A	N/A
Minimum number of yards per retroreflective band width	1 in (25 mm) or 2 in (50 mm) combined-performance material (without background material)	1.378 in2 (35 mm)	2 in (50 mm)
Minimum number of yards per retroreflective band width	4.3 yds of 1 in (25 mm) wide bands 3.1 yds of 1.378 in (35 mm) wide bands 2.15 yds of 2 in (50 mm) wide bands	4 yds of 1.378 in^2 (35 mm) wide bands 2.8 yds of 2 in (50 mm) wide bands	4.3 yds of 2 in (50 mm) wide bands

Retroreflectivity

Retroreflective fabrics are necessary to extend the same level of protection at night that fluorescent fabrics provide during daylight. Retroreflective fabric works like a mirror, reflecting light back to its source. The standard identifies the requirement (photometric performance) of retroreflective material alone or combined with fluorescent fabric. Photometric performance is measured by candle power ($cd/lux/m^2$). There are two classes of retroreflectivity. Apparel must provide 360 degrees of visibility, so the retroreflective striping must basically encircle the torso. All retroreflectors deteriorate with time. The rates of deterioration depend on the type of material, use and exposure to the environment. **Table 7.3** provides a summary of the ANSI/ISEA 107-2004 garment class requirement.

American National Standards Institute/International Safety Equipment Association 207

The revised ANSI/ISEA 107-2004 standard clearly prohibits any kind of sleeveless garment to be labeled Class 3 when worn alone. This change would have a significant effect on some emergency response departments. Because of these problems, a number of public safety organizations, led by the Emergency Responder Safety Institute (ERSI), lobbied DOT, ANSI and ISEA for a specific standard for a vest to be used in the public safety sector.

ANSI/ISEA 207-2006, "American National Standard for High-Visibility Public Safety Vests" was released in December 2006. ANSI/ISEA 207-2006 establishes design and performance specifications and use criteria for highly visible vests that are used by public safety industries. The standard includes basic requirements such as vest dimensions, color and materials performance and also incorporates criteria for special features for users in fire, emergency medical and law enforcement services.

These special features include easier access to belt-mounted equipment (guns for police, EMS tools, etc.) and the ability for vests to tear away from the body if they are caught on a moving vehicle. Vests labeled as ANSI 207-compliant should have breakaway features on the two shoulder seams, two sides and in the front for a total of five breakaway points **(Figure 7.37)**. The ERSI urges buyers to specify five breakaway points and accept no less than four breakaway points (all except the front closure) when ordering the public safety vests. ANSI/ISEA 207-2006 also allows for color-specific markings on the vest panel or trim to clearly and visibly distinguish between police, fire and EMS responders. These colors include red for fire officials, blue for law enforcement, green for emergency responders and orange for DOT officials.

Figure 7.37 — An ANSI 207 public safety vest.

When comparing the new ANSI/ISEA 207-2006 public safety vest standard to the ANSI/ISEA 107-2004 standard, the following distinctions should be noted:

- ANSI/ISEA 207-2006 is for public safety responders only and is not intended to replace or be interchangeable with ANSI 107-2004 Class 2 requirements. In fact, the 450 square inches of reflective material required of an ANSI 207 vest falls between the requirements for ANSI 107 Class 1 and 2.
- Law enforcement officers performing traffic control duties are still encouraged to follow ANSI 107 Class 2 or Class 3 guidelines whenever possible.
- A lesser background area requirement on ANSI/ISEA 207-2006 allows for short designs, giving tactical access to equipment belts.
- Retroreflective area requirements for ANSI/ISEA 207-2006 are the same as those for ANSI 107-2004 Class 2 vests.
- The new standard suggests use of many design options, such as breakaways, colored identifiers, loops, pockets, badge holders and ID panels.

In addition to the ANSI/ISEA draft for public safety vests, the FHWA released a revision to the 2009 MUTCD that states: "All workers, including emergency responders, within the right-of-way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to work vehicles and construction equipment within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107–2004 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear."

The MUTCD also addresses the use of warning lights at roadway incident scenes in Section 6I.05. The use of emergency lighting is essential, especially in the initial stages of a traffic incident. However, it only provides warning; it does not provide traffic control. Emergency lighting is often confusing to drivers, especially at night. Drivers approaching the incident from the opposite direction on a divided roadway are often distracted by the lights and slow their response, resulting in a hazard to themselves and others traveling in their direction. (It also often results in traffic congestion in the unaffected opposite lane(s) and increases the chance of a secondary collision.)

Summary

There are several NFPA standards related to emergency vehicle response and roadway scene safety. Although written for the fire service, these standards provide a good resource for third service or private EMS and law enforcement agencies in developing their own SOPs. In addition to the standards, all emergency disciplines should be aware of and follow the recommendations of the DOT MUTCD as they relate to working in an incident management zone.

Chapter 8
Roadway Incident Scene Safety

Introduction

One of the leading causes of injuries and deaths for firefighters, law enforcement personnel, EMS responders, transportation department workers and tow truck operators remains being struck by a vehicle while operating at roadway incidents. Fortunately, the tide has begun to turn in recent years as responders recognize the staggering loss statistics that occur when operating on roadways and have begun to take measures to reduce the frequency and severity of these incidents.

For the purpose of this document, the term "roadway" is a generic term that is used to describe all types of driving surfaces. These include surface streets that are found in rural, suburban and urban jurisdictions, as well as limited access highways such as interstates and turnpikes. When it is necessary to differentiate between types of roadways the terms surface streets and highways are used.

Agencies That Respond to Roadway Incidents and Their Responsibilities

There are few instances where a roadway incident of any magnitude will be handled by a single agency or response discipline. Most of these incidents trigger the response of multiple agencies, each with their own important role to play in the successful resolution of the incident. In order to avoid conflict, maximize safety and optimize the efficient handling of any roadway incident, all of the potential "players" must understand who the other players are, as well as their responsibilities relative to the incident.

The types of agencies that respond to roadway incidents depend on a number of factors, including the agencies serving a particular jurisdiction and the type or magnitude of the particular incident. The primary agencies that most commonly respond to roadway emergencies include:

- Law Enforcement Agencies.
- Fire and Rescue Agencies.
- EMS.
- Transportation Agencies.
- Towing and Recovery Services.
- Emergency Management Agency.
- Coroners and Medical Examiners.
- Hazardous Materials Clean-up Firms.
- Animal Medical Response Services.
- News Media.

Law Enforcement Agencies

Law enforcement agencies are primary responders to roadway incidents and will be present on virtually every occasion. Law enforcement agencies are designated as lead agencies for roadway incidents in many states or regional jurisdictions. Although not always the case, they may have authority over all the other responders at the scene. Law enforcement responsibilities at a roadway incident may include any or all of the following:

- Traffic control: This includes protecting the scene and rerouting traffic when necessary **(Figure 8.1)**.
- Incident investigation: In most cases, the law enforcement agency will be responsible for gathering information on the parties involved, investigating the circumstances leading to the incident, documenting all the information that is gathered, and determining whether formal charges should be made against any of the parties involved in the incident **(Figure 8.2)**.
- Incident reconstruction: In the case of fatal or otherwise serious incidents, it may be necessary for law enforcement reconstruction specialists to attempt to reconstruct the events that occurred to completely understand the outcome.
- Crowd control: All bystanders must be kept clear of the scene to ensure their safety and the safety of the responders working on the incident.

Figure 8.1 — Law enforcement personnel provide blocking protection at roadway incident scenes. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 8.2 — Police officers are exposed to traffic when investigating collisions. (Photo/Mike Wieder)

Of these responsibilities, traffic control is probably the most important to the other responding agencies. Ensuring responder safety by protecting the scene and incident work area must be the highest priority. Of course, the surest way to effect scene safety would be to completely halt all traffic flow in the vicinity of the incident until the incident is cleared. However, this tactic is often unnecessary and unreasonable. Law enforcement officials must constantly balance the safety of responders working at the scene with the amount of disruption caused for other motorists on the roadway.

Figure 8.3 — Firefighters are not required to wear safety vests if they are wearing an SCBA to perform their duties. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Fire and Rescue Agencies

Next to law enforcement agencies, fire and rescue agencies are the next most likely responders to roadway incidents. Fire and rescue services are typically dispatched to incidents such as motor vehicle collisions, vehicle fires, other fires in proximity to the roadway, medical emergencies on or near the roadway, and hazardous materials incidents. The primary roles for fire and rescue agencies at these incidents include:

Figure 8.4 — Firefighters should wear traffic vests when performing vehicle extractions. (Photo/Mike Wieder)

- Extinguishing fires and making the scene as safe as possible **(Figure 8.3)**.
- Standing by to ensure any leaking fuels do not ignite and taking immediate action if they do.
- Extricating victims from vehicles or other entrapments **(Figure 8.4)**.
- Providing emergency medical treatment on the scene and transporting victims to the hospital if the fire department responsibilities also include EMS.
- Containing the spread of any hazardous materials that may have been released until a hazardous materials clean-up agency arrives.

- Assisting other response agencies with necessary special apparatus or equipment provided by the fire department, such as additional traffic control equipment, floodlighting, communications equipment and thermal imaging devices.

Emergency Medical Services

EMS are dispatched to roadway incidents when there is a report of the possibility of one or more injured victims on the scene as a result of a fire or collision. They may also be dispatched to medical emergencies occurring on or near the roadway, such as ill motorists in a stopped vehicle and ill or injured highway workers. Depending on the emergency response system of the jurisdiction, EMS may be provided by the fire department, a separate EMS agency (often referred to as a "third service") or a combination of both. Whoever the responders are, they are responsible for treating all of the victims at the scene and then having them transported to an appropriate medical facility **(Figure 8.5)**.

Figure 8.5 — EMS providers commonly work on the roadway. (Photo/Mike Wieder)

Ground ambulances will transport the vast majority of victims requiring transport to a hospital from a roadway incident. However, the use of air medical helicopters has become commonplace in many jurisdictions when the victim is seriously injured or ill and timely transportation to an appropriate medical facility may be delayed by traffic conditions or simply a long distance **(Figure 8.6)**. This adds an additional layer to the roadway safety issue as it necessitates identifying a safe location to land the helicopter near the incident scene. In many cases, this may be directly on the roadway itself, which may require additional rerouting of traffic and other issues affecting scene security and safety.

Figure 8.6 — EMS helicopters often are required to land on or near the roadway. (Photo/Mike Wieder)

Transportation Agencies

Historically, transportation agencies have not played a major role in the response to roadway emergencies, and other emergency response disciplines overlooked their resources. However, in recent years, there has been a major shift in this philosophy, and the role of transportation agencies has substantially increased in many parts of the nation. Much of this is credited to the DOT FHWA's ITS initiative and research project that is focused on improving the efficiency and safety of the nation's systems of roadways. These transportation agencies are operated at the local, county, regional or state levels.

On longer-term incidents, the transportation agency may respond with additional, heavier equipment, such as barrier trucks; larger signs and message boards; additional cones, markers or traffic barrels; additional lighting equipment; and a variety of other resources **(Figure 8.7)**. It is important for fire and law enforcement agencies to understand the resources that the transportation agency has available and coordinate the use of those resources in an effective manner.

Figure 8.7 — Most transportation agencies have barrier vehicles suited for lengthy deployments.

Towing and Recovery Services

Towing and recovery services will be required any time a roadway incident involves a disabled vehicle that must be removed from the roadway. Oftentimes, there will be more than one vehicle that needs to be removed. Expedient removal of vehicles in the roadway is a critical factor in restoring the normal flow of traffic as quickly as possible. In most cases, local law enforcement agencies have a working policy on what towing services are summoned when they are needed. Their dispatch is usually coordinated through the police dispatch center. In other jurisdictions, the transportation agency may coordinate these services through their responder units or traffic management centers.

The type of equipment used for these services can range from small wreckers or rollback vehicles to large wreckers capable of towing tractor-trailer vehicles **(Figure 8.8)**. For incidents where vehicles are overturned, special equipment, such as cranes or airlifting bags, may be required to right the vehicle in order to haul it away.

Figure 8.8 — Large wreckers may be required to remove large vehicles from the roadway.

Emergency Management Agency

Local and state level emergency management agency (EMA) officials typically are not involved in routine incidents that occur daily on roadways. However, in some cases, they may become involved in large-scale, long-term incidents such as major hazardous materials incidents, large fires (particularly brush fires) affecting roadways, incidents where travelers must be evacuated from the roadway, and bridge or roadway collapses. In some jurisdictions, the EMA operates portable command and communications trailers or vehicles that can be of great assistance in coordinating multiagency or multijurisdictional incidents **(Figure 8.9)**.

Figure 8.9 — Many local and state EMAs operate mobile command post vehicles. (Photo/Mike Wieder)

Coroners and Medical Examiners

Depending on the laws and/or operating procedures within a particular jurisdiction, the response of coroner or medical examiner personnel to a roadway incident may be required when a fatality occurs. The duties of these personnel may include officially confirming the victim's death, initial inquiry into the cause of death and/or removal of the deceased from the scene. All other response agencies must be familiar with the duties of the medical examiner's agency in order to ensure that there is no compromise to the inquiry of the incident by inappropriate actions taken before their arrival.

Hazardous Materials Clean-up Firms

Hazardous materials clean-up firms may be needed for incidents that involve the actual or potential release of hazardous materials. In most cases, these are privately owned firms specializing in this work. Many local jurisdictions keep these firms on retainer to ensure their expedient response to an incident when needed. Despite their status as privately owned contract firms, these agencies must follow all applicable local regulations, occupational safety laws, and environmental protection regulations when performing their duties. They must also be required to operate under the ICS that is in place and follow any directions given to them by the Incident Commander or another Command staff member.

Animal Medical Response Services

Many jurisdictions have specific agencies that respond to assist wildlife or domestic animals that are injured on or near the roadway **(Figure 8.10)**. These include state or local wildlife agencies, local animal control agencies, and veterinary emergency response services. Veterinary emergency response services may provide a level of service to animals that are comparable to what standard EMS services provide for humans. Regardless of the level of service an agency performs, their responders must follow roadway safety precautions just like other emergency services.

Figure 8.10 — Some jurisdictions have mobile veterinary emergency service vehicles. (Photo/Mike Wieder)

News Media

Even though they are not part of the emergency response that affects the outcome of the incident, emergency responders must be prepared to interact with the media at significant roadway incidents **(Figure 8.11)**. Just like the emergency responders, members of the various forms of the media also have their jobs to do, and this includes reporting incidents that occur on the roadway. In some circumstances, the media may be able to assist responders in mitigating the incident. The media can provide information to the public about avoiding certain routes affected by the incident. This may help reduce traffic congestion near the primary incident and reduce the chance of a secondary incident occurring. First responders may find images broadcast from a news helicopter helpful in getting a bigger picture of the situation. In some cases, the news helicopter can be used to transport a member of the Command Staff who can then radio visual information back to the IC. All agencies must have established policies for handling the media when they are present at an incident.

Figure 8.11 — Effective media relations are important for the image of any response agency. (Photo/Ron Jeffers, Union City, New Jersey)

Understanding and Respecting Each Other's Roles

It is not only important for the members of each discipline to understand what their own role is in the incident, but also to understand and **respect** the roles of the other disciplines at the incident. Failure to understand and respect each other's roles frequently leads to conflict, disruption of critical incident activities, negative media coverage and long-standing interorganizational issues after the incident is over. Incidents where these types of conflicts occur tend to gain wide, sometimes national, media attention and cast a poor image over everyone involved, regardless of who technically was right or wrong. The only "winner" in these situations is the media that gets an extra-hot story to report.

Historically, the greatest source of conflict at these incidents has been between law enforcement officers and fire or EMS personnel. Dozens of case studies exist where overzealous members of each discipline acted irresponsibly and created a situation that actually disrupted and overshadowed the original event. This is unfortunate for everyone involved, including the original incident victims, who are often overlooked during the course of these unproductive behaviors.

The immediate and easy answer to the cause of roadway incident scene disputes is to blame overblown egos of the responders who create the dispute. While this may be the case in many situations, failure to understand and respect the primary concerns and incident priorities of each response discipline is generally at the very root of all of these disputes. Several things can contribute to this lack of understanding:

- Basic training of the responders from each discipline is inconsistent on jurisdictional issues.
- Failure to conduct joint in-service training with all agencies involved on a regular schedule.
- Failure to perform advanced planning for interagency incidents.
- Interagency relationships do not have an ongoing positive, proactive foundation.

From the beginning of their training, we teach firefighters and EMS personnel that their own personal safety is their highest priority. The protection of other people and property are secondary to their own safety. Therefore, fire and EMS training for responding to roadway emergencies focuses primarily on setting up a safe work zone before performing other tasks.

Most training in this area is based on information contained in NFPA 1500 and the DOT's MUTCD. Both of these documents recommend that the lanes of traffic in which the incident occurred plus one extra lane next to the lane of the incident should be closed to moving traffic. This is typically done by placing apparatus in a diagonal manner across the lanes they desire to be closed **(Figure 8.12)**. Firefighters and EMS personnel are trained not to operate upstream of these blocking apparatus.

Figure 8.12 — Proper blocking positioning for a vehicle at a roadway incident scene. (Photo/Ron Moore, Plano, Texas)

Most fire and EMS personnel are not trained on issues like the effects of reduced traffic flow or the hazards of long vehicle queues. Therefore, they pay little attention to these issues. They are only trained to block as much traffic as is necessary to maximize their own safety, which does not sound like a bad idea.

Police officers receive an extensive amount of training concerning roadway incidents, and scene safety is an important piece of that training. Unlike fire and EMS training, law enforcement training is more likely to cover not only the safety of personnel at the scene, but also safety for the other motorists near the incident. Law enforcement personnel are trained to focus on minimizing the disruption to the normal flow of traffic as much as possible. Excessive lane changes and slowing or stopping the flow of traffic will cause long vehicle queues that, in extreme cases, may last for many hours after the original incident has been cleared.

What police officers understand, and what is often missing from fire/EMS training, is that impediments to the normal flow of traffic create a significantly dangerous situation. DOT statistics indicate that secondary collisions following an initial roadway incident are responsible for 18 percent of civilian traffic fatalities in the U.S. Reducing the chance of secondary collisions is the reason police officers often focus on minimizing lane closures and disruptions to normal traffic flow.

Understanding other responders' roles at a roadway incident applies to all potential emergency responders. Waiting until an incident occurs and then trying to work out agency coordination at the scene is neither a productive way to address the issue nor likely to be successful.

Developing workable procedures for responding to and working with other agencies at roadway incidents is an activity best conducted well in advance of an incident. Effective preincident planning is the key to efficient, predictable operations and helps minimize the chance of conflict between various disciplines. Apply the principles of preincident planning to roadway incidents in much the same way they are applied to structure fires or tactical incidents. In reality, the roadway is just another target hazard in much the same way as a school, industrial facility or apartment complex. The difference is that police, fire and EMS agencies, as well as the other common responders in a jurisdiction, must all have a role in preincident planning for roadway incidents.

When developing a preincident plan for roadway incident operations, take a number of considerations into account, including:

- Make sure that all departments/agencies that may respond to a roadway incident are involved in the planning effort **(Figure 8.13)**.
- Ensure that the representatives from each agency have the authority of their agency to make binding decisions for or commitments to the plan that is developed. If not, identify what the adoption process is going to entail.
- Formalize what the specific role for each agency will be at these incidents.
- From the outset, establish who is going to be in charge overall at these incidents. This may be based on local practices or regional or state laws or regulations.
- Set up a workable framework for Unified Command operations when the nature of the incident dictates that need.
- Establish basic protocols that all parties can agree on for setting up work zones or traffic incident management areas. Understand that these may be adjusted based on the requirements of a specific incident.
- Develop requirements for all agencies to train their personnel on the plan and practice the plan on a regular basis to ensure that it will work in real-life situations.

Figure 8.13 — Multiple agencies may respond to a single roadway emergency scene. (Photo/Ron Jeffers, Union City, New Jersey)

It does absolutely no good if a group of high-ranking officers from each agency, many of whom are long-removed from routinely responding to roadway incidents, develops a plan that is unrealistic for the responders. Striking a balance between senior staff and actual practitioners is a key factor for the planning process to be successful.

The best plan in the world is not helpful if it is simply stuck somewhere in each respective agency's file cabinets. All responders from each agency should receive effective training on the plan and understand how to implement it at roadway incidents. If possible, have a mix of disciplines in the training sessions so responders can develop positive relationships and identify potential conflicts before they work together at incident scenes.

The plan design must be workable and easily implemented. Once the original plan is put in place and used for a period of time, it may become obvious that some adjustments are required. A mechanism for reviewing the plan on a regular basis and making revisions is needed. The various parties should work together to make those adjustments and communicate the revised plan to all of the responders, highlighting the changes.

Managing Roadway Incident Scenes

Proper preincident planning and training are important considerations when preparing to respond to roadway incidents. When incidents occur, it will be necessary to apply the principles of sound incident management in order to bring the incident to a safe and satisfactory conclusion. All of the agencies, not just the fire service, that respond to highway incidents must operate under the umbrella of a common command system in order for the incident to run efficiently.

Size-up and Assuming Command

In order for incident management to be successful, effective incident command must be established, beginning with the arrival of the first emergency responder, regardless of rank or agency **(Figure 8.14)**. The first-arriving responder should establish incident command, perform some basic command functions and take charge of the incident. From the onset of the incident, integrate principles of sound risk management into the functions of incident command.

Figure 8.14 — The first responders on the scene of a roadway emergency must establish command. (Photo/Mike Wieder)

Rules of Engagement

Historically, the fire service has been very quick to apply rules of engagement to incidents such as structure fires, wildland fires and hazardous materials incidents, yet not so quick to apply those same principles to more routine operations such as roadway incidents. The principles of risk management outlined in NFPA Standard 1500 serve as rules of engagement for roadway scenes and operations as well. According to NFPA Standard 1500, base the rules of engagement on the following principles:

- Activities that present a significant risk to the safety of members shall be limited to situations where there is a potential to save endangered lives.
- Recognize activities taken to protect property as inherent risks to the safety of members. Take actions to reduce or avoid hazards and unnecessary risks.
- No risk to safety of members shall be acceptable when there is no possibility to save lives or property.

The principles of risk management and the rules of engagement apply to all agencies and all hazards encountered in conjunction with highway incidents. Therefore, all agencies should adopt common rules for highway incident management. This will greatly assist ICs when considering courses of action. **Figure 8.15, p. 135** shows a template for model rules of engagement applied to roadway emergency scenes. All fire departments should consider adopting them into their SOPs and applying them on all roadway incidents.

Highway Incident Model Rules of Engagement

We will balance risks with the benefits of taking any action.

1. We **may** risk our lives a lot, in a calculated manner, for savable lives, or for preventable further injury or death.
2. We **will not** risk lives at all for property or lives that are already lost.
3. We **may** risk lives only a little, in a calculated manner, for salvageable property or preventable further damage or destruction.
4. We **will** endeavor to consider the needs of others in the vicinity.

Engagement Needs Assessment

We will assess the benefits of our planned actions.

1. We **will** consider the likelihood of success of our actions.
2. We **will** consider the benefit we could provide if we succeed.

Engagement Risk Assessment

We will assess the risks of our planned actions.

1. We **will** assess the threats of injury and death to responders and those in their care.
2. We **will** consider the likelihood of threats occurring and their severity.
3. We **will** endeavor to consider threats of property damage or destruction.

Hazards

- Fire and explosion hazards.
- Environmental hazards.
- HAZMAT hazards.
- Criminal and terrorist threats.

Incident Factors

- Condition of crash vehicles.
- Scene access and egress.
- Environmental conditions.
- Evidence.
- Risk to vehicle occupants.
- Known or probable occupants.
- Occupant survival assessment.

Responder Capabilities

- Available resources.
- Operational capabilities.
- Operational limitations.
- Training.
- Experience.
- Rest and rehabilitation.

Figure 8.15

Risk Analysis

In order to perform an effective size-up of the incident, the initial (and subsequent) IC must have a basic understanding of the hazards associated with these incidents, the various factors that must be considered in developing a plan of action, and capabilities of the responders who will be working the incident. While this is important at the start of the incident, risk assessment is an ongoing process that lasts for the entire incident. The IC should continually re-evaluate conditions and change strategy or tactics as necessary. At a minimum, the risk analysis for a roadway incident should consider:

Hazards

- Fire and explosion hazards.
- Environmental hazards.
- Criminal and terrorist threats.
- Traffic hazards.

Incident Factors

- Condition of involved vehicles.
- Scene access and egress.
- Risk to vehicle occupants.
- Known or probable occupants.
- Environmental conditions.
- Evidence.
- Occupant survival assessment.

Responder Capabilities

- Available resources.
- Operational capabilities.
- Operational limitations.
- Training.
- Experience.
- Rest and rehabilitation.

Size-up

The first responder (law enforcement, fire service, EMS, transportation) to arrive at the scene shall assume command of the incident. The initial IC shall remain in command until command is transferred or the incident is stabilized and terminated. The first-arriving responder on the scene must initiate the necessary parts of the ICS needed to manage the incident scene. The exact actions undertaken will vary depending on the type or scope of the incident:

Figure 8.16 — A minor roadway incident. (Photo/Mike Wieder)

- A single-resource incident (e.g., single-patient medical incident, traffic collision with minor injuries, disabled vehicle, property damage collision) may only require that the initial IC provide a size-up report and acknowledge arrival on the scene **(Figure 8.16)**.
- For incidents that require the commitment of multiple companies, the first responder or member on the scene must establish and announce "Command" and initiate an incident management structure appropriate for the incident **(Figure 8.17)**.

Figure 8.17 — A major roadway incident may affect traffic flow for more than 24 hours. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

The first-arriving responder activates the command process by giving an initial size-up report. A traditional size-up report based on standard incident command practices would include the following information:

- Designation of the resource arriving on the scene.
- A brief description of the incident situation (e.g., hazmat release, multivehicle crash, guardrail damage).
- Verify the exact location of the incident, including route identification; direction of travel; closest intersection, milepost or landmark; and lane(s) and/or shoulder affected.
- Obvious conditions (e.g., hazmat spill, multiple patients, working fire, bridge collapse).
- Brief description of action taken (e.g., "Squad 65 is setting up a temporary traffic diversion").
- Declaration of the strategy or standardized operation (e.g., traffic stop, vehicle tow, tire change) to be used.
- Any obvious safety concerns.
- Assumption, identification and location of command.
- Request or release resources as required.

This information should then be formed into a concise verbal report that is transmitted to the agency's dispatch or control center, as well as the other responders who are en route to the scene and monitoring the radio frequency.

In addition to the above, the MUTCD requires that the initial responders determine the magnitude of the incident, the estimated time duration that the roadway will be blocked or affected, and the expected length of the vehicle queue (backup) that will occur as a result of the incident. Use this information to set up appropriate emergency traffic control (ETC) measures to handle the incident. Keep in mind that for every one minute a lane of traffic is blocked, four minutes of backup are developed. This fact emphasizes the need for a quick, accurate size-up and the implementation of appropriate ETC procedures as soon as possible.

Tactical Priorities

Along with a lack of understanding of various responders' roles, confusion and conflict has occurred between emergency responders as the result of a failure to agree on the tactical priorities of the incident. All agencies involved in the response to incidents on the roadway should work together to develop a basic agreement on tactical priorities for these operations. While the tactical priorities may vary somewhat from jurisdiction to jurisdiction, the following model is a good place to start:

- Establish command and communications.
- Establish a safe work zone considering:
  - Responder safety.
  - Scene safety
  - Traffic safety
- Begin incident mitigation efforts.
- Facilitate investigation, always being aware of evidence protection while working.
- Remove all disabled or obstructing vehicles, debris and cargo.
- Wrap up the scene with proper incident termination protocol.

One of law enforcement's main duties when responding to these incidents involves conducting an investigation of the circumstances of the incident. This is important for the determination of fault and whether a crime has been committed. Firefighters and other responders should work together to ensure that law enforcement personnel have the information and resources they need to conduct an effective investigation. Responders should not needlessly move or remove debris unless approved by a police officer. The position of the debris may be important information in determining the cause of the incident. All personnel should try to preserve potential evidence until otherwise directed by law enforcement personnel.

Figure 8.18 — A towing service will be needed to move inoperable vehicles. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

The removal of debris from an incident scene is typically conducted after all hazards have been abated, victims have been removed, and the preliminary investigation and evidence collection has been completed. Who removes it and how it is removed depends on the nature of the debris. Remove inoperable vehicles using an appropriate tow or rollback vehicle **(Figure 8.18)**. Various types of spilled cargo may require heavy equipment and dump trucks for removal. Hazardous materials will need to be carefully cleaned and removed by professionals who are qualified to perform this task. Local roadway response plans should include a list of the various service providers who can perform these duties when needed.

Using safe incident termination procedures is just as crucial as the initial set-up of the scene, and it is equally dangerous. All unnecessary vehicles should leave the area before carefully removing traffic control equipment starting from the incident work zone and working back to where the initial markers are located. When possible, have a large vehicle between the responders who are picking up the equipment and oncoming traffic.

Basic Incident Command System Structure

All personnel who respond to roadway incident scenes must be trained and competent in the principles of ICS. The effective management of an incident hinges on all responders working within the same ICS. The following provides an overview of a basic ICS.

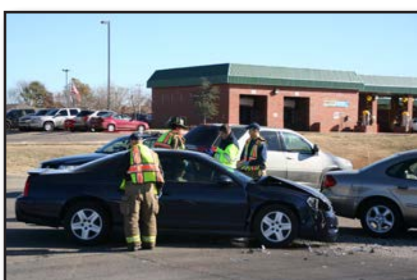


Figure 8.19 — The initial response to a roadway incident may be a limited number of personnel from one or two agencies.

Response

In most jurisdictions, an **initial response** to a reported highway incident consists of one to five single resources that may split among two or more response disciplines, such as fire, EMS and police agencies **(Figure 8.19)**. The first-arriving resource, regardless of discipline, assumes command until the arrival of a higher-ranking officer or more appropriate person to be in charge, at which point command is transferred. If the initial response resources are insufficient, the IC will request a **reinforced response**, which may include special resources from within the agency, other responder disciplines or mutual aid.

Levels of Command

The basic configuration of command includes three levels: strategic, tactical and task. The strategic level involves the overall command of the incident. All planning, determining appropriate strategy and establishing incident objectives that is included in the Incident Action Plan (IAP) is accomplished at the strategic level. Supervisors direct operational activities toward specific incident objectives at the tactical level. Individual companies or specific personnel normally complete activities at the task level.

Even a single unit response involves all three levels of the command structure. For example, the officer assumes command, determines the strategy and tactics, and supervises the crew doing the task. Many incidents involve a small number of resources, such as an engine, ambulance and police officers. In this situation, the IC handles the strategic and tactical levels. Resources report directly to the IC and operate at the task level. The vast majority of roadway incidents are handled by the units assigned to the initial response or with just a few additional resources in a reinforced response.

Expanding the Organization

Complex situations often exceed the capability of one officer to effectively manage the entire operation. Dividing an incident scene into Divisions (geographic area assignments) or Groups (functional assignments) reduces the span of control to more manageable units and allows the IC to communicate with an organizational level rather than multiple individual officers.

The ICS will develop according to the nature, size and complexity of the incident. The only difference between the ICS of a large incident and the ICS of a small incident is the pattern of organizational growth to meet the needs of the incident. Expanding the ICS is the sole decision of the IC and is done when the IC determines that the initial responders are not enough to handle the incident.

The IC has the option of appointing three Command Staff positions that report directly to the IC. Command Staff positions are responsible for key activities that are not part of the line organization. The Public Information Officer (PIO) is normally the POC for the media and other governmental agencies seeking information related to the incident. The Safety Officer assesses hazardous and unsafe situations and develops measures for assuring responder safety. The Liaison Officer is the POC for representatives from cooperating or assisting agencies and is not directly involved in incident operations. All Command Staff positions can have assistants as required by incident complexity.

When the number of Divisions or Groups exceeds the recommended span of control of three to seven or the incident involves two or more distinctly different operations, the IC may choose to establish a multibranch structure and allocate the Divisions and Groups within those Branches.

Some incidents may require a structure with each involved discipline within the jurisdiction having its own functional Branch. It is important to remember that resources at multijurisdictional incidents are best managed under the agencies that have normal control over those resources.

Incidents that expand beyond the implementation of a few simple Branches in order to manage the assigned resources will typically require the activation of one or more of the four major sections recognized by ICS: Operations, Planning, Logistics and Finance/Administration **(Figure 8.20)**. Each of these sections is led by a Section Chief who reports directly to the IC.

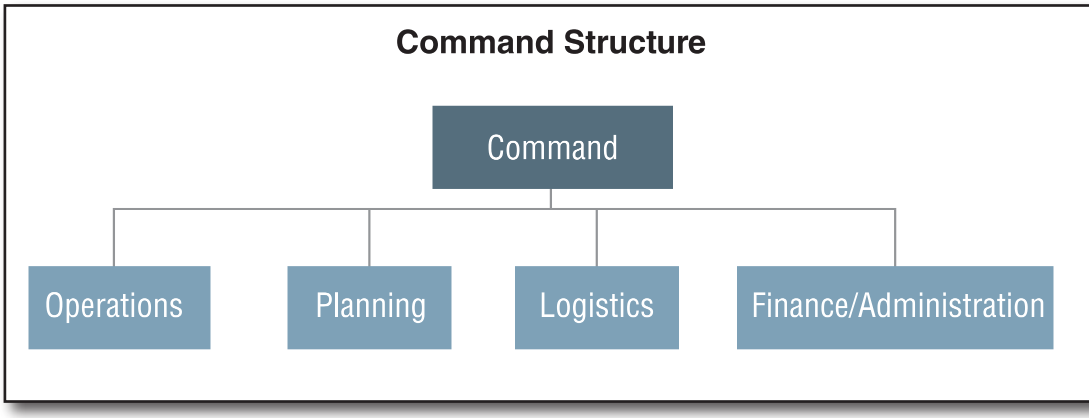


Figure 8.20

Operations Section

The Operations Section is responsible for the direct management of all incident tactical activities, the tactical priorities, and the safety and welfare of the personnel working in the Operations Section. The Operations Section Chief designates an appropriate command channel to communicate strategic and specific objectives to the Branches and/or tactical level management units. The Operations Section Chief also has responsibility for oversight of staging area functions.

The Operations Section is often implemented (staffed) as a span-of-control mechanism. When the number of Branches, Divisions or Groups exceeds the capability of the IC to effectively manage, the IC may staff the Operations Section to reduce the span of control, and thus transfer direct management of all tactical activities to the Operations Section Chief. The IC is then able to focus his or her attention on management of the entire incident rather than concentrating on tactical activities.

Highway incidents often involve aircraft. Aeromedical helicopters are frequently used to transport patients **(Figure 8.21)**. Law enforcement may have helicopters in the vicinity, and news services may have traffic reporting helicopters in the area. If the incident is large and prolonged, sightseers in private aircraft may also contribute to air traffic in the area. If aircraft are involved in the operations of the incident, the Operations Section Chief should establish the Air Operations Branch to manage this portion of the incident.

Figure 8.21 — Helicopters may land in a lot or field adjacent to a roadway incident scene. (Photo/Mike Wieder)

It is important to emphasize that the implementation of an Operations Section is not an automatic event based upon the arrival of higher-ranking officers or supervisors on the scene. It may be more appropriate to assign supervisory personnel to developing Division, Group or Branch positions first. Having supervisor-level personnel in these positions enhances the command organization and improves the decision-making process.

In some situations, it is wiser to implement one of the other Section Chiefs before the Operations Section is implemented. For example, a prolonged incident may require the early implementation of a Planning Section before the span-of-control criteria requires an Operations Section Chief.

Planning Section

The Planning Section is responsible for gathering, assimilating, analyzing and processing information needed for effective decision-making. Information management is a full-time task at large and complex incidents. The automation of traffic management in recent years has greatly increased the amount and quality of information available to traffic managers, enabling them to adjust traffic signals and other controls in reaction to a highway incident. These new traffic management capabilities depend upon receiving information concerning the current situation and also the forecasted duration and extent of incident scene operations. The Planning Section will handle much of this demand for information, working closely in coordination with the Information and Liaison Officers on the Command Staff.

Critical information should be immediately forwarded to Command (or whoever needs it). Information should also be used to make long-range plans. The Planning Section Chief's goal is to plan ahead of current events and identify the need for resources before their usage is necessary.

Transportation organizations have a great deal of specialized knowledge that can be helpful in planning, and they should be used as technical specialists by the Planning Section. These technical specialists are especially helpful when the incident involves more than one mode of transportation, such as rail crossings or transit facilities.

Logistics Section

The Logistics Section is the support mechanism for the organization. It provides services and support systems to all the organizational components involved in the incident, including facilities, transportation, supplies, equipment maintenance, fueling, feeding, communications, and responder medical services and rehabilitation. According to the size of the incident, the Logistics Section may be separated into Branches.

Finance/Administration Section

The Finance/Administration Section is only established when involved agencies have a specific need for financial services. There are always cost-reimbursement issues with multiagency operations. The designated members of this section are responsible for authorizing expenditures to obtain resources necessary to manage all aspects of the incident.

Unified Command

The importance of an effective Unified Command on major roadway incidents cannot be overemphasized. There are multiple priorities by various agencies involved in these incidents. Failure to establish Unified Command is often responsible for conflict between agencies or responders. Some of the concepts associated with using an effective Unified Command are complex and require preincident planning and training.

Unified Command may be appropriate in a multijurisdictional incident (e.g., collision that crosses city and county lines) or a multidepartmental incident (e.g., a collision on an interstate that brings responders from fire, EMS, law enforcement, DOT and other agencies). Lacking state-mandated direction, the lead agency is determined by the initial priorities. For example, the fire department would be the lead agency on an extrication or vehicle fire incident. As priorities change, the lead agency may change. For example, once all patients have been removed and transported, law enforcement would most likely take over as lead agency. Changes in the lead agency should be accompanied by staffing changes in the Operations Section.

Under Unified Command, priorities, strategies and objectives are determined jointly by the representatives from each agency or jurisdiction. In some states, the lead agency may be dictated by state laws or regulations, regardless of the type of incident. Unified Command structures must be in unison with these requirements where they apply.

The concepts surrounding Unified Command exceed what can be covered in this type of document. The National Incident Management System Consortium's (NIMSC's) "Incident Command System Model Procedures Guide for Incidents Involving Structural Fire Fighting, High-Rise, Multi-Casualty, Highway, and Managing Large-Scale Incidents Using NIMS-ICS" dedicates an entire chapter to this topic. It is highly recommended that agencies consult that document and work those concepts into their SOPs.

Setting Up a Safe Work Zone at Roadway Incidents

One manner in which we can reduce the likelihood of a secondary collision occurring at a roadway incident scene is to follow safe procedures in setting up the work zone surrounding the actual incident **(Figure 8.22)**. In the DOT MUTCD, this area is referred to as the TIMA. Setting up a TIMA involves the use of TTC devices. The primary functions of TTC at a TIMA are to inform road users of the incident and to provide guidance information on the path to follow through the incident area.

Figure 8.22 — A safe zone should be established early on in the incident. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Civilian drivers have a variety of driving skill levels. Some drive without a license; some drive extremely slowly, while others drive well beyond the speed limit; some drive visually impaired; some are alcohol or drug impaired; and all of them "rubberneck" the scene instead of focusing on the road. Alerting these road users to the immediate emergency zone and establishing a well-defined path to guide them through the incident area will serve to protect the civilians themselves and those responders working at the incident scene. It will also aid in expeditiously moving road users past or around the traffic incident, reducing the likelihood of secondary traffic crashes, and precluding the unnecessary use of the surrounding local road system.

Emergency responders do not have to meet all MUTCD requirements for TTC during the initial phase of a highway incident. The MUTCD requirements for TTC beyond the basic cones, flares or fluorescent pink signs begin 30 minutes after scene arrival. By this time, law enforcement and highway agencies should be on-scene to establish a TTC zone that fully meets at least the MUTCD minimum standards for the extended incident. Fire departments and EMS agencies should accept the responsibility for providing a minimum level of traffic control devices to be carried on each responding apparatus and to direct traffic until law enforcement arrives.

Figure 8.23 — This engine company is protecting the work area. (Photo/Ron Moore, Plano, Texas)

Figure 8.24 — In some cases, a street may need to be closed for an extended period. (Photo/Mike Wieder)

Emergency Vehicle Placement

Setting up a safe work zone begins with the proper placement of the first-arriving vehicle and expands from there. Regardless of which discipline arrives on the scene first, the vehicle driver has three primary concerns when determining where to park the vehicle at a roadway incident:

1. Park the vehicle in a manner that reduces the chance of the vehicle being struck by oncoming traffic.
2. Park the vehicle in a manner that shields emergency responders and the operational work area from being exposed to oncoming traffic **(Figure 8.23)**.
3. Park the vehicle in a location that allows for effective deployment of equipment and resources to handle the incident.

The procedures for performing each of these options will differ depending on the type of incident, the type of road and the location of the incident. Drivers must be versed in the appropriate positioning procedures for all possible expected environments.

Operations on Surface Streets

Surface streets range from rural, unpaved roads to busy urban and suburban avenues. Most often, the tactical needs of the incident will dictate the positioning of the emergency vehicle. However, there are some safety principles to be followed as much as possible:

- Park the emergency vehicle off the street in a parking lot or driveway, when possible. This reduces the risk of being struck by a moving vehicle whose driver is not paying attention to the emergency scene.
- Close the street that the emergency is located on to through traffic. This eliminates the potential of a civilian vehicle driving into the emergency vehicle or responders **(Figure 8.24)**.
- Do not block access to the scene for later-arriving emergency vehicles. Oftentimes, crashes occur when one vehicle is parked in a poor position and another attempts to squeeze around it.
- If the emergency scene is in the street, such as with a vehicle fire or motor vehicle crash, and the street may not be closed to all traffic, park the emergency vehicle in a manner that uses it as a shield between the scene and oncoming traffic. It would be better for a stray vehicle to drive into the emergency vehicle than it would be to strike a group of responders.

- On EMS calls, use another emergency vehicle to shield the patient loading area behind the ambulance **(Figure 8.25)**. This area is particularly vulnerable to oncoming traffic. If at all possible, the ambulance should be pulled into a driveway or otherwise out of the route of traffic to reduce the exposure of the loading area.
- Never park the emergency vehicle on railroad tracks. Keep the emergency vehicle far enough away from the tracks so that a passing train will not strike it. Park the emergency vehicle on the same side of the tracks as the incident. This negates the need to stretch hoselines across the tracks or for personnel to be crossing the tracks.
- Position pumping apparatus so that the pump panel is located on the opposite side of the vehicle from oncoming traffic. This will protect the pump operator from being struck by a stray vehicle.

Figure 8.25 — This engine company is protecting the ambulance patient loading area. (Photo/Ron Moore, Plano, Texas)

When the incident occurs in an intersection, it may be necessary to shield the incident scene from two or more directions **(Figure 8.26)**. Whenever possible, use law enforcement personnel to assist with scene protection and redirection of traffic at these incidents. If sufficient law enforcement personnel are not available to adequately redirect traffic and protect the scene, dispatch additional fire companies and use their apparatus to shield the scene. Use the additional personnel who respond with the extra apparatus to assist with on-scene tactical operations or to perform flagging and other scene protection duties.

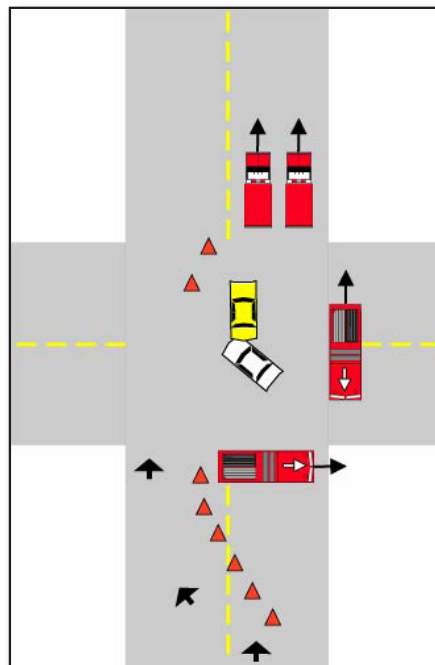


Figure 8.26 — In some cases, an intersection may need to be blocked from more than one direction.

Operations on Highways

There are numerous challenges relative to apparatus and vehicle placement, operational effectiveness, and responder safety when dealing with incidents on limited access highways. Simply accessing the scene on a limited access highway can be a challenge.

Emergency response vehicles may have to respond over long distances between exits to reach an incident. In some cases, they may be required to travel quite far before there is a turnaround that allows them to get to the opposite side of the median. Emergency vehicles must not be driven against the normal flow of traffic unless it can be confirmed that police units or highway department officials have closed the road.

The driver must use common sense when responding to an incident on a highway or turnpike. A fire apparatus usually travels slower than the normal flow of traffic, and the use of warning lights and sirens may create traffic conditions that actually slow the fire unit's response. Some fire departments have SOPs that require the driver to turn off

Figure 8.27 — Multiple blocking vehicles may be used on larger, more heavily traveled roadways. (Photo/Bob Esposito, Pennsburg, Pennsylvania)

Figure 8.28 — Multiple vehicles with warning lights may confuse nighttime drivers. (Photo/Mike Wieder)

all warning lights and audible warning devices when responding on limited access highways. The warning lights are turned back on once the apparatus reaches the scene. Only select warning lights may be used to prevent blinding the oncoming civilian drivers.

Place emergency vehicles between the flow of traffic and the personnel working on the incident to act as a shield. Park all fire apparatus at an angle so the tailboard protects the driver from traffic. Turn front wheels away from the working responders so the apparatus is not driven into them if struck from behind. Consider parking additional emergency vehicles 150 to 200 feet behind the shielding vehicles to act as additional barriers between responders and the flow of traffic **(Figure 8.27)**.

Position law enforcement vehicles so they provide a barrier and visual warning between oncoming traffic and the incident work zone. Position ambulances in a manner that protects the patient loading area from approaching traffic.

All responders must use extreme caution when exiting their vehicles. Whenever possible, firefighters mount and dismount the apparatus on the side opposite flowing traffic. Responders in other vehicles that do not allow exiting from either side must be especially careful when exiting on the exposed side of the vehicle. Similarly, personnel are extremely vulnerable to being struck by motorists if they step out of the protection offered by properly positioned apparatus.

All responders should have full protective clothing and ANSI-compliant traffic vests before exiting the apparatus. Check for approaching traffic before exiting. Personnel should exit on the nontraffic side of the vehicle whenever possible. Personnel should remember to look down to ensure that any debris on the roadway will not become an obstacle, resulting in a personal injury.

If it is necessary to move around a corner of an apparatus while working at the scene, personnel should move along the downstream, protected side of the apparatus. Stop at the corner of the vehicle and check approaching traffic. Constantly monitor traffic while getting whatever equipment is necessary and moving back to the protected side of the vehicle.

Effective Use of Warning Lights on the Roadway Emergency Scene

Especially in the initial stages of a roadway incident, emergency vehicle warning lights are essential for the safety of responders, victims involved in the incident and motorists approaching the incident. However, remember that emergency vehicle lighting provides warning only and no effective traffic control. It is often confusing to motorists, especially at night **(Figure 8.28)**. Motorists approaching from the opposite direction on a divided roadway can be distracted by emergency vehicle lighting and slow down to look at the incident, resulting in a hazard to themselves and others traveling in their direction.

The use of emergency vehicle lighting can be reduced if good TTC measures have been established. This is especially true for large traffic incidents that might involve a number of emergency vehicles. Responders can perform their tasks on-scene with minimal emergency vehicle lighting if good traffic control is established through the placement of advanced warning signs and traffic control devices to divert or detour traffic.

The MUTCD recommends that public safety agencies examine their policies on the use of emergency vehicle lighting with the intent of reducing its use as much as possible while not endangering those at the scene, especially after the incident is secured. Consider reducing or extinguishing forward-facing emergency vehicle lighting, especially on divided roadways, to reduce distractions to oncoming motorists. Turn off vehicle headlights not needed for illumination or notice of a response vehicle's location at night.

Many fire departments have adopted SOPs that call for the reduced use of warning lights for emergency vehicles that are parked on the roadway during nighttime operations. These policies include extinguishing all forward-facing lights, including headlights, and minimizing the number of lights flashing on the sides and rear of the vehicle. Some fire departments equip their vehicles with amber (yellow) flashers on the side and rear of the apparatus **(Figure 8.29)**, and require drivers to turn off all lights other than the amber lights when parked on a roadway at night. In some cases, the lights, other than the amber lights, automatically turn off when the vehicle's transmission is shifted into the park or neutral position or when the parking brake is set. An override switch is provided if it is deemed necessary to activate all the warning lights while the apparatus is parked. For example, it may be better to have all the lights activated on daylight incidents.

Figure 8.29 — Some agencies revert to all amber lighting once parked on the emergency scene. (Photo/Mike Wieder)

Figure 8.30 — Floodlights should not blind approaching motorists. (Photo/Mike Wieder)

In addition to warning lights, take caution with the use of floodlights at nighttime **(Figure 8.30)**. Floodlights provide a safe, efficient work area on nighttime incidents. However, they must be raised and deployed in a manner that does not blind motorists driving past the incident scene. When floodlights are used, they must be raised to a height that allows light to be directed down on the scene. This provides the optimum working conditions at night by improving the vision of responders, reducing trip hazards by minimizing shadows, and preventing lights from shining in the eyes of approaching motorists.

Proper Protective Clothing for Personnel Operating at Roadway Incidents

High-visibility vests should be used at all times at crashes on the roadway (Chapter 7, Figure 7.37). The only exception would be when a firefighter is directly involved in firefighting (wearing an SCBA) or hazardous materials tactical activities (wearing chemical protective clothing). Vests should be donned again once these activities conclude.

There are three general classes of vests acceptable for roadway use. These include the ANSI/ISEA 107-2004 Class 2 or Class 3 garments, and the ANSI/ISEA 207-2006 public safety vest. The latter was created to enable police and EMS personnel to more easily access items on their belts. It also offers many options for differing colors for different disciplines, and items such as badge, ID slots and pockets. In addition it allows for, but does not require, "breakaway" features in case a vest is snagged on a close passing vehicle or some other dangerous obstruction.

All department/agency SOPs must clearly dictate that all personnel wear appropriate high-visibility vests when operating on the roadway. Personnel must police themselves to ensure that their fellow responders are following this policy. The 2009 version of NFPA 1901 requires outfitting all new fire apparatus with one ANSI-compliant vest for each seating position in the apparatus.

Summary

It is important for the members of each discipline to understand both their own role and the roles of the other disciplines at the incident. Effective preincident planning is the key to efficient, predictable operations and should minimize the chance of conflicts between various disciplines.

All of the agencies that respond to highway incidents must operate under the umbrella of a common command system in order for the incident to run efficiently. Setting up a safe work zone at a roadway incident will protect responders, victims and the motorists entering the incident area. This includes following DOT requirements for temporary work zones, effective use of apparatus warning lights at roadway incidents, and protective clothing for responders. Applying principles of sound incident management will bring the incident to a safe and satisfactory conclusion.

Chapter 9
Summary and Recommendations

The USFA embarked on an ambitious mission in 2000 to reduce the number of annual firefighter fatalities by 25 percent within five years and 50 percent within 10 years. The USFA provided funding for research on the issues that were leading to injuries and deaths in order to transform the manner in which responders operate. The USFA published the research and made it available to fire and emergency services. Other federal government agencies, including the DOT, DOJ and the DHS, provided funding and assistance to the USFA for a number of these projects. Because medical and vehicle-related issues accounted for nearly three-quarters of firefighter fatalities, these were the first areas addressed with research efforts.

Historically, approximately 25 percent of all firefighter fatalities in the U.S. are the result of vehicle-related incidents. These include emergency vehicle crashes, POV crashes and being struck on the roadway. These types of incidents have also been the leading cause of law enforcement officer fatalities in 11 of the previous 12 years at the time this report was completed. Similar statistics exist for EMS, towing, highway department and other personnel who operate at incidents on or near roadways.

The USFA immediately began addressing vehicle and roadway safety following the establishment of its firefighter fatality reduction goals in 2000. In partnership with aforementioned federal agencies, the USFA authorized a series of research projects and reports aimed at improving firefighter safety relative to emergency vehicle response and roadway incident safety. These works included topics such as fire department tanker/tender safety, TIMS, emergency vehicle visibility and conspicuity, emergency vehicle warning light effectiveness, and best practices for emergency vehicle response and roadway scene safety.

In particular, one of the early projects was titled the EVSI. This project brought together a diverse group of SMEs charged with identifying the problems and hazards associated with these activities and recommending necessary accomplishments to reduce the level of hazard. The members of this panel included representatives of all of the emergency response disciplines, transportation officials, industry trade associations and government agencies. The USFA published the findings of this group in the 2004 report titled "Emergency Vehicle Safety Initiative." The USFA used findings of this report to chart the course of the other research projects that followed in the years after the release of the EVSI report.

In 2011, the USFA entered into a cooperative agreement with the IFSTA at Oklahoma State University to develop a revised edition of the "Emergency Vehicle Safety Initiative." The DOJ NIJ funded the revision of this report. The basic purpose of this project was twofold:

1. Report on and summarize all of the research that has been conducted in the past 10 years.

2. Recommend areas in which further study and improvements are necessary.

This edition provides the latest research and information on a variety of related topics, including common causes of crashes, improving vehicle design and safety, establishing effective SOPs and training to support them, and regulating emergency response and roadway scene safety.

In analyzing all the information that is contained in the report, please note the following list of recommendations relative to improving emergency vehicle and roadway incident safety:

- There must be continued effort at the local, state and federal levels to support research and provide new information on this topic to emergency responders.
- Agencies that operate emergency vehicles and/or operate at roadway incident scenes shall use the information contained in these various research reports to strengthen their SOPs, training programs and incident operations.
- Design all new emergency vehicles to meet, as a minimum, the appropriate national consensus standards for that type of vehicle. Use the information contained in the various research reports regarding enhanced emergency vehicle visibility, conspicuity and lighting as a guide to exceed minimum standards and improve vehicle and scene safety, where applicable.
- Fully train all emergency vehicle drivers for each type of vehicle that they are expected or assigned to drive.
- All agencies within a given jurisdiction must work together to ensure that roadway incident response roles, policies and procedures among the agencies are defined, consistent, applied and enforced. Interagency training sessions are useful for ensuring appropriate handling of emergency incidents.
- Train all personnel who operate at roadway incident scenes to perform their roles according to local SOPs; mutual-aid agreements; and applicable local, state and federal laws and national standards.
- Ensure that all personnel wear appropriate personal protective clothing and retroreflective vests or garments when operating at incidents on or adjacent to a roadway. The only exceptions to wearing retroreflective vests or garments are when personnel are required to wear chemical protective suits or SCBA during the course of their duties.
- Thoroughly investigate all emergency vehicle response and roadway scene incidents to determine the circumstances and causal factors that played a role in the incident. This should include all near-miss, injury, fatal or otherwise unusual incidents. Use this information to amend policies and procedures, if necessary.
- Use the NIMS-ICS at all roadway incident scenes, and ensure that all agencies and personnel operate within the command structure.
- Develop departmental regulations that require that all emergency vehicles operate at a safe and controllable speed and that all members be seated and belted when the vehicle is in motion.
- Ensure that all vehicles that respond to roadway incidents are equipped with the appropriate types and amounts of traffic control equipment and at least one retroreflective vest for each person riding on the vehicle.

Appendix
Resource Websites and Information Sources

The following websites and information sources contain useful information on emergency vehicle response and roadway incident scene safety that was available at the time this report was released. Website addresses do change on occasion and some websites are discontinued, so the availability of each of these sites cannot be ensured in the future.

Ambulance Visibility
This website provides information on international practices for increasing the visibility of emergency medical service vehicles: http://ambulancevisibility.com.

Alive on Arrival: Tips for Safe Emergency Vehicle Operations
2012 USFA publication featuring safe tips on emergency vehicle response: http://www.usfa.fema.gov/downloads/pdf/publications/fa_255f.pdf.

Battenburg Markings on Emergency Vehicles
Information on Battenburg markings for emergency vehicles: http://en.wikipedia.org/wiki/Battenburg_markings.

British Police Car Visibility Research
This Web location contains the report "High Conspicuity Livery for Police Vehicles": http://theheap.net/files/14-04-high-conspicuity-livery.pdf.

This Web location contains the report "Specification for the Livery on Police Patrol Cars": http://theheap.net/files/2-98-specification-for-livery.pdf.

California Commission on Peace Officer Standards and Training Driver Training Study
This study is located at http://lib.post.ca.gov/Publications/driver_training.pdf.

Department of Transportation Emergency Transportation Operations
The DOT FHWA website on handling roadway emergencies: http://ops.fhwa.dot.gov/eto_tim_pse/index.htm.

Department of Transportation Intelligent Transportation Systems Project
Their main website is http://www.its.dot.gov/index.htm.

Drive to Survive Website
This website has safety information on emergency vehicle safety: www.drivetosurvive.org.

Effects of Warning Lamp Color and Intensity on Driver Vision
A 2008 USFA/SAE report on this topic: http://www.sae.org/standardsdev/tsb/cooperative/warninglamp0810.pdf.

Effects of Warning Lamps on Pedestrian Visibility and Driver Behavior
A 2008 USFA/SAE report on this topic: http://www.sae.org/standardsdev/tsb/cooperative/nblighting.pdf.

Emergency Responder Safety Institute
Their main website is www.respondersafety.com.

Their "Highway Incident Safety for First Responders" PowerPoint training program may be downloaded at http://www.lionvillefire.org/hwy_safety.

Federal Highway Administration
Numerous resources are provided by the FHWA at the following websites:

"Traffic Incident Management Handbook": http://ops.fhwa.dot.gov/eto_tim_pse/publications/timhandbook/tim_handbook.pdf.

"Best Practices in Traffic Incident Management": http://ops.fhwa.dot.gov/publications/fhwahop10050/index.htm.

"Manual on Uniformed Traffic Control Devices": http://mutcd.fhwa.dot.gov.

"Simplified Guide to the Incident Management System for Transportation Officials": http://ops.fhwa.dot.gov/publications/ics_guide/ics_guide.pdf.

Firefighter Close Calls
This website contains news and other information related to all aspects of firefighter safety: www.firefighterclosecalls.com.

Hampton Roads Highway Incident Management Regional Concept for Transportation Operations
This 2008 document may be downloaded at http://www.hrpdc.org/Documents/Transportation/2008/RCTOExecSum_%20FinalCopy.pdf.

I-95 Corridor Coalition
Upload the I-95 Corridor Coalition's "Coordinated Incident Management Toolkit for Quick Clearance" at http://www.i95coalition.net/i95/Portals/0/Public_Files/uploaded/Incident-toolkit/toolkit_document_dvd.pdf.

International Association of Chiefs of Police
The Arizona Blue Ribbon report on police vehicle safety: http://www.theiacp.org/Portals/0/ppts/AZ_DPS/AZ_DPS_files/frame.htm.

International Association of Fire Chiefs' Guide to Model Procedures for Emergency Vehicle Safety
This program can be downloaded for free from the following website: http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=602.

International Association of Fire Fighters Best Practices for Emergency Vehicle and Roadway Operations Safety in the Emergency Services
This program can be downloaded for free from the following website: http://www.iaff.org/hs/EVSP/guides.html.

International Association of Fire Fighters Response and Roadway Safety Program
This program can be downloaded for free from the following website: http://www.iaff.org/hs/evsp/home.html.

"Manual on Uniformed Traffic Control Devices"
This document can be viewed online or downloaded for free at http://mutcd.fhwa.dot.gov.

Minnesota Traffic Incident Management Recommended Operational Guidelines
Their main website is http://www.dot.state.mn.us/tmc/documents/Freeway%20Incident%20Management.pdf.

National Fire Protection Association
Their various standards that apply to vehicle and roadway safety, including NFPA 1002, 1500 and 1901, can be previewed for free at www.nfpa.org.

National Fire Fighter Near-Miss Reporting System
This site allows firefighters to report and search reports on near-miss safety incidents: www.firefighternearmiss.com.

National Highway Traffic Safety Administration
Their main website is http://www.nhtsa.dot.gov.

National Incident Management System Consortium
Their main website is http://www.ims-consortium.org. Information on their publications titled "Incident Command System Model Procedures Guide for Incidents Involving Structural Fire Fighting, High-Rise, Multi-Casualty, Highway, and Managing Large-Scale Incidents using NIMS-ICS" and "IMS Model Procedures Guide for Highway Incidents" can be found at www.ifsta.org or by calling 1-800-654-4055.

National Institute for Occupational Safety and Health
The website for their Fire Fighter Fatality Investigation and Prevention Program is http://www.cdc.gov/niosh/fire.

The National Law Enforcement Officers Memorial Fund
Their mission is to generate increased public support for the law enforcement profession by permanently recording and appropriately commemorating the service and sacrifice of law enforcement officers, and to provide information that will help promote law enforcement safety. Their website is www.nleomf.com.

National Safety Council
Online defensive driving courses and information available from the NSC: http://www.nsc.org/ddc/training/ddconline_train_courses.aspx.

National Traffic Incident Management Coalition
Their main website is http://timcoalition.org/?siteid=41.

NTIMC has a variety of free training resources at
http://ntimc.transportation.org/Pages/TRAININGRESOURCES.aspx.

National Volunteer Fire Council Emergency Vehicle Safe Operations for Volunteer and Small Combination Emergency Service Organizations
This program can be downloaded for free from the following website: http://www.nvfc.org/files/documents/EVSO_2009.pdf.

North Florida Transportation Planning Organization TIMe4Safety Program
This program includes a handbook and video presentations: http://www.northfloridatpo.com/index.php?id=25.

Nova Scotia Traffic Management Guidelines for Emergency Scenes
Their main website is http://www.gov.ns.ca/lwd/firesafety/docs/EmergencyRespondersTrafficManagementGuidelines-EmergencyScenes.pdf.

State of New Hampshire Memorandum of Understanding for Statewide Traffic Incident Management
This example of a statewide Memorandum of Understanding can be downloaded here: http://www.i95coalition.org/i95/Portals/0/Public_Files/uploaded/Incident-toolkit/documents/MOU/MOU_QC_NH.pdf.

The Officer Down Memorial Page
This page provides statistics and case study information on police officer fatalities: www.odmp.org.

Police Driving International
This site is dedicated solely to improving the safety of driving police vehicles: http://policedriving.com/.

Seattle/Raleigh Fire Department Tiller Apparatus Video
This video was co-developed by the Seattle, Washington, and Raleigh, North Carolina, Fire Departments following a rollover crash involving Raleigh's tillered aerial apparatus on July 10, 2009: http://www.seattle.gov/fire/firefighting/video/Raleigh/default.htm.

State of Tennessee "Strategic Plan for Highway Incident Management in Tennessee"
This document outlines a statewide plan for highway incident management: http://www.tdot.state.tn.us/incident/CompleteIMPlan.pdf.

U.S Fire Administration
The USFA website: http://www.usfa.fema.gov.

The USFA Roadway Operations Safety Website: http://www.usfa.fema.gov/fireservice/firefighter_health_safety/safety/roadway_safety/index.shtm.

The USFA Emergency Vehicle Safety Website: http://www.usfa.fema.gov/fireservice/firefighter_health_safety/safety/vehicle_safety/index.shtm.

USFA "EMS Safety" report (FA-144): http://www.usfa.fema.gov/downloads/pdf/publications/fa-144.pdf.

USFA "Firefighter Fatality Retrospective Study" (FA-220) report: http://www.usfa.fema.gov/downloads/pdf/publications/fa-220.pdf.

U.S. Federal Highway Administration
Their "2011 Traffic Incident Management National Analysis Report Executive Summary" report is located at http://ops.fhwa.dot.gov/eto_tim_pse/docs/timsa11/tim_sa2011_ex_sum.pdf.

Their "Traffic Incident Management Handbook" is located at http://ntl.bts.gov/lib/jpodocs/rept_mis/13286.pdf.

Volunteer Fireman's Insurance Services

Volunteer Fireman's Insurance Services (VFIS) has emergency vehicle driver and instructor materials available at www.VFIS.com.

Selected Related Articles and Papers

Air Ambulance Operations: Too Little, Too Late by Slack, Michael L.
http://www.slackdavis.com/wp-content/uploads/2009/05/airambslackatla.pdf.

Unnecessary Flight Risks? by Robert Little, Baltimore Sun
www.baltimoresun.com/health/bal-te.medevac23oct23,0,1393502.story.

Texas Department of Transportation Vehicle Fleet Warning Light Policy Research
http://onlinepubs.trb.org/Onlinepubs/circulars/ec013/1CUllman.pdf.


DO NOT CROSS CENTER LINE

Acronym List

AAA	American Ambulance Association
ABS	anti-lock braking system
ACEP	American College of Emergency Physicians
ACN	automated collision notification
AED	automated external defibrillator
AHJ	authority having jurisdiction
ALS	advanced life support
AMA	American Medical Association
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AVL	automated vehicle location
BLS	basic life support
BRP	Blue Ribbon Panel
CCTV	Closed Circuit Television
CDC	Centers for Disease Control and Prevention
CDL	Commercial Driver’s License
CP	Command Post
CVPI	Crown Victoria Police Interceptors
CVVFA	Cumberland Valley Volunteer Firemen’s Association
DHS	Department of Homeland Security
DMS	Dynamic Message Signs
DOJ	Department of Justice
DOT	Department of Transportation
EMA	emergency management agency
EMS	Emergency Medical Services
EMSOP	Emergency Medical Services Outcomes Project
ERSI	Emergency Responder Safety Institute
ETC	emergency traffic control
ETO	Emergency Transportation Operations

EVOC	Emergency Vehicle Operator Course
EVSI	Emergency Vehicle Safety Initiative
FARS	Fatality Analysis Reporting System
FDIC	Fire Department Instructors Conference
FEMA	Federal Emergency Management Agency
FHP	Florida Highway Patrol
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standards
FPDS	Fire Priority Dispatch System
GPS	Global Positioning System
GSA	General Services Administration
HAR	highway advisory radio
IACP	International Association of Chiefs of Police
IAFC	International Association of Fire Chiefs
IAFF	International Association of Fire Fighters
IAP	Incident Action Plan
ICP	Incident Command Post
ICS	Incident Command System
IFSTA	International Fire Service Training Association
IP	Internet Protocol
ISEA	International Safety Equipment Association
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
JPR	job performance requirement
LED	light-emitting diode
LEDITP	Law Enforcement Driver Instructor Training Program
LODD	line-of-duty death
MHz	megahertz
MMUCC	Model Minimum Uniform Crash Criteria
MPDS	Medical Priority Dispatch System

mph	miles per hour
MUTCD	"Manual on Uniform Traffic Control Devices"
NASS GES	National Automotive Sampling System General Estimates System
NEMSIS	National EMS Information System
NEMSMS	National EMS Memorial Service
NFFF	National Fallen Firefighters Foundation
NG9-1-1	New Generation 9-1-1
NHTSA	National Highway Transportation Safety Administration
NIJ	National Institute of Justice
NIMSC	National Incident Management System Consortium
NIOSH	National Institute for Occupational Safety and Health
NSC	National Safety Council
NTIMC	National Traffic Incident Management Coalition
NVFC	National Volunteer Fire Council
OJP	Office of Justice Programs
OSU	Oklahoma State University
PIO	Public Information Officer
POC	point of contact
POST	Peace Officer Standards and Training
POV	privately owned vehicle
PPDS	Police Priority Dispatch System
PPE	personal protective equipment
PSAP	public safety answering point
PSE	planning for special events
RITA	Research and Innovative Technology Administration
RPM	revolutions per minute
RWIS	Roadway Weather Information System
SAE	Society of Automotive Engineers
SCBA	self-contained breathing apparatus
SME	subject-matter expert

SOG	standard operating guideline
SOP	standard operating procedure
SUV	sport utility vehicle
SWAT	Special Weapons and Tactics
TIM	traffic incident management
TIMA	Traffic Incident Management Area
TIMS	Traffic Incident Management Systems
TMC	Traffic Management Center
TTC	temporary traffic control
UMTRI	University of Michigan Transportation Research Institute
USFA	U.S. Fire Administration
VIDS	video imaging detector systems
VoIP	Voice over Internet Protocol