

LEO 2016-01
November 7, 2017

Officer Struck By a Motorhome While Establishing Temporary Traffic Control on Interstate—Tennessee

EXECUTIVE SUMMARY

On May 10, 2014, a 25-year-old police officer was fatally injured when he was struck by a motorhome and drug under the trailer it was pulling on a four-lane interstate highway. The officer had responded to a jackknifed and overturned pickup/trailer combination that was blocking an entrance ramp to the interstate northbound lanes. To assist with traffic control, the officer positioned his patrol unit south of the entrance ramp in lane three, and a Tennessee Department of Transportation help truck operator positioned his vehicle next to the patrol unit to block the shoulder and lane four. The officer and help truck operator were standing between their vehicles, near the help truck's driver's side door, when a motorhome pulling a trailer approached the scene in lane three (lane second from the right). The driver of the motorhome reported the speed and volume of traffic in lanes one and two prevented him from moving to the left; as a result, he attempted to drive between the police car and the help truck. The help truck operator saw the oncoming motorhome, yelled to the officer, and ran out of the way; the officer was unable to do so. The motorhome and trailer sideswiped the help truck and struck the officer. The officer was dragged underneath the trailer for 116 feet before the motor home came to a stop. He died at the scene.



The incident scene showing the position of the patrol unit and the help truck.

(Photo courtesy of Metropolitan Police Department.)

CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

- Motorhome driver did not slow down and merge left.
- Positioning of patrol unit.
- Law enforcement officer standing in partially open lane.
- Law enforcement officer looking away from oncoming traffic; discussing traffic control with help truck operator.
- Delay in updating dynamic message sign.

KEY RECOMMENDATIONS

NIOSH investigators concluded that, to help prevent similar occurrences:

- State, county, and municipal authorities should consider promoting public awareness campaigns to inform motorists of the risks that law enforcement officers face while operating along the roadside and of the need to follow “Move Over” laws.
- Law enforcement officers and other emergency responders should identify and move to a safe area within an established temporary traffic control zone that minimizes their exposure to oncoming vehicle traffic and should maintain situational awareness.
- Law enforcement agencies should consider developing a standard operating procedure (SOP) that includes guidance on how to properly establish a temporary traffic control plan, including advance warning and transition areas for highway/roadway emergency incidents.
- Emergency responders should consider positioning patrol units and other emergency vehicles as they arrive on-scene to maximize the protected work zone for the emergency responders.

NIOSH Law Enforcement Officer Investigations

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. Through an interagency agreement, the National Institute of Justice funded a NIOSH pilot program to investigate line-of-duty deaths of law enforcement officers resulting from vehicle crashes and being struck by vehicles while responding to roadside emergencies and making traffic stops. These NIOSH investigations are intended to reduce or prevent occupational deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. NIOSH does not enforce compliance with State or Federal occupational safety and health standards and does not determine fault or assign blame. Participation of law enforcement agencies and individuals in NIOSH investigations is voluntary. Under its program, NIOSH investigators interview persons with knowledge of the incident who agree to be interviewed and review available records to develop a description of the conditions and circumstances leading to the death(s). Interviewees are not asked to sign sworn statements and interviews are not recorded. The agency's reports do not name the deceased officer, the law enforcement agency or those interviewed. The NIOSH report's summary of the conditions and circumstances surrounding the fatality is intended to provide context to the agency's recommendations and is not intended to be definitive for purposes of determining any claim or benefit. The NIOSH report is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

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INTRODUCTION

On May 10, 2014, a 25-year-old police officer from a metropolitan police department (Metro PD) was struck and killed by a motorist during a response to an overturned pickup truck/trailer combination on an interstate highway. NIOSH learned of this incident in May 2016. After enlisting the cooperation of the Metro PD, an investigation team from the NIOSH Division of Safety Research traveled to Tennessee to review records, conduct interviews, and examine the scene of incident. NIOSH investigators reviewed the officer's training record, photographs, the Metro PD Fatal Collision Report, witness statements, and the Metro PD Training Academy curriculum. NIOSH met with the Metro PD Crash Investigation Unit who investigated and reconstructed the crash. Interviews were also conducted with the Tennessee Department of Transportation (TDOT) help truck operator who was talking with the officer when the crash occurred.

LAW ENFORCEMENT AGENCY

The Metro PD was formed when the city and county governments consolidated. Approximately 1,300 officers protect and serve an area of almost 533 square miles and a population of approximately 700,000; [USCB 2015]. The police department is divided into eight precincts, and each precinct is designed similarly to a medium-sized police department, with uniform patrol, undercover officers, directed patrol officers, plainclothes detectives, and other specialties.

DEPARTMENT OF TRANSPORTATION HELP

The Tennessee Department of Transportation (TDOT) operates HELP trucks on Tennessee's most heavily traveled highways. The program began in 1999 for the purpose of reducing traffic congestion, improving safety, and assisting motorists in distress.

The mission of HELP is to minimize traffic congestion, promote the safe movement of people and products, and improve the travel environment. HELP works in partnership with emergency response agencies and other TDOT units as part of a highway incident management team [TDOT HELP, no date].

TRAINING AND EXPERIENCE

The officer who was struck and killed was a 2013 graduate from the Metro PD Training Academy and had served with the department for approximately 8 months. The officer also held a degree in criminal justice and was a lieutenant in the National Guard.

All officers are required to graduate from the Metro PD Academy. However, before being accepted into the academy, candidates must pass a physical assessment test (PAT) and a civil service written test. The PAT consists of four components, and applicants must pass 3 of the 4 components.

The scores from the PAT and the written test are combined; all applicants scoring in the outstanding category are invited to attend the Applicant Panel Interview, where they will be scored and ranked. Those scoring in the upper portion are sent for a background investigation. A conditional offer of employment is extended to the applicant who successfully completes the background investigation. Following the conditional offer of employment, the applicant must complete a battery of tests, including a medical examination, a drug screen, psychological assessments, and a Computer Voice Stress Analysis. Based upon the results of these tests, a determination is made by the police department as to whether the applicant is qualified to join the police department as an officer trainee.

The training at the academy consists of 110 training days totaling 935 hours. The candidate must pass all areas before receiving certification from the academy. The academy program is guided by minimum requirements established by the Peace Officer Standards and Training Commission—the governing agency of law enforcement training on behalf of the state of Tennessee. The academy provides basic police training to those candidates who have completed the application process. The curriculum was developed with the goal of providing the most qualified officers.

At the academy, each candidate completes thorough training in areas including:

- classroom and practical firearms training
- emergency medical training
- written and interpersonal communications
- professional and ethical conduct
- physical defense techniques
- criminal and constitutional law and procedures
- human relations
- criminal justice system
- law enforcement stress
- administration
- emergency vehicle operation
- National Safety Council defensive driving course

The academy provides 7 hours of instruction on the Incident Command System, providing the candidate with a working knowledge of the department's policies and procedures on the system. A separate 3-hour block of instruction on traffic direction and control is provided. During this block, the candidate is instructed on safe and proper direction and control of traffic as well as the services of the TDOT help trucks and how an officer can utilize these services. More specific instruction pertaining to the direction and control of traffic at collision and other traffic incidents is provided in the 8-hour Traffic Collision Investigation block.

Upon completion of training at the academy, the training continues with a Field Training Program under the supervision of a veteran officer.

State law and department policy require all sworn officers to attend a minimum of 40 hours in-service training program annually. At least 8 of the 40 hours must be firearms training and qualification, including use of force training and training with all issued weapons. Other topics covered in the training program include updates in criminal/constitutional laws, diversity, management, officer survival, child sexual abuse, administrative issues, department policies/procedures, professional communication, defensive and arrest tactics/procedures, and departmental inspections. Officers must take a written test and make a passing score at the end of the training. Officers must also qualify twice yearly with any firearm they carry.

ROAD AND WEATHER CONDITIONS

The surface of the interstate roadway was asphalt with approximate 0.01 percent grade, and a concrete barrier separated four lanes in each direction, north and south. At the incident scene, a guardrail was present on the outside of lane four northbound. From archived weather reports, the temperature was

approximately 70 degrees Fahrenheit with no precipitation. Visibility was reported to be 10 miles with little to no wind [Weather Underground 2014].

INVESTIGATION

On the morning of May 10, 2014, two Metro police officers responded to investigate a motor vehicle crash on an interstate. This was a single vehicle crash that involved a pick-up truck towing a large trailer. The driver had tried to avoid crashing into a vehicle that was merging into traffic from an on ramp, when he lost control of his vehicle, which flipped the trailer on its side. The pickup was facing southbound in the outermost northbound lane (lane number four) and the trailer was blocking the on ramp (see Photo 1).

Officer A was the primary officer as the incident occurred in his patrol zone. Officer B was providing assistance, protection, and traffic control while Officer A investigated.

Two TDOT help trucks also responded to this crash to assist with traffic flow and lane closure. Initially, both patrol units and both help trucks were located south of and close to the pickup truck. In order to provide a larger buffer zone, one help truck and one patrol unit were repositioned further south (see Diagram 1). Help Truck A remained in lane four and Patrol Unit A was parked at an angle across the entrance ramp.

The operator of Help Truck B repositioned his vehicle farther south, straddling the right shoulder and lane four and placed cones behind the truck. The operator of Help Truck B judged this position to be as close to the curve in the road as he considered safe. The truck's arrow board with the left directional arrow flashing was activated, and the operator notified his supervisor that an additional help truck was needed to assist with traffic farther south due to the location of the crash and the lay of the road.

TDOT also controls the Dynamic Message Signs (DMS) that are used to alert motorists to travel conditions, Amber alerts, and severe weather. A DMS was located approximately 2 miles south of the crash scene, alerting motorists traveling northbound of a right lane closure ahead.

Patrol Unit B also moved south, blocking lane three and parking parallel to Help Truck B. The emergency lights were activated on Patrol Unit B in a right-to-left directional pattern consistent with the help truck arrow board; the Help Truck B operator repositioned the cones to block lanes three and four, behind both of the vehicles. Officer B exited his vehicle to speak to the Help Truck B operator. The Help Truck B operator advised Officer B he had another help truck on the way to assist with traffic control.



Photo 1. Initial incident the officers responded to, looking southbound in the northbound lanes.
(*Photo courtesy of Metropolitan Police Department.*)

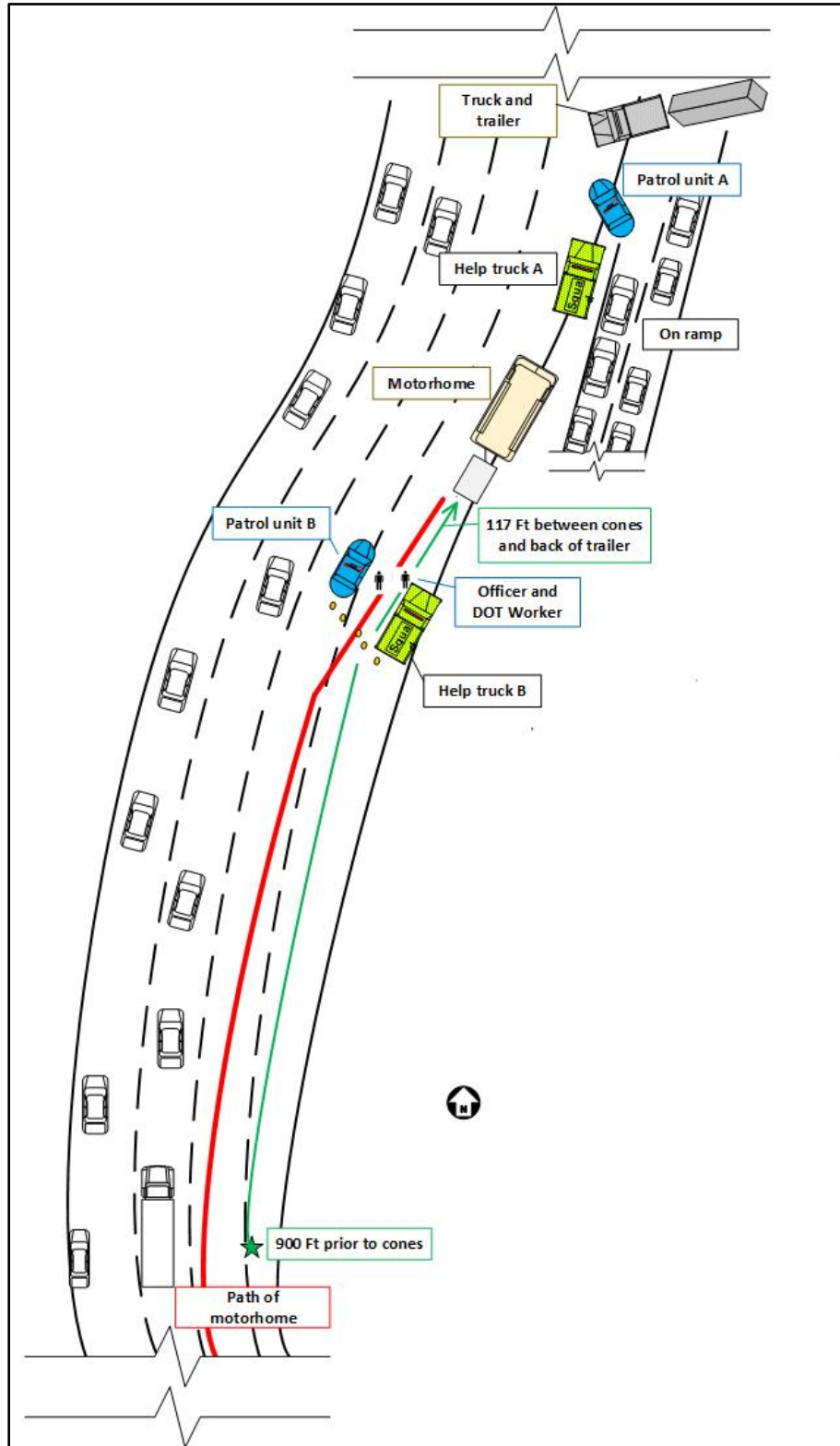


Diagram 1. Roadway where crash occurred.

The Help Truck B operator and Officer B were facing each other between their two vehicles discussing traffic control when the Help Truck B operator noticed a large motorhome pulling a trailer traveling toward them and realized the motor home was not going to stop. The Help Truck B operator yelled, “Look out,” and ran in front of his truck, toward the right shoulder of the interstate. According to the help truck operator, Officer B turned facing the motor home, waving his arms. The motor home continued traveling through the cones, sideswiped the Help Truck B and struck Officer B. The officer was pinned underneath the trailer and drug 116 feet before the motor home reached its resting point with Officer B trapped under the trailer.

The Help Truck B operator stated he immediately notified his dispatcher that the officer had been hit, requested an ambulance, then ran to Patrol Unit A to report Officer B had been struck. Officer A could see Officer B pinned under the trailer and ran to the scene where he determined Officer B showed no signs of life.

Officers from the Metro police, Tennessee Highway Patrol, ambulances, fire department, and additional help trucks arrived to secure the scene. The northbound lanes of the interstate were closed down and traffic was rerouted. The scene was cleared at 1600 hours.

After the incident, the motorist told the investigating officer that as he approached the crash site, he saw the DMS, and at that time the sign read right lane closed. In response, he moved left from lane four to lane three and continued driving. The motorist stated his speed was approximately 60 miles per hour (mph) as he came around what he described as a blind curve in the road. He could see the patrol unit and the help truck blocking the two right lanes as well as the two people standing between the vehicles. He stated he was not able to move over into lane two due to the traffic density. Although he saw the two people standing between the help truck and patrol unit, he thought driving through the opening was the only option.

The Crash Investigation Unit investigated the incident. During their investigation, an older police department command vehicle, similar in size and geometry to the motor home, was used to recreate the motorist’s actions. At 900 feet south of the crash site, the parked patrol unit and help truck were clearly visible (see Photo 2).



Photo 2. Recreation of motorist visibility; 900 feet south of crash site.
(Photo courtesy of Metropolitan Police Department.)

The investigator used mathematical computations to determine if the motorist should have been able to see the patrol unit and help truck, perceive the situation, and stop within 900 feet.

- Using the computations, it was determined traveling at 60 mph, it would have taken the motorist 10.23 seconds to travel 900 feet.
- By subtracting the 1.6 seconds perception to reaction time from the 10.23 seconds travel time, the motorists had 8.63 seconds remaining to take action.
- During the 1.6 seconds perception to reaction time, the motorist traveled 140.73 feet, reducing the available stopping distance to 759.27 feet.

Next, the investigating officer computed the distance needed for the motor home to come to a stop. Using friction values of 0.20 and 0.40, it was determined that 300–600 feet would be necessary for the motor home to come to a stop with normal braking. An example of normal braking, as provided by the investigator, is driving down a roadway and seeing a traffic light ahead of you turn red. Emergency braking would have reduced the distance necessary for the motor home to stop.

Viewing photographs taken at the scene, it was determined the motorist did not begin braking until coming in contact with the help truck. At this time, the motorist applied emergency braking. Measuring the tire marks from where the braking began to the final resting point of the motor home, the investigator determined the distance for the motor home to come to a final resting point was 117 feet. Given the viewing distance, it was concluded the motorhome driver should have been able to stop in time with normal braking.

CONTRIBUTING FACTORS

Occupational injuries and fatalities are often the result of one or more contributing factors or events that result in the injury or fatality. NIOSH investigators identified the following contributing factors in this incident:

- Motorhome driver did not slow down and merge left.
- Positioning of patrol unit.
- Law enforcement officer standing in partially open lane.
- Law enforcement officer looking away from oncoming traffic; discussing traffic control with TDOT help truck operator.
- Delay in updating dynamic message sign.

CAUSE OF DEATH

A Tennessee medical examiner recorded the immediate cause of death as multiple blunt force injuries.

RECOMMENDATIONS/DISCUSSION

The following recommendations focus on methods that could be used to eliminate or mitigate the factors identified as contributing to this incident. They are not aimed at any agency, but are intended for consideration by law enforcement agencies, state and local governments, and departments of transportation nationwide, as well as safety researchers and the general public.

Recommendation #1: State, county, and municipal authorities should consider promoting public awareness campaigns to inform motorists of the risks that law enforcement officers face while operating along the roadside and of the need to follow “Move Over” laws.

Discussion: In 2007, the National Safety Commission, the National Sheriffs' Association, and the National Association of Police Organizations established Move Over America, the first nationally coordinated effort to educate Americans about "Move Over" laws. All 50 states have some form of law that requires motorists to move over and/or slow down when approaching stationary emergency vehicles displaying flashing lights. Most states include tow trucks, wreckers, highway maintenance, and recovery vehicles in the list to which this law applies. Some states also instruct drivers to slow down to a speed safe for weather, road, and traffic conditions. Others states are more specific; for example, on a highway with a speed limit 25 mph or greater, the driver must slow by at least 20 mph below the posted speed limit, and if the speed limit is 20 mph or less, the driver must slow to 5 mph [NSC 2015].

The Tennessee state law “Move Over for Stopped Emergency Vehicles” was passed in 2006 and requires motorists to move over into the adjacent lane of traffic, when safe to do so, or to slow down for emergency vehicles. As of 2011, utility service equipment was added to the list of vehicles that require motorists to move over or slow down [TN DSHS, no date].

Traffic-related incidents were the leading cause of officer deaths in 2015, killing 52. Thirty-five officers died in automobile crashes, 11 were struck and killed outside their vehicle and 6 were killed in motorcycle crashes. Traffic-related fatalities increased 6 percent from 2014 when 49 officers were killed. [NLEOMF 2016].

One of the more dangerous actions law enforcement officers make during their shift is getting out of their patrol unit while parked on the side of a roadway. The purpose of the Move Over Law is to protect law

enforcement officers and other workers from being hit by passing vehicles; however, being struck and killed is a major cause of law enforcement deaths [NSC 2015]. Failure of motorists to move over remains a significant concern for the safety of officers and emergency responders; therefore, a continual public awareness campaign to educate the public and promote the "Move Over" laws is necessary. Public service announcements, bill boards, and handouts are all methods used by states to promote the "Move Over" laws.

In this case, message boards, temporary traffic control devices, and emergency vehicles with activated directional lighting had been positioned to direct motorists to move to the left. However, the motorist continued driving in the restricted travel lanes, believing that he was unable to merge left due to the traffic density in lanes 1 and 2. Public awareness campaigns to educate the motoring public on the dangers faced by emergency responders when assisting at traffic incidents and the need to move over and encouraging motorists in unblocked travel lanes to increase vehicle spacing to facilitate left merging of traffic could eliminate or decrease the risk for law enforcement officers being struck by motorists.

Free resources are available including those found at:

- [Emergency responder Institute](#)
- [Move Over America](#)

Recommendation #2: Law enforcement officers and other emergency responders should identify and move to a safe area within an established temporary traffic control zone that minimizes their exposure to oncoming motor vehicle traffic and should maintain situational awareness.

Discussion: Situational awareness can be defined as being aware of one's surroundings and identifying potential threats or dangerous conditions that can occur around you. It is important for all law enforcement officers to maintain and practice good situational awareness throughout the operation, especially at highway/roadway incidents, to better protect themselves and those around them. A crash scene is a dynamic situation and can change in seconds; a threat can come from any direction, exposing the officer to 360° vulnerability. Not having the capability to apply or manage situational awareness can create more problems for the officers and others present at the scene. Dr. Gasaway, Situational Awareness Matters [Gassaway 2016], states: "*Once the initial size up is complete and you decide on your action plan, it is very easy to move right into the implementation of your plan without giving thought to outcome of the plan first. When you force yourself to think about the outcome, it causes you to think through the steps to achieve the plan and you may be able to see where your plan might go awry before you start down that path.*"

Continuous assessments of the scene are necessary to keep the scene as safe as possible, identify safety factors that must be considered, as well as adjusting the traffic management system accordingly. Three phases or processes are necessary to achieve situational awareness—perception of the elements in the environment, understanding of the current situation, and predicting future actions of the elements in the environment [Endsley 1995].

According to The Emergency Responder Safety Institute (ESRI), training is the first line of defense and recommends training all emergency response personnel to "*work under the premise of if it's moving, and you're not driving it, it is out to kill you*" [Emergency Responder Safety Institute 2009]. All responders should understand and appreciate the risks they are exposed to when operating in or around moving vehicles. Many variants can influence approaching vehicles, such as

- Speed—can be very slow or exceeding the speed limit.

- Operators—can be vision impaired, under the influence of drugs or alcohol, distracted, or have a medical conditions that affects their judgment or abilities.
- Weather—snow, rain, or other inclement weather.
- Time of day—darkness reduces visibility and reaction time; sunlight can obscure visibility.
- Visual obstructions—lay of the land, buildings.

One of the first priorities is to prevent further incidents at the scene by positioning patrol units to provide protection for everyone involved and to warn motorists of the crash. Officers should use all appropriate emergency lighting available and consider the lay of the land when positioning response vehicles to protect the scene.

Additionally, responders should locate themselves in the most protected space possible that allows them to accomplish the task they need to perform. If you don't need to be near the traffic, go as far away as possible. Officers should not lose sight of their own safety by standing between vehicles or turning their back to traffic [Law Enforcement Explorer 2010]. In this incident, an example of a safe location to communicate would have been on the shoulder of the road several yards to the front of the help truck.

During this incident, Officer B had just exited his patrol unit, after repositioning it next to Help Truck B. He approached the Help Truck B operator; both were standing between the vehicles, close to the door of the help truck, discussing their next steps in controlling the traffic through the crash site. The Help Truck B operator had requested an additional help truck to alert traffic upstream. The men were standing facing each other with their backs toward their respective vehicles. Face-to-face communication is the most common body position taken when information is being shared [PAHO, no date]. The approaching traffic was not in the direct line of vision of the officer or the help truck operator. The help truck operator spotted the motorhome, alerted the officer, and then ran to the shoulder of the road. According to the help truck operator, the officer turned toward the motor home and started waving his arms. The motorhome continued traveling toward the officer, driving through the cones and between the patrol unit and help truck, striking the officer.

The following techniques can be used to teach and improve situational awareness.

Assess your environment

- Look around you and take account of the type of situation you are in. Different environments will require different levels of focus to maintain situational awareness.
- Determine a baseline. Identify what should be considered normal sounds, behaviors, and sights in your current situation so you have a frame of reference to compare unusual behavior.
- Once a baseline is established, identify and consider any possible sources of dangerous situations.
- Create scenarios in your mind and plan for ways to address them.

Control your focus and attention

- Avoid Normalcy Bias, the act of ignoring prospective threats because it seems unlikely that a dangerous situation might occur.
- Avoid focusing on one thing so hard that you are too distracted to identify potential threats.
- Fight against complacency.

Be aware in dangerous situations

- Continually assess and reassess the situation.

- Position yourself to easily identify threats.
- Immediately identify dangerous factors of those who enter your personal space [BeSurvival.com 2015; Reeve 2013].

Recommendation #3: Law enforcement agencies should consider developing a standard operating procedure (SOP) that includes guidance on how to properly establish a temporary traffic control plan, including advance warning and transition areas for highway/roadway emergency incidents.

Discussion: Developing a standard operating procedure for traffic incident management may improve the safety of emergency responders. The National Fire Protection Association (NFPA) develops voluntary standards and recommended practices that can be adopted by any agency or organization. *NFPA 1091 Standard for Traffic Control Incident Management Personnel Professional Qualifications (2015 Edition)* applies to anyone who performs temporary traffic control (TTC) duties at incident scenes, regardless of the agency the individual belongs. The standard was developed in response to the need to mitigate risks for all responders and specifies the minimum job performance requirements (JPR) for traffic control incident management personnel (TCIMP).

Temporary traffic control at incident scenes is not uniformly taught across all responder disciplines, and in some cases, it is not formally taught at all. The NFPA 1091 standard establishes the job performance requirements and training criteria for all persons involved in TTC at incident scenes. Adopting a common protocol across agencies enables responders to work together and have less confusion at the incident. To be qualified as a TCIMP, the responder must meet each of the nine JPRs as described in Chapter 4. Each JPR contains a description of the responsibility, as well as a requisite knowledge and requisite skills section. The nine JPRs include:

- Size up incident and establish command.
- Position vehicle to provide a TIMA.
- Establish the TIMA.
- Establish advance warning.
- Operates a member of a team within a TIMA using unified command.
- Manage noninvolved persons.
- Monitor and adjust TTC to address problems or changing conditions.
- Adapt the TIMA in response to hazard.
- Perform demobilization functions [NFPA 1091 2015].

The standard also stresses the importance of reinforcing the training; Section 1.2.6 states that TCIMP “shall remain current with general knowledge and skills and job performance requirements addressed for the level of qualification” [NFPA 2015].

Additionally, the *Traffic Incident Management (TIM) Handbook* contains detailed information to assist law enforcement agencies in creating policies and is based on *The Manual on Uniform Traffic Control Devices (MUTCD)*. MUTCD contains the standards for traffic control devices and direction for temporary traffic control (TTC) used to protect emergency responders, victims, and others at the incident scene. MUTCD defines a Traffic Incident Management Area (TIMA) as “an area of a highway where temporary traffic controls are installed, as authorized by a public authority or the official having jurisdiction of the roadway, in response to a road user incident, natural disaster, hazardous material spill, or other unplanned

incident” [FHWA 2009]. In addition, “it is a type of TTC zone and extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where vehicles return to the original lane alignment and are clear of the incident” [FHWA 2009].

Each TTC zone is different, depending upon

- type of work
- duration
- location
- type of highway/roadway
- lay of the land
- lighting
- weather

As previously mentioned in support of recommendation #2, the Emergency Responder Safety Institute (ESRI) states that training is the first line of defense and recommends training all emergency response personnel to “*work under the premise of if it’s moving, and you’re not driving it, it is out to kill you*” [Emergency Responder Safety Institute 2009]. All responders should understand and appreciate the risks they are exposed to when operating in or around moving vehicles.

The TIM handbook suggests forming a multiagency team of all emergency responders and coordinating incident response efforts [FHWA 2010]. Joint in-person TIM training provides an opportunity to identify potentially conflicting procedures and come to consensus on response protocol. The discussions can lead to formalized TIM policies and procedures among responder agencies and outline what to expect from each other.

Typical Applications (TA) for common situations can be found in Chapter 6H of the MUTCD; however, these activities and applications do not cover every possible situation and should be modified as needed. Establishing TTC zones vary with road configuration, location of the work, work activity, duration of work, road user volumes, road vehicle mix (buses, trucks, cars, motorcycles, and bicycles), and driver speed. Chapter 6H also contains formulas for determining taper lengths and sign spacing [FHWA 2009].

Each TA provides information as well as a diagram of the applicable TTC zone description. Features from more than one TA can be combined or adapted to create a TTC zone. TA-37 Double Lane Closure on a Freeway states: “*An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.*” The following additional guidance is provided in TA-37.

Ordinarily, the preferred position for the second arrow board is in the closed exterior lane at the upstream end of the second merging taper. However, the second arrow board should be placed in the closed interior lane at the downstream end of the second merging taper in the following situations:

- When a shadow vehicle is used in the interior closed lane and the second arrow board is mounted on the shadow vehicle.
- If alignment or other conditions create any confusion as to which lane is closed by the second arrow board.
- When the first arrow board is placed in the closed exterior lane at the downstream end of the first merging taper (the alternative position when the shoulder is narrow) [FHWA 2009].

Chapter 6I “Control of Traffic through Traffic Incident Management Areas” provides guidance on the recommended size of a TIMA, depending upon road configuration, vehicle speed, and weather conditions. The purpose of temporary traffic control at a TIMA is to alert motorists to the incident, divert the traffic away from the incident area, and protect emergency responders as well as others in the area. The TIMA begins where the motorist is first warned of an upcoming incident and is dependent on traffic speed, motorist expectation, weather, and roadway/highway conditions [FHWA 2010]. Improved TIM has been shown to reduce both overall incident duration as well as secondary crashes; it is estimated that the likelihood of a secondary crash increases by 2.8 percent for every minute that the primary incident remains a hazard [FHWA 2010].

Incidents are divided into three general classes according to the duration: major, intermediate and minor. Each class has unique traffic control characteristics and needs. MUTCD defines these durations as:

Major traffic incidents are typically traffic incidents involving hazardous materials, fatal traffic crashes involving numerous vehicles, and other natural or man-made disasters. These traffic incidents typically involve closing all or part of a roadway facility for a period exceeding 2 hours.

Intermediate traffic incidents typically affect travel lanes for a time period of 30 minutes to 2 hours, and usually require traffic control on the scene to divert road users past the blockage. Full roadway closures might be needed for short periods during traffic incident clearance to allow traffic incident responders to accomplish their tasks.

Minor traffic incidents are typically disabled vehicles and minor crashes that result in lane closures of less than 30 minutes. On-scene responders are typically law enforcement and towing companies, and occasionally highway agency service patrol vehicles” [FHWA 2010].

First responders should evaluate the incident scene and deploy the proper TTC, paying special attention to the upstream traffic and the decision sight distance of drivers. The decision sight distance is the distance a driver needs to become aware of something unexpected or a hazard in a roadway, recognize the hazard, develop a plan to respond—such as an appropriate speed and path—and then safely complete the action [Transportation Research Institute 1997]. MUTCD recommends the following formula for determining taper length: “L” is the taper length in feet; “W” is the width of offset in feet; and “S” is the posted speed limit, or the anticipated operating speed in mph, or the off peak 85th-percentile speed prior to work starting (see Table) [FHWA 2009]. Diagram 2 is an example of temporary traffic control tapered lane closure that is recommended by MUTCD to be used for highway/roadway emergency incidents [WisDOT 2014].

Table. MUTCD formula for determining taper length.

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = WS^2 / 60$
45 mph or more	$L = WS$

Studies have been conducted to estimate brake reaction times for specific situations. Driving-related variables such as expectancy, driver’s age, and cognitive load were considered in estimating the time from the motorist’s perception to brake reaction. Expectancy has the greatest effect; a surprised motorist takes longer to brake. Evidence exists that motorists respond faster under shorter time to collision and are able to steer away faster than braking [Green 2013]. A motorist’s brake reaction time is slower when his

cognitive load is high; winding or complex roadway, looking at in-car displays, and cell phone use all increase a motorist's cognitive load. This, however, does not include the time it takes the vehicle to stop. Thus, the higher the speed, the less time the motorist has to make a decision, and the greater the need for more advanced warning. According to the TIM Handbook, on a high-speed roadways, the distance, in feet, for placing the first advanced warning should be computed by multiplying the speed limit by 8–12 times and on an open roadway/highway should extend 1,500 feet or more. For example, using the formula, at $70 \text{ mph} \times 12$, the first advanced warning should be 840 feet [FHWA 2010].

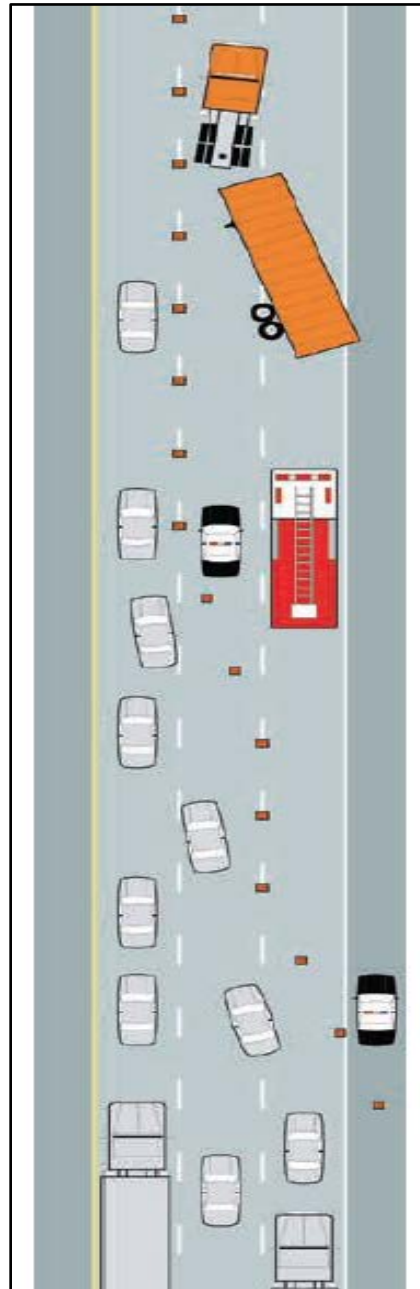


Diagram 2. Example of temporary traffic control tapered lane closure for for highway/roadway emergency incidents.

(Source: Wisconsin Department of Transportation Emergency Traffic Control and Scene Management Guidelines [WisDOT 2014])

Recommendation #4: Emergency responders should consider positioning patrol units and other emergency vehicles as they arrive on-scene to maximize the protected work zone for the emergency responders.

Discussion: When dealing with incidents on highways, there are many challenges such as apparatus and vehicle placement, effectiveness, and emergency responder safety. Regardless of which emergency responder arrives at the scene first, the driver has three primary concerns when determining where to park the vehicle: reducing the chance of the vehicle being struck by oncoming traffic, shielding emergency responders from oncoming traffic, and allowing for effective use of equipment and resources to handle the incident [UFSA 2014]. The coverage is maximized with the positioning of additional patrol units and other responding vehicles as they arrive; vehicles may need to be repositioned as the response continues. The largest vehicle should be used as the initial blocking vehicle.

The following recommendations appear in the U. S. Fire Administration's *Emergency Vehicle Safety Initiative* [USFA 2014].

- Place emergency vehicles between the flow of traffic and the personnel working on the incident to act as a shield.
- Turn front wheels away from the working responders so the apparatus (vehicle) is not driven into them if struck from behind.
- Consider parking additional emergency vehicles 150 to 200 feet behind the shielding vehicles to act as additional barriers between responders and the flow of traffic.
- Park all fire apparatus at an angle so the tailboard protects the driver from traffic.
- Position ambulances in a manner that protects the patient loading area from approaching traffic.
- Position law enforcement vehicles so they provide a barrier and visual warning between oncoming traffic and the incident work zone.

During this incident, law enforcement officers and the operators of the TDOT help trucks positioned their vehicles and traffic control cones in an effort to block lanes 3 and 4 and the shoulder in advance of a motor vehicle crash scene (see Diagram 1). Additional traffic control resources had been requested to strengthen the lane blocks and direct traffic flow through the area. However, the incident occurred before additional resources had arrived. In retrospect, positioning the vehicles closer together to the oncoming traffic covering lanes 3 and 4 may have provided a more visible cue for the motorist to choose to merge into the lane 2 traffic earlier or make an attempt to come to a complete stop before colliding with the blocking response vehicles or attempting to go between.

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INVESTIGATOR INFORMATION

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