Best Practices for Emergency Vehicle and Roadway Operations Safety in the Emergency Services

Best Practices for Emergency Vehicle and Roadway Operations Safety in the Emergency Services

Division of Occupational Health, Safety, and Medicine

International Association of Fire Fighters, AFL-CIO, CLC

This project was developed through a Cooperative Agreement (Emergency Vehicle and Roadway Operations Safety Project - EMW-2008-CA-0593) between the Department of Homeland Security, United States Fire Administration and the International Association of Fire Fighters. This Cooperative Agreement supports the 2005 Memorandum of Understanding on integrated projects between the US Department of Justice - National Institute of Justice (NIJ) and the United State Fire Administration.

International Standard Book Number: 0-942920-52-X

Preface

While the daily jobs of fire fighters and law enforcement officers differ, we face a number of similar hazards as we do our jobs. Indeed, as we work together on the scene of a motor vehicle crash, both fire fighters and law enforcement officers face the danger of working near moving traffic. We also face similar hazards as we respond in our vehicles to the scene of any emergency.

The number of law enforcement officers and fire fighters killed in vehicle crashes and as the result of being struck by vehicles as they work at the roadside is disturbing and unacceptable. The purpose of this book is to provide information to both types of emergency responders that will make their jobs safer.

Information will be provided on case studies of past tragedies, loss statistics, organizational and personal responsibilities, and strategies to improve fire fighter and law enforcement officer safety while in vehicles. In addition, information will be provided on emergency vehicle lighting and markings and on safety while working at the road side.

The IAFF is very pleased to be working on this project in a Cooperative Agreement with the United States Fire Administration (USFA) supported by the National Institute of Justice, part of the United States Department of Justice. The support provided by NIJ makes this work possible and will provide significant benefits to fire fighters and our brothers and sisters in law enforcement. We are pleased to be working together on issues of mutual concern.

The hazards faced by law enforcement officers and fire fighters while operating their vehicles and while working at the roadside can be mitigated through training, policy development, education, and through technology.

As we have stated on many occasions, the key to preventing these tragic deaths and injuries is within our hands. We hope that this document serves as a basic guide for all law enforcement officers and fire fighters to improve their level of safety at work.

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Acknowledgements

The IAFF Division of Occupational Health, Safety and Medicine would like to lend its appreciation and gratitude to the United States Department of Homeland Security's United States Fire Administration and the United States Department of Justice's National Institute of Justice (DOJ/NIJ) for their commitment to first responder health and safety and for providing the funding for the development of this report. Special thanks are due to USFA Fire Program Specialist William Troup for his particular efforts towards improving emergency responder safety related to emergency vehicle response and roadway safety.

The IAFF extends its deepest appreciation to all of the fire and law enforcement agencies, local unions, and other organizations who allowed their stories and photographs to be used as examples and cases studies within this document. These examples are presented not to assess blame or ridicule, but rather to learn from these often difficult lessons so that they may not be repeated in the future.

The IAFF also greatly appreciates the following other people and organizations for their efforts in reviewing and providing comments to strengthen this document:

- Richard J. Ashton, Grant/Technical Management Manager, International Assoc. of Chiefs of Police
- Jack Sullivan, International Association of Fire Chiefs Safety and Health Section
- Les Korelis, Emergency Vehicle Training Instructor, Federal Law Enforcement Training Center

Special appreciation is extended to the members of the following fire departments who staged numerous photographs that were used in developing this program:

- McKinney, Texas Fire Department Local 4017 and Training Chief Ron Moore
- Frisco, Texas Fire Department Local 3732
- Plano, Texas Fire Department Local 2149
- Oklahoma State University Police Department

We also wish to thank FACETS Consulting; Kevin Roche, Fire Protection Engineer, Phoenix Fire Department; and Mike Wieder, Executive Director, IFSTA, Oklahoma State University for their efforts in developing this report.

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Section 1

Introduction

Regardless of the discipline, all emergency responders face a wide variety of hazards to their health and safety. While a good number of these hazards are discipline-specific, many of them also happen to be hazards that apply across all disciplines. Historically, most disciplines chose to address these common hazards from within their own perspective, failing to explore the solutions that may have already been found in one of the other response disciplines.

Fortunately, many state and federal agencies have begun to realize the benefit of cross-jurisdictional collaboration on issues that are germane to two or more disciplines. This belief was the basis for a 2005 Memorandum of Understanding on integrated projects between the United States Department of Justice's National Institute of Justice (DOJ/NIJ) and the United States Fire Administration (USFA). The leadership of these two organizations realized the value of working together and to date have already accomplished a variety of successful ventures.

One area that is certainly a serious concern and that touches both the fire service and law enforcement worlds is that of emergency vehicle response and roadway scene safety. As will be shown later in the report, these two areas rank among the leading causes of injuries and deaths to both fire fighters and police officers. As the numbers of vehicles on roadways continues to grow and those vehicles tend to drive faster and faster, it is imperative that fire and law enforcement officials work together to develop strategies and policies to minimize these hazards to their members.

Both of these agencies have previously worked on these issues within their own fields. The DOJ/NIJ has completed a number of initiatives related to these important issues. The USFA previously developed documents such as the *Emergency Vehicle Safety Initiative, Safe Operation of Fire Tankers*, and a series of related programs in collaboration with the International Association of Fire Fighters (IAFF), the International Association of Fire Chiefs (IAFC), and the National Volunteer Fire Council (NVFC).

In 2006, the DOJ/NIJ and the USFA began to collaborate on a number of issues related to emergency vehicle response safety and roadway scene safety issues that affected both disciplines. The first project, *Effects of Warning Light Color and Intensity on Driver Vision*, focused on determining what are the most effective types and colors of emergency vehicle warning lights. Other research partners on this project include the Society of Automotive Engineers (SAE) and the University of Michigan Transportation Research Institute. The second project, titled *Emergency Vehicle Visibility and Conspicuity,* focused on the effectiveness of reflective markings that are being used on emergency vehicles. The development of this report was actually conducted by the International Fire Service Training Association (IFSTA) at Oklahoma State University. With

support from the U.S. Department of Transportation, IFSTA and the USFA also teamed up to develop the report *Traffic Incident Management Systems (TIMS)* in 2008. This document focuses exclusively on roadway scene safety.

The report you are viewing here reflects the next step in the DOJ/NIJ and USFA partnership. The purpose of this document is to examine issues related to emergency vehicle response and roadway scene operations that are common to both police and fire agencies. In order to develop this document the USFA formed a cooperative agreement with the IAFF. The USFA and the IAFF previously worked together on the *Improving Apparatus Response and Roadway Operations Safety in the Career Fire Service* project. This new project is seen as an extension of the previous work to include similar information as it applies to law enforcement agencies.

This report covers a variety of topics related to response and roadway scene safety. Section 2 examines cases studies from incidents where fire fighters or police officers were injured or killed as a result of these types of incidents. The case studies bring to life the hazards fire fighters and police officers face when they operate their vehicles and work on the roadway. Section 3 shows the magnitude of the problem by exploring the various statistics we have related to incidences of emergency vehicle collisions and responders being struck on the roadway.

Both organizations and individuals have responsibilities in improving response and roadway scene safety. Section 4 highlights these responsibilities. Section 5 addresses the common causes of these incidents and provides strategies for the reduction of these hazards. Section 6 provides the latest information on emergency vehicle lighting and reflective markings. Section 7 provides information on safely and effectively managing incidents that occur on the roadway.

A couple of points regarding the law enforcement information in this report must be understood before proceeding. First, data and information relayed in this report only cover incidents and situations involving law enforcement automobile collisions and officers being struck while working on the roadway. They do not include motorcycle, bicycle, and aircraft incidents, except where noted to make a specific point. Secondly, although police pursuit-related data may be included in the overall injury and death statistics, information on police pursuit procedures is beyond the scope of this report. Lastly, the information in this document is geared toward responding to incidents such as collisions, fires, and other types of incidents on the roadway requiring the response of multiple units and agencies. The topic of safe procedures for traffic enforcement vehicle stops for law enforcement officers are not within the parameters of this document.

It is hoped that the information in this document will be accepted and placed into use by all fire and law enforcement agencies alike. There is no agency that cannot benefit by at least some of the information contained in this document. Clearly, the lives of all of our emergency responders can be better guarded by applying the principles applied here within.

Section 2

Case Studies

It can't happen to me! I am a good driver. It was a one-in-a-million situation that I will never experience. These are typical statements or thoughts that, unfortunately, many law enforcement and fire personal commonly believe. It always happens somewhere and to somebody else. Of course, we all must realize that if we do not follow the basic principles of response and roadway safety, these incidents can happen anywhere, anytime, and to anybody.

One way to effectively convey this message is to relate a series of case studies of actual incidents that have occurred. One can assume that most of the people involved in these incidents also uttered the statements made above at some point or another. In the end they learned (if they survived the incident) that these incidents are not all that rare and they do happen everywhere. When you read the case studies contained in this section, think back to all the times you might have found yourself in one of these situations, but because of skill, training, luck, or a combination of these factors you managed to avoid becoming one of these case studies. You may not be so lucky if there is a next time. We must recognize the significance of these situations in order to avoid them in the future. As the old saying goes, "you can only cheat the Devil for so long."

The purpose of relating these case studies is not to affix blame, embarrass, or otherwise cast negative aspersions on the individuals or organizations who were involved in these incidents. They are truly intended to impress upon the reader the how quickly they themselves can become a statistic or case study.

FIRE SERVICE CASE STUDIES

As we will see in the next section of this guide, traffic-related injuries and deaths account for a significant percentage of the total injuries and deaths to fire fighters in the U.S. each year. Following are several case studies that display the hazards of emergency vehicle response and roadway scene safety that all fire fighters face at some time or another.

Fire Response Safety Case Study # 1

On Saturday morning April 2, 2005, Fort Lauderdale Rescue 8 (an ambulance staffed by two personnel) was returning to quarters after dropping off a patient at Broward General Hospital. The ambulance exited the SE 3rd Avenue ambulance exit from the hospital and proceeded north on SE 3rd Avenue. As Rescue 8 proceeded north through the intersection with a green traffic signal at NE 3rd and Broward Boulevard, an eastbound Honda Civic traveling at a high rate of speed struck Rescue 8. The car struck the ambulance near the rear of the patient compartment on the driver's side. Personnel in Rescue 8 reported that the ambulance seemed to shift towards the right and then back towards the left. At

that time they noted numerous objects flying through the cab of the apparatus. The ambulance ended up resting on the driver's side, with both personnel being restrained by their seatbelts (**Figure 2.1**).

The fire fighters self-extricated themselves through the missing windshield opening **(Figure 2.2)**. Upon exiting the cab, the lesser of the injured fire fighters found a portable radio that had been thrown from the ambulance and used it to call dispatch to report the collision. This fire fighter then found a fire extinguisher and extinguished a small fire under the hood of the Honda Civic and sought assistance from civilians and a police officer on the scene to start treating the trapped driver of that vehicle **(Figure 2.3)**. He also checked on the welfare of the second fire fighter. By that time other fire department personnel arrived on the scene and took charge of the incident.

Both fire fighters received minor injuries and were treated and released from the hospital. The driver of the Honda Civic had to be extricated from his vehicle and was transported as a high priority trauma-alert to a local hospital. Rescue 8 was totally destroyed in the incident.

Lessons Learned From This Incident

In reviewing the details of this incident, the student should recognize the following important points:

1. **Fire fighters must always wear their seatbelts whenever riding in a vehicle that is in motion.** In this incident a vehicle traveling at a high rate of speed struck the fire fighters. As a result their ambulance rolled over and skidded a considerable distance. During the process the front windshield was completely dislodged from the vehicle. Had the fire fighters not been properly belted, it is likely that they would have been ejected from the vehicle and suffered more serious, possibly fatal, injuries.
2. **Use caution when driving through all intersections, even when you have the right of way.** In this incident Rescue 8 had a green light and the right-of-way to proceed through the intersection. A vehicle that drove through a red traffic signal at a high rate of speed struck them. Fire apparatus drivers must always be prepared to take defensive actions, even when they have the right-of-way.

Fire Response Safety Case Study # 2

At approximately 17:15 hours on Sunday September 5, 2004, Kansas City, Missouri Fire Department Pumper 33 was one of several fire department units who were dispatched to a reported fire at an apartment complex (this would turn out to be a very minor incident). Pumper 33 was traveling southbound on Blue Ridge Avenue (a four-lane street) with their siren and lights activated. As they did so they approached a southbound passenger vehicle that appeared to come to a complete stop in the left (inside) lane. In reality the second vehicle was slowing to make a left hand turn into a driveway at that location.

Figure 2.1

Figure 2.2

Figure 2.3

As Pumper 33 approached the slowing vehicle they crossed left of center in an attempt to pass the vehicle. At that time the slowed vehicle turned left towards the driveway and into the path of Pumper 33. Pumper 33 struck the vehicle with a glancing blow and veered across the northbound lanes of Blue Ridge Avenue **(Figure 2.4)**. Pumper 33 collided head-on with a 2nd passenger vehicle that had pulled over to the curb to yield right-of-way to the approaching fire engine **(Figure 2.5)**. After striking this vehicle, Pumper 33 sheared off a utility pole and then struck a large tree. The main point of impact was in front of the officer's seat position **(Figure 2.6)**.

The driver of the car who turned in front of Pumper 33 was not seriously injured. The driver of the second vehicle struck by Pumper 33 required extrication and was critically injured. The 57 year-old acting captain riding in the front of Pumper 33 was killed and the driver was seriously injured. Two other fire fighters on the apparatus were not seriously injured.

In the ensuing investigation it was revealed that Pumper 33 was traveling approximately 51 mph in a 35 mph speed zone at the time of the initial collision. It was also calculated that the pumper was traveling approximately 34 mph when it struck the second vehicle and 24 mph when it struck the tree. An inspection of the apparatus braking system revealed that the brakes were out of proper adjustment. The braking system had not been properly serviced for a period of 16 months before the collision. The KCFD maintenance program had been backlogged due to a severe shortage of reserve apparatus. The final report noted that the improperly adjusted brakes were not an issue with the initial collision. However, properly operating brakes should have been able to stop the apparatus before it struck the tree, which was the fatal blow for the acting captain in the passenger seat.

Lessons Learned From This Incident

In reviewing the details of this incident, the student should recognize the following important points:

1. **Driver/operators should use extreme care when moving the apparatus left of center in the roadway.** Apparatus should be moved left of center only when absolutely necessary and then should do so with caution. Proceed past stopped vehicles slowly to ensure that they do not enter your lane of travel.
2. **Fire apparatus should undergo regular maintenance to ensure that all systems, including the braking systems, are operating properly.** All apparatus should be maintained in accordance with manufacturer's recommendations and specifications. This is especially crucial for systems that impact vehicle safety, such as the braking and steering systems. In this incident the faulty braking system would not have prevent the initial collision, but likely would have prevented the fire fighter fatality following the first crash.

Figure 2.4

Figure 2.5

Figure 2.6

Fire Response Safety Case Study # 3

On November 28, 2005, a 25-year-old male career fire fighter of the Calera, Alabama Fire Department was alone while driving an engine with its lights and sirens operating to a dispatched medical emergency situation at approximately 0900 hours. The engine was following a rescue truck with an officer and a fire fighter who were dispatched from the same station. The victim was traveling north on a divided county road and approaching an intersection with turning lanes and a traffic light that controlled traffic entering the roadway from an interstate off-ramp **(Figure 2.7;** *Courtesy of NIOSH*).

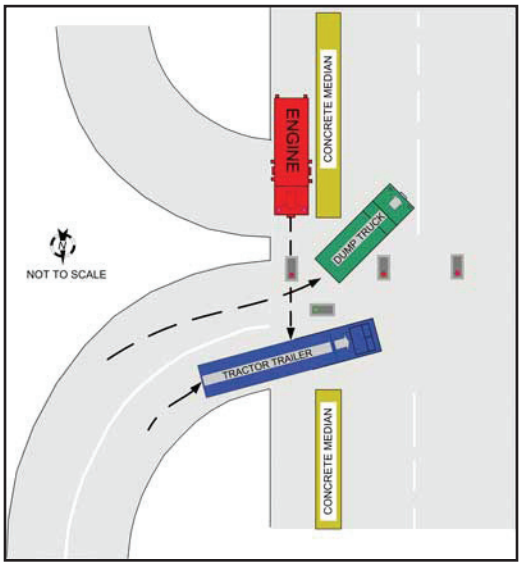


Figure 2.7

As the engine approached the intersection the traffic light turned red. The light for the off-ramp turned green and a dump truck drove into the intersection just in front of the engine, and proceeded south on the county road in the opposite direction. A tractor trailer in a lane adjacent to the dump truck also entered the intersection. The engine missed the dump truck and struck the tractor trailer. The front driver's side of the engine contacted the tractor trailer at the beginning of the trailer section. *Note: The angle of the tractor trailer behind the dump truck could have shielded it from the line of sight of the victim. There weren't any skid marks on the road indicating that the engine's brakes possibly failed or the driver's vision was obscured. The collision could also have been a combination of both the brakes and obscured vision. There were reports from multiple fire fighters who drove this apparatus that the brakes would fail without warning. The department reportedly attempted to fix the problem in house and through the city's maintenance department. The department also reported that they had the brakes changed in the spring of 2005 by an outside mechanic who had previously been certified and employed by a fire apparatus dealer.*

Figure 2.8

The force of the impact drove the tractor trailer through the intersection and lodged the engine under the trailer. Due to the cab over engine design of the chassis, the cab on this type of apparatus does not place anything in front of the driver's compartment (i.e. motor, bumper, frame) to provide protection from a frontal collision. The front driver's side area received the full impact of the collision **(Figure 2.8;** *Courtesy of NIOSH*). The front of the engine and dashboard were crushed inward trapping the victim's lower extremities. The steering wheel was pushed in toward the victim who was wearing a lap belt. The seat was forced up lodging the victim's torso against the steering wheel.

Rescue crews arrived on the scene within minutes of the crash. Due to the extensive damage, the crews had to operate for approximately 45 minutes to remove the victim, who was responsive throughout the extrication. He was flown to a local trauma center where he died as a result of his injuries.

Lessons Learned From This Incident

In reviewing the details of this incident, the student should recognize the following important points:

1. **Fire departments have an obligation to ensure that all apparatus are properly maintained and in safe working order.** In this incident there had been multiple occasions where the brakes on this apparatus were noted to be not operating correctly. The apparatus should not have been returned to service until its mechanical condition had been assured.
2. **Apparatus driver/operators should be prepared to stop the apparatus at all intersections.** Although there was some question about the mechanical condition of the braking system in this case, it was not 100% clear that this was the cause of the collision. It also appears that (assuming the brakes were functional) the driver/operator failed to slow or stop the apparatus when approaching a negative right-of-way situation at an intersection.

Fire Response Case Study # 4

On February 7, 2007, an engine company from the Detroit, Michigan Fire Department was dispatched as part of a multiple unit response to a working (arson) structure fire. The apparatus was being operated with lights and siren activated. It was staffed by an officer, engineer, and two fire fighters.

As the apparatus responded through an intersection the apparatus was struck by a full-sized SUV that approached from the right side of the apparatus at a high rate of speed. The force of the collision deflected the path of the apparatus and it ended up on the opposite side of the roadway. Both the engineer and the company officer were ejected from the apparatus. The engineer was ejected through either the driver's side door or the windshield and was run over by the apparatus and trapped under the rear wheels. He died at the scene. He was unable to be removed until a large wrecker arrived at the scene.

Police reports indicated that the SUV disregarded the flashing traffic control light at the intersection and the warning lights on the apparatus. At the time of impact it was estimated that the SUV was traveling 80 mph and the apparatus was traveling between 15 and 30 mph.

The other three fire fighters on the apparatus were injured. The driver of the SUV was killed and three passengers were injured.

Lessons Learned From This Incident

In reviewing the details of this incident, the student should recognize the following important points:

1. **Apparatus occupants must be seated and belted at all times the vehicle is in motion.** In this case neither the engineer nor the company officer was wearing their seatbelts at the time of collision. It is likely that that the engineer would have survived this crash had he worn his seatbelt. The company officer would also not have been ejected from the vehicle had he been wearing his seatbelt.
2. **Apparatus driver/operators should be prepared to stop the apparatus at all intersections.** Although there was some question about the mechanical condition of the braking system in this case, it was not 100% clear that this was the cause of the collision. It also appears that (assuming the brakes were functional) the driver/operator failed to slow or stop the apparatus when approaching a negative right-of-way situation at an intersection.

Fire Roadway Scene Safety Case Study # 1

On July 27, 2007, the Sasser, Illinois Fire Department responded to a tractor-trailer fire on an interstate highway. Three fire trucks were on the scene and were parked on the right shoulder and the first traffic lane to the left of the shoulder. Safety cones had been placed in the roadway and all apparatus warning lights were activated.

The response of the state police was significantly delayed. The Incident Commander declined offers of assistance from local law enforcement agencies offering traffic control assistance, citing the lack of traffic on the highway.

At approximately 04:15 hours one fire fighter was replacing equipment that had been used into a compartment on the driver's side of the vehicle. The fire fighter was struck by a passing bus and thrown over 200 feet to the side of the road. The fire fighter suffered fatal injuries. The bus driver was charged with negligent homicide and reckless driving.

Lessons Learned From This Incident

In reviewing the details of this incident, the student should recognize the following important points:

1. **All sources of assistance for traffic control should be used at all incidents on the roadway.** It is possible that the additional traffic control that could have been provided by local law enforcement officers could have routed the bus further away from the apparatus. Never turn down qualified assistance in these situations.
2. **Personnel should never operate between the apparatus and the oncoming flow of traffic.** In this case the fire fighter was on the oncoming traffic side of the apparatus. If equipment cannot be stowed in its normal location with the fire fighter being directly exposed to oncoming traffic, it should be stowed in a temporary location on the safe side of the apparatus until a safe location for proper storage is located.

Fire Roadway Scene Safety Case Study # 2

On December 23, 2000, Chicago, Illinois Fire Department Truck 27 was dispatched at 02:45 hours to the site of a motor vehicle collision on an expressway to provide a traffic shield with their apparatus and to assist ambulance personnel. Two state police cars were positioned upstream (behind the ladder truck) in a further attempt to divert traffic from the work zone.

As the original incident was being concluded, the 37-year-old lieutenant (who had just been promoted to that rank two weeks previously) walked around the Truck 27 to make sure that everything was ready to go. As the lieutenant walked on the upstream side of the truck, a passenger car ran over a line of flares in an attempt to slip by traffic. The car then struck a tractor-trailer, spun, and pinned the lieutenant between the car and the ladder truck. The lieutenant was treated at the scene and then airlifted to the hospital. His legs were crushed in the collision and he had lost a substantial amount of blood. He died 10 hours later.

The driver of the car that struck the lieutenant was determined to be under the influence of alcohol and driving on a suspended driver's license. He was later charged with reckless homicide. There were no injuries in the original collision. The Chicago fire commissioner was quoted as saying "I have a hard time calling this an accident; this was a crime, an absolute crime."

Lesson Learned from this Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measure had been taken:

1. **Fire fighters operating at roadway incident scenes should not place themselves between apparatus or other barriers and oncoming traffic.** In this incident, the lieutenant was between the apparatus and on coming traffic when he was struck and mortally wounded. Apparatus should be designed and positioned to avoid the need to retrieve equipment from exposed areas when at all possible.

LAW ENFORCEMENT CASE STUDIES

As will be detailed in Section 3 of this document, traffic related incidents are the leading cause of deaths in the law enforcement community. Detailed below are a number of case studies to highlight these issues.

Law Enforcement Response Safety Case Study # 1

On Sunday October 22, 2006 at 10:05 a.m., a 29 year-old West Yellowstone, Montana police officer was dispatched to a traffic crash on US Highway 20 in Gallatin County, Montana. The initial crash, involving a sport utility vehicle with a trailer, occurred approximately 6 miles west of West Yellowstone.

The officer responded to the crash in his marked SUV with emergency lights activated. The temperature was 21°F and the road was wet and icy in spots. US 20 is two lanes wide and runs east-west. He was traveling west on a section of road that is straight and level. As he passed two vehicles going in the same direction as he was, the officer lost control of his vehicle. The SUV went into a skid, rolled one and one-half times, and hit a tree on the south side of the road. He was declared dead at the scene, due to severe head trauma.

The crash investigation determined that the officer was not exceeding the posted speed limit but was going too fast for the icy road conditions. The officer was not wearing his seat belt. The officer had been with the West Yellowstone Police Department for just over two years.

Lessons Learned From This Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measures had been taken:

1. **The vehicle must be operated in a safe manner and at a safe speed based on the condition of the roadway.** In this case even though the officer was within the posted speed limit, the speed at which he was operating was too fast to safely negotiate the icy road conditions.

2. **Avoid risky vehicle maneuvers when road or traffic conditions may not be safe for them to be successfully performed.** This officer attempted to pass two vehicles while operating on an icy road surface. It is likely that this movement led to the loss of control of the vehicle and resulted in the fatal crash.

3. **Police officers must wear their seat belts at all time while the vehicle is being driven.** The chances of being severely injured or killed increase exponentially when the occupant is not wearing their seatbelt. There is absolutely no acceptable excuse for officers not wearing their seatbelts when their vehicle is moving.

Law Enforcement Response Safety Case Study # 2

At about 03:00 hours on February 17, 2007, a 33 year-old Durham, North Carolina police officer was responding to help another officer who called for assistance after stopping a vehicle for suspicious activity. The officer was a two-year veteran of the department, but also had served 6 years as a Duke University police officer prior to being hired by Durham. He was also a Marine Corp veteran who saw service in Afghanistan.

While en route the police officer lost control of his police vehicle as he approached an intersection, slid off the road, and his side of the car struck the concrete bridge support pillar for North Carolina Highway 70. The officer was pronounced dead at the scene.

Lessons Learned From This Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measures had been taken:

1. **Operate your vehicle at a reasonable speed so that control of it may be maintained at all times.** In this case it is apparent that the officer was operating at a higher speed than he was able to control the vehicle at. This resulted in a skid that ultimately led to the fatal collision. The driver has no control when a vehicle is sliding sideways.

Law Enforcement Response Safety Case Study # 3

On May 11, 2006, a 40 year-old Illinois State Police Acting Master Sergeant began work at 07:00 in the position of Commander of the Special Investigations Unit in the Champaign, Illinois region. He was a 16-year veteran of the ISP. In this role, he was called to assist with an investigation concerning a local police department's SWAT action that resulted in a subject shooting himself.

As a result of this activity, the Sergeant remained at work well beyond his normal eight-hour shift and did not go off duty until almost 02:00 on May 12. Less than six hours later, at 07:40, the Sergeant began his next shift and subsequently performed follow-up activities regarding the aforementioned incident. At approximately 16:30 that afternoon, he left the office for home in the covert agency vehicle he was authorized to use for commuting purposes. While traveling west on a county road near Bondville, IL and talking on his cell phone to a friend, the Sergeant apparently did not see a stop sign and skidded through an intersection, where his car was struck in the passenger side by a southbound pickup truck. The Sergeant's vehicle then impacted a utility pole and came to rest in a ditch. While the other motorist was not seriously injured, the Sergeant was pronounced dead at the scene of multiple blunt force trauma.

Lessons Learned From This Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measures had been taken:

1. **Police officers must be extra cautious in situations where fatigue may be a factor.** Officer fatigue is frequently cited in cases where officers are injured, killed or make otherwise poor judgments. The nature of an officer's duties sometime requires him or her to work longer than normal hours. This not only has an impact on the officer's action during the first extended period, but may also have an impact on the next work period if sufficient rest and sleep is not obtained between the two work periods.
2. **Officer should limit the use of communication devices while driving the vehicle to a minimum.** Police officers are more highly trained and experienced in vehicle operations than the typical civilian and they also are accustomed to talking on radios or cell phones while the vehicle on a routine basis. However this does not necessarily mean that they may not become distracted at times and fail to observe safe driving practices. In this case the officer was talking on the cell phone and failed to stop at a stop sign resulting in the collision. The officer's level of fatigue also likely added to the loss of attention.

Law Enforcement Response Safety Case Study # 4

On the night of August 5, 2007, the 54 year-old police chief of the Port Barre, Louisiana Police Department left the police station in an attempt to assist officers with a vehicle and foot pursuit of a suspect. The chief had been involved in law enforcement for more that 30 years. The police chief was traveling eastbound on US Route 190 and lost control of his vehicle before he could become involved in the pursuit.

The police chief's vehicle partially exited the roadway. When he overcorrected to the right the vehicle rotated off the highway, struck a group of trees, and then traveled back across the road. The police chief was ejected from the vehicle and was pronounced dead at the scene shortly after midnight on August

6, 2007. Due to the extent of damage to the car, investigators were unable to determine conclusively whether or not the police was wearing his seatbelt at the time if the crash.

The vehicle being pursued also eventually crashed and all four occupants fled on foot. They were all in custody by 03:45 on August 6th.

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measures had been taken:

1. **Operate your vehicle at a reasonable speed so that control of it may be maintained at all times.** In this case it is apparent that the police chief was operating at a higher speed than he was able to safely control the vehicle. This resulted in the vehicle leaving the driving surface and ultimately led to the fatal collision.

2. **Police officers must wear their seatbelts at all time while the vehicle is being driven.** Although the investigation of this incident was inconclusive as to whether the victim was wearing his seatbelt, it appears likely that he was not. Instances of people being ejected from a car when properly belted are fairly rare. The wearing of seatbelts at all times that the vehicle is in motion cannot be overemphasized. Seatbelts significantly reduce the level or injury of possibility of death when involved in a crash.

Law Enforcement Roadway Safety Case Study # 1

On June 14, 2008, a North Carolina Sheriff's deputy and a volunteer assistant fire chief were fatally injured after being struck by a tractor-trailer on a four-lane highway at the scene of a previous motor vehicle collision. Visibility at the time of the incident was described as near-zero due to fog and smoke from a fire on a nearby military range.

The truck driver attempted to slow his tractor-trailer down after encountering the smoke and fog and swerved suddenly to miss a vehicle parked on the highway. The tractor-trailer struck Sheriff's deputy #2's patrol car, positioned partially on the shoulder and left lane, in the right rear quarter-panel. The patrol car skidded to the left striking Sheriff's deputy #2 and knocking him into the median and injuring him. The tractor-trailer continued north in the left lane striking the fire officer and Sheriff's deputy #1, killing them on impact. It is believed that Sheriff Deputy #1 had just finished providing instructions to move the parked vehicle in the right northbound lane. The tractor-trailer then swerved right striking a vehicle in the right northbound lane that was involved in the first northbound incident. The tractor-trailer finally came to rest against the rear doors of an ambulance parked in the left northbound lane.

The Highway Patrol estimated the speed of the tractor-trailer was 55 mph when approaching this area and 50 mph upon striking the first vehicle. The tractor-trailer tire skid marks before striking the patrol car were 54 feet in length and the tractor-trailer traveled 167 feet after striking the patrol car.

Lessons Learned From This Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measure had been taken:

1. **Ensure that police officers (and fire fighters) responding to a scene involving a highway incident control oncoming traffic first, before addressing the emergency.** In this case there was a significant delay between arriving on the scene and addressing the visibility and roadway safety issues that were present.
2. **Ensure that emergency vehicles are parked in a manner to protect work areas when operating at roadway incident scenes.** In this case there were police and fire personnel operating outside of the safety zone that a properly positioned emergency vehicle would have created.
3. **In extremely low visibility situations, the roadway in the area of the incident scene should be completely shut down while personnel are working on the roadway.** In these situations the approaching traffic, even at appropriate slow speeds may not be able to see personnel or vehicles in time to prevent from striking them.

Law Enforcement Roadway Safety Case Study # 2

At about 14:00 hours on June 16, 2007, a 31 year-old Howard County, Maryland Police Department officer was part of a three-person team conducting a speed enforcement detail on eastbound Maryland Route 32. This officer was a highly decorated 6 ½-year veteran of the department who specialized in traffic enforcement. At the time of this incident the officer was working overtime as part of a grant-funded program to abate speeding. He normally worked night shifts in the county's southern police district, based in Laurel.

The officer targeted a speeding Nissan Sentra traveling eastbound on MD 32. He stepped into the outside lane and signaled the operator of the speeding vehicle to move to the shoulder of that lane. The 24 year-old female operator of the vehicle failed to yield to the officer's directions, made an evasive maneuver in an attempt to avoid a collision, applied the brakes, and swerved to the right. Despite the fact that the officer was wearing an approved safety vest, it is believed that the driver never saw the officer until a split second before striking him. The vehicle struck the officer and, as both the vehicle and the officer continued east, the officer's body vaulted the roof of the vehicle and came to rest in the inside lane. Officer was airlifted to the University of Maryland Shock Trauma Center where he was treated and later pronounced dead due to severe head trauma.

Following this incident numerous Maryland law enforcement agencies, including Howard County and the Maryland State Police, suspended the practice of performing "step out" speeding enforcement activities.

Lessons Learned From This Incident

In reviewing the information contained in this case study, the reader should recognize that incident could have been avoided or its severity lessened if the following measure had been taken:

1. **Reconsider the use of "step out" speeding enforcement activities.** In these activities the officer stand on the shoulder of the road until a radar instrument indicates the approach of a speeding motorist. The officer then move either near to or into the lane of traffic and then flags the speeding vehicle over to the shoulder. This practice places the officer in an inordinate amount of danger as he or she is exposed directly to speeding vehicles.

CONCLUSION

There is a famous saying that states those who fail to recognize past experiences are doomed to repeat them. This seems to be the situation in the case studies presented in this chapter. None of these incidents were unique or of the type that had never been seen before. On the contrary, they were types of incidents that had been repeated many, many times before. It is hoped that the highlighting of these incidents in this document will set the groundwork for a more serious attempt at avoiding them in the future with the information that is contained later in this report.

Section 3

Law Enforcement and Fire Department Response and Roadway Incident Loss Statistics

While the case studies in Section 2 bring to life the types of incidents that can occur when operating an emergency vehicle or operating at a roadway incident, the true magnitude of the problem cannot be explored without looking at the statistics for law enforcement officer and fire fighter injuries and deaths. The serious scope of this problem becomes very evident when these figures are reviewed.

Many people find statistics and data to be boring and not useful. Nothing could be further from the truth. The review of statistics such as these emphasizes where issues of particular concern are located and allows us to prioritize addressing those situations that have the largest impact on our health and safety.

For an example in fire service terms, many fire departments and training agencies in recent years have spent an enormous amount of time, resources, and energy in developing firefighter rapid intervention programs and procedures. The ability to rescue a firefighter in need is very important and must be part of the overall training program and fire department standard operating procedures.

However, a review of the statistics shows that the incidents where a rapid intervention team (RIT) or rapid intervention crew (RIC) team is needed or make saves are drastically lower than the incidents where better apparatus driver/operator training and procedures can make a positive difference in a critical situation. In short, the number of injuries and deaths related to response and roadway incidents *vastly* exceed the number of injuries and deaths in fire fighter incident scene entrapments and rapid intervention situations. Training programs and policy development should be commensurate with the level of hazard. The sad truth is that most agencies spend much less training on regular apparatus driver/operator training drills and roadway safety training than they do on preparing for the much less likely hazard scenarios.

Similar parallels can also be drawn in the law enforcement field. Law enforcement officers are more likely to be injured or killed in response or roadway situations, than they are in gun- or weapon-related incidents. Yet many agencies have strict requirements for regular training and recertification on firearms, but do not have similar requirements for driver training or roadway safety practices. Accordingly, recruit and in-service training programs must reflect the importance of addressing the situations in which injury and death are most likely.

FIRE FIGHTER FATALITIES

Historically, fire fighters deaths related to response and roadway incidents are the second leading cause of all fire fighter fatalities. Over the 12 years (1996-2007) for which complete figures were available, vehicle collisions claimed 257 fire fighter lives and another 53 fire fighters were lost as a result of being struck by a vehicle. (**Table 3.1**) Between 1996 and 2007, vehicle collisions/struck-by incidents accounted for 24% of all fatalities. In 2003, this figure jumped dramatically to 35% of all fatalities with 34 fire fighters killed in vehicle collisions and 5 struck by vehicles.

Those past 12 years are reflective of the longer term statistics. Through the years, on average, about 25 percent of all fire fighter fatalities are response or roadway scene related. The number of these deaths is second only to cardiac-related deaths, which annually account for about 45% of fire fighter deaths.

Table 3.1
Fire Fighter Fatalities in Vehicle Collisions and Struck by Vehicles: 1996-2007

Year	Total Deaths	Vehicle Collision	Struck by Vehicle	Percent of Total Deaths
1996	99	17	3	20
1997	100	22	5	27
1998	93	17	4	23
1999	113	11	5	14
2000	103	21	7	27
2001	106*	21	4	24
2002	101	24	7	31
2003	112	34	5	35
2004	119	20	6	22
2005	115	25	3	24
2006	106	19	3	21
2007	118	26	1	23

Source: U.S. Fire Administration, *Fire FIghter Fatality Reports* (1996-2007)

* **Note:** The 2001 figures do not include the 343 fire fighters who died in the September 11, 2001 terrorist attack on the World Trade Center in New York City. Statistically, a loss of this unprecedented proportion is an anomaly that would skew the annual results.

The types of vehicles involved in fatal collisions have remained consistent over this time period as well; privately owned vehicles (POV) continue to be the most common vehicle involved in fire fighter fatalities responding to and returning from an incident. Approximately 40% of response-related deaths occur in POVs. The vast majority of these are volunteer fire personnel.

As for actual fire apparatus, the most likely apparatus to be involved in a collision fatal to fire fighters are water tankers/tenders. In a 2003 United States Fire Administration (USFA) report entitled *Safe Operation of Fire Tankers*, a study of fatal crashes over an 11-year period revealed that 21 percent of the crashes fatal to fire fighters involved tankers/tenders. This was more fatalities than in crashes involving pumpers and aerial apparatus *combined*. This is despite the fact that the USFA estimates that tankers/tenders account for only about 3% of the nation's total fire apparatus fleet and only respond on a small percentage of their department's calls.

A report released by the Centers for Disease Control (CDC) in 2005 also provides some interesting comparative data related to this study. The CDC report titled *Fatal Injuries Among Volunteer Workers — United States, 1993-2002* looked at the causes of deaths in all areas of volunteerism in the United States. This report noted that fire fighters accounted for 185 deaths (37%) of the 501 fatal injuries to volunteers of all types. The single most common volunteer activity (in all volunteer disciplines) at the time of death was firefighting, with 76 deaths (15%) recorded. Driving a motor vehicle (e.g. automobile, truck, or farm vehicle) was recorded in 100 (21%) of the fatalities in all volunteer activities. Fifty four percent (54%) of fatalities in volunteer workers aged 34 years or less were volunteer fire fighters or firefighting supervisors.

Perhaps most interesting to note, in relation to the topic of this document, is the fact that the CDC report showed that 21% of the total fatalities experienced by volunteers in all disciplines were vehicle-related. This figure is very consistent with the fire service's own experience in this area. What this number may be telling us is that although any number of injuries and deaths is unacceptable, the number of vehicle-related deaths that the fire service experiences is not out of line with those in the general population of the U.S. This does not mean, however, that we cannot improve upon those statistics.

FIRE FIGHTER INJURIES

Table 3.2 on page 20 shows the summary of fire fighter injuries occurring during response and return from 1990 through 2006, the most recent years available at the time this report was written. What is statistically interesting in these numbers is the fact that while vehicle-related deaths account for a fairly significant percentage (second leading cause overall) of fire fighter deaths, they actually account for only a small percentage of overall fire fighter injuries.

Interestingly, these numbers tend to mirror the fire service's experience with cardiac-related injuries and deaths. Heart attacks and strokes are the leading killer of fire fighters. On average, these events are responsible for 40 to 50% of fire fighter deaths annually. However, cardiac events account for less than 2% of all fire fighter injuries. What this tells us about both cardiac and vehicle-related events is that while they tend to be lower in frequency in the grand scheme of overall fire fighter casualties, when they do occur they are serious events.

Table 3.2 Fire Fighter INJURIES RESPONDING To/Returning From Incidents: 1990-2006					
Year	Fire Apparatus Collisions	Fire Apparatus Collisions Injuries	POV Collisions	POV Collisions Injuries	Crash Injuries as a Percent of all Fire Fighter Injuries
1990	11,325	1,300	950	175	N/A
1991	12.125	1,075	1,375	120	N/A
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

LAW ENFORCEMENT OFFICER FATALITIES

Those who are not familiar with recent actual statistics may assume that the largest cause of law enforcement officer deaths on annual basis is firearms-related incidents. This is a natural assumption because of the duties police officer perform and clientele with which they deal. This may also be possible because the truth is that firearms-related deaths were the leading causes of deaths among police officers in days gone by. In particular, in the early and mid 1970's more than half of all police officer deaths were gun-related.

However, significant progress has been made in reducing the number of gun-related deaths in police officers in recent decades. Among other things, this can be attributed to better training procedures and advances in body armor and protective vests. Whereas gun-related deaths accounted for more than half of all police officer deaths in the 1970s, in 2008 they represented less 30% of the deaths reported.

According to statistics kept by the National Law Enforcement Officers Memorial Fund, 2008 represented the 11th consecutive year that vehicle-related incidents were the leading cause of police officer deaths. Deaths involving automobile and motorcycle crashes, as well as officers being struck by vehicles, accounted for a little more than half of all law enforcement officer deaths. Seventy-one officers died as a result these incidents in 2008. In fact, specifically, more officers died in automobile crashes (44) than by gunfire (41) in 2008. It should also be noted that 2008 actually marked an improvement over 2007 when there were 83 fatalities in vehicle-related incidents. **Table 3.3** shows the number of law enforcement officer deaths due to vehicle-related incidents since 1998.

Table 3.3
Vehicle Related Law Enforcement Officer Deaths
1998-2008

Circumstance	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Automobile Collision	48	41	42	36	40	50	48	39	38	49	44	475
Motorcycle Collision	3	6	6	7	7	10	10	4	8	6	10	77
Struck by Vehicle (Total)	14	9	14	19	12	10	10	11	13	12	17	141
Traffic Stop or Road Block	4	3	7	7	4	6	3	5	4	7	N/A	50
Directing Traffic or Motorist Assistance	10	6	7	12	8	4	7	6	9	5	N/A	74

It is clear that law enforcement agencies need a broad training program that prepares officers for safely handling the many dangers that they face on a regular basis, including assaults and gun-related incidents. However what the above information seems to suggest is that perhaps additional effort needs to be placed on vehicle and roadway safety. History has shown that with increased training, refinement of procedures, and advances in technology that gun-related deaths have been drastically reduced in the past 30 years. Similar efforts must be placed on vehicle and roadway safety. If that effort is undertaken, similar results can realistically be expected.

LAW ENFORCEMENT OFFICER INJURIES

Unlike the records on officer fatalities kept by several organizations, finding long-term data on police injuries as a result of vehicle crashes or being struck by vehicles is not so simple. During the course of this research no reliable source of long term data on these injuries was able to be located.

However, some useful information that puts some perspective on this issue was gleaned from a 2007 report issued by the National Safety Council (NSC). In that report the law enforcement data for the three-year period of 2004 to 2006 was reviewed. During that period 81,707 total crashes involving law enforcement vehicles were documented. This averaged out to about 27,235 per year. During that three-year period approximately 37,655 law enforcement officer injuries were reported.

The report also noted that police vehicles were in 3.4 times more crashes than fire and EMS vehicles during that period. Without further examination this may seem to be an alarming figure however that should not be the case. If you examine the operations of these three disciplines it is quite obvious that 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 mph. Costs from non-emergency response crashes were four times higher than pursuit and emergency response combined.

CONCLUSION

A review of the statistics of law enforcement officer and fire fighter injuries and deaths due to motor vehicle collisions and being struck by vehicles emphasizes the scope of the problem we are facing. These account for a significant percentage and, in some cases, the majority of injuries and deaths to these responders each year. What is more frustrating is the knowledge that so many of these incidents could be prevented if better techniques and judgment were used. We will never be able to completely eliminate all crashes and struck-by incidents, the nature of our duties will always place us in risk of them. However, by using the information that is contained in the remainder of this report we can make significant progress in reducing the number of occurrences of these situations.

Section 4

Organizational and Personal Responsibilities

In order to reduce the number of injuries and deaths to law enforcement officers and fire service personnel due to vehicle collisions and being struck while operating in the roadway, all parties involved must take responsibility for addressing and solving the problem. This includes agency administrations, labor organizations, and individual members. If any one of the links in this chain fails, the likelihood of unnecessary injuries or deaths increases.

While the services that law enforcement agencies and fire departments provide are obviously different, the responsibilities associated with managing the hazards and reducing risks associated with vehicle response and roadway scene safety are generally similar. The following section highlights the responsibilities of each of these entities.

Figure 4.1

DEPARTMENTAL RESPONSIBILITIES

All employers have an obligation, both legally and morally, to provide safe working conditions to the extent possible. Obviously, because of the nature of the duties performed by law enforcement officers and fire fighters this task becomes immeasurably difficult for all activities performed outside the confines of departmental facilities **(Figure 4.1;** *Courtesy of Ron Moore, McKinney, TX F.D.*). Once police officers or fire service personnel leave their stations and go to work on the streets, they are exposed to an almost endless array of hazards.

The fact that these responders are working in an uncontrolled, hazard-filled environment does not mean that measures cannot be put in place to minimize the risk that fire fighters and police officers face. On the contrary, significant reductions in hazards can be made if there is a commitment from both the organization and the individuals serving within it. In this section we will examine some of the measures that organizations can use to manage this risk.

Develop and Enforce Standard Operating Procedures

In this report we will refer to operational rules and policies of the agency as *standard operating procedures* or SOPs. There are a variety of other terms that

can be applied to these regulations, including standard operating guidelines, protocols, administrative guidelines or orders, directives, and agency policies. These terms generally all mean the same thing.

One of the primary means by which agencies establish consistent operations and manage risk is through the adoption and enforcement of SOPs. SOPs allow agencies and the personnel working within them to operate in a predictable and efficient manner. The SOPs must be developed in such a manner that they allow effective delivery of services without overly compromising the safety of people following the SOPs.

The development and enforcement of SOPs related to emergency vehicle response procedures and roadway incident scene operations are particularly important due to the level of hazard these operations pose for responders. The development of the SOPs is the responsibility of the agency administration, 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. Examples of the topics that must be contained in these SOPs include:

- Minimum training requirements
- Vehicle inspection and maintenance procedures
- Emergency and non-emergency operations
- Safe positioning of vehicles
- Establishing traffic management areas
- Command responsibilities and procedures

It is important that when developing SOPs for emergency vehicle responses and roadway incidents that the SOPS conform to applicable state and national laws and standards. These include state and federal laws, national consensus standards, state and federal requirements, and the U.S. Department of Transportation's *Manual for Uniformed Traffic Control Devices* (MUTCD) **(Figure 4.2)**. SOPs that are in conflict with these regulations can place the agency and the individuals with those agencies in a significant amount of liability and risk.

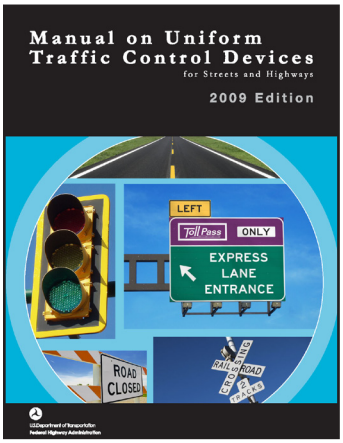


Figure 4.2

To develop, maintain, and revise SOPs is only one-half of the equation. If the agency fails to educate the members on these procedures and then also fails to consistently enforce them, the best SOPs in the world are worthless. Agencies must hold members accountable for following the SOPs. Lacking accountability, SOPs often get disregarded leading to unsafe behaviors, unnecessary damage, injuries, and deaths.

Provide Adequate Training

It is important that all agencies ensure that their personnel are trained appropriately for the duties that they are expected to perform. In the fire service this is required by NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*. Specific minimum training requirements are then spelled

out within the various professional qualifications standards. In the law enforcement community this is most commonly addressed in state-level requirements for peace officer training.

It goes without saying that all personnel must meet minimum training standards before being allowed to perform their duties in the field. It must be recognized that in some cases the initial training the officer or fire fighter received truly is the minimum required to be certified. In areas of particular safety concern, such as vehicle operations and roadway scene safety, additional initial training beyond the minimum may be warranted.

The training that is provided in recruit-level training 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 being adequately maintained and to determine if additional training is warranted.

In addition to requiring refresher training on a specified time schedule, there are other triggers 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.

Another common and crucial trigger for required in-service training is whenever a police officer or fire apparatus driver/operator is expected to drive a new or different type of vehicle. Examples of this situation include:

- A police officer being switched 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 being switched from a standard patrol cruiser to an SUV or pick-up truck.
- A police or fire officer who is switching from a front-wheel drive to rear-wheel drive vehicle or vice versa.
- A police officer or fire apparatus driver/operator being assigned for the first time to a vehicle with an antilock or auxiliary braking system.
- A fire company receiving a new vehicle to replace their older model.
- A fire company or police officer receiving a reserve vehicle while their primary vehicle is being repaired or otherwise serviced.
- A fire apparatus driver/operator being assigned to a different vehicle than those he or she was trained on. For example, the addition of a water tanker/tender or aerial apparatus to a fleet that previously had none **(Figure 4.3, P. 26)**.

Numerous cases can be cited where the examples above were not heeded and the result was a serious, in some cases fatal, crash occurring.

The training that is provided, both at the recruit level and in on-going training programs must meet all applicable recognized standards and protocols. Training may be provided from in-house personnel or through other organizations such

Figure 4.3

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.

One new tool that is being used in driver training programs across all of the emergency fields are computer-operated driving simulators. These simulators provide the trainee with a fairly 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 whatsoever. It would be impossible to safely simulate these situations using real vehicles and driving areas.

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. A study of police officer driver training that was conducted by the California Commission on Peace Officer Standards and Training (POST) came to the conclusion 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 timeframe to reinforce decision-making to prevent collisions. The POST report also noted the following findings:

- Driver training technologies such as the SkidCar and driving simulators allow for situational training that cannot (safely) be undertaken in a "real" setting.
- 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.

Conduct a Formal Review of All Collisions

As stated earlier in this report, those who fail to recognize past events are doomed to repeat them. This is certainly the case in the area of vehicle and roadway safety. Much can be learned from reviewing previous incidents where losses were incurred. However, in order to be able to do that, an agency must be diligent in thoroughly investigating all crashes and struck-by incidents within their agency. The focus on this review must be to identify the circumstances and causes surrounding these incidents.

Figure 4.4

Agencies should have formal procedures for handing these investigations **(Figure 4.4)**. There are a number of important things that should be considered. First is the liability associated with any of these incidents. Procedures used to investigate these incidents must be done with the protection of the agency and individuals involved in mind. Another issue is that of objectivity, as seen both from within and outside the organization. Even the appearance of nonobjectivity can have major consequences for all of those involved. Therefore it is common in many jurisdictions to have an outside organization be involved, or even take the lead in investigations of this type. For example, fire departments should allow the appropriate law enforcement agencies to perform their duties as required by statute. Fire service representatives from outside the involved agency may also be asked to provide an objective review of the incident.

Each law enforcement agency should have a policy on how crashes involving their vehicles will be handled and that policy must be adhered to at all such incidents. 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 case. Even if an outside agency is assigned to formally investigate a collision an internal review is still needed to identify corrective measures, if any, that must be undertaken.

Data that is collected from these investigations should be reviewed and stored appropriately. It can be invaluable in identifying patterns or issues that need to be addressed to reduce the chances of future similar incidents from occurring. It is important to document poor driving performance. In many cases the behavior was most likely exhibited in the past. Supervisors must observe, document and correct deficiencies and discipline policy violations and be held accountable if they do not.

Lastly, it is important that the 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 is no compromise when it comes to issues of safety.

Procure Safe and Effective Vehicles

One manner in which law enforcement agencies and fire departments are similar is the manner in which we deliver our service. In both these disciplines we take our service to the customer's location, not vice versa. In order to deliver our service we need appropriate vehicles to convey us to the necessary location and to facilitate the delivery of that service.

It is incumbent on agencies in both disciples to procure safe and effective vehicles from which their members can do their jobs. While the vehicles will typically vary significantly between the police and fire services, the basic factors that go into their selection and use are generally similar in nature. Agencies seek to select vehicles that maximize the member's service delivery, that are as safe as possible, and that balance with the fiscal capabilities of the organization.

First and foremost, both police and fire vehicles must be designed in accordance with the motor vehicles 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.

In the fire service, all new fire apparatus must also be designed to meet the requirements of National Fire Protection Association (NFPA) Standard 1901, *Standard for Automotive Fire Apparatus*. This standard specifies the minimum design and performance requirements for most types of fire apparatus (**Figures 4.5 a to c**; *Figures b and c Courtesy of Ron Jeffers, Inion City, NJ*). Similar

Figure 4.5a

Figure 4.5b

Figure 4.5c

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

There is no comparable national standard for the design and performance of standard police patrol vehicles. These requirements are typically determined by the agency purchasing the vehicle and usually involve modified versions of standard passenger and sport utility vehicles **(Figures 4.6 a and b;** *Courtesy of Jose Ybarra*). The typical modifications include upgraded drive-line 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. Again, agencies should ensure that modifications and vehicles in general are in compliance with applicable state motor vehicle codes and Society of Automotive Engineers (SAE) recommendations.

Figure 4.6a

Figure 4.6b

The police agency should also evaluate the types of vehicles that compose their fleet and determine which of those are acceptable to be operated in high-speed applications 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.

Some police agencies operate vehicles that are larger than standard patrol-type vehicles. These may include SWAT vehicles, rescue apparatus, command post vehicles, bomb squad vehicles, and similar special types of apparatus **(Figures 4.7 a and b)**. The NFPA 1901 standard serves as an excellent reference for the design and specifications for these types of vehicles.

Figure 4.7a

Figure 4.7b

Properly Maintain Vehicles

As stated in the previous section, procuring safe and effective vehicles is very important. However, even the most well-designed, safe, and high-performance vehicles will quickly because ineffective and potentially dangerous should they not be properly maintained for the duration of their service lifetime. All agencies should have and enforce standard operating procedures (SOPs) for vehicle maintenance procedures. The primary goal of this program is to keep all vehicles in a safe and operable condition. The SOP must dictate the responsibilities of the vehicle operators, command officers, and maintenance personnel relative to vehicle maintenance. This includes timetables and procedures for performing regular vehicle maintenance. There must be an agreed upon list of conditions that warrant the removal of a vehicle from service when it is deemed to be 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 a potentially unsafe condition.

The SOP should 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 and fire apparatus driver/operators 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. The SOPs should also dictate what conditions may be corrected by the member and which require the attention of a designated mechanic. Depending on the agency, repairs may be made by a maintenance division of the organization or by private service companies contracted by the agency.

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

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.

Any of the above conditions justify the removal of the vehicle from service. **Personnel must not operate vehicles that they feel are unsafe**. Personnel with appropriate automotive repair training and certifications must perform repairs. Major components of a vehicle being repaired should be thoroughly tested before being placed back in service.

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

Agencies must also establish policies relative to the storage of loose equipment within the passenger riding compartment of the vehicle. It recent years it has become increasingly common to mount and store a variety of tools and equipment within fire apparatus cabs 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. Equipment found in the police car passenger compartment may include firearms, mobile computers, flashlights, clipboards, and similar equipment.

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 over having to retrieve 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 fire fighters who would have otherwise been uninjured in relatively minor collisions.

It is highly recommended that fire department establish policies that minimize the storage of tools and equipment in the apparatus passenger compartment, including self contained breathing apparatus. Breathing apparatus cannot be properly donned while wearing a seatbelt and 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 4.8, p. 34)**. Fire fighters who are seated and belted may don the SCBA facepiece 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 fire fighter 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 their organization.

Figure 4.8

Obviously, police patrol vehicles do not have the outside storage space that most fire apparatus have. They typically only have a trunk. Equipment that absolutely must be ready at hand in the passenger compartment must 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. Poor trunk packing practices was noted as the cause for about one-third of the officer fatalities that occurred in collisions involving Crown Victoria Police Interceptor (VCPI) vehicles. These can be prevented by proper storage of the trunk's contents.

LABOR ORGANIZATION'S RESPONSIBILITIES

Much of the responsibilities for establishing and enforcing policies, procedures, and programs related to vehicle response and roadway scenes lies with the agency administration. However, the administration is not alone in this respect. Both the labor organization and the members it represents must also play a role in making their operations safer.

The members of most law enforcement agencies and career fire departments are represented by some type of formal labor organization, or union. Typically, this labor unit is a local affiliate of a larger national or international organization such as the Fraternal Order of Police (FOP) or the International Association of Fire Fighters (IAFF). In a small percentage of cases the members may be affiliated with a different trade or local government labor organization.

Figure 4.9

Another situation that affects some agencies is the presence of more than one labor organization representing the members. An example of this would be one union local that represents rank and file level members and a second union that represents higher ranking officers.

Regardless of the affiliation of the labor unit, the union should strive to work with the department administration when developing operational policies and procedures that relate to the safety and efficient operations of its member. Conversely, the agency administration must be open to the concerns and input of the labor organization when developing these policies. Development and implementation plans that are inclusive of all affected parties from the beginning of the process have a greater chance of success once they are placed into use.

The leadership of the local union may choose to be directly involved in the development of these types of policies and procedures or it may choose members from its ranks to represent the local's interests. Regardless of who is involved, it should be the role of these participants to provide balance and a user's perspective on the work that is being done. The union representatives must ensure that the policies being developed are reasonable and provide for the maximum safety of their fellow members.

Perhaps the most important responsibility of the labor organization is to establish a culture of safety and compliance with policies and SOPs within its ranks. Assuming that reasonable policies and SOPs are in place, there simply should be no tolerance for operating outside those procedures, particularly where member or public safety in involved. The issues discussed in this document represent some of the most critical areas affecting the safety and well-being of officers and fire fighters. The leadership of the local must impress this fact upon

their membership and be willing to hold them accountable when the members fail to adhere to these critical safety functions. When the members of the labor unit police themselves in a responsible manner, there is less need for formal disciplinary procedures to be undertaken by the agency administration.

PERSONAL RESPONSIBILITIES

All of the response and roadway scene safety policies and SOPs in the world will be of little use or help if officers and fire fighters fail to abide by them. The most basic responsibility of any emergency responder is to first and foremost account for their own safety and well-being. Failing to operate within the manner in which you were trained and within the established SOPs of the agency is counteractive to personal safety.

Each member must hold themselves and the members they work 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 that needs to be worried about. However, when someone begins to operate beyond the bounds of safe practice, then the other members who are witnessing 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 agency and/or labor organization) to stand up and address or stop unsafe behaviors when they are observed. Much information on these issues can be gleaned from reviewing documented stories found on the International Association of Fire Chief's *National Fire Fighter Near-Miss Reporting System* (www.firefighternearmiss.com).

Each member must exercise reason and good judgment as they relate to emergency vehicle and roadway scene operations. Assuming that each member has been properly trained and is knowledgeable on the agency's procedures, the member must have the ability to apply that information in an appropriate manner.

For example, ambulances are given certain motor vehicle code privileges as they relate to standard driving procedures that other motorists are not given. Depending on the jurisdiction, ambulances may be allowed to exceed posted speed limits, proceed against red lights after stopping, and other actions that are beyond standard motor vehicle code requirements when facing an emergency situation. However, should that ambulance be operated in the emergency mode, driving at excessive speeds, proceeding against negative right-of-way while transporting a juvenile with stable vital signs and a possible simple fractured wrist to the emergency room, the operation of this vehicle in this manner would not be within reason and would show poor judgment on behalf of the operator and the crew in the ambulance. This is not an emergency situation requiring these types of response procedures to be employed.

Finally, although this is a subject that is often overlooked in standard treatments of this topic, it cannot be overemphasized that the officer's or fire fighter's level of personal wellness and fitness plays an important role in this issue. Many cases can be cited where a police officer or fire fighter suffered a medical emergency,

such as a cardiac event, while operating the vehicle that led to a serious crash. As well, 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 and wellness for the job they are performing. While some medical emergencies may occur regardless of the level of fitness and wellness, their chances are greatly reduced when the responder is healthy and fit. All fire fighters and law enforcement officers must take responsibility for living a healthy lifestyle and maintaining an appropriate level of fitness.

CONCLUSION

Using safe procedures for operating emergency vehicles and working at roadway incident scenes is everyone's responsibility. Certainly, the agency administration, the labor organization, and each individual member play important parts in this overall responsibility. The failure of any of those parts to function responsibly and operate outside the bounds of safe practice is unacceptable and must not be tolerated. All of these parties must work together to ensure maximum member safety.

Section 5

Improving Response-Related Safety

To this point in the report we have focused on the "hows" and "whys" of the ways response and roadway scene collisions occur. Understanding this information is important in order to recognize the scope and magnitude of the problem. However, it is critically important we go well beyond a simple understanding of the problem and use this information to develop safe practices and policies that will help us avoid these losses in the future.

This section of the report deals specifically with the major causes of law enforcement and fire service response-related crashes and the ways they can be mitigated in the future. Included in this discussion is a look at agency response policies, how they may contribute to the problem, and how they can be modified to lessen the chances of a response-related incident in the future.

COMMON CRASH CAUSES AND THEIR PREVENTION

The services that police, fire, and emergency medical services provide can be quite different in nature. However, when looking at vehicle response crash data, statistics, and case histories, it quickly becomes evident that the causes of vehicle crashes across these disciplines are, for the most part, strikingly similar. This section will examine the common causes for all emergency vehicle crashes and place particular emphasis on issues that tend to affect one discipline more than others.

Intersections

Across all emergency disciplines, the most likely place to be involved in a collision with another vehicle is intersections. This is because intersections are the most likely location for the emergency vehicle to come into contact with other vehicles that are directly in their path of travel. Most commonly emergency vehicles collide with civilian vehicles whose drivers fail to yield to the emergency vehicle **(Figure 5.1, p. 40)**. In other cases the driver of the emergency vehicle disregards safe practice and the laws that dictate the manner in which they are supposed to traverse an intersection, especially in a negative right-of-way situation. Lastly, on occasion two emergency vehicles will strike 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.

When considering intersection safety, it is important to consider the theory behind proceeding through red lights and stops signs and realizing what is really gained by this practice versus the level of hazard it presents. In theory, 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

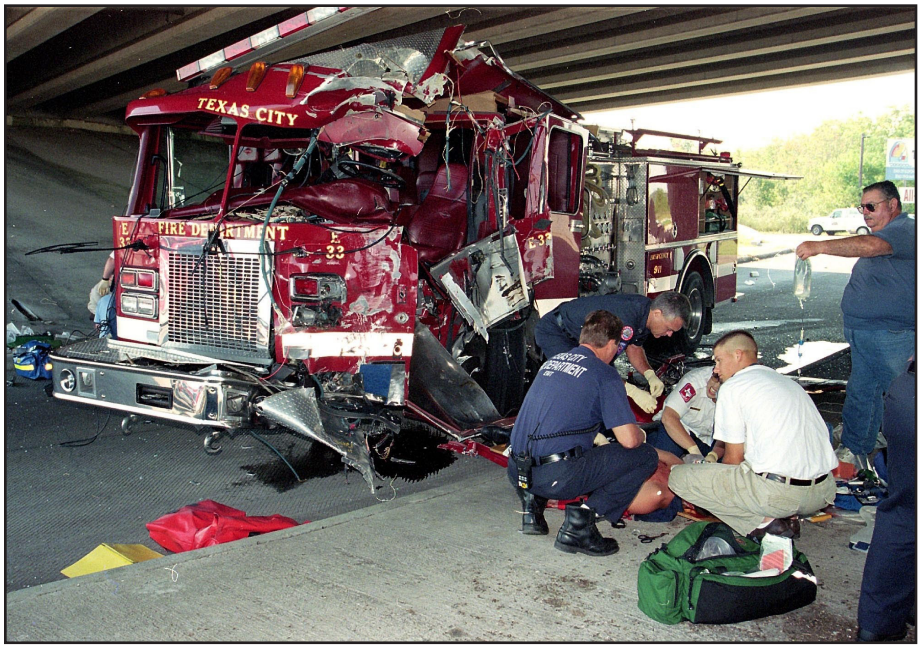


Figure 5.1

urgency of the event to which they are responding. However, as we will discuss later in this section, in many cases we are responding to incidents that do not truly necessitate this sense of urgency.

Furthermore, in reality 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 2-3 seconds per intersection in fire apparatus. This figure may even be less in police vehicles, as they tend to have quicker stopping and acceleration capabilities than do larger fire apparatus. Assuming that a fire apparatus may encounter five negative right-of-way intersections during an average response, the total response time may be extended by only 10-15 seconds. Rarely, if ever, could it be identified that an additional 15 seconds during a response had a significant impact on the outcome of the incident. On the other hand, there is no doubt of the significance of the apparatus being involved in a collision because of failure to use safe intersection procedures and the impact the collision has on the fire fighters and any civilians they strike.

The same is true of law enforcement vehicles. Passing through negative right-of-way intersections without stopping places officers and the driving public at an unnecessary level of risk. Because of the factors mentioned in the previous paragraph, coming to complete stops at intersections in police vehicles probably increases the overall response times even less than it does for fire apparatus. There few, if any, situations serious enough to warrant proceeding through negative right-of-way situations at intersections without first coming to a complete stop. **We are in the business of solving problems. You cannot do that if you become part of the problem!**

This concept was clearly identified in a classic, graphic episode of the popular television show *COPS*. Two officers on patrol in a large western U.S. city were dispatched to assist other officers in capturing an armed robbery suspect. The officers approached and entered what was a clearly visible four-way stop intersection without slowing or stopping the vehicle. Upon entering the intersection, this vehicle was struck by another police department vehicle that also entered the intersection from a cross direction without stopping. The result was four injured officers, two injured *COPS* camera crew members, two totaled police vehicles, and the inability of any of the involved parties to be able to assist in the incident to which they were responding.

Given that intersections are the most likely place in which an emergency vehicle will be involved in a collision, it is important that SOPs and training reinforce safe procedures for getting through them. The application of a few basic principles will greatly increase the safety of vehicles traversing the hazard zone.

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). Most local law enforcement agencies have similar policies.

It should be noted that some state motor vehicle codes actually do not require emergency vehicles to come to a complete stop at negative right-of-way intersections. One example is found in the State of Ohio's Revised Code, Section 4511.03:

> *Ohio Revised Code 4511.03*
> *Emergency vehicles at red signal or stop sign.*
>
> *(A) The driver of any emergency vehicle or public safety vehicle, when responding to an emergency call, upon approaching a red or stop signal or any stop sign shall slow down as necessary for safety to traffic, but may proceed cautiously past such red or stop sign or signal with due regard for the safety of all persons using the street or highway.*

While this may be granted in the state code, all agencies should set stricter policies than allowed by law. Many of these motor vehicle codes (regardless of how they may be titled) have not been substantially revised for decades and are not reflective of modern traffic conditions or recognized best and safe practices for emergency responders.

When the vehicle has two members riding in the front, such as with two police officers or a fire apparatus driver/operator and a company officer, both the occupants must work together when negotiating intersections to ensure that the vehicle safely makes its way through.

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, the vehicle must be slowed to a speed that would allow for an expedient stop if necessary. Situations where an expedient stop may be required include if there are any obstructions, such as buildings or trucks, that block the driver's view of the intersection or the driver cannot ensure that all other vehicles have stopped to give the vehicle the right of way.

At busy intersections, the driver must remove his or her foot from the throttle pedal and place it on the brake pedal so that there will be no delay if the need to stop occurs. 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 the vehicle is moving at the time, this technique can save anywhere from 30 to 60 feet of travel/stopping distance. In critical situations this 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 on an emergency response may proceed through a red traffic signal or stop sign after coming to a ***complete*** stop according to NFPA 1500. Local SOPs on this issue for law enforcement agencies may differ from jurisdiction to jurisdiction. Do not proceed into the intersection until you are certain that every other driver sees you and is allowing you to proceed. Simply slowing when approaching the intersection and then coasting through is not an acceptable substitute for coming to a complete stop. When proceeding through the intersection, attempt to make eye contact with each of the other drivers to ensure that they know you are there and about to proceed. This method is not foolproof. The only sure way is to visually ensure that all other vehicles have come to a complete stop.

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 5.2)**. 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 must be closely monitored.

The driver must also try to note if a green signal he or she is approaching 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 seconds or so before the green signal turns to yellow.

Figure 5.2

Figure 5.3

Some jurisdictions use traffic control devices to assist emergency vehicles in negotiating intersections during their response. The driver must be aware of the traffic control devices used in his or her jurisdiction and how they operate. Depending on the jurisdiction, these devices may be activated by a strobe light on the vehicle, by the sound of the vehicle's siren, or by a global positioning sensor (GPS) on the vehicle **(Figure 5.3)**. When the system receives the signal from the approaching emergency vehicle, the traffic signal turns to green in the emergency vehicle's direction of travel and red in all other directions of travel. This will, in theory, allow the emergency vehicle to safely get through the intersection, assuming that all the other drivers obey the traffic signals they get.

Traffic 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 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.

Whether or not the jurisdiction utilizes traffic control devices, the driver must be especially mindful of the possibility of encountering other emergency vehicles in intersections. Over the years many serious collisions between emergency vehicles have occurred in intersections. In some cases the vehicles were responding to the same incident and in others they were going to separate calls. By following the procedures discussed above, these types of collisions can be avoided. Some jurisdictions, particularly in the fire service, make it a practice for a vehicle occupant to make a radio broadcast when they are approaching an intersection in which they feel they may encounter another fire apparatus. This action does not take into account vehicles that are operating on a different radio frequency than the approaching apparatus. While any action that increases safety is a good idea, in reality if proper driving techniques are used and the vehicle comes to a complete stop when facing a red signal, this radio transmission is completely unnecessary.

In cases where multiple vehicles will be leaving the same location en route to a call, all vehicles must take the same route of travel and maintain a distance of 300-500 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 in to the lane of travel.

This policy also reduces the chances of the emergency vehicles encountering each other in an intersection near the incident scene. In the early 1990's an engine and truck company from a midwestern U.S. career fire department left the station at the same time and took different routes to the same fire. About two blocks from the incident scene the vehicles violently struck each other in an intersection resulting in injuries to all the fire fighters, demolishment of both apparatus, and complications at the working fire that was the reason for their response. This could have been avoided by following each other to the scene and by using proper intersection driving techniques.

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 list excessive speed of the vehicle as one of the primary contributing factors to the cause of the crash. There exists an old adage that "speed kills." This 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 emergency vehicles, or any other vehicles for that matter. The problems associated with excessive speed manifest themselves in a number of ways:

1. The vehicle is unable to negotiate a curve in the road **(Figure 5.4)**.
2. The vehicle is unable to stop before hitting another vehicle or object **(Figure 5.5:** *Courtesy of Jose Ybarra***)**.
3. The vehicle is unable to stop before entering an intersection or railroad crossing.
4. A weight shift occurs when the vehicle is slowed, causing it to skid or overturn.
5. Control of the vehicle is lost after hitting a pothole, speed bump, or similar defect in the driving surface.
6. 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) leave the road surface **(Figure 5.6)**.
7. Tire traction is lost on wet, icy, snowy, or unpaved road surfaces.

Figure 5.4

Figure 5.5

Fire and police departments 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 to slow down, but never give 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 it to be maintained under control, on the roadway, and able to stop within a reasonable distance. This speed will need to be reduced if the road is wet, icy, or unpaved.

During training, the driver must develop a sense of what the safest maximum speed for operating the vehicle is under a variety of conditions. Training must begin at low speeds and increase only as the driver becomes more comfortable driving the vehicle. 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.

In truth, there is little fire service tactical advantage to be gained by increasing the apparatus speed by 10-15 miles per hour. 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. Fire departments who wish to decrease response times will have much better results by improving dispatch handling times, station turnout times, and other factors than they will be 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 do the fire service. This is most likely due to the wider range of emergencies to which police officers respond. Much more discretion on speed is left to the individual officers operating in the field. 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. Through experience officers should learn to make these types of judgments and limit high speed responses to only those situations where it is *likely* to be necessary. Many law enforcement driving instructors liken the judgment on whether to use a more rapid response to that when 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, it all boils down to a couple of simple facts. 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, and any number of other reasons. The increased speed reduces that reaction time to adjust for these situations. Secondly, 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 the vehicle on dry surface. This distance is further increased on wet, snowy, or icy roads. An increased stopping distance increases the likelihood of running into some type of other object before the vehicle can be brought to a stop.

As the rest of this report is reviewed, the reader will note that the issue of excessive speed comes back time and time again. It 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 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 5.7)**. 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. A 2003 USFA report that focused specifically on water tanker/tender crashes found that over an 11-year period, 66 percent of fatal crashes were the result of the right side wheels leaving the road surface. A review of cases 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 5.7

Generally, the simple act of the tires leaving the paved surface does not create a significant hazard in and of itself. 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. However, most crashes that occur when the right side wheels leave the paved surface are as a 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 of control of the vehicle **(Figure 5.8)**. In other cases, the vehicle may stay on the roadway, but the jerking action of jumping back onto the paved surface causes the rear end of the vehicle to swing out in a counterclockwise motion, causing the vehicle to slide and/or overturn.

Figure 5.8

The best way to avoid these collisions is to simply keep all the wheels on the road surface at all times. 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 towards the right edge of the road. The following are a few tips for keeping 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 their right side.

Even though our goal is to keep the vehicle on the road, driver must be trained in how to react should the wheels drift off the right side of the paved surface. 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 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 in the roadway may be the next most dangerous place to drive an emergency vehicle. Numerous serious emergency vehicle collisions have occurred when the vehicle failed to safely negotiate a curve in the roadway. 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 apparatus wheels on the road surface.

This is a particularly important issue for the fire service as entering a curve at an excessive speed is particularly dangerous due to fire apparatus' 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/operator is able to keep the apparatus wheels on the road surface, these forces may cause the apparatus to slide and/or rollover once in the curve. In order to keep the apparatus 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 of a speed, either the vehicle's right side wheels or, in severe cases, the entire vehicle will leave the road surface. Once this occurs, there are a variety of things (almost all bad) that can occur. These were detailed in the previous section. 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 to the instability situation.

In many cases, the highway department posts 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 5.9**). 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 such as fire apparatus or police tactical 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.

Figure 5.9

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. Unfortunately this is not the case in the real world in which we live and operate. Even though this practice is required by law in virtually all jurisdictions, a substantial portion of the vehicles in our travel path do not clear the way on almost every response we make. If all of the other vehicles moving in the same direction as us are moving at the same or a higher speed than us, this is not much of an issue. It becomes a serious issue as we approach a slower vehicle who fails to yield, requiring us to overtake that vehicle for the purpose of making an expedient response.

There are a number of reasons why traffic may fail to yield to us. Most commonly the driver is not paying attention to us and may not be aware we are approaching because of a tightly-enclosed, noise-insulated passenger compartment, loud music, or other distractions such as cell phone or text messaging use. In some cases the civilian driver may either panic and make an unpredictable movement or freeze and come to a complete stop wherever they are. 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. There

are a number of situations in which passing another vehicle should never be attempted, including when:

- 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

If the driver feels the need to pass another vehicle, there are several considerations that you should evaluate before making the move.

1. *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 panic reaction at the last second or continues on with what they were doing. A classic example of this occurred in Kansas City, Missouri in 2004. A fire department pumper was traveling southbound on a four-lane, residential street with their siren and lights activated. As they did so they approached a southbound passenger vehicle that appeared to come to a complete stop in the left (inside) lane. In reality the second vehicle was slowing to make a left hand turn into a driveway at that location.

   As the pumper approached the slowing vehicle the pumper crossed left of center in an attempt to pass the vehicle. At that time the slowed vehicle turned left towards the driveway and into the path of the pumper. The pumper struck the vehicle with a glancing blow and veered across the northbound lanes of the street where it collided head-on with a 2nd passenger vehicle that had pulled over to the curb to yield right-of-way to the approaching fire engine **(Figure 5.10, p. 52)**. After striking this vehicle, Pumper 33 sheared off a utility pole and then struck a large tree. The main point of impact was in front of the officer's seat position **(Figure 5.11, p. 52)**. The driver of the car who turned in front of the pumper was not seriously injured. The driver of the second vehicle struck by the pumper required extrication and was critically injured. The acting captain riding in the front of the pumper was killed and the driver was seriously injured. Two other fire fighters on the apparatus were not seriously injured.

2. *Are there intersections, driveways, side roads, parking lots, or other locations that might present a vehicle that is ready to turn into your path?* These are particularly dangerous is the intervening roadway is not visible to the approaching emergency vehicle. If you cannot account for these, passing another vehicle may be ill-advised.

3. *Is there enough room to safely make the pass?* The driver must make sure that there is sufficient room to safely make the pass and get back in the proper lane for the direction of travel before encountering other vehicles coming in the opposite direction. This will vary depending on the speed and handling characteristics of all the vehicles involved in the scenario. For example, a police patrol vehicle is a lot more nimble and able to make a pass and return to the correct lane in a shorter amount of time than is a

fire department aerial apparatus. The driver must know the capabilities of the vehicle they are operating and use their judgment and experience in these situations accordingly.

Figure 5.10

Figure 5.11

It is important the driver be aware of both the speed of his or her vehicle and that of the vehicle they are trying to pass. This will help estimate the time it will be required to be in the opposing lane of traffic. The driver should not pull up directly on the rear bumper of the vehicle to be passed, but rather should start the pass from a safe following distance. 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.

Make sure that have a safe amount of clearance between your vehicle and the vehicle being passed so as to not create a side-swiping situation. 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.

This report would be remiss if we did not address the topic of emergency vehicles passing other emergency vehicles, especially when they are going the same direction to the same call. There is a temptation for a faster moving vehicle, such as a police vehicle or ambulance that is approaching a slower vehicle, such as a large fire truck, to want to proceed around the slower vehicle. In most cases this type of passing is not advisable, particularly if you are going to the same place. On rare instances it may be necessary, such as in the case of a violent incident where police need to first secure the scene before other responders can perform their work. 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.

Vehicle Unfamiliarity

A review of case studies of crashes in both the fire and law enforcement communities will note that driver unfamiliarity with a vehicle is often cited as a possible cause of a collision. This situation can develop in a number of ways. Case studies in the fire service reveal the following scenarios where this situation can occur:

- Lacking a qualified driver, an untrained member attempts to drive a vehicle to an incident.
- A driver who is trained on smaller vehicles, in a pinch, tries to drive a larger vehicle, such as a tanker or police tactical vehicle, to an incident.
- 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 all drivers are not sufficiently trained on it before it is placed in service **(Figure 5.12, p. 54;** *Courtesy of Ron Jeffers, Union City, NJ***)**.
- A driver is rotated into a station that he or she has not previously worked at and there are different kinds of vehicles there than he or she is used to driving.

Figure 5.12

Similar scenarios have been known to occur in the law enforcement community as well. In many cases 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) **(Figure 5.13;** *Courtesy of Jose Ybarra***)**.
- Officers switching from a standard patrol vehicle to a sport utility vehicle (SUV) or a special tactical vehicle without sufficient training **(Figures 5.14a and b;** *Courtesy of Jose Ybarra*).

Another issue that could affect the driver's ability to control a vehicle is the difference in sight lines and blind spots in vehicles of various types. 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.

The solution to reducing these types of incidents from occurring is rather simple. It all boils down to a training issue. Members should not be allowed to operate vehicles on which they have not received sufficient training. 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 driving the vehicle in the performance of field duties. In the fire service this is a requirement contained in NFPA 1500.

Figure 5.13

Figure 5.14a

Figure 5.14b

Driving In Inclement Weather

Having to operate a vehicle in any condition that reduces the driver's vision or the amount of traction provided by the road surface is perhaps the most dangerous condition in which fire and police personnel must operate. It is common to issue advisories to the public in conditions such as icy or snowy weather requesting them to stay home and off the roads if at all possible. However, because of the nature of the services they deliver, police and fire services are often unable to heed their own advice. In fact, their 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 under difficult conditions. EMS agencies may see a greater demand for service as civilians are unwilling to drive themselves to seek medical treatment for minor illnesses and call EMS to take them.

Figure 5.15

Calls for service also tend to increase for the fire service during inclement weather. This can include lightening strikes, wires down, wind damage, traffic incidents, structural collapses, and similar situations (**Figure 5.15**; *Courtesy of Ron Moore, McKinney, TX, F.D.*). Inclement 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. For example, the City of Tulsa, Oklahoma Fire Department responds to an average of 300 working structural fires per year. Following a December 2008 ice storm that caused wide spread, lengthy power outages, the TFD responded to more than 170 working fires in the first three weeks after the storm.

Common inclement weather conditions that emergency service personnel may need to drive in (depending on their geographic locations) include fog, wind, rain, ice, and snow. The 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 you will be driving is in good mechanical condition. Personnel should check the fluid levels of their vehicles, particularly 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 car is based upon friction with the ground beneath your 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 your tires is critical. This becomes even more critical during inclement weather driving.

Personnel are reminded to completely clear their vehicles of snow and ice prior to driving if they have been parked out in the weather. Clearing vehicles of snow and ice enhances the safety of all motorists by providing an unobstructed view to the operator 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. Vision can be reduced by fog, blinding rain or snow, or accumulations of precipitation on the windshield and windows. In addition to cleaning the vehicle off as mentioned above, it is also important for items such as the defroster and wipers to be in good working condition.

Speed must be adjusted accordingly with 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. Wig-wag headlights should not be used under these conditions.

Perhaps the two biggest keys to safe driving in slick road conditions are reducing speed and increasing the following distance of 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 and proper to operate at a speed that is well below the posted limit. It is better to take a little longer to get to a dispatched call than to not arrive at all.

Under optimal driving conditions, drivers should leave at least one car length for every ten miles per hour 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 afford for increased stopping distances.

Slick road conditions require that your steering, acceleration and braking be smoother. Any actions you take as a driver result in weight shift that decreases the stability of your vehicle. The harsher the action, the more weight shift occurs and the harder it is to control. So if you jerk the wheel or stab the brakes, you are much more likely to lose traction and begin to slide. Small mistakes can become big problems.

The following guidelines should be heeded in adverse weather driving situations:

- Increase the stopping distance between you and other vehicles.
- Use extra caution in shaded areas during the winter since such areas will remain icy when open areas have melted.

- Remember that bridges will freeze before other 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.
- Be careful when driving just after rain begins because the water will mix with oil on the entire road surface.
- To reduce instances of hydroplaning on standing water, reduce your speed, keep the tires at proper inflation and maintain sufficient tread depth.
- 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 bake.
- 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. This is discussed in further detail in the next section.

Avoiding and Combating Skids

The most effective way to combat vehicle skids is to avoid them altogether. 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 lacking in reasonable tread depth make the vehicle more susceptible to skids. On passenger-type vehicles it is acceptable to use the suggested pressure on the side wall of the tire. On larger vehicles the proper tire pressure should be obtained from the *Tire and Rim Year Book* published by the Tire and Rim Association, not from the sidewall of the tire.

Most newer vehicles are equipped with an all-wheel, antilock 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, when driving a vehicle equipped with an ABS, maintain a steady pressure on the brake pedal (rather than pumping the pedal) until the apparatus is brought to a complete halt.

On vehicles that are equipped with both an antilock braking system and an auxiliary braking system, as most fire apparatus and police tactical vehicles are, the computer controlling the *antilock* braking system will shut off the *auxiliary* braking system during a skid condition. This will help to reduce the vehicle's tendency to continue the skid.

If a vehicle that is **not** equipped with an 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.

Drivers must also be alert for hydroplaning conditions in wet weather. Driving through even a very shallow ¼-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 at all be in contact with the pavement. 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.

If partial hydroplaning and skidding occurs, the driver can regain control by compensating for the specific type of skid. The driver should countersteer, turning the wheel in the direction of the skid, and remove his or her 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.

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 5.16)**. All training should be done at slow speeds to avoid damaging the vehicle or injuring participants. Some jurisdictions choose to use reserve or other older vehicles for this part of the training process.

Figure 5.16

Safe Vehicle Spacing

Although it has been mentioned previously in this document relative to specific situations, the importance of maintaining safe spacing between the emergency vehicle and other traf-

fic cannot be overemphasized in all conditions. Appropriate spacing between vehicles allows for a margin of error if a civilian driver makes an unexpected move. Spacing increases visibility and with visibility you create time to react, avoid a collision, and stop. A four-second following distance is recommended in ideal conditions. If the conditions are not ideal, such as on 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

Collisions that occur when an emergency vehicle is being driving in reverse account for a large percentage of the overall number of emergency vehicle collisions. While these are rarely serious in terms or injury or death, they do account for a high percentage of emergency vehicle crash repair costs. All fire and police 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 law enforcement policies on this issue.

As with most things in life, the easiest way to prevent a problem is to avoid the conditions that lead up to it. Whenever possible, the driver must avoid backing the vehicle. It is normally safer and sometimes quicker to drive around the block and start again. It is most desirable that new fire stations be designed with drive-through apparatus bays that negate the necessity to back the apparatus into them.

There are situations when it is necessary to back fire apparatus. This operation must be performed very carefully. When backing, there must be at least one firefighter — and preferably two — with a portable radio assigned to clear the way and to warn the driver/operator of any obstacles obscured by blind spots **(Figure 5.17)**. If portable radios are not available, flashlights may be used at night to signal (but not blind) the driver/operator. The department must establish preset signals for using the flashlights. If two spotters are used, only one shall communicate with the driver/operator. The second spotter must assist the first one. This is a very simple procedure that 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 must be equipped with an alarm system that warns others when the apparatus is backing up.

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/operator 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 if the apparatus **(Figure 5.18)**. This camera transmits a significant view of the area behind the apparatus

Figure 5.17

Figure 5.18

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 5.19, p. 62)**. Both of these devices improve backing safety **but neither are substitutes for having spotters** assisting the driver/operator during backing operations.

Figure 5.19

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. These devices are no substitute for having spotters assist with backing the apparatus. Backstop devices simply 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.

Police vehicles are typically not nearly as large as a fire apparatus 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 is still a good idea to get out of the vehicle and check the area behind the vehicle if it is not clearly visible from the driver's position. Other personnel should be used to guide the driver backwards if there are extremely tight clearances behind the backing vehicle.

Driver Distractions

Driver distractions are a major factor in the causes of collisions involving police, fire, and general public vehicles. Statistics kept by the National Highway Traffic Safety Administration (NHTSA) include that about 25% of all reported collisions in the U.S. are caused, at least in part, by a driver distraction. It is likely that this figure will grow for general public drivers in the years to come as a result of increased usage of cell phones and texting devices that reduce the driver's ability to react to situations they encounter. It is very easy for fire and police department members to fall victim to the same types of distractions.

In reality, driver distractions have always been a particular problem for the fire and police services. There are a variety of things common to both vehicles that can cause a distraction for the driver. These include warning device controls,

Figure 5.20

mobile computers, map books, preincident plan documentation, emergency radios, and standard radio/CD players **(Figure 5.20)**. Drivers who have their attention diverted away from the road and directed towards one of these distractions are at greater risk for being involved in a collision.

Whenever possible, the driver should not be operating other devices, including reading map books or utilizing mobile computers while they are driving the vehicle. If a second person is riding in the front of the vehicle they should be one to perform these functions. In many cases law enforcement officers do not have the luxury of having a passenger 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 that is on foot. The officer must balance the amount of time they are scanning the immediate area with the amount to time they are watching the roadway.

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 response rate.

Siren Syndrome

Many operators of emergency vehicles have been known to fall prey "siren syndrome" or "sirencide." In essence 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 sense of invincibility. But this is really a false sense of security that can get the driver into serious danger if it is not controlled.

This condition becomes particularly dangerous when the emergency vehicle driver assumes that every other motorist they encounter will hear and react appropriately to the siren that has entranced the emergency vehicle driver. As note earlier in this chapter, motorists do not always hear us coming for a variety of reasons. If the emergency vehicle driver is not keen to this fact and is "overdriving" his or her vehicle, problems could occur when encountering an unaware motorist.

This condition can also be hazardous absent of encounters with other vehicles. The increase in adrenaline caused by this situation can simply result in the driver operating beyond his or her real capabilities, 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. This will help to make an impression on the drivers if they get to experience these conditions in a training environment.

Fatigue

Fatigue has always been an issue in both the police and fire service communities. The reasons for this are many, including unique and changing shift schedules, long shift schedules, interrupted sleep patterns, extended periods of physical activities, and numerous other causes. Fatigue poses a significant hazard to drivers because it lowers visual efficiency and increases reaction time in emergencies. Fatigue most frequently manifests itself in the form of drowsiness. This causes reflexes to slow up, the mind to wander, and the eyelids become heavy and closed 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" fatigue is a sufficient quantity of rest and sleep. The effect may temporarily be offset by changes in the activity level, such as police officers talking out loud, if alone, making frequent stops to conduct security checks of businesses and homes, or inspecting known trouble spots. Fire fighters may try to engage in some type of physical exercise activity 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 so-called 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 cognizant of the effect fatigue may have on their performance and, albeit, their health and safety. Fatigue reduces the person's ability to think, act, and react clearly. This may lead to an increase in

the likelihood of a crash or injury. The best ways to avoid fatigue situations are to stay in a physically fit condition and get plenty of sleep.

An excellent report on the effect of fatigue on the health and performance of fire fighters and EMS workers was developed by the U.S. Fire Administration and the International Association of Fire Chiefs (IAFC). It can be downloaded from the IAFC website at www.iafc.org. A similar 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

The bulk of this chapter has focused on the causes of emergency vehicle crashes. The purpose of this discussion has been to focus on the safety issues that most greatly influence the tendency of emergency vehicles to become involved in crashes. Certainly any discussion relative to safety issues as they affect these crashes would not be complete if the issue of passenger restraint or seatbelt use were not reviewed **(Figure 5.21)**. 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.

Figure 5.21

In the case histories and statistics that were covered earlier in this report, you will not see instances where failure to wear a seatbelt was listed as a cause for a crash. Some crash reconstruction specialists have speculated that particular incidents may have occurred after the 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 overcorrective action to return the vehicle to the roadway after the right side wheels had slipped off the edge. However, these instances are very rare.

On numerous occasions, the failure to wear seatbelts has been determined to be a significant factor in the serious injury or death of the emergency vehicle operator and/or occupant(s). In many cases, drivers and/or occupants being seriously injured or killed after being partially or totally ejected from the vehicle following a crash is a common theme. This occurs despite the fact that information and studies on the benefits of wearing seatbelts have been available for more than 30 years.

The U.S. Department of Transportation (DOT) and the National Highway Traffic Safety Administration (NHTSA) have been compiling data and statistics on seatbelt use for more than 30 years. While they have not reported data specific for fire or police department vehicles, the information they have reported on all types of vehicles should be considered relevant for fire apparatus and police vehicles. A 1999 DOT report (DOT HS 809 090; available at http://www.nhtsa.dot.gov/)indicates that the proper use of seatbelts by vehicle occupants reduces the risk of fatal injury by 60 percent and moderate-to-critical injury by 65 percent.

The 1999 DOT report also indicates that 75 percent of all occupants who are totally ejected from a vehicle suffer fatal injuries. While that figure is applied to all types of crashes, seatbelts show their most dramatic effects on safety when rollover crash statistics are reviewed. DOT records indicate that nearly 80 percent of all fatalities in large truck rollover crashes, a category that would include fire apparatus and large police special operations vehicles, involved the ejection of an unbelted occupant from the vehicle.

These fatalities in rollover crashes are highly preventable. Again, the DOT report shows that 22 percent of all unrestrained occupants involved in a rollover crash are totally ejected from the vehicle. Dramatically, only one percent of properly restrained occupants are totally ejected from the vehicle in a rollover crash. Emergency vehicle drivers and other personnel should be reminded of the above facts in these simple terms:

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

Fire personnel have no excuse for failing to wear seatbelts when driving or riding on fire apparatus. NFPA 1901 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.

Despite these facts and evidence, the case studies will show that a significant number of fire service personnel still fail to wear seatbelts when riding on the apparatus. 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 benefits that seatbelts have proved to hold time and time again, these omissions are unforgivable. Fire department leadership must enforce seatbelt usage for all members of the department.

All fire departments must have in place SOP's 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 benefits of adhering to such a policy have been noted numerous times in recent years. Highly publicized apparatus rollover crashes in Los Angeles (California) and Phoenix (Arizona) resulted in the properly seated and belted firefighters walking away relatively unscathed. Many of their fire service counterparts who failed to follow this policy were seriously injured or killed.

There is no doubt that safety belts are a protective device that works for police officers as well **(Figure 5.22)**. Countless studies have shown that the chance of survival in a police vehicle crash is greatly increased when seat belts are worn. The severity of injuries is also dramatically reduced by seat belts.

Figure 5.22

One misconception that must be overcome is that while their value to the civilian driver and passengers cannot be disputed, that they may be a safety hazard to police officers. Some officers have offered that seatbelts are not appropriate for patrol driving and making frequent stops. Many personnel fear that the police officer will be restricted by a seat belt and vulnerable to assault when stopped. This fear is really unfounded. It takes a second to either fasten or unbuckle a seat belt. Conversely, an officer on patrol and especially one who must suddenly respond to an emergency call without a fastened seat belt endangers himself needlessly.

In simpler terms, in most states and local jurisdictions, law enforcement personnel routinely enforce seatbelts 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 must wear.

AGENCY VEHICLE RESPONSE POLICIES

All public safety agencies must develop effective standard operating procedures (SOPs) or guidelines for all areas related to vehicle operation and response safety. These SOPs must ensure that personnel operate in compliance with applicable laws and standards such as state and federal motor vehicle codes. Personnel must be educated as to their responsibilities within these SOPs and the SOPs must be consistently enforced to ensure everyone is in compliance and operating in the safest possible manner.

Without question, all emergency personnel are in their greatest position of vulnerability when they are responding to a reported emergency with lights and siren activated. In many jurisdictions this is referred to as an "emergency rate" or "Code 3" response. Responding without lights and siren, operating under normal traffic conditions is referred to as a "nonemergency" or "Code 1" response. When prorated for actual miles driven, the odds of being involved in a collision when operating under emergency rate conditions are significantly higher than under normal traffic flow conditions.

It is nearly impossible to enforce safe practices and behaviors if they are not spelled out in the form of expectations as specified in a policy. The basic issues that must be covered are generally the same in either discipline and include the following:

- Driver and passenger responsibilities
- Nonemergency driving procedures
- Emergency driving procedures
- Conditions that warrant/justify an emergency response
- Conditions that do not warrant/justify an emergency response

It is not the purpose of this report to cover the full range of policies that are needed relative to vehicle operations in a police or fire department. Rather, the purpose of this report is to identify specific areas that pose significant hazards to fire and law enforcement personnel. As stated above, the primary concern in this area is the issue of emergency rate responses. It is highly important that we examine our policies and practices related to emergency rate responses to determine if they are appropriate from a risk-benefit standpoint.

As mentioned at the beginning of the report, if we are going to make significant reductions in the number of firefighter and law enforcement officer injuries and deaths, a major cultural shift is required. One of these shifts is the realization that many of the calls we now respond at an emergency rate to are not really justified by an honest risk-benefit analysis.

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. Thus, many jurisdic-

tions have begun looking at policies that reduce the number of emergency rate responses made by their fire companies. By reducing the number of emergency rate responses, these departments reduce the level of risk to their members (and the public) created by the emergency rate response.

The reduction in emergency rate 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. This information is then used 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 non-emergency, nonemergency responses:

- Activated fire alarm, without an additional call reporting fire conditions
- Trash fire
- Small brush fire inside the city limits
- Wires down/hanging
- Smoke/gas odor in the vicinity
- Carbon monoxide detector activation without reported patient symptoms
- Basic life support EMS calls
- Company relocations
- Water leaks
- Investigating a controlled burn

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 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 as a result of these policies.

In jurisdictions where there is significant resistance to responding all apparatus Code 1 on certain types of calls, it is highly recommended that SOPs be revised so that only the closest unit to a reported incident scene respond emergency rate and all other responding units start towards the incident operating under normal traffic flow (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 can be safely assumed that those figures would probably hold true in almost

any jurisdiction. Based on that information, it is pretty difficult to justify the response of a full first-alarm assignment, with all companies operating under emergency rate conditions, to every activated fire alarm. The odds of a 3rd or 4th 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.

While reducing the number of emergency rate responses undoubtedly reduces the chances of the apparatus being involved in a collision, there are some situations in which this policy may not be practical. 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. In these cases though the incident they are currently responding to may not necessarily warrant an emergency rate response, excessive out-of service times might prevent them from being available to respond to a true emergency should one occur. Because of congestion in those areas, second and third due companies who might have to cover for the out-of-service companies might have seriously delayed response times. In these situations, driver/operators should use a modified emergency rate response. Warning devices should be used to clear a reasonable path to the incident, but the apparatus should not be operated with the sense of urgency that would be used when responding to a true emergency.

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 departments. Although the percentage of calls that police officers historically have responded to using an emergency rate response is significantly less than with fire apparatus, there still are many calls in which the risk-benefit analysis probably does not justify an emergency rate 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 that is focused on these events. The reality is that on-average, only about 5 percent of all vehicle-related officer fatalities occur during pursuits. This fact can be emphasized by reviewing the information contained in **Table 5.1**. This information shows the information on vehicle-related police officer deaths for the most recent year available at the time of this report. It is very typical of the results of previous years in the same categories.

These figures clearly show that the principle danger to officers as far as vehicle-related incidents is not pursuits. A review of the case histories on the 36 fatalities that were listed as automobile crashes indicates that the majority of these occurred when en route to call, driving at an emergency rate or otherwise, at a high rate of speed.

Table 5.1 Police Officer Vehicle-Related Fatalities - 2008		
Activity	Number of Deaths	Percentage of Vehicle Related Deaths
Automobile Crashes	36	51%
Motorcycle Crashes	9	13%
Struck By Vehicle	12	17%
Pursuit Crashes	3	4%
Vehicular Assault	11	15%

Officials that 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 section. 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 service, 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 developed at the local level and are 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 at an emergency response rate. This is because of the perception that every call is a different situation and certain variable may or may not justify an emergency rate response.

In reality, all law enforcement agencies should have relatively firm polices on what justifies an emergency rate 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 rate driving is appropriate.

One of the critical factors that must be considered when developing this type of policy is whether or not 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 9-1-1 dispatcher. There is no difference to the outcome of the incident that an emergency rate response will make versus a

nonemergency response. Traffic crashes are a perfect example of this. It is highly unlikely that a quicker response by police officers to this type of call will have any significant outcome on the resolution of the incident.

Another issue that must be addressed by policy is the perception that is held by many officers that a rapid emergency-type response to a location without using warning lights and sirens is safer and more effective than a true emergency rate response. This based on the often correct 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 rate 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 the path of the police vehicle.

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 making a high-speed response without using the appropriate warning devices, the officer may be exposed to criminal liability and both the officer and the department may be exposed to civil liability. Every effort should be made within department policy, training, and enforcement to prohibit these types of responses.

The International Association of Chiefs of Police (IACP) has developed a set model polices 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 the link listed in Appendix A of this report.

In summary, all law enforcement agencies should review their current policies on emergency response procedures. The department should make an honest assessment of the types of calls that are likely to be a true emergency and those that have a high probability of not being a true emergency. Response policies should balance the need to respond emergency rate with the actual likely benefit by doing so. By reducing the number of unnecessary number of emergency rate responses, the level of safety for police officers and the motoring public will both increase.

Section 6

Emergency Vehicle Lighting and Markings

When you address the topic of emergency vehicle lighting and markings what you are really talking about is the concept of visual conspicuity. In general, the term *conspicuity* refers to the degree to which a specific object can be easily seen and recognized within its immediate context. There are two types of conspicuity with which we must be concerned. *Search conspicuity* refers to the ability of a person searching for an object to pick it out from the various other objects in the field of vision. *Attention conspicuity* refers to the ability to draw attention to an object that a person is not actively looking for. The ultimate goal of visual conspicuity is to improve motorists' ability to detect emergency vehicle lighting displays and vehicle markings in a manner the leads them to react appropriately. Effective conspicuity conveys to motorists that an emergency vehicle is present or approaching; is stopped while performing their duties; and provides effective guidance around the vehicle and the incident workspace.

Effective visual conspicuity for all emergency responders, including police and firefighters, is particularly important in two primary contexts: when responding through traffic to an incident and when parked on the incident scene (**Figure 6.1**). As will be shown in this chapter, the requirements for safe and effective visual conspicuity differ between when the vehicle is driving through traffic and when positioned at an incident.

Figure 6.1

It should be noted that this section of the report addresses two specific aspects of overall vehicle conspicuity: emergency vehicle lighting and reflective markings on the vehicle. Issues such as vehicle paint colors are not addressed in detail by this document. The issue of best vehicle color has been in debate by both the law enforcement and fire service communities for many years. While there is conclusive evidence that some colors (such as yellow-green) are more visible to the human eye under a variety of conditions, there are no conclusive regional or national studies that show any significant reduction in collisions involving vehicles of these special colors.

Figure 6.2

It is possible that the paint color of today's emergency vehicle is less important than it was when much of the supporting research on the topic was conducted in the 1960s and 1970s. The types of warning lights that were available for emergency vehicles up to that period were fairly limited and not especially effective **(Figure 6.2**; *Courtesy of Steve Loftin***)**. Advances in lighting technology and the introduction of retroreflective markings on modern vehicles show much more promise in advancing vehicle conspicuity than do the vehicle's paint color. When equipped with modern lighting systems and appropriate reflective markings today the paint color of emergency vehicles is generally a moot point.

VEHICLE LIGHTING AND REFLECTIVE MARKING STANDARDS

There exist no national laws or standards relative to vehicle lighting or reflective markings on law enforcement vehicles. Much discretion on this matter is left to the individual law enforcement agency, as long as it stays within the bound of the state motor vehicle code in which the agency is located **(Figure 6.3;** *Courtesy of Denis Desmond***)**. State motor vehicle codes typically specify the appropriate colors of warning lights for various types of emergency vehicles. They also may specify minimum number or types of lights that are required.

Beyond what is required by a state motor vehicle code, most law enforcement agencies tend to specify vehicle lighting and markings (reflective or not) based on a number of factors, including tradition, regional practices, best practices, equipment costs, and community identity or preferences. As will be discussed later in this section, many law enforcement agencies are now recognizing the value of research on this topic and best practices from other emergency responders and international law enforcement agencies and are incorporating those concepts into their current day vehicles.

Figure 6.3

The fire service is also bound by any requirements that are established in the state motor vehicle code under which they operate. Most of these requirements pertain solely to the type and colors of lighting that are permissible on fire department vehicles. While being within the bounds of state motor vehicle requirements is important, the fire service is also somewhat bound by NFPA 1901, *Standard for Automotive Fire Apparatus*. While NFPA standards are not law, unless formally adopted by an authority have jurisdiction, they are recognized by civil courts as nationally-accepted consensus standards and they almost always hold weight in civil litigation matters.

It should be noted that NFPA standards only apply to new apparatus, or apparatus that undergo extensive rehabilitation, during the period in which that specific edition of NFPA 1901 is in effect. Fire departments are not required to retrofit apparatus that were constructed or refurbished under a previous edition of the standard. Many departments do choose to update lighting and reflective markings on older apparatus in order to keep the appearance of all the department's vehicles similar.

NFPA 1901 requires all fire apparatus have a system of optical warning lights in the upper and lower zones and on all four sides of the vehicle. The standard identifies two modes of emergency lighting. The "calling for right of way" mode is the light pattern used while the apparatus is in motion. The "blocking right of way" mode is the light pattern used while the apparatus is parked at the incident.

Previous editions of NFPA 1901, *Standard for Automotive Fire Apparatus*, required a simple 4-inch wide retro-reflective stripe that extends at least 50% of the length of the vehicle on each side and 25% of the width of the front of the vehicle (**Figure 6.4, p. 76**; *Courtesy of Steve Loftin*). A graphic design that meets

Figure 6.4

Figure 6.5

Figure 6.6

these parameters is an acceptable substitute. NFPA 1901 also requires retroreflective striping inside cab doors to maintain conspicuity and alert passing drivers to an open door **(Figure 6.5)**. A major addition to the 2009 version of NFPA 1901 was the requirement for a European-style retroreflective chevron pattern to cover at least 50% of the rear-facing surface of the vehicle. The stripes must slope downward and away from the centerline of the vehicle at a 45° angle **(Figure 6.6;** *Courtesy of Allen Baldwin, Gettysburg, PA FD***)**. Each stripe must be 6 inches wide and in an alternating pattern of red and yellow, fluorescent yellow, or fluorescent yellow-green.

All law enforcement and fire service agencies should make sure that all of their vehicles have lighting systems and reflective markings that are within the bounds of their state motor vehicle code and any other standards that apply. Departments that are unsure whether or not they are in compliance with the state motor vehicle code should seek assistance from their state police agency or department of transportation. Fire apparatus manufacturers are typically well-versed in the requirements of NFPA 1901.

EMERGENCY VEHICLE LIGHTING

The term "emergency vehicle lighting" refers to special visual warning devices that are affixed to a emergency vehicle for the purpose conveying to other motorists the urgent nature of their journey, to provide warning of a hazard when stationary, and for use by police officers as a means of signaling a civilian driver to pull over so the officer may make contact with them. Emergency vehicle lighting is in addition to the standard lighting, such as headlights and hazard flashers, that are required on all motor vehicles.

As stated earlier in this report, most state vehicle codes have provisions that exempt emergency vehicles from certain provisions of the code when responding to an emergency. This may include situations such as exceeding the posted speed limit and passage through intersections against a red traffic light. 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 so the emergency vehicle may proceed through expediently.

Emergency vehicle lighting is also important from the standpoint of providing protection to emergency workers who are engaged in the performance of their duties while positioned along the roadway. In these instances warning lights must provide notice to approaching motorists of the presence of emergency responders working on the highway. They must also provide some basic guidance on how to safely approach and navigate around the work area.

This section of the report will examine research and best practices on the topic of emergency vehicle lighting. The intent of this information is to provide a more global view on the issue for fire and police officials around the country. It will also make them aware of research efforts that are being undertaken to benefit their level of safety.

Warning Light Colors

There are a variety of warning light colors that are available for use by emergency response agencies. As stated earlier, 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. In general, the following five colors of lights, or any combination of these five, are used on emergency vehicles in the United States.

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 6.7. p. 78)**.

Figure 6.7

Figure 6.8

The only other permissible use for red warning lights in most states are on school buses for the loading and unloading mode. Most other nonemergency service vehicles are prohibited from displaying red flashing lights. Most motor vehicle codes require other motorists to yield or come to a complete stop for vehicles displaying red warning 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, tow trucks, funeral escorts, security patrol vehicles, snow plows, 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 are designed to switch to all amber lighting when stationary (**Figure 6.8**).

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. It should be noted that in many jurisdictions flashing white beacons or strobes are used on public transportation or school buses.

Green lights are typically limited to fire service applications. Most commonly they are used to signal the dedicated position of an incident command post **(Figure 6.9;** *Courtesy of Daniel Techie*). This practice was derived from the practice of using a green flag to denote the Command Post in early versions of the Incident Command System (ICS). In some states green lights are also used on volunteer firefighter or EMS personnel's privately-owned vehicles 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 6.9

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 6.10)**. In a small number of states all blue lighting is used for law enforcement vehicles. In other states blue lights are used on privately-owned vehicles 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 6.10

Table 6.1
International Emergency Vehicle Warning Light Colors

Country/ Region	Light Colors
Argentina	Red on police vehicles, red/blue on fire apparatus, green on ambulances
Australia	Red on fire apparatus and ambulances, blue on police vehicle
Canada	Red is used on all emergency vehicles, in general. There are different requirements in specific provinces.
European Union	Most agencies use blue lights on all emergency vehicles, with some minor deviations in a few countries.
Hong Kong	Police use a combination of red and blue, fire vehicles use all red, ambulances use all blue.
Japan	Use red lights on all emergency vehicles
New Zealand	Police vehicles use a combination of red, white, and blue; fire and EMS use red or red and white
South Korea	Police vehicles use red and blue; ambulances use any combination of red, green, and white, fire apparatus use red and white
United Kingdom	All emergency vehicles use blue lights

Clearly, 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. Of interest to note is that there exists the same issue on the international level. **Table 6.1** shows examples of warning light colors used around the world.

Types of Warning Lights

In general, there are four main types of emergency lights that are used on emergency vehicles in the United States. 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 is 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 basic type of warning lights to be used on emergency vehicles **(Figure 6.11)**. 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° surrounding the vehicle to which they are mounted. Depending on the design a flashing 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 6.11

Other rotating lights commonly contain 2 to 4 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 6.12)**. 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 6.12

Fixed Flashing Lights

Fixed flashing lights, also referred to as fixed flashers, provide a beam of light that is projected in a single direction **(Figure 6.13, p. 82)**. 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 rear inside deck of a passenger-type vehicle. Older designed for these device utilized quartz-halogen or conventional incandescent sealed-beam lamps that were usually white in color. The housing over the lights could be of any color desired. More 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 larger lighting system on the top of the vehicle.

Figure 6.13

Figure 6.14

Figure 6.15

Strobe Lights

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. 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 6.14)**.

The actual light that is produced by a xenon strobe is not perfectly white. It tends to be in the blue spectrum of light. Thus, for example, when used in conjunction with red flasher covers or dome covers on light bars the light emitted may have a pinkish or purplish tint to it. Other concerns regarding strobe lights are covered later in this section.

Light-Emitting Diode (LED) Lighting

The newest trend in the field of emergency vehicle lighting is the use of warning lights comprised of multiple light-emitting diodes or LEDs **(Figure 6.15)**. 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. Light 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. As mentioned above, strobe lights function by discharging an electrical current through xenon gas. This does not make them ideal for any kind of programmed flash pattern. LED lights are simply 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 warning lights are typically limited to one or a combination of the types described above. This is somewhat due to tradition, but more likely due to the smaller size of their vehicles and the limited capacity of their vehicle 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 are 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.

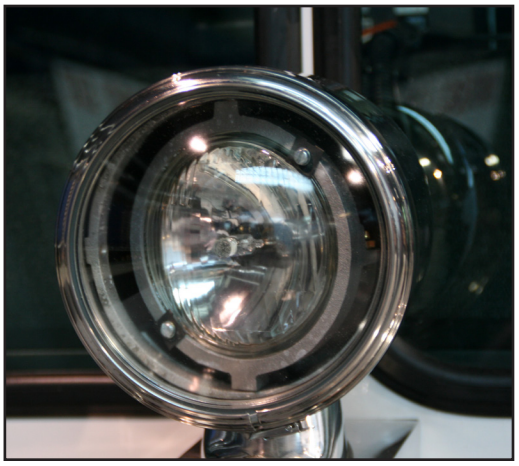


Figure 6.16

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 of Eight **(Figure 6.16)**. Depending on their design the bulb and assembly oscillate or on other models a reflector behind the light rotates. These lights are commonly known as "Mars" lights in deference to their inventor and most common brand name. The light was invented in the 1930s by Chicago, Illinois firefighter Jerry Kennelly. Although his original intention was to develop a better warning light for fire apparatus, these lights also gained wide popularity and use in the railroad industry. The most common colors used for oscillating lights are red and white. They are still very commonly specified on modern day apparatus.

Figure 6.17

Rotary beacon lights are most commonly known as Roto Ray lights, as this company was the inventor of this type of light and remains the only manufacturer of them. The original *Buckeye Roto-Ray* was designed by Edward C. Rumsey, of the Buckeye Iron and Brass works. The patent was filed for on September 23, 1927, and patent received on August 12, 1930. The Roto Ray warning light unit is made up of 3 sealed-beam lights that rotate in a vertical plane at 200 RPM. The plane of rotation is perpendicular to the longitudinal axis of the vehicle. The most common light combinations in these lights are three red lamps or two red lamps and one white lamp, although other variations can be found. Older apparatus sometimes had these lights mounted on the roof or next to the driver's door **(Figure 6.17)**. When equipped with a clear bulb the sweeping patterns on a roof mounted unit tended to interfere with visibility through the windshield. Modern apparatus almost solely have these lights mount just below the center of the windshield **(Figure 6.18)**.

Figure 6.18

Available Research on Emergency Vehicle Lighting

For agencies that are seeking reputable information on the topic of effective emergency vehicle lighting, there are a variety of sources where this can be found. 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 will highlight the results of some of the more commonly known and respected research projects that have been conducted.

It should be noted that when reading the summaries of some of the research that is provided here, one will occasionally note discrepancies and contradictions among the results of various projects. This was possibly due to the different circumstances, variables, and goals that were used for the respective research projects. 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 a report of this type.

Loughborough University Study

One well-known study was conducted at Loughborough University in the United Kingdom in 1999. This report was titled *Motor Vehicle and Pedal Cycle Conspicuity: Part 3, Vehicle-Mounted Warning Beacons*.

This study favored the use of traditional strobe lighting on emergency vehicles. Keep in mind that LED lights were not widely used in the emergency service at the time this study was conducted. The study showed that strobe lighting conveyed a greater sense of urgency to other road users than did rotating or traditional flashing lights. It also 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 alternately flashing 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 issue discussed below.

The Loughborough study also looked at different colors of lights 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 both at daytime and night.

The Loughborough study also reported on several hazards to other motorists related to the use of emergency warning lights and these effects should be mitigated as far as possible during vehicle design. The particular hazards that this report addressed were as follows:

Photosensitive epilepsy – Some people who are afflicted with epilepsy may experience a reaction when exposed to certain type of strobe lights. This reaction can range in severity from an unusual feeling or involuntary twitch to a full-blown seizure. Studies have shown that this reaction can be triggered by any color of lights flashing in the 10-20 Hz 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 spectrum. The Loughborough study also noted that emergency workers have reported distraction and eyestrain from working around these the lights.

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 Loughborough 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 towards them. This might include emergency vehicles or responders working in the roadway. Discomfort glare is a more general effect that may cause motorists to divert their eyes in one direction or another. It is during this diversion time that they may fail to see things such as emergency responders in the roadway in time to avoid them. The report noted that 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 through out the emergency services, the authors of the Loughborough study were unable to locate any supporting scientific research that proved this theory at the time 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 four relatively recent crashes involving Ford Crown Victoria Police Interceptors (CVPI) that resulted deaths of three Arizona police officers and the serious injury of a fourth officer. Three of these collisions occurred when the police vehicle was parked along the shoulder of the roadway and was struck from behind by another vehicle. The fourth incident was an intersection collision involving the CVPI and a civilian passenger car that resulted in the CVPI sliding broadside into a utility pole at a high rate of speed. All four vehicles caught fire following the collisions.

The BRP was composed of Arizona and Florida police officers, an outside expert, and Ford personnel. Florida law enforcement agencies had experienced several incidents that were similar to the Arizona incident mentioned above. The outside expert was Dr. Stephen S. Solomon, a New York ophthalmologist and fire service practitioner. Dr. Solomon was an early pioneer in the field of fire end emergency vehicle visual conspicuity. The overall purpose of the BRP was to find ways to avoid future collisions and improve officer safety. A secondary goal was to improve communications between law enforcement agencies and Ford. Ford also promised to review CVPI technical developments to improve officer safety.

The obvious primary emphasis of this review was the noted tendency for CVPIs to burst into flames following being struck in or near the rear of the vehicle. Reports of similar experiences were attracting media attention across the country. Investigations and research would ultimately determine that about one-third of the fatal fires were a result of a bolt from a brake system bracket and/or tabs from the sway bar puncturing the fuel's fuel tank during a rear end collision. The result would be an inferno that quickly consumed the vehicle. Recommendations to retrofit existing vehicles and redesigning new vehicles were developed and ultimately implemented.

To their credit, the BRP did not limit their attention to simply addressing the fire issue. The group performed an overall examination of the safety of police officers who operating while parked on or near the roadway. This distinction must be noted; the BRP only looked at the hazards as the applied to stationary vehicles and officer operating inside or outside parked vehicles. The study did not focus on moving police vehicles.

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

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

- *Light Output* – This 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. An acceptable level that takes into account the prevailing illumination, other light sources in the visual field, and the driver's to adapt must be considered.
- *Light Color* – Light color is an important factor in visual conspicuity. From a scientific standpoint, given a halogen light and a set of the four most common lens colors that a white lens allow almost all of the light to pass through. Amber (60%), red (25%), and blue (15%) allow lesser amounts of

light to pass through the lens. However, the human eyes are not a science experiment. Theirs 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 are, 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 Society of Automotive Engineers (SAE) recommends flash rates ranging from 8 to 2.2 hertz, which are about 1 to 2 flashes per second. Although an urban legend asserted that emergency vehicle strobe lights could trigger seizures in certain epileptics, research conducted by two physicians in 1991 dispelled this myth. While strobes can be used to trigger seizures in some people, the strobe needs to be in the 6 to 40 Hz range, which far exceeds typical emergency vehicle strobe lights.
- *Ramp Times* – This is the time that it takes for the light to go from off to fully on. In general it is believed that the quicker ramping occurs, the greater the conspicuity of the light.

In the end, the people who participated in the demonstrations that were part of this study reported that LED lights appeared to provide a fairly narrow range of focus and were too bright. They also felt that strobe lights were too bright and might confuse approaching drivers. This group determined that rotating halogen lights were the most acceptable type of lighting over a range of conditions. More specifically, red and blue lights, in combination with amber lights, provided the most effective conditions.

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 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, the process began to reconfigure engines for all non-amber warning lights (clear, red, and blue) to go off when the apparatus parking brake was 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 **(Figure 6.19 a & b)**. Many other fire departments in the United States have also adopted this practice.

Figure 6.19a & b

Florida Highway Patrol Study

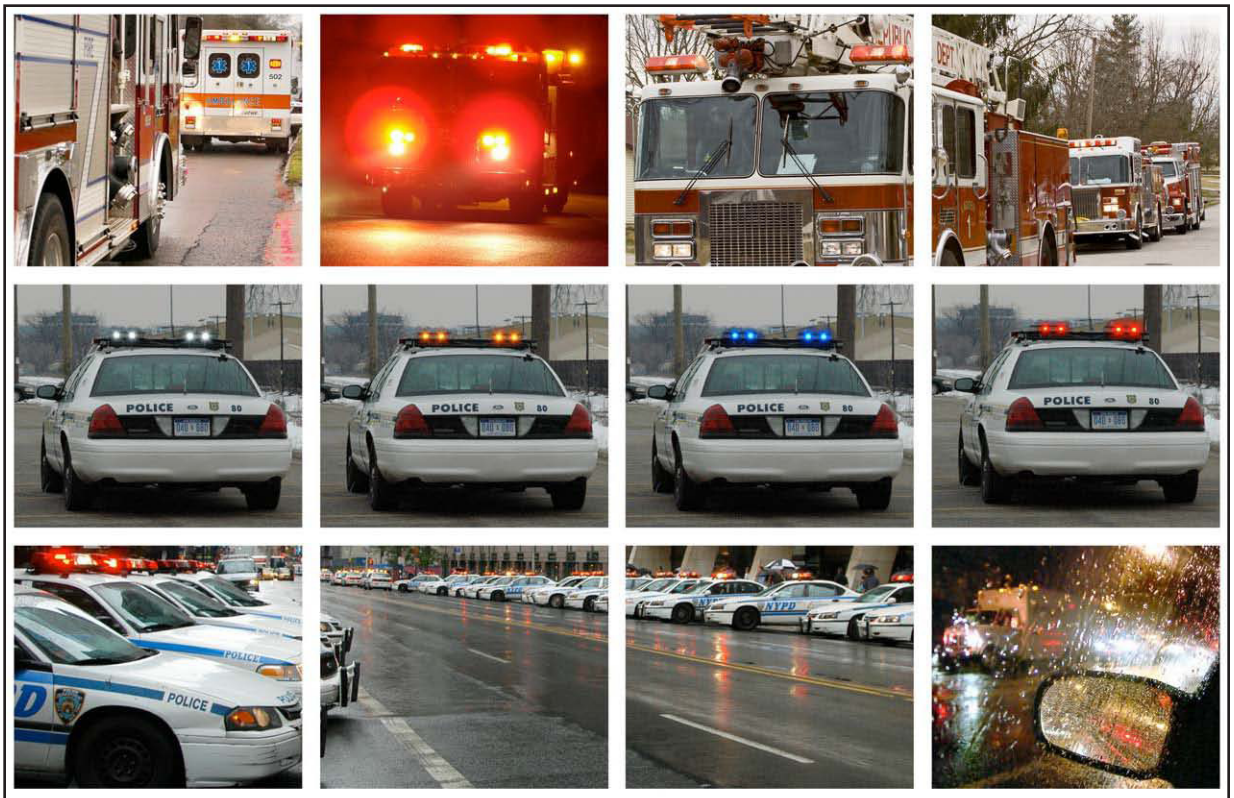
The Florida Highway Patrol conducted their own study of effective police vehicle emergency lighting in 2003 and 2004. They noted that at night in dimly lit areas, red lights are seen as either farther away or moving away from an observer while blue to violet lights can be seen as closer or approaching the observer. Overall they determined that red LED lights were the most visible during daylight conditions and blue LEDs or blue halogen lights were most visible at night. 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. Based on these tests the agency developed a final model that has now been installed on all of the agencies vehicles. It represented a significant adjustment from their previous practice of using all blue lighting. However the officers driving these vehicles have provided favorable comments on the changes.

USFA/FEMA Sponsored Research

The United States Fire Administration (USFA), which is a unit within the Federal Emergency Management Agency (FEMA), coordinates a variety of research on issues related to firefighter health and safety. In recent years they have paid particular attention to the issues surrounding emergency vehicle response and roadway scene safety as these account 25% of all firefighter fatalities on an annual basis and an equally significant number of injuries. Some of the projects that have come out of this effort include the *Emergency Vehicle Safety Initiative, Safety Operation of Fire Tankers,* and a trio of targeted projects developed by the International Association of Fire Fighters, National Volunteer Fire Council, and the International Association of Fire Chiefs.

In 2007 the USFA, in partnership with the U.S. Department of Justice's (DOJ) Office of Justice Programs (OJP), entered into a Cooperative Agreement with the Society of Automotive Engineers (SAE) to look at the issue of non-blinding emergency vehicle lighting. The SAE worked with the researchers at 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* in October 2008 **(Figure 6.20)**.

This report was part of a program of research 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 on factors such as glare and driver distraction. The report also provides information about how the colors and intensities of warning lights influence both positive and negative effects of such lights, in both daytime and nighttime lighting conditions. Color and intensity have received considerable attention in standards covering warn-



Effects of Warning Lamp Color and Intensity on Driver Vision

October 2008

Figure 6.20

ing lights at the local, state, and national levels. Interest in these variables has recently 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 insure 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 day and night conditions:

1. 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 on one of two possible paths. Faster performance for a certain type of lamp can be taken to mean that the lamp provides better conspicuity.
2. 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).
3. 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 day and night 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 improvements that can be made in warning lights may be in adopting different light levels for night and day.

Over the range of light intensity that was used, there were improvements with higher intensity for the light search task during the day, but performance on light search at night was uniformly very good, and did not improve with greater 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 different photopic 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 basically boiled it down to three basic recommendations based on the results of the experiment and on previous results in existing literatures:

1. Use different intensity levels for day and night
2. Make more use of blue overall, day and night
3. 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 and the 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, at least in the sense that 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 ms) 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.

Similarly, 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 on light on the markings and in terms of observation angles and 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 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 night 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 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 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 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

VEHICLE MARKINGS AND STRIPING

From the earliest days of the use of motorized vehicles for the delivery of emergency services, agencies and responders depended primarily on the use of audible warning devices and flashing lights to gain attention and warn motorists of their approach or presence. Although advances in the technology of audible warning devices and warning lights improved the level of responder safety as time wore on, there was one line of thinking that indicated that there must be an additional, non-mechanical solution to improving our visibility.

Figure 6.21

Early attempts at increasing and improving our visibility included the movement towards lime-green or yellow-green colored fire apparatus in the 1970s and 1980s. This concept and the effort towards its implementation in the fire service was the source of considerable debate and controversy. While scientific tests could show that these new colors clearly were more visible to the human eye over a wide range of conditions, the use of them was never conclusively shown to have resulted in a significant reduction of the number of collisions these vehicles were involved in. Many of the fire departments who switched to the lime-green or lime-yellow color have since switched to other colors, though a number continue to use those colors **(Figure 6.21**; *Courtesy of Denis Desmond*).

Figure 6.22

In reality, in the United States emergency vehicle colors, lighting, and markings are, in large part, a matter of local or state-level preference. The combination of color patterns, markings, lighting equipment, audible warning devices, and other features are often considered important in reflecting each agency's identity. In many, if not most, cases these liveries are based on local tradition, even though the selected scheme may detract from the vehicle's conspicuity. This is often why a community with an Irish name or background or the color green in its name may choose to have emerald green fire apparatus or a town named Grapetown has purple police cars **(Figure 6.22**; *Courtesy of Ron Jeffers, Union City, NJ*). Historically there has been little standardization, or for that matter rhyme or reason, to how emergency vehicles look.

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

Figure 6.23

Figure 6.24

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 requires all ambulances to be primarily white in color. A 12-inch, midline "Omaha orange" stripe must circle the vehicle. Use of the blue Star of Life emblems and the word "AMBULANCE" in reverse lettering on the front of the vehicle is also required. Many states and local jurisdictions adopted those requirements into their specifications or requirements, even if the ambulances were not federally funded **(Figure 6.23;** *Courtesy of Jose Ybarra*). Although these specifications were never based on any research or citable references, they remain the requirements for federally-purchased ambulances to this day. However many local and state jurisdictions have relaxed their requirements to follow these marking requirements and now allow local agencies to choose their own liveries **(Figure 6.24**; *Courtesy of Jack Sullivan, Emergency Responder Safety Institute*).

There are no national standards on the color or markings to be used on law enforcement vehicles. Again, the choice of vehicle exterior designs and warning equipment remains squarely within the discretion of each individual local, regional, state, or federal agency. Although many people view the standard old black and white car as a traditional look for police vehicles, there is little agreement or consistency on police vehicle liveries across the profession, as a whole **(Figures 6.25a through c;** *Courtesy of Jose Ybarra and Denis Desmond*).

Research and Standards

When examining the topic of vehicle markings, there is a significant amount of research from within the U.S. and around the world that is useful and relevant. In some cases there are applicable, recognized national consensus standards that should be followed. This section highlights some of the more respected studies and standards relative to emergency vehicle markings.

NFPA 1901

Until the late 1980's, there were no recognized standards for markings, retroreflective or otherwise, on fire apparatus. However, the 1987 adoption of the first edition of NFPA 1500®, *Standard on Fire Department Occupational Safety*

Figure 6.25a

Figure 6.25b

Figure 6.25c

and Health Program, had a profound effect on the fire service's safety attitude. It addressed a number of apparatus safety-related issues that had not been previously addressed by the NFPA 1901®, *Standard for Automotive Fire Apparatus* committee, such as the requirement for all new apparatus to be designed so that all firefighters ride within a completely enclosed cab. Many of these safety requirements were then carried into the next edition of NFPA® 1901.

NFPA® 1901's first significant requirement for standard safety markings was the requirement that all new fire apparatus be equipped with a basic 4-inch wide retro-reflective stripe around the perimeter of the apparatus. Its purpose is to illuminate the apparatus at night when visibility is limited. Later editions of the standard would increase the requirements for retroreflective markings.

At the time this report was written, the 2009 edition of NFPA® 1901 was in effect. The requirement for a minimum of a 4-inch wide stripe remains in place. The stripe must extend at least 50% of the length of the apparatus on each side and also span at least 25% of the front of the apparatus. The stripe does not have to be continuous and may skip over objects in its path. The stripe does not necessarily have to be a simple, solid line. The standard allows for a graphic design to be used in place of the stripe as long as is meets the same requirement as a simple stripe **(Figure 6.26**; *Courtesy of Ron Jeffers, Union City, NJ***)**.

New to the 2009 edition of NFPA® is the requirement that at least 50 percent of the vertical surfaces on the rear of the apparatus must be equipped with retroreflective striping in a chevron pattern sloping downward and away from the centerline of the vehicle at an angle of 45 degrees. Rear-facing, open pump panels are excluded from this requirement **(Figure 6.27)**. The standard specifies that each stripe in the chevron must be 6 inches in width and be a single color alternating between red and either yellow, fluorescent yellow, or fluorescent yellow-green **(Figure 6.28)**.

The insides of apparatus cab doors, ambulance box doors, and swing out compartment doors should be equipped with retroreflective markings that indicate the presence of the open door. **Figures 6.29 a through c** show a variety of acceptable ways to accomplish this.

United Kingdom (U.K) Law Enforcement Research

Starting in 1992, the U. K. Police Scientific Development Branch (PDSB) (later renamed the Home Office Scientific Development Branch [HOSDB]) began researching more effective markings for police vehicles at the request of the national motorway policing sub-committee of the Association of Chief Police Officers. The result was a set of visibility/conspicuity standards, titled the *Specification for the Livery on Police Patrol Cars*, now used on law enforcement vehicles throughout the country. Efforts to develop conspicuity specifications in the U.K. were undertaken with several objectives in mind:

- It must be recognizable at a distance from 200 to 500+ meters (650 to 1,650+ feet)
- It needs to assist with high-visibility policing

Figure 6.26

Figure 6.27

Figure 6.28

Figure 6.29a

Figure 6.29b

Figure 6.29c

- It must be readily identifiable nationally as a police vehicle, with room for local markings
- At least 75 percent of the staff using it must find it acceptable

Figure 6.30

The specification was originally designed to make police vehicles operating along high-speed roadways in the U.K. "visible throughout the day and night and be clearly identifiable as a police car." This design considers a minimum viewing distance of 500 meters (1,640 feet) under weather conditions including "rain, mist, etc.," with nighttime illumination provided by an approaching vehicle with normal headlights. In addition to retroreflective chevrons on the rear of the patrol car, this livery also requires a retroreflective "Battenburg" pattern (named after a cake with similar markings) along the sides, to improve both day and nighttime conspicuity and recognition as a police vehicle **(Figure 6.30)**. The results of this research indicated that the human eye is most sensitive to yellow/green colors in daylight and blue/green color after dark. The Battenburg pattern for police vehicles consists of two or more rows of alternating yellow and blue retroreflective squares or blocks along the sides of a vehicle **(Figure 6.31)**. While most small vehicles only have two rows in the design, larger vehicles can be marked with more than two rows.

Figure 6.31

In 2004, the U.K. Home Office Scientific Development Branch published a subsequent specification detailing a "high-conspicuity" livery for police vehicles used in cities and towns. (Harrison, 2004) In addition to the "full-Battenburg" scheme used on patrol cars primarily assigned to high-speed roadways, the 2004 document allows for a "half-Battenburg" pattern for patrol vehicles deployed in the urban environment **(Figure 6.32)**.

Figure 6.32

Figure 6.33a

Figure 6.33b

Figure 6.34a

Figure 6.34b

Since law enforcement's adoption of the yellow/blue Battenburg pattern on their vehicles, numerous other emergency and service agencies have adopted their own versions of the Battenburg pattern **(Figures 6.33 a & b;** *a Courtesy of Dennis Desmond*). Although not endorsed by the government they are commonly found in use throughout the U.K. **Table 6.2, p. 100).** It should also be noted that some use of the Battenburg pattern is now being found in the United States **(Figures 6.34 a through c;** *b Courtesy of Denis Desmond*).

Figure 6.34c

Table 6.2
Common Battenburg Patterns in the U.K.

	Police	Yellow / Blue
	Ambulance and doctors	Yellow / Green
	Fire and Rescue	Yellow / Red
	National Blood Service	Yellow / Orange
	Highways Agency and VOSA	Yellow / Black
	Rail response	Blue / Orange
	Mountain rescue	White / Orange
	HM Coastguard	Yellow / Navy Blue

Figure 6.35a

Figure 6.35b

Arizona Blue Ribbon Panel Study and Report

In addition to the information on warning lights discussed earlier in this chapter, the Arizona Blue Ribbon Panel also looked at the impact of vehicle color and markings on visual conspicuity. Since vehicle color is not addressed in this report, this discussion will be limited to the BRP's findings related to vehicle markings. At the time this study was conducted, the use of retroreflective markings on law enforcement vehicles was not nearly as common as its use on fire and EMS vehicles.

In general, because this concept was so new for police vehicles, the BRP only made some anecdotal comments relative to the use of retroreflective materials. They felt that the chevron marking on the rear of the vehicle presented the appearance of a traffic barricade or bridge abutment, both objects that an approaching motorist would adjust travel direction to avoid **(Figures 6.35 a & b)**. The group also observed that the use of two very high-intensity colors used to make the stripes of a chevron might be counterproductive as there would be little contrast between the colors of the two stripes. The group also expressed

Figure 6.36

some concern about the Battenburg pattern that is used on U.K. police vehicles. There was concern that this pattern may actually "camouflage" the vehicle in some urban settings.

The group was favorably impressed with two different concepts. One was the use of thin reflective striping to outline the perimeter of the vehicle on all sides **(Figure 6.36)**. This concept is being used in some European countries and is similar to the requirements for marking large trucks and trailers in the United States. When light is directed towards the vehicle, the entire perimeter of the vehicle reflects the light back to the source providing not only notice of the presence of the vehicle, but also the relative size of the vehicle. The other concept that the group liked was a new marking scheme being used by the Arizona Department of Safety. This included a larger retroreflective "Highway Patrol" on the rear-facing portion of the trunk lid, the use of red retroreflective shapes on either side of the license plate, and a narrow barricade pattern covering the length of the rear bumper **(Figure 6.37)**.

Figure 6.37

In the end, the BRP failed to make any strong recommendations relative to the use of retroreflective markings on police patrol vehicles. This was based on their belief that this concept was too new and more study of the issue and concept was required.

U.S. Fire Administration Research

In August 2009 the USFA released a report entitled *Emergency Vehicle and Conspicuity Study.*

This report was produced with support of the U.S. Department of Justice (DOJ), National Institute of Justice (NIJ) and with the actual research being done through a cooperative agreement with the International Fire Service Training Association (IFSTA) at Oklahoma State University **(Figure 6.38)**. The report analyzes emergency vehicle visibility and conspicuity with the goal of expanding efforts in these areas to improve vehicle and roadway operations safety for all emergency responders. The emphasis of this report is passive visibility/conspicuity treatments that could be added to emergency vehicles. It did not explore vehicle paint colors or warning lights, as the latter were studied in the report covered earlier in this chapter.

This report was based on three basic sources of information. First, an extensive amount of literature research was conducted using sources from around the world. Interest in vehicle conspicuity is not limited to the United States and many foreign countries are actually well ahead of the U.S. in research and application of these concepts. The writers of the report also made numerous visits to reflective trim and apparatus manufacturers, as well as practitioners and other research organizations, to gather information. This included organizations such as 3M, Reflexlite Americas, the University of Michigan Transportation Institute, Avery-Dennison, Rosenbauer Apparatus, the Arizona Department of Public Safety, and the City of Boston EMS. The third component was the use of a panel of subject matter experts to provide input on the desired content of the report and review of the final document. This included representatives of numerous national fire and law enforcement organizations, various federal agencies, and other recognized experts on this topic.

The report goes on to provide some basic background on this topic. This includes basic concepts of visibility, conspicuity, people's ability to recognize and properly identify objects, and the predictable actions that people may take when they recognize the object. The concept of retroreflectivity is explained and the technology of how to make it happen is detailed. The report also highlights applicable standards and requirements in the United States regarding the use of these materials on emergency vehicles.

The use of retroreflective materials on emergency vehicles is much more prevalent in emergency services outside of North America. The report details best practices for the use of these materials in places such as Europe and Australia **(Figures 6.39 a though d, p. 104)**.

Emergency Vehicle Visibility and Conspicuity Study

FA-323/August 2009

FEMA

Figure 6.38

Figure 6.39a

Figure 6.39b

Figure 6.39c

Figure 6.39d

A number of key findings were detailed in this report. Principal among these findings is the need for additional research on emergency vehicle visibility and conspicuity in the United States, with particular emphasis on the interaction between civilian drivers and emergency vehicles during responses and on incident scenes; other key findings include:

- The increased use of retroreflective materials holds great promise for enhancing the conspicuity of emergency vehicles. These materials are effective and considerably less expensive than active types of warning devices.
- The use of contrasting colors can assist drivers with locating a hazard amid the visual clutter of the roadway.

- Fluorescent colors (especially fluorescent yellow-green and orange) offer higher visibility during daylight hours.
- There is limited scientific evidence that drivers are "drawn into" highly-visible emergency vehicles.
- It is theoretically possible to "over-do" the use of retroreflective materials and interfere with a drivers' ability to recognize other hazards.
- Effectiveness of the "Battenburg" pattern in the UK appears primarily related to its association with police vehicles in that country. It may not be as readily identifiable when used in the U.S.

The report states that despite meaningful limitations, the existing visibility/conspicuity research, combined with that on passenger vehicle lighting and human factors, provides several potential opportunities for improving the safety of emergency vehicles in the United States using readily available products. These include:

- Outline vehicle boundaries with "contour markings" using retroreflective material, especially on large vehicles. This provides the observer with a relative size of the vehicle they are approaching **(Figure 6.40)**.
- Concentrate retroreflective material lower on emergency vehicles to optimize interaction with approaching vehicles' headlamps **(Figure 6.41)**. Materials above the majority of the headlight beams from approaching vehicles may not be as effective as those at the same level.
- Consider (and allow) the use of fluorescent retroreflective materials in applications where a high degree of day and night time visibility is desired.
- Using high-efficiency retroreflective material can improve conspicuity while reducing the amount of vehicle surface area requiring treatment. This avoids "over doing it" and may reduce the cost of the materials needed **(Figure 6.42)**.

Figure 6.40

Figure 6.41

Figure 6.42

Figure 6.43a

Figure 6.43b

Figure 6.43c

- For law enforcement vehicles, retroreflective material can be concentrated on the rear of the vehicle to maintain stealth when facing traffic or patrolling.
- Applying distinctive logos or emblems made with retroreflective material can improve emergency vehicle visibility and recognition **(Figures 6.43 a through c;** *b Courtesy of Jose Ybarra; c Courtesy of Eric Hansen*).

The entire *Emergency Vehicle and Conspicuity Study* may be read and downloaded from the USFA website at www.usfa.dhs.gov.

CONCLUSION

There is a wide variety of information available to emergency responders of all disciplines relative to what is effective and what is not effective in regards to emergency vehicle lighting and the use of retroreflective trim. First and foremost, agencies should ensure that they remain within the motor vehicle codes of the jurisdictions in which they operate. It is also advisable that every effort be made to meet the applicable national consensus standards that were discussed in this section. However in the long run, as stated at the beginning of this section, most agencies will determine what combination of these items they wish to include on their response vehicle. Hopefully, the information in this section will help them make the best choices in terms of both public and responder safety.

Section 7

Roadway Incident Scene Safety

The dangers associated with operating at roadway incident scenes have been firmly established earlier in this report. Yet in many jurisdictions the hazards associated with these operations remain largely ignored by emergency responsers. There are a number of reasons why this may be true. Some responders may not see these incidents as their primary mission. Some fire fighters are focused solely on structural fire fighting; some police officers are mindset on catching bad guys. Fire fighters spend a significant amount of time and energy developing policies for, and training on, safe fireground operations. Law enforcement agencies do the same relative to tactical operations. While these are extremely critical functions for both agencies, they tend to be low frequency incidents. The statistics discussed earlier in the report also note that these are not the most likely situations in which responders are likely to be injured or killed.

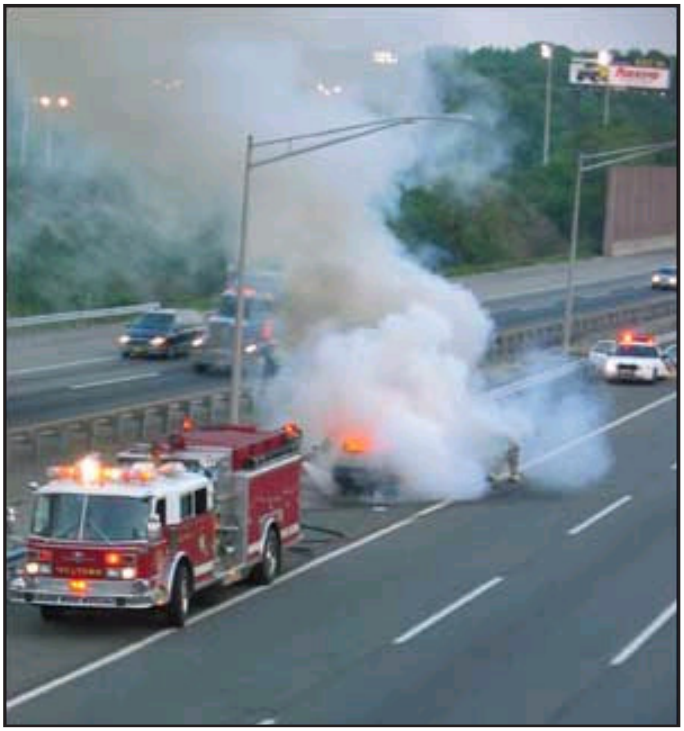


Figure 7.1

Response-related duties and roadway incident scenes remain the largest cause of traumatic deaths to fire fighters and law enforcement officers alike. Response-related losses have the highest of potential frequency possible: on every response. As well, in most jurisdictions the number of roadway-related incidents far outnumbers the number of working structure fires or tactical law enforcement events. Yet, in many cases, fire and police departments do not spend nearly as much effort to develop and enforce SOPs and training programs related to roadway incident scene safety as they do for the less common incidents. Again, as a reminder for this report, roadway incidents include events such as vehicle collisions, hazardous materials incidents, vehicle fires, and emergency medical incidents on or adjacent to the roadway **(Figure 7.1**; *Courtesy of Ron Jeffers, Union City, NJ*). This document does not address routine law enforcement traffic stops.

The hazards of working on the roadway are not limited to fire fighters and police officers. Being struck by another vehicle while operating at roadway incidents also account for one of the leading causes of injuries and deaths for third-service emergency medical service personnel, transportation department workers, and tow truck operators. Fortunately, we are beginning to see the tide turn in recent years and the fire service, law enforcement community, and other allied responders have begun to 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* will be used.

In this section we will explore some of the major issues related to roadway incident safety and how fire fighters and police officers can minimize the risk posed by operating in these dangerous locations. Four primary topics will be explored in particular:

- Agencies that Respond to Roadway Incidents and their Responsibilities
- Understanding and Respecting Each Other's Roles
- Managing Roadway Incident Scenes
- Establishing a Safe Work Zone at Roadway Incidents

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 and what their responsibilities relative to the incident will be.

The exact types of agencies that typically respond to roadway incidents depends on a number of factors, including the types of agencies serving a particular jurisdiction and the type or magnitude of the particular incident. In this section we will briefly review the primary agencies that most commonly respond to roadway emergencies and we will overview the primary duties that they are charged with at these incidents. The agencies include:

- Law Enforcement
- Fire and Rescue
- Emergency Medical Services (EMS)
- Transportation Agencies
- Towing and Recovery Services
- Emergency Management Agency
- Coroners and Medical Examiners
- Hazardous Materials Clean-up Firms
- News Media

Law Enforcement Agencies

Law enforcement agencies are one of the primary responders to roadway incidents and will be present at these incidents on virtually every occasion. In many states or regional jurisdictions law enforcement agencies are designated the lead agency for roadway incidents and they have overarching authority over all the other responders to the scene, although this is not always the case. Law enforcement responsibilities at roadway incident may include any or all of the following:

Figure 7.2

Figure 7.3

- Traffic control – This includes protecting the scene and rerouting traffic when necessary **(Figure 7.2)**.
- Incident investigation – In most cases the law enforcement agency will be responsible for gathering information on the parties involved in the incident, 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 7.3)**.
- 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.

Of these responsibilities, traffic control is probably the most important to the other agencies responding to the incident. 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. As will be highlighted later in the chapter, the greater the impediment to traffic that is created, the greater the chance of a secondary incident occurring. 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.

Fire and Rescue Agencies

Next to law enforcement agencies, fire and rescue agencies likely are the next most common 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:

- Extinguishing fires and making the scene as safe as possible **(Figure 7.4)**.
- 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 7.5;** *Courtesy of Phoenix, Arizona Fire Department***)**.
- Providing emergency medical treatment on the scene and transporting victims to the hospital if the fire department in this jurisdiction is charged with those responsibilities **(Figure 7.6;** *Courtesy of Phoenix, Arizona Fire Department***)**.
- 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 special apparatus or equipment that the fire department has and is needed by other responders. This includes things such as additional traffic control equipment, floodlighting, and thermal imaging devices **(Figure 7.7)**.

Emergency Medical Services (EMS)

Emergency medical services 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. This includes situations such as ill motorists in a stopped vehicle and ill or injured highway workers. Depending on the emergency response system used in that jurisdiction, emergency medical services may be provided by the fire department, a separate EMS agency (often referred to as a "3rd service EMS agency"), or a combination of both. Whoever the responders are, they are responsible for treating all of the victims at the scene and then seeing that they are transported to an appropriate medical facility.

The vast majority of victims that need to be transported to a hospital from a roadway incident will be transported by ground ambulances **(Figure 7.8)**. In cases where 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, the use of air medical helicopters has become commonplace in many jurisdictions **(Figure 7.9)**. This adds an additional layer to the roadway safety issue as it will be necessary to find a safe location to land the helicopter near the incident scene. In many cases this may be directly on the roadway itself. This may require additional rerouting of traffic and other issues affecting scene security and safety.

Transportation Agencies

Historically, transportation agencies did not play a major role in the response to roadway emergencies and their resources were commonly overlooked by the other emergency response disciplines. However in recent years there has been a major shift in this philosophy and the role of transportation agencies in

Figure 7.4

Figure 7.5

Figure 7.6

Figure 7.7

Figure 7.8

Figure 7.9

roadway incident responses has been substantially increased in many parts of the nation. Much of this can be credited to the Federal Highway Administration's *Intelligent Transportation Systems* (ITS) initiative and research project. This project is focused on improving the efficiency and safety of the nation's systems of roadways. Included in this project is work being done to improve the response to all types of incidents that occur on the roadway, including emergency incidents, disabled vehicles, and adverse weather conditions.

ITS has increased the awareness of the importance of transportation agencies being involved in the response to incidents that occur on the roadway. After all, it is the ultimate responsibility of the transportation agency to operate the roadway and ensure the efficient and safe flow of traffic on those roadways. These transportation agencies may be operated at the local, county, regional, or state levels. In recent years these agencies at all levels have increased both the passive and active ways in which they can affect the safe and efficient outcome of roadway incidents.

Figure 7.10

Passive methods of improving roadway incident management include better designs for roadways, improved signage, the use of variable message signs, dedicated traffic information radio frequencies/channels for motorist listening, and operating transportation monitoring centers (**Figure 7.10**). By ensuring that roadways are properly designed, maintained, and marked, transportation agencies can lessen the chances of an incident occurring. Many jurisdictions now use variable message signs (VMS) to alert motorists of traffic situations that are ahead in their direction of travel. This allows the motorist to be prepared for delays, changing traffic patterns, or gives them the chance to take an alternate route around the problem area. This same information may also be broadcast over dedicated AM radio stations that motorists can turn to for information.

There are also a number of active manners in which the transportation agency can improve roadway safety and assist in the response to roadway incidents. The first is by pre-treating or treating roadways during icy or snowy weather. They may also clear debris that has fallen off vehicles, blown onto the road surface, or fallen onto the road surface from breaks in rocks or mudslides. These actions can prevent collisions from occurring and improve the safe flow of traffic through the area.

Many transportation agencies are now operating response vehicles to assist with roadway incidents. These are referred to by a variety of names including motorist assistance units, highway service patrols, and roadway response services. These vehicles may be staffed during heavy travel periods or 24 hours

per days depending on the desires of the transportation agency. Most commonly they are staff by a sole driver, but in some cases there may be more than one person on the vehicle. These personnel may be trained in basic auto mechanics, first aid, and setting up roadway incident scenes, among other things **(Figure 7.11 a and b;** *Courtesy of Georgia DOT and Jack Sullivan, Emergency Responder Safety Institute*).

Figure 7.11a

These vehicles generally display highly visible liveries and warning light systems that increase their safety when operating in traffic. They may be operated by the transportation agency themselves of they may be a contracted service. Depending on the services the transportation agency wants to provide, these vehicles may be equipped with any of the following equipment **(Figure 7.12 a and b, p. 114;** *Courtesy of Jack Sullivan, Emergency Responder Safety Institute and Georgia DOT*).

Figure 7.11b

- Flashing arrow boards or variable message signs
- Portable signage, traffic cones or tubes, flares, and barricades
- First aid equipment
- Air compressors
- Floodlighting systems
- Fire extinguishers
- Small quantities of fuel
- Towing or pushing equipment to remove vehicles from lanes of traffic

On longer term incidents the transportation agency may respond with additional, heavier equipment. These things can include items such as barrier trucks, larger signs and message boards, additional cones, markers, or traffic barrels, additional lighting equipment, and a variety of other resources. 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.

Towing and Recovery Services

Towing and recovery services will be required any time a roadway incident involves a vehicle that has become disabled for any reason and must be removed from the roadway. On many incidents 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 will be summoned when they are needed. Their dispatch is usually coordinated through the police dispatch center. In other jurisdictions in may be the transportation agency that coordinates these services through their responder units or traffic control/command centers.

Figure 7.12a

Figure 7.12b

Figure 7.13

Figure 7.14

The type of equipment used for these services can range from small wreckers or roll-back vehicles to large wreckers capable of towing tractor-trailer vehicles (**Figure 7.13;** *Courtesy of Jose Ybarra*). On incidents where vehicles are overturned special equipment such as cranes or air lifting bags may be require to right the vehicle in order for it to be hauled away.

Emergency Management Agency

Local and state level emergency management agency (EMA) officials typically are not involved in responses to daily, routine incidents that occur on roadways. However they may become involved in large-scale, long-term incidents in some cases. These incidents include major hazardous materials incidents, large fires (particularly brush fires) affecting roadways, incidents where travelers must be evacuated off 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 multi-agency or multi-jurisdictional incidents (**Figure 7.14**).

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 there is a fatality involved. 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 victim from the scene. All other response agencies must be familiar with the duties of the medical examiner's agency in order to ensure their inquiry to the incident is not compromised by in appropriate actions taken before their arrival.

Hazardous Materials Clean-up Firms

Hazardous materials clean-up firms may be needed to respond on incidents that involve the actual or potential release of hazardous materials. In most cases these are privately-owned firms who specialize in this work. Many local jurisdictions keep these firms on retainer in order to ensure their expedient response to an incident when needed. Despite their status as privately-owned, contract firms, these agencies must be expected to 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 incident command structure that is in place and follow any directions given to them by the Incident Commander.

News Media

Even though they are not part of the emergency response that will typically affect the outcome of the incident, emergency responders must be prepared to interact with the media at significant roadway incidents **(Figure 7.15)**. 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. Emergency response agencies should be aware that in some circumstances the media may be able to assist responders in mitigating the incident. The media can provide information to the public on avoiding certain routes that are being affected by the incident. This may help reduce traffic congestion in the vicinity of the primary incident and reduce the chance of a secondary incident from occurring. First responders who do not have a helicopter available to agency may find images broadcast from a news helicopter to be helpful in getting a bigger picture of the situation. In some cases the helicopter may be used to transport a member of the command staff who can then radio visual information back to the Incident Commander. All agencies must have established policies for how the media will be handled when they are present at an incident.

Figure 7.15

UNDERSTANDING AND RESPECTING EACH OTHER'S ROLES

The previous section highlighted the primary roles for each of the likely responders to a roadway incident scene. 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. This is critical in the smooth handling of an incident. In this section we will underscore the need for this cooperation among all of the incident responders.

Failure to understand and respect each others 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 who is involved in the incident, whether or not they were the ones who technically were right or wrong. Nobody "wins" in these situations, except for 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 could be cited where overzealous members of each discipline acted irresponsibly in these situations and created a situation that actually disrupted and overshadowed the original event to which they all responded. This is unfortunate for everyone who is involved, including the original incident victims who often get overlooked while these unproductive behaviors are playing themselves out.

So what are the general causes of these roadway incident scene disputes? The immediate and easy answer is to blame overblown egos of the responders who create the dispute. While this is clearly often the case, it minimizes the true root of the issue. 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 incidents. This failure occurs due to basic training of the responders from each discipline being inconsistent on these issues and because of the lack of joint regular in-service training with all agencies involved. It also a symptom of agencies that do not preincident plan for these types of incidents and that do not have a positive, proactive relationship between them on an ongoing basis.

What Law Enforcement Officers Need to Understand About Fire and EMS Responders

From the very beginning of their initial training, fire fighters and EMS personnel are taught that their personal safety is their highest priority. The protection of other people and property are secondary to their own safety. This philosophy translates to roadway incidents just like it does at structure fires or other types of emergencies.

Fire and EMS training on responding to roadway emergencies focuses first and foremost on setting up a safe work zone before performing other tasks. Most training in this area is based on information contained in NFPA 1500,

Standard for Fire Department Occupational Safety and Health Program and the USDOT's *Manual on Uniformed Traffic Control Devices* (MUTCD). Both of these documents recommend that the lanes of traffic in which the incident has occurred should be closed to moving traffic, plus one extra lane next to the lane the incident is in **(Figure 7.16**; *Courtesy of Ron Moore, McKinney, TX FD***)**. This is why fire personnel seek to close an extra lane; they are trained to do so and it is often required under the organizational procedures they are bound to. This is typically done by placing apparatus in a diagonal manner across the lanes they desire to be closed. Fire fighters and EMS personnel are trained not to be operating upstream of these blocking apparatus.

Figure 7.16

Quite honestly, most fire and EMS personnel are not trained on issues such as the effects of reduced traffic flow or the hazards of long vehicle queues. That is why they pay little attention to these issues. All they are trained in is to block as much traffic as possible to maximize their own safety, which doesn't sound like a bad idea if you don't have a full picture of the entire story.

What Fire/EMS Personnel Need to Understand About Law Enforcement Officers

Certainly, police officers receive an extensive amount of training on roadway incidents and scene safety is an important piece of that training. However, where the fire and EMS service's roadway scene safety training tends to be limited to responder and victim safety, law enforcement training is more apt to cover the broader issue of safety not only to personnel at the scene, but also safety for the other motorists in the vicinity of 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 actually in extreme cases may last for many hours after the original incident has been cleared. That is why you sometimes find yourself crawling along on an interstate and then all of a sudden you resume normal speed with no apparent reason for the slow down. The truth is there may have been a collision or disabled vehicle there several hours earlier.

What police officers are trained to understand, and what is often missing from fire/EMS training, is the fact these impediments to the normal flow of traffic create a significantly dangerous situation. USDOT statistics indicate that secondary collisions following an initial roadway incident are responsible of 18% of civilian traffic fatalities in the United States. Police officers are aware of this fact and that is why they are driven to minimize lane closures and disruptions to the normal flow as much as possible. They are very focused not only on the safety of the initial incident scene, but also on mitigating any additional incidents from occurring as much as possible.

Working Together

Law enforcement and fire/EMS agencies must have an understanding of each other's roles so that they can develop positive working relationships on the incident scene (**Figure 7.17;** *Courtesy of Phoenix, Arizona Fire Department*). Certainly this principle applies to all the other potential emergency responders to these incidents as well. Waiting until an incident occurs and then trying to work these issues out on the fly at the scene is not a productive manner to address the issue and is likely to be unsuccessful.

Figure 7.17

Developing workable procedures for responding to and working at roadway incident scenes is an activity that should be conducted well in advance of any incident. Effective preincident planning will be the key to efficient, predictable operations and they should minimize the chance of conflicts between the various disciplines. The principles of preincident planning can be applied to roadway scene incidents in much the same way they are applied structure fires, tactical incidents, or the other types of incidents that historically been planned for. In reality, the roadway is just another target hazard in much the same way are a school, industrial facility, or apartment complex.

The primary difference in developing a preincident plan for a roadway incident as opposed to the other examples is the need for all affected agencies to be involved in developing the plan. When fire departments develop a preincident plan for a nursing home, they usually do it themselves. Likewise, law enforcement agencies typically do not significantly involve fire and EMS agencies in planning for barricaded suspect operations. The responsibilities at roadway incidents are much more equal for both agencies than a lot of other types of incidents. Thus both police and fire/EMS agencies, as well as the other common responders in a jurisdiction, must have a more equal role in preincident planning for these events.

When developing a preincident plan for roadway incident operations there are number of considerations that should be taken into account. The following summarizes some of the key issues that need to be addressed:

Figure 7.18

- Make sure that all disciplines/agencies who may respond to a roadway incident are involved in the planning effort.
- Ensure that the representatives from each agency have the authority of their agency to make binding decisions or commitments for the plan that is developed. If not, indentify what the adoption process is going to entail.
- Formalize what the specific role for each agency will be at these incidents.
- Establish from the outset who is going to be in overall charge 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 that can be implemented when the nature of the incident dictates that need (**Figure 7.18**; *Courtesy of Ron Jeffers, Union City, NJ*).
- Establish basic protocols for setting up work zones or traffic incident management areas that all parties can agree on. Understand that these may need to 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 it will work in real-life situations.

One of the key factors that must be considered in this planning process is that 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 these incidents, develop a plan that is unrealistic for the troops in the street who will need to implement it. There must be a balance between senior staff and actual practitioners involved in the process.

As well, it does no good if the group develops the best plan in the world and then it is simply stuck somewhere in each respective agency's file cabinets. The plan must be designed so that it is workable and easily implemented. All responders from each agency should receive effective training on the plan and understand how it will be implemented when they respond to roadway incident scenes. If possible, have a mix of disciplines in the training sessions so that responders can develop positive relationships and identify potential conflicts before they work together at incident scenes.

There must also be a mechanism for reviewing the plan on a regular basis and making revisions as needed. Once the original plan is put in place and used for a period of time, it may become obvious that some adjustments are required. The various parties should work together to make those adjustments and then the revised plan, highlighting the changes, should be communicated to all of the responders.

MANAGING ROADWAY INCIDENT SCENES

Proper preincident planning and training are important considerations when preparing to respond to roadway incidents **(Figure 7.19)**. When incidents occur it will be necessary to effectively apply the principles of sound incident management in order to bring the incident to a safe and satisfactory conclusion. 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.

Figure 7.19

Through much of the early histories of the various emergency services, the use of any formal incident command system was a hit or miss proposition. Most disciplines had no standardized incident command system and the ones who did had a system that applied only to their agency. Of all the disciplines, the fire service took the lead in this area in the 1970s with the development of two systems that became widely used throughout the U.S. The initial Incident Command System was developed in Southern California by an assortment of local, state, and federal agencies organized under the umbrella of an organization called FIRESCOPE. This system would ultimately be adopted by the National Fire Academy and other federal agencies. At the same time the Phoenix, Arizona Fire Department was also developing its own Fire Ground Command system that would ultimately be adopted for widespread use around the U.S.

There were some significant differences between these two systems and as the nation advanced toward developing regional or national responses to major incidents, the need to resolve these issues and agree on one system was recognized. In 1989 a group of emergency response and government agencies

formed the National Fire Service Incident Management System Consortium (now known as the National Incident Management System Consortium). By 1993 this consortium developed a model procedures guide that merged the principles of both prevailing incident management systems into one common system. However many agencies continued to do their own thing when it came to using an incident management system.

Following the tragedy that occurred on September 11, 2001, it became clear to the federal government that it would be necessary to mandate the use of an incident management system by all response disciplines in the U.S. in order to effectively manage emergencies, natural or manmade, that might occur in the future. In Homeland Security Presidential Directive (HSPD-5), *Management of Domestic Incidents*, the President of the United States directed the Secretary of Homeland Security to develop and administer a National Incident Management System (NIMS). On March 1, 2004, the Department of Homeland Security (DHS) issued the NIMS to provide a comprehensive national approach to incident management, applicable to all jurisdictional levels across functional disciplines. NIMS provides a consistent nationwide approach for federal, state, tribal, and local governments to work effectively and efficiently together to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity.

NIMS is an expansive document and set of regulations. For the purpose of this report we are most interested in the incident management requirements contained in NIMS. NIMS dictates the use of their designated Incident Command System (ICS) to be used on all incidents. With very few minor exceptions, the ICS mandated within NIMS was virtually identical to the merged system that was developed by the previously discussed Consortium.

In this section we will cover the basics of incident management with an emphasis on multiple disciplines working at roadway incident scenes. Included will be information on incident size-up and assuming command, appropriate tactical priorities, basic incident command structures for these incidents, and principles of unified command that can be used to effectively manage the various agencies that respond to these incidents.

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 their rank or agency. 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, principles of sound risk management should be integrated into the functions of incident command.

Rules of Engagement

Historically, the fire service and law enforcement communities have been very quick to apply rules of engagement to incidents such as structure fires, wildland fires, hostage situations, and high-speed chases. Yet they have not been so

quick to apply those same principles to other more routine operations such as roadway incident scene operations. As stated previously in this document, the roadway is one of the most hazardous locations at which we operate. Therefore we must apply principles of risk management to these scenes and operations.

The most common risk management model that is used in any of the response disciplines is one that is adapted from The National Fire Protection Association (NFPA) Standard 1500, *Standard on Fire Department Occupational Safety and Health Program*, states that the concept of risk management shall be utilized on the basis of the following principles:

- Activities that present a significant risk to safety of members shall be limited to situations where there is a potential to save endangered lives.
- Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of members. Actions shall be taken 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 professions and all hazards encountered in conjunction with highway incidents. Therefore, all agencies should adopt common rules for highway incident management. This will greatly assist incident commanders when considering courses of action. **Figure 7.20** shows a template for Model Rules of Engagement as they are applied to roadway emergency scenes. Agencies should consider adopting them into their SOPs and applying them on all roadway incidents.

Risk Analysis

In order to perform an effective size-up of the incident, the initial (and subsequent) Incident Commander (IC) must have a basic understanding 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
- Environmental hazards
- Criminal and terrorist threats
- Traffic hazards

Incident Factors

- Condition of involved 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

Highway Incident Model Rules of Engagement

We will balance risks with the benefits of taking any action.

I. We MAY risk our lives a lot, in a calulated manner, for savable lives, or for preventable further injury or death.
II. We WILL NOT risk lives at all, for property or lives that are already lost.
III. We MAY risk lives only a little, in a calculated manner, for salvageable property, or preventable further damage or destruction.
IV. We WILL endeavor to consider the needs of the others in the vicinity.

Engagement Needs Assessment

We will assess the benefits of our planned actions.

I. We WILL consider the likelihood of success of our actions.
II. We WILL consider the benefit we could provide if we succeed.

Engagement Risk Assessment

We will assess the risks of our planned actions.

I. We WILL assess the threats of injury and death to responders and those in their care.
II. We WILL consider the likelihood of threats occuring and their severity.
III. We WILL endeavor to consider threats of property damage or destruction.

Figure 7.20

Size-Up

The first responder (law enforcement, fire service, EMS, transportation) to arrive at the scene shall assume Command of the incident **(Figure 7.21)**. 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 whatever parts of ICS are needed to effectively manage the incident scene. The exact actions undertaken will vary depending on the type or scope of the incident:

Figure 7.21

- A single-resource incident (single-patient medical incident, traffic collision with minor injuries, disabled vehicle, property damage collision, etc.) may only require that the initial Incident Commander provide a size-up report and acknowledge its arrival on the scene.
- 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.

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., haz mat release, multi-vehicle crash, guardrail damage, etc.)
- 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 (haz mat spill, multiple patients, working fire, bridge collapse, etc.)
- 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 center or control center, as well as the other responders who are en route to the scene and monitoring the radio frequency. Examples of concise size-up report by the first on-scene responder include:

For an ordinary, nonblocking vehicle with mechanical trouble:
"*PATROL 325, I am off with a disabled pickup truck on the right shoulder, westbound I-64 at mile marker 232. Apparent overheated engine.*"

For a vehicle crash with an unexpected severity:
"Medic 21 on the scene of a multivehicle collision with a rollover. Correct location as dispatched and the vehicles are blocking the left lane and left shoulder. Apparent multiple patients. Dispatch a heavy rescue unit, two suppression units, two additional rescue-ambulances with an EMS supervisor, traffic control, and one air ambulance. Medic 21 is beginning triage."

The information above is pretty standard size-up information for most agencies on most types of incidents. However the MUTCD has some specific size-up requirements that it requires to be addressed. 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 requires the initial responders to 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 (back-up) that will occur as a result of the incident. This information must then be used 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 back-up are developed. This fact emphasizes the need for a quick, accurate size up and the implementation of appropriate ETC procedures as soon as possible.

The MUTCD categorizes roadway incidents into one of three classifications:

- *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.
- *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.
- *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, non-injury collisions and stalled vehicles are examples of minor traffic incidents.

Each of these categories has its own requirements for how the incident work area must be established and set up. These requirements will be detailed later in this section.

Tactical Priorities

Much of the confusion and conflict that has occurred between emergency responders in the past has not only been caused by a lack of understanding on what various responders roles were, but also on the 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 the order of 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:

1. Establish Command and Communications
2. Establish a Safe Work Zone
   - Responder Safety
   - Scene Safety
   - Traffic Safety
3. Incident Mitigation
4. Facilitate Investigation/Evidence Protection
5. Vehicle/Debris/Cargo Removal
6. Incident Termination

Establishing command and setting up a safe work zone are covered in more detail later in this section. It is not the purpose of this document to provide information on tactics on mitigating the various types of incidents that emergency responders may encounter at roadway incidents. Those techniques and skills should be a part of standard responder training programs.

The final three priorities are worthy of a brief discussion here, as they will not be addressed anywhere else in this document. 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 a number or reasons including the determination of fault and whether a crime has been committed. All 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 it is approved by a police officer. The position of the debris may be important information in determining the cause of the incident.

In some cases this debris may actually be important evidence that can have a significant impact on the outcome of the investigation. A perfect example of this occurred at the bombing of the Alfred P. Murrah Building on April 19, 1995 in Oklahoma City. The suspect, Timothy McVeigh was ultimately tracked and caught by being linked to the VIN number on a truck axle that was found two blocks from the blast site. Had someone moved or removed that axle, the job of identifying the suspect could have been much more complicated. All personnel should try to preserve potential evidence until otherwise directed by law enforcement personnel.

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 and how it will be removed depends on what needs to be removed. Inoperable vehicles will be removed by an appropriate tow or rollback vehicle. Various types of cargo that may be spilled may require heavy equipment and dump trucks to be removed. Hazardous materials will need to be carefully cleaned up 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 and the initial set-up of the scene and it is equally as dangerous. All unnecessary vehicles should leave the area and then traffic control equipment should be carefully removed by working from the work zone back towards where the initial markers were place. When possible, have a large vehicle between the responders picking up the equipment and oncoming traffic.

Basic ICS Structure

All personnel who respond to roadway incident scenes must be trained and competent in the principles of ICS. The effective management of the incident hinges on all responders working within the ICS structure. Entire books have been written on incident command, and more specifically on the application of ICS to manage roadway incidents. It is not within the scope of this report to provide a complete, extensive coverage of the application of ICS at roadway incidents. However we will provide a brief overview.

The ICS organizational structure develops based on the nature, size, and complexity of the incident. The only difference between ICS on a large incident and ICS on a small incident is the method of organizational growth to meet the needs of the incident. Expanding the ICS organization is the sole decision of the Incident Commander (IC) and is done when it is determined that the initial responders are not enough to handle the incident.

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). 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 initiate a ***reinforced response***, which may include special resources from within the agency, other responder disciplines, or through mutual aid.

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 are included in the Incident Action Plan (IAP) are accomplished at the strategic level. Supervisors direct operational activities toward specific incident objectives at the tactical level. Activities at the task level are normally completed by individual companies or specific personnel **(Figure 7.22;** *Courtesy Bob Esposito***)**.

Figure 7.22

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 will be handled by the units assigned to the initial response or with just a few additional resources in a reinforced response. The command structures at these incidents are fairly simple. **Figures 7.23 and 7.24** show two examples of simple command structures.

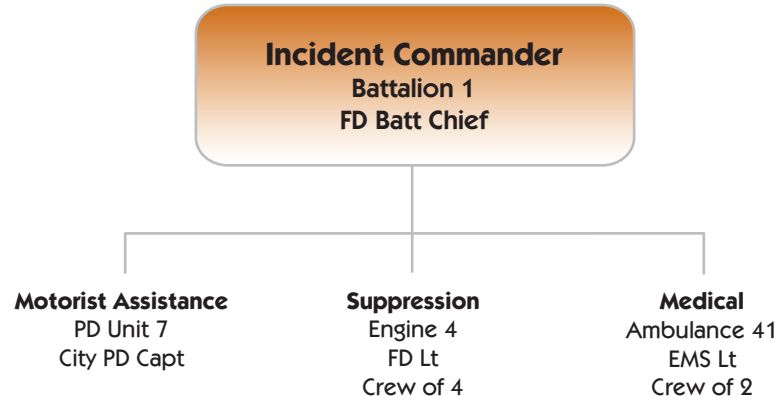


Figure 7.23

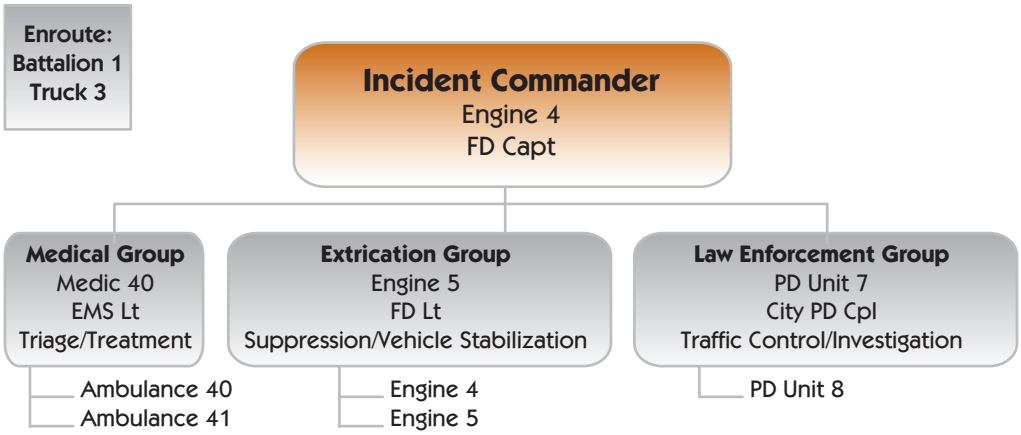


Figure 7.24

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.

Expanding the Organization

When the number of Divisions/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 multi-branch structure and allocate the Divisions/Groups within those Branches **(Figures 7.25 and 7.26)**.

Some incidents may require a functional Branch structure with each involved discipline within the jurisdiction having its own functional Branch **(Figure 7.27, p. 130)**. It is important to remember that resources at multi-jurisdictional incidents are best managed under the agencies that have normal control over those resources.

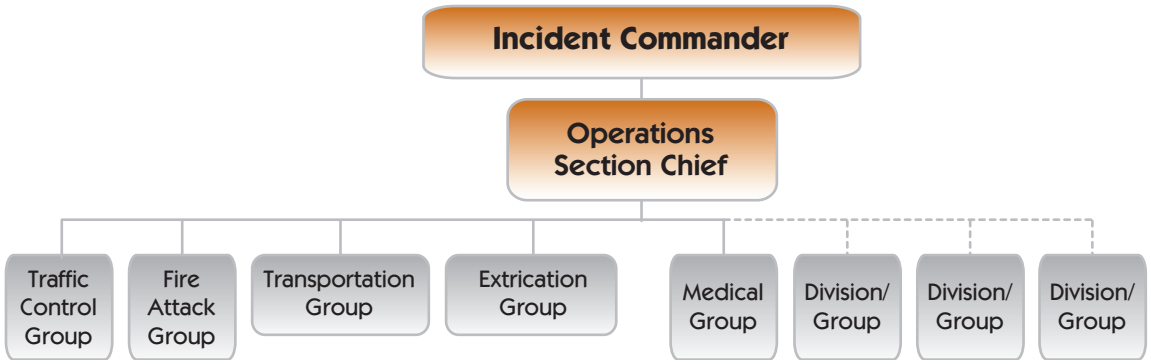


Figure 7.25

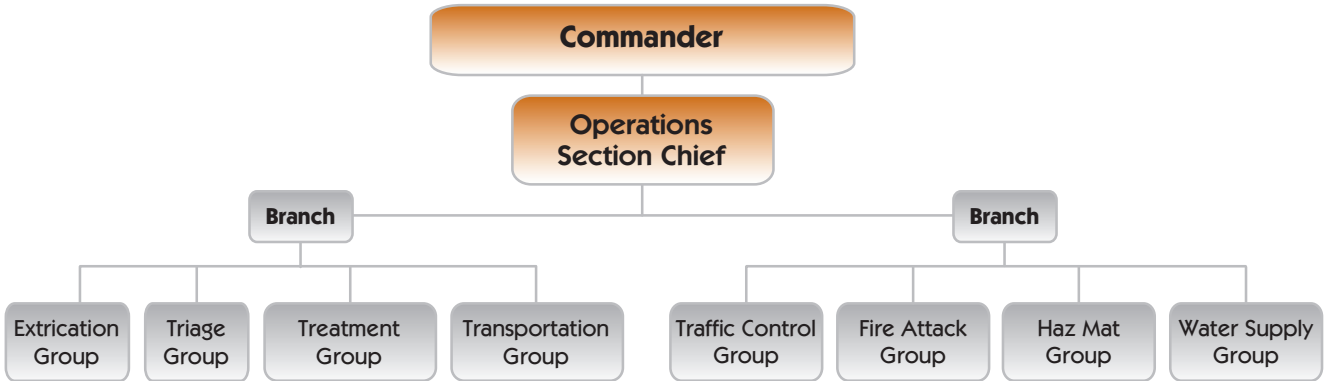


Figure 7.26

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: Operation, Planning, Logistics, and Finance/Administration. Each of these sections is led by a Section Chief who reports directly to the IC.

The IC also 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 is normally the point of contact for the media and other governmental agencies seeking information related to the incident. The Safety Officer as-

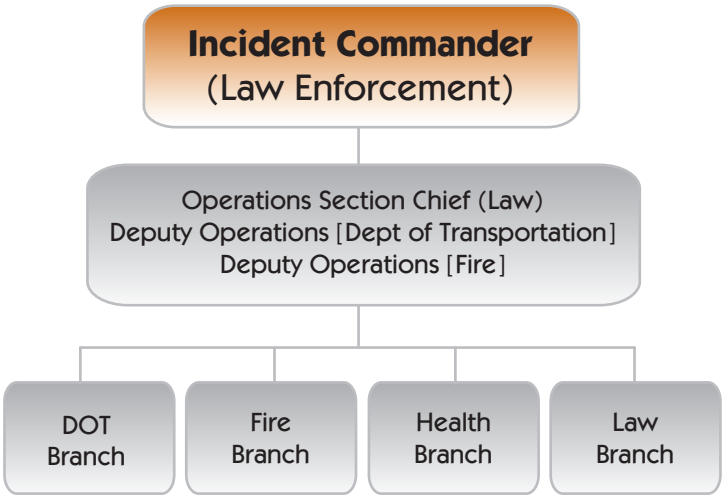


Figure 7.27

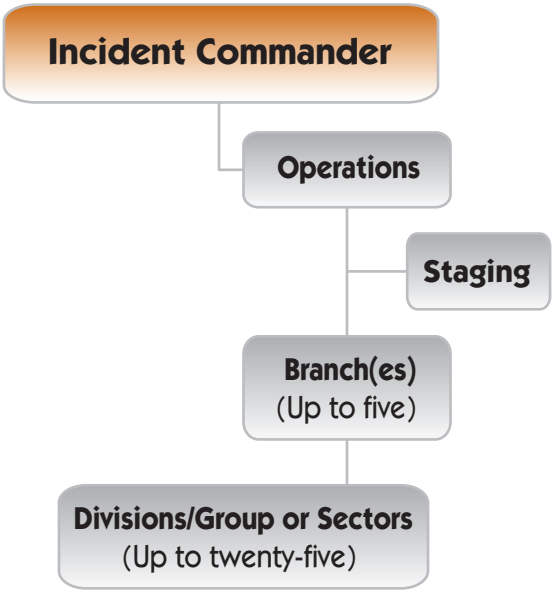


Figure 7.28

sesses hazardous and unsafe situations and develops measures for assuring responder safety. The Liaison Officer is the point of contact for representatives from cooperating or assisting agencies and is not directly involved in incident operations. All Command Staff positions can have assistants as indicated by incident complexity.

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 **(Figure 7.28).** The Operations Section Chief (or simply "Ops Chief") designates an appropriate command channel to communicate strategic and specific objectives to the Branches and/or tactical level management units. The Ops 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 or D/Gs 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 attention on management of the entire incident rather than concentrating on tactical activities.

Highway incidents often involve aircraft. Aeromedical helicopters may be used to transport patients **(Figure 7.29)**. 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 7.29

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 enhance the command organization and improve the decision-making process.

In some situations, it is more prudent 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.

The **Planning Section** is responsible for gathering, assimilating, analyzing, and processing information needed for effective decision-making **(Figure 7.30)**. 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.

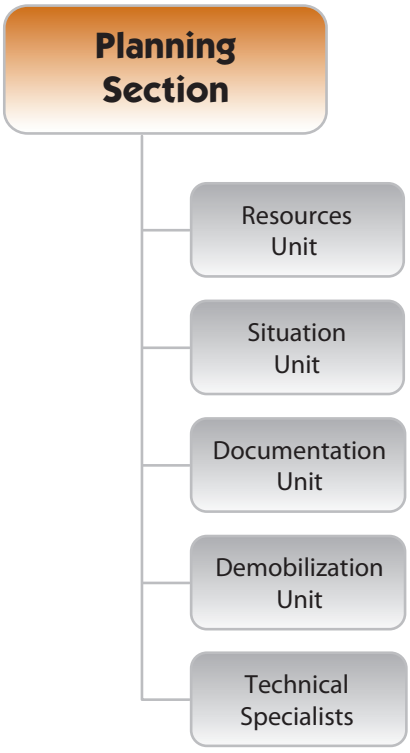


Figure 7.30

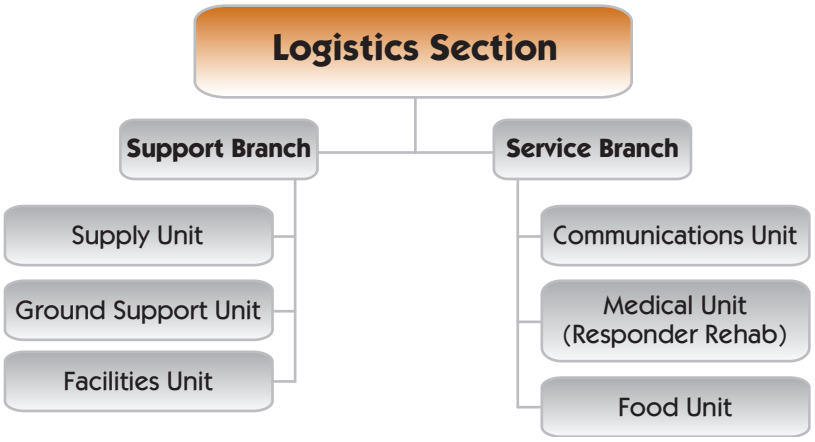


Figure 7.31

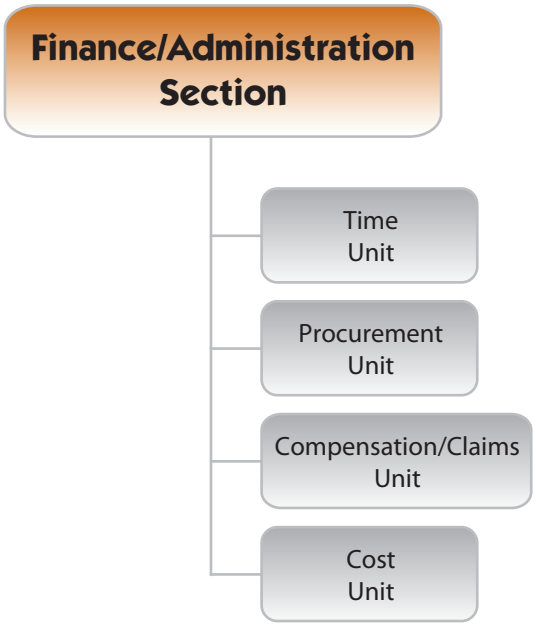


Figure 7.32

This 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 they are needed. The strategic concerns of the Incident Commander need to extend forward with sufficient foresight to cover all of his ICS organization's activities.

Transportation organizations have a great deal of specialized knowledge that can be helpful to the planning function, and they should be used as technical specialists by the Planning Section on complex incidents. These technical specialists are especially helpful when the incident involves more than one mode of transportation, such as rail crossings or transit facilities.

The **Logistics Section** is the support mechanism for the organization. The Logistics Section provides services and support systems – which may be separated into Branches – to all the organizational components involved in the incident, including facilities, transportation, supplies, equipment maintenance, fueling, feeding, communications, and responder medical services and rehabilitation. Its organizational breakdown is shown in **Figure 7.31**.

The **Finance/Administration Section** is established only when involved agencies have a specific need for financial services **(Figure 7.32)**. There are always cost-reimbursement issues with multi-agency 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

Unified Command may be appropriate in a) a multi-jurisdictional incident, such as a collision that crosses city and county lines or b) a multi-departmental incident, such as a collision on an interstate that brings responders from fire, EMS, law enforcement, DOT, and other agencies. The lead agency is determined by the initial priorities **(Figure 7.33)**. For example, the fire department would be the lead agency if extrication or vehicle fire was involved. 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.

Figure 7.33

The importance of an effective unified command on major roadway incidents cannot be overemphasized. There are multiple priorities by various agencies on these incidents. Failure to establish Unified Command is often what becomes responsible for conflict between agencies or responders. Some of the concepts associated with using an effective Unified Command are somewhat complex and require preincident planning and training. The concepts surrounding unified command exceed what can be covered in this type of document. The National Incident Management System Consortium's *Incident Command System Model Procedures Guide for Structural Fires, High-Rise, Multi-Casualty, and Highway Incidents* dedicates an entire chapter to this topic. It is highly recommended that agencies consult that document and work those concepts into their SOPs.

SAFE WORK ZONES 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. In the MUTCD this area is referred to as the traffic incident management area (TIMA). While there is always the risk of an approaching motorist failing to recognize or yield to traffic control measures, in most cases these measures will significantly reduce the level of hazard for emergency responders working on the scene.

Setting up a safe work zone begins with the proper placement of the initial vehicle that arrives on the scene and expands from there. Regardless of which discipline arrives on the scene first, the driver of the first arriving vehicle has three primary concerns when determining where to park the vehicle at a roadway emergency scene:

- Park the vehicle in a manner that reduces the chance of the vehicle being struck by oncoming traffic.
- Park the vehicle in a manner that shields emergency responders and the operational work area from being exposed to oncoming traffic.
- 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 surroundings at which the emergency scene is located. Drivers must be versed in the appropriate positioning procedures for all of the possible environments that they may be expected to operate within.

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 that must be followed as much as possible:

- When not needed for blocking, park emergency vehicles off the street in a parking lot or driveway, when possible. This reduces the risk of being struck by a moving vehicle that is not paying attention to the emergency scene.
- When possible, completely close the street that the emergency is located on to through traffic **(Figure 7.34)**. This reduces the potential of a civilian vehicle driving into the emergency vehicles or responders. (There are many examples of responders who have been struck even on roads or in parking lots that have been "completely closed")
- Do not block access to the scene for later-arriving emergency vehicles **(Figure 7.35)**. Oftentimes crashes occur when one vehicle is parked in a poor position and another attempts to squeeze around it. This is a frequent source of conflict between fire, IMS, and law enforcement personnel.
- 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 for it to strike a group of responders **(Figure 7.36**; *Courtesy of Ron Moore, McKInney, TX FD***)**. Parking the emergency vehicle on an angle allows approaching motorists to more quickly recognize that the unit is parked and not moving.
- On EMS calls, use another emergency vehicle to shield the patient loading area behind the ambulance **(Figure 7.37**; *Courtesy of Jose Ybarra***)**. 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 vehicles on railroad tracks. Keep the vehicle far enough away from the tracks so that a passing train will not strike it. In general, park the emergency vehicle on the same side of the tracks as

Figure 7.34

Figure 7.35

Figure 7.36

Figure 7.37

the incident. This negates the need to stretch hoselines or deploy other equipment across the tracks or for personnel to be traversing back and forth between each side. It may be advantageous to have law enforcement or transportation agency personnel staged on the opposite side of the tracks to begin moving traffic to different lane or rerouting it before it reaches the crossing.

- Consider positioning fire apparatus with pumps so that the pump panel is located on the opposite side of the vehicle from oncoming traffic **(Figure 7.38, p. 136)**. This will help protect the pump operator from being struck by a stray vehicle. However, if the position of the truck could cause it to be pushed into the work zone if struck by a vehicle, then consider angling it away from the work zone and have the pump operator move to a safe area after activating the pump and charging lines. If rescue tools will be the primary equipment used at the scene then consider protecting that side of the rig where those tools are located. The bottom line is that the blocking position of fire apparatus should be a risk management decision at the scene based on the location of the incident, work zone location, equipment to be used off the apparatus and/or location of the pump and pump operator.

Figure 7.38

When the incident occurs in an intersection, it may be necessary to shield the incident scene from two or more directions **(Figures 7.39 a & b)**. Whenever possible, law enforcement personnel must be used 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, additional fire companies may be dispatched and their apparatus used to shield the scene. The additional personnel that respond with the extra apparatus can be used to assist with on scene tactical operations or to perform flagging and other scene protection duties. If the local transportation department has a response capability, they may also be helpful in supplying equipment and trained personnel to assist in these situations.

Operations on Highways

There are numerous challenges relative to emergency vehicle placement, operational effectiveness, and responder safety when dealing with incidents on limited-access highways.

Simply accessing the emergency scene on a limited-access highway can be a challenge to emergency responders. Emergency vehicles may have to respond over long distances between exits to reach an incident. While making directional changes at entrance and exit ramps should always be the first choice, in some cases emergency vehicles will be required to travel a long distance between regular exits. Only in these cases should the use of turnarounds that allow them to get to the opposite side of the median be considered. Extreme caution must be used when using turnarounds that do not have deceleration and acceleration lanes on either side. Emergency vehicles must not be driven against the normal flow of traffic unless police units or highway department officials have closed the road.

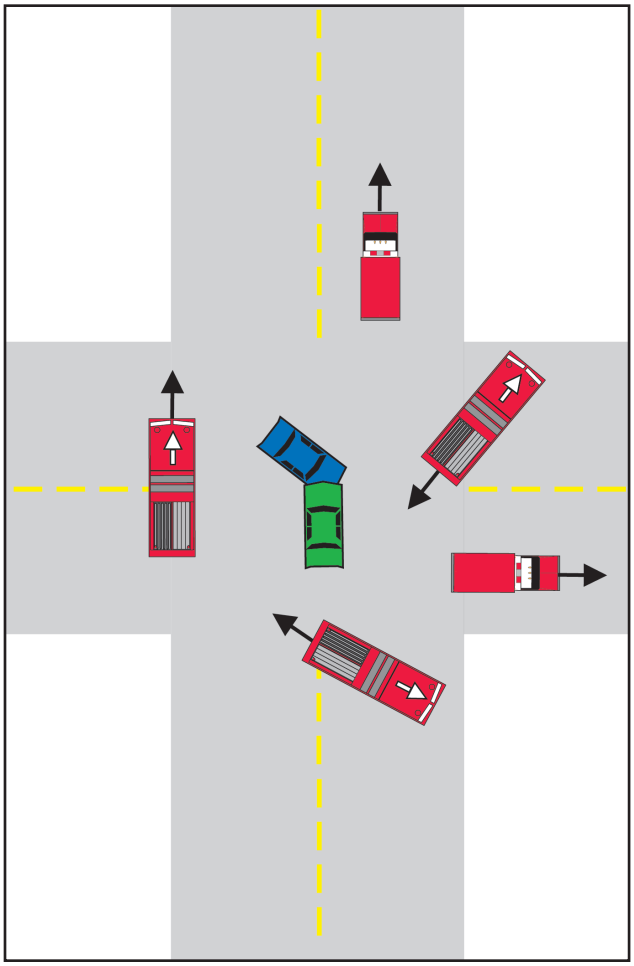


Figure 7.39a

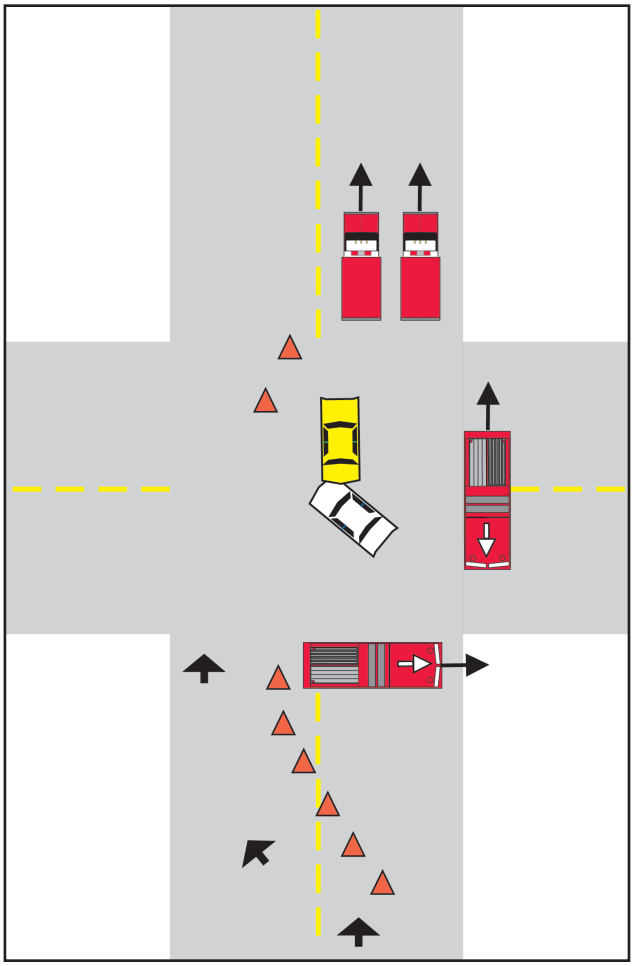


Figure 7.39b

A fire apparatus driver/operator 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. Many fire departments have SOPs that require the driver/operator to turn off 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. However, as will be discussed later in this section, only select warning lights must be used to prevent the blinding of oncoming civilian drivers.

Law enforcement officers should follow their agency's policy on the appropriate way to respond to roadway incidents. Some agencies advocate a full lights and siren response to these incidents. Other agencies have their vehicle respond with only the rear-facing warning lights flashing so as to not create confusion for vehicles they are approaching. One advantage that police vehicles have over most fire apparatus is that they are smaller and can more easily access a clogged incident area using the shoulders or median, although extreme care must be used when operating in these areas.

Emergency vehicles, preferably a full-sized fire apparatus, must be placed between the flow of traffic and the personnel working on the incident to act as a shield. The vehicle must be parked on an angle, either to the right or left depending on conditions at the scene as described above. Front wheels must be turned away from the personnel working highway incidents so that the vehicle will not be driven into them if it is struck from behind **(Figures 7.40 a & b)**. Also consider parking additional emergency vehicles 150 to 200 feet behind the shielding vehicle to act as an additional barrier between responders and the flow of traffic **(Figure 7.41)**.

Figure 7.40a

Figure 7.40a

All personnel must use extreme caution when getting out of their vehicle so that they are not struck by passing traffic. The fire fighters must only mount and dismount the apparatus on the side opposite flowing traffic whenever possible. Similarly, drivers are extremely vulnerable to being struck by motorists if they step back beyond the protection offered by the apparatus or by watching for a break in traffic before exiting the vehicle.

Setting Up a Safe Work Zone at Roadway Incidents

Historically, in many jurisdictions the establishment of a "work zone" on roadway incidents was limited to positioning emergency vehicles close to the incident scene and perhaps setting out a few traffic cones or road flares in a non-specific manner. This lack of attention to detail and the hazards presented by oncoming traffic are probably the reason that we have experienced so many injuries and deaths to police officers and fire fighters while working at roadway incidents. Progressive departments now realize that these practices need to change in order to maximize the safety of our responders.

Another important organization that has realized the need for changes is the United States Department of Transportation (DOT). The DOT, through its Intelligent Transportation Systems (ITS) initiative, has spent a considerable

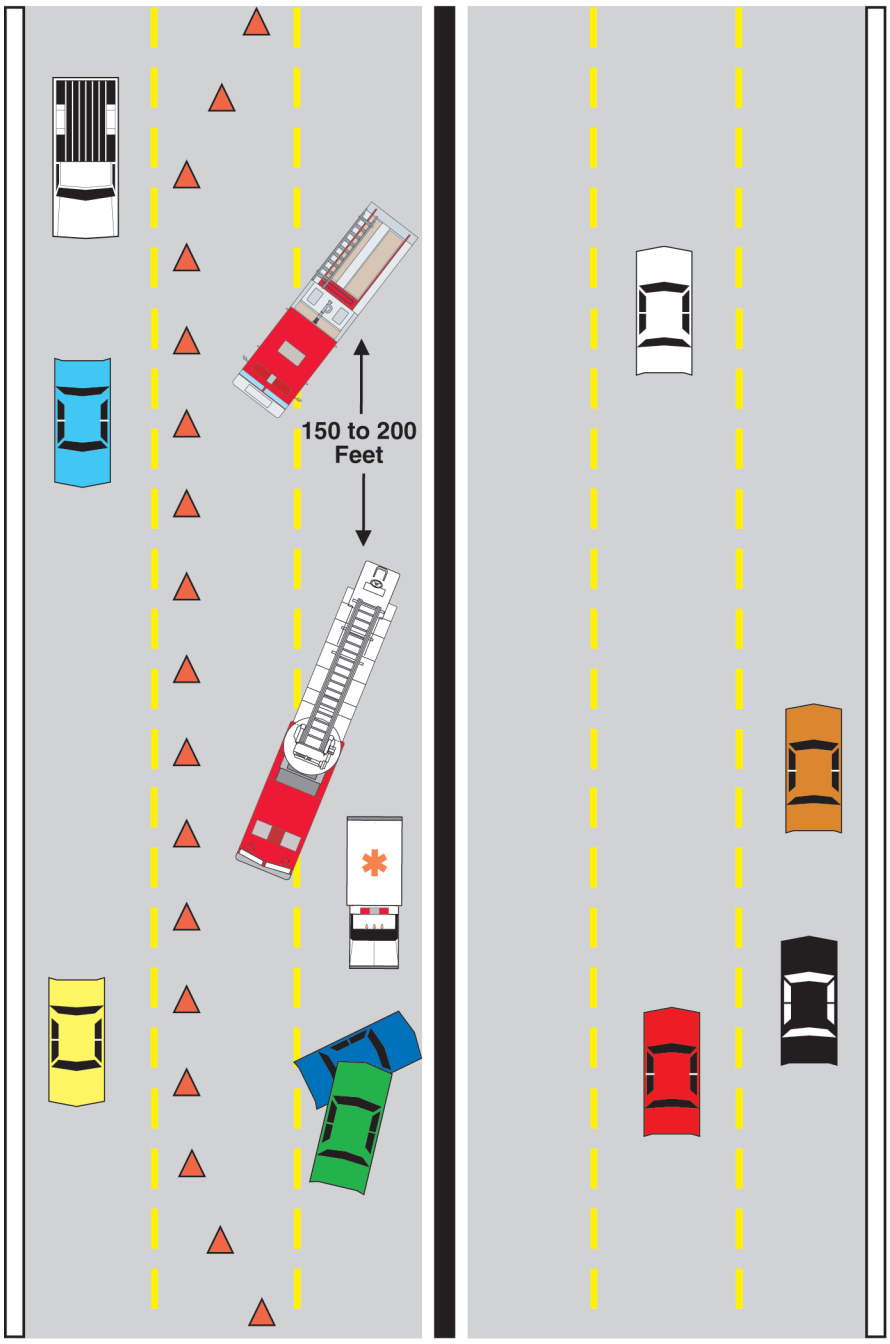


Figure 7.41

amount of effort in recent years studying the effects of roadway incidents on responders who operate at them and to the motoring public that encounters them. The goals of this research have been, among other things, to increase the level of safety for responders operating on the emergency scene and to minimize traffic disruption, thus improving the flow of traffic around the incident. These goals are not mutually exclusive. Procedures can be used that will address the concerns of all those organizations involved in the incident.

Previously, the balancing of scene tactical and safety concerns has been a source of conflict between various disciplines of emergency responders and transportation officials. Ultimately these conflicts are responsible for a reduced level of service to the victims of the roadway incident and the motoring public, as well as an increased level of risk to responders operating on the roadway. It is hard to focus on service delivery and safety when you are involved in an argument with one of the other responders. Hopefully the information discussed earlier in this document will lead to avoiding these counterproductive situations.

In this section we will examine some of the important aspects of setting up safe work zones at a roadway emergency. This includes following DOT requirements for temporary work zones, effective use of apparatus warning lights on roadway incidents, and protective clothing for responders.

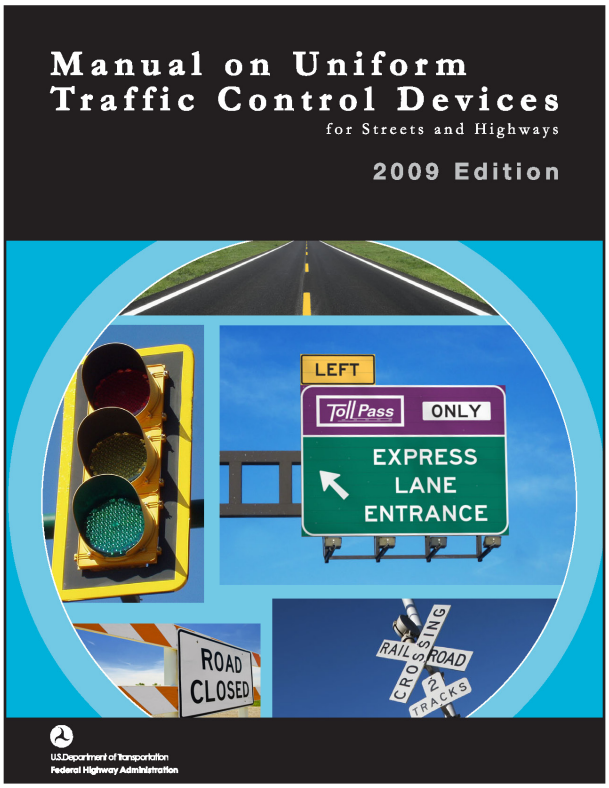


Figure 7.42

Manual on Uniform Traffic Control Devices (MUTCD)

Title 23 of the United States Code of Federal Regulations charges the DOT with developing a manual on uniform traffic control standards and requires each state to adopt these standards. The document that contains these standards is called the *Manual on Uniform Traffic Control Devices (MUTCD)* **(Figure 7.42)**. Historically, most emergency response agencies have failed to recognize the existence of this document and have not abided in 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 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. These requirements were reinforced in the December 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 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 organization's 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

Figure 7.43

and these principles must be applied to every roadway emergency **(Figure 7.43)**. 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 or around an incident or emergency scene. There are three basic goals of TTC:

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

(Note: See http://mutcd.fhwa.dot.gov/pdfs/2009/part6i.htm for details)

Secondary crashes are those crashes that occur as a result of traffic back-ups or lane closures related to an initial roadway incident. As mentioned earlier in this section, DOT statistics show that approximately 18 percent of all highway fatalities occur as a result of 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, we will highlight the major topics and points to give you 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, ETC sign colors, and use of initial control devices, such as road flares and traffic cones.

Figure 7.44

Figure 7.45

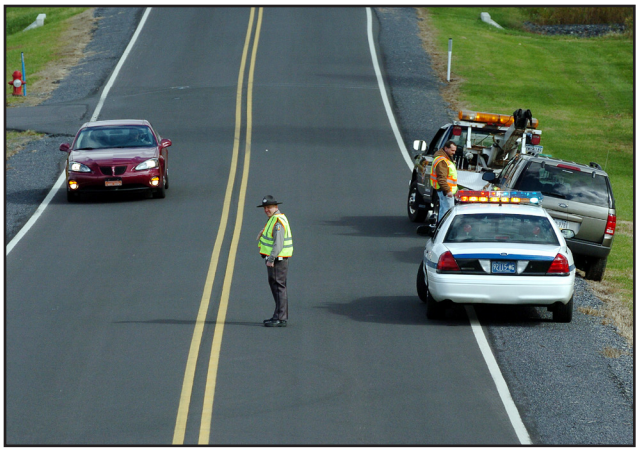


Figure 7.46

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 7.44**;*Courtesy of Bob Esposito*).
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 7.45)**.
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, non-injury collisions and stalled vehicles are examples of minor traffic incidents **(Figure 7.46)**.
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.

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/closures are made, the *activity area* where responders are operating, and the *incident termination area* where normal flow of traffic resumes. **Figure 7.47** shows the various parts of a TIMA. 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 distance 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 7.48 a & b, p. 144; a** *Courtesy of Ron Moore, McKinney, TX FD*). 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.

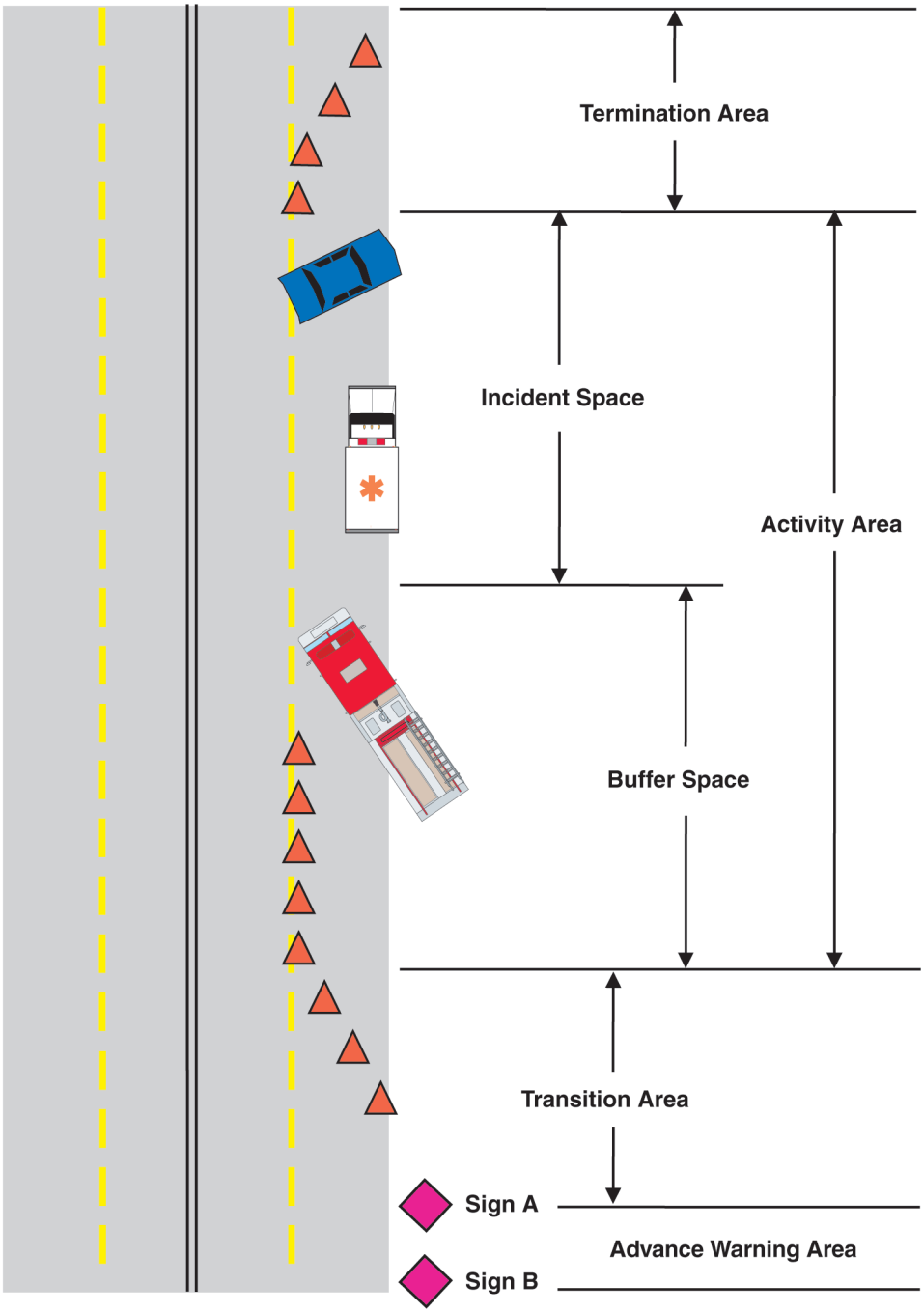


Figure 7.47

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 operating at roadway incidents. For more information on the MUTCD document and to download a free copy, go to http://mutcd.fhwa.dot.gov.

Effective Use of Warning Lights on the Roadway Emergency Scene

The use of emergency vehicle lighting as described earlier in this document is essential, especially in the initial stages of a roadway incident, for the safety of emergency responders and persons involved in the traffic incident, as well as

Figure 7.48a

Figure 7.48b

Figure 7.49

motorists approaching the traffic incident. Emergency vehicle lighting, however, provides warning only and provides no effective traffic control. It is often confusing to civilian motorists, especially at night (**Figure 7.49**; *Courtesy of Ron Moore, McKinney, TX FD*). Motorists approaching the traffic incident from the opposite direction on a divided roadway are often distracted by emergency vehicle lighting and slow their vehicles to look at the traffic incident posing 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 at a roadway incident scene. This is especially true for large traffic incidents that might involve a number of emergency vehicles. If good traffic control is established through the placement of advanced warning signs and traffic control devices to divert or detour traffic, then emergency responders can perform their tasks on scene with minimal emergency vehicle lighting.

The MUTCD recommends that public safety agencies examine their policies on the use of emergency vehicle lighting, especially after a roadway incident scene is secured, with the intent of reducing the use of this lighting as much as possible while not endangering those at the scene. Special consideration must be given to reducing or extinguishing forward facing emergency vehicle lighting, especially on divided roadways, to reduce distractions to oncoming motorists. Vehicle headlights not needed for illumination, or to provide notice to other motorists of the incident response vehicle being in an unexpected location must be turned off at night.

Many fire and police 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 **(Figures 7.50**; *Courtesy of Ron Moore, McKinney, TX FD*). They then require driver/operators 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 are automatically turned 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. In some cases, particularly on daylight incidents, it may be better to have all the lights activated.

Figure 7.50

In addition to warning lights, fire fighters must use caution in the use of floodlights at nighttime roadway incident scenes. Floodlights are essential providing a safe, efficient work area on nighttime incidents. However, they must be raised and deployed in a manner that is not blinding motorists driving past the incident scene **(Figure 7.51)**. 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.


Figure 7.51

Proper Protective Clothing for Personnel Operating At Roadway Incidents

An increased interest and emphasis in wearing appropriate high-visibility garments when responders are working at roadway incidents was spurred by the enactment of the Federal Highway Administration's Rule 634 in November 2008. This rule was amended several times with the most current ruling being issued on June 15, 2009. The final version, Rule 634.3, states "All workers within the right-of-way of a Federal-aid highway who are exposed either to traffic (vehicles using the highway for purposes of travel) or to construction equipment within the work area shall wear high-visibility safety apparel. Firefighters or other emergency responders working within the right-of-way of a Federal-aid highway and engaged in emergency operations that directly expose them to flame, fire, heat, and/or hazardous materials may wear retroreflective turn-out

gear that is specified and regulated by other organizations, such as the National Fire Protection Association. Firefighters or other emergency responders working within the right-of-way of a Federal-aid highway and engaged in any other types of operations shall wear high-visibility safety apparel."

For all practical purposes this means that high-visibility vests should be used at all times at crashes roadway **(Figure 7.52)**. The only exception would be when a fire fighter is directly involved in fire fighting or hazardous materials tactical activities. 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 new ANSI/ISEA 207-2006 public safety vest **(Figure 7.53)**. 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. Importantly, it also allows for, but does not require, "breakaway" features in case a vest is snagged on a close passing vehicle or some other dangerous obstruction. The Emergency Responder Safety Institute encourages the use of five point breakaway vests for maximum safety.

Figure 7.52

Figure 7.53

For many years fire fighters have relied on the reflective trim of their fire fighting turnout clothing to make them visible when operating on the roadway during daylight and nighttime conditions. However, the reflective trim that is found on most fire fighter turnout clothing is insufficient for proving adequate safety on the roadway and it must be supplemented with additional garments that make the fire fighter more visible. There is currently no turnout gear on the market that meets the requirements for traffic vest as specified by ANSI.

Emergency response agency SOPs must clearly dictate that all personnel wear appropriate high-visibility vests when operating on the roadway. All personnel must police themselves to ensure that their fellow responders are following this policy. The 2009 version of NFPA 1901, *Standard on Automotive Fire Apparatus*, requires all new fire apparatus to be outfitted with one ANSI-compliant vest for each seating position in the apparatus.

CONCLUSION

As stated at the beginning of this section, roadways are among the most dangerous locations in which all types of emergency responders must operate. These operations are further impaired if the various responders do not understand and respect each other's roles in the incident. All agencies should be involved in the development of procedures for response to these incidents and these procedures must be used on every response. These procedures must reflect applicable standards, laws and best practices. The information in this section provided much of the information needed to meet this objective.

Addendix A

Web Resources That Supplement the Information in This Report

The following websites provide additional information on roadway response and scene safety:

www.policedriving.com – This site is dedicated solely to improving the safety of driving police vehicles.

www.odmp.org – The Officer Down Memorial Page provide statistics and case study information on police officer fatalities.

www.nleomf.com – The National Law Enforcement Officers Memorial Fund's 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.

http://ops.fhwa.dot.gov/eto_tim_pse/index.htm - The U.S. DOT Federal Highway Administration website on handling roadway emergencies.

http://www.theiacp.org/Portals/0/ppts/AZ_DPS/AZ_DPS_files/frame.htm - The Arizona Blue Ribbon report on police vehicle safety.

http://ambulancevisibility.com – This website provides information on international practices for increasing the visibility of emergency medical service vehicles.

http://mutcd.fhwa.dot.gov – You may view or download a free PDF copy of the latest edition of the *Manual of Uniformed Traffic Control Devices*.

http://www.iaff.org/hs/EVSP/home.html - The International Association of Fire Fighter website dedicated to improving roadway response and incident scene safety. Includes free, downloadable instructor and student materials.

http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=602 – The International Association of Fire Chiefs website on vehicle safety. Include sample procedures and policies.

http://www.nvfc.org/index.php?id=988 – The National Volunteer Fire Council website on safe emergency vehicle operations. Includes a downloadable guide on this topic.

http://www.cdc.gov/niosh/fire - The National Institute for Occupational Safety and Health fire service web page. This pages provides fire service injury and death statistics as well as investigative reported on selected incidents.

http://www.respondersafety.com – The Emergency Responder Safety Institute website focusing on incident scene safety.

http://www.usfa.dhs.gov/downloads/pdf/publications/fa-272.pdf - Download a copy of the U.S. Fire Administration's *Emergency Vehicle Safety Initiative* report.

http://www.usfa.dhs.gov/downloads/pdf/publications/fa-248.pdf - Download a copy of the U.S. Fire Administration's *Safe Operation of Fire Tankers* report.

http://www.sae.org/standardsdev/tsb/cooperative/nblighting.pdf - Download a copy of the U.S. Fire Administration and Society for Automotive Engineering's *Effects of Warning Lamps on Pedestrian Visibility and Driver Behavior.*

http://www.usfa.dhs.gov/downloads/pdf/publications/tims_0408.pdf - Download a copy of the U.S. Fire Administration's *Traffic Incident Management Systems* report.

http://www.usfa.dhs.gov/downloads/pdf/publications/fa_323.pdf - Download a copy of the U.S. Fire Administration and IFSTA *Emergency Vehicle Visibility and Conspicuity Study.*

http://www.sae.org/standardsdev/tsb/cooperative/warninglamp0810.pdf - Download a copy of the U.S. Fire Administration/SAE report entitled *The Effects of Warning Light Color and Intensity on Driver Vision*.

http://www.usfa.dhs.gov/downloads/pdf/publications/fa-110.pdf - 1996 U.S. Fire Administration report titled *Emergency Vehicle Driver Training.*

http://scienceandresearch.homeoffice.gov.uk/hosdb/publications/road-policing-publications/14-04-High-Conspicuity-Li1.pdf?view=Binary – Down load a copy of the British Home Office's report titled *High Conspicuity Liveries for Police Vehicles*.

http://en.wikipedia.org/wiki/Battenburg_markings - Information on Battenburg markings for emergency vehicles.

http://www.i95coalition.net/i95/Portals/0/Public_Files/uploaded/Incident-toolkit/toolkit_document_dvd.pdf - Upload the I-95 Corridor Coalition's *Coordinated Incident Management Toolkit for Quick Clearance*.

http://onlinepubs.trb.org/Onlinepubs/circulars/ec013/1CUllman.pdf - Download the Texas DOT's *Texas DOT Vehicle Fleet Warning Light Research Policy.*

http://www.fletc.gov/training/programs/driver-and-marine-division/driver-training-branch/ - Information on law enforcement driver training programs at the Federal Law Enforcement Training Center in Glynco, Georgia.

http://www.iadlest.org/ - International Association of Directors of Law Enforcement Standards and Training. Contains model standards and training information for law enforcement agencies.

http://www.post.ca.gov/Publications/Driver_Training_Study/pdf/driver_training.pdf - California Commission on Peace Officer Standards and Training (POST) Driver Training Study.

http://www.skidcar.com – Information on SkidCar™ and SkidTruck™ training devices for controlling skids when driving emergency vehicles.

http://www.doronprecision.com/index.html - Information on Doran Precision Simulation Systems for driving various emergency vehicles.

http://www.mpri.com/driver - Information on MPRI simulation systems for driving various emergency vehicles.

http://www.faac.com/policesimulators.htm - Information on FAAC Incorporated simulation systems for driving various emergency vehicles.

http://www.drivesquare.com/home - Information on the Drive Square Simulation System™ that enables a trainee to drive in a virtual space, while operating the controls of an actual vehicle.

www.lmc.org/media/document/1/emgncy**vehicledriving**.pdf - *North Memorial Medical Center (Minnesota) tips on safe emergency vehicle driving.*

http://www.nsc.org/ddc/training/ddconline_train_courses.aspx - Online defensive driving courses and information available from the National Safety Council.

http://www.cdc.gov/niosh/pdfs/hid12.pdf - June 2001 NIOSH report on *Traffic Hazards to Fire Fighters Working Along Roadways.*

www.VFIS.com – VFIS has emergency vehicle driver and instructor materials available.

http://www.springerlink.com/content/qw05uw46240t3052/fulltext.pdf - *A Historical Perspective of the Use of Driving Simulators in Road Safety Research.*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