2014
06

Death in the line of duty...

NIOSH Fire Fighter Fatality Investigation and Prevention Program

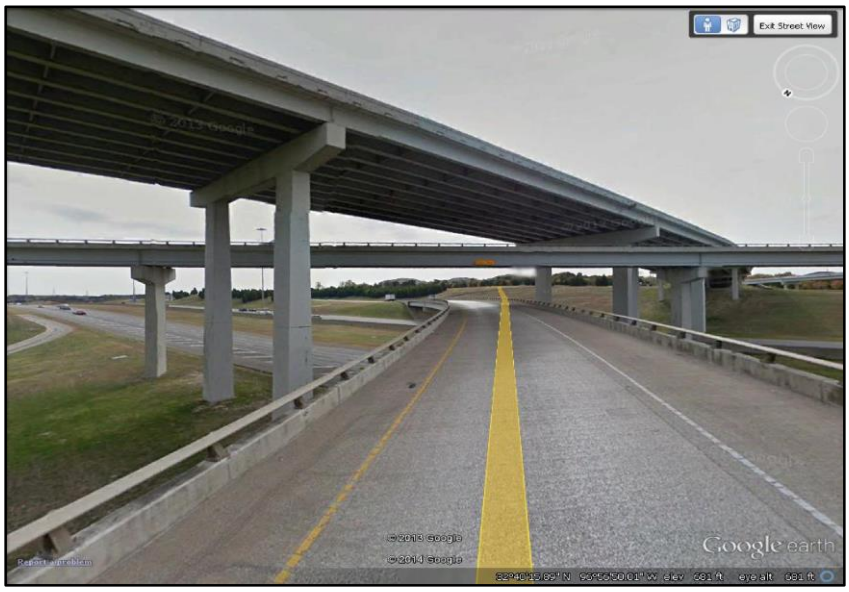
A summary of a NIOSH fire fighter fatality investigation

August 12, 2015

Career Fire Fighter Struck and Killed While Working a Crash Scene on Ice Covered Interstate Overpass – Texas

Executive Summary

On February 10, 2014, a 40-year-old male career fire fighter died after being struck by a civilian's vehicle and falling from an overpass. The fire fighter was one of four fire fighters that were working a crash scene involving multiple vehicles on an ice covered interstate bridge and overpass. The fire fighter was assisting a stranded motorist and crossed over the protective barrier where he was struck by another vehicle and fell 56 feet from the bridge onto the underpass below. Fire fighters rushed to his aid and performed several life saving measures, including CPR. He was transported by a fire department rescue unit to a local hospital where he was pronounced deceased upon arrival.



The fire fighter was assisting a stranded motorist and struck on the overpass above and fell onto this underpass. ***(Photo courtesy of Google maps and Fire Department)***

Contributing Factors

- *Weather conditions (ice)*
- *Scene/Traffic Management*
- *Operating in unprotected zone (Situational Awareness)*
- *Inattentive motorist*

Key Recommendations

- *Fire departments should ensure that officers, fire fighters and emergency responders are properly trained in highway incident safety procedures.*
- *Fire departments should ensure that officers, fire fighters and emergency responders are trained in situational awareness, risk assessment, fire fighter and command safety responsibilities.*

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- *Municipalities and local authorities having jurisdiction should develop strategies for pre-treating bridges, overpasses and roadways subject to early freezing.*

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. In 1998, Congress appropriated funds to NIOSH to conduct a fire fighter initiative that resulted in the NIOSH "Fire Fighter Fatality Investigation and Prevention Program" which examines line-of-duty-deaths or on duty deaths of fire fighters to assist fire departments, fire fighters, the fire service and others to prevent similar fire fighter deaths in the future. The agency does not enforce compliance with State or Federal occupational safety and health standards and does not determine fault or assign blame. Participation of fire departments 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 victim, the fire department 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.

For further information, visit the program website at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1800-232-4636).

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Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

July 15, 2015

Career Fire Fighter Struck and Killed While Working a Crash Scene on Ice Covered Interstate Overpass – Texas

Introduction

On February 10, 2014, a 40-year-old male career fire fighter died after he was struck by a vehicle and fell onto an underpass below. On February 11, 2014, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research, Fire Fighter Fatality Investigation and Prevention Program of the incident. On March 3-7, 2014, a NIOSH investigator traveled to Texas to conduct an investigation. The NIOSH investigator met with the Assistant Fire Chief, senior staff of the fire department and the fire communications center. The investigator reviewed fire department standard operating procedures, training records from the department, and audio radio transmissions. During the investigation, witness statements were reviewed and interviews were conducted with the fire fighters and fire officers involved in the incident. The NIOSH investigator inspected and photographed the personal protective clothing (turnout gear) worn by the deceased fire fighter, and traveled to the interstate overpass where the crash had occurred.

Fire Department

The fire department involved in this incident is a career department consisting of 1,750 members that provide fire suppression protection and emergency medical first responder services. There are 57 fire stations located strategically throughout the city that serve a population of more than 1,200,000 in a geographic area of approximately 385 square miles. These fire stations house 56 engines, 22 ladder trucks, 5 aircraft rescue fire-fighting apparatus (ARFF), 9 booster pumpers, 1 hazmat unit, as well as 40 front line rescues and 3 peak demand rescues. A minimum of four firefighters respond with each engine and ladder truck company.

Training and Experience

The fire fighter (Fire Fighter #1) in this incident had approximately 14 years of experience with the department as a professional fire fighter. He had completed the department's required training and had additional training in incident command, hazardous materials and driver's training. The department requires all fire fighters to complete Fire Fighter 1 and 2 training, driver training, hazardous materials awareness and operations training, and emergency medical training.

The Texas Commission on Fire Protection requires 468 hours of curriculum training covering structural fire topics for certification as a fire fighter. The department's recruit academy includes 26 weeks of training exceeding 950 hours due to special target hazard and facilities procedures training unique to the city (i.e., hi-rise buildings, light rail transit underground tunnel, trolley car system, etc.). In addition to the 950 hours of recruit training above, the fire fighter also had 543.5 hours of in-service fire and rescue training in a number of areas including:

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- Fire Fighter Safety, SCBA, Rescue
- Apparatus, pumps, tools and equipment, ventilation
- SOPs, Fire and EMS guidelines rules and regulations, records and reports, communications, Incident command, high-rise procedures, fire fighting strategy
- Building construction, forcible entry, fire streams, hydraulics, water supply systems
- Hazmat Operations, Fire Science, PPE, wild land fire fighting, swift water rescue, confined space and trench rescue, aircraft rescue fire fighting (ARFF)
- EMS/ALS training, public transportation

Equipment and Personnel

Units that initially responded to the report of a crash(s) in the area:

- E-12 (Engine 12) with 4 personnel including an officer (Fire Fighter 1 rode on this engine)
- E-50 (Engine 50) with 4 personnel including an officer
- R-50 (Rescue 50) with 2 personnel
- T-33 (Truck 33) with 4 personnel including an officer

Note: Several crashes had occurred within minutes of each other in the area. E-12, T-33 and R-50 were dispatched to one of the many crashes, but all of the initial units responded to the same area for multiple crashes. Additional fire department resources were dispatched as listed below.

- T-50 (Truck 50) with 4 personnel including an officer
- R-26 (Rescue 26) with 2 personnel was originally dispatched and then replaced with R-50
- R-33 (Rescue 33) with 2 personnel
- E-52 (Engine 52) with 4 personnel including an officer
- R-52 (Rescue 52) with 2 personnel
- B-6 (Battalion 6) with 2 personnel

Timeline

This timeline is provided to set out, to the extent possible, the sequence of events according to recorded radio transmissions. Times are approximate and were obtained from review of the dispatch records, witness interviews, self-contained breathing apparatus (SCBA) and personal alert safety system (PASS) data loggers and other available information. Some of the times have been rounded to the nearest minute. This timeline is not intended, nor should it be used, as a formal record of events.

- Prior to being dispatched for the motor vehicle crash, the E-12 officer reported that dispatch had announced icing conditions on bridges and overpasses throughout the city.

- **2010 Hours**
  Dispatch receives multiple accident calls in the area of interstate and overpass area.

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- **2010-2012 Hours**
  Dispatch receives many more accident calls for this area.

- **2010-2012 Hours**
  E-12, R-50 and T-33 dispatched to a motor vehicle crash involving multiple vehicles, note: R-26 was originally assigned but replaced by R-50.

- **2017 Hours**
  Engine 12 arrives and requests sand trucks and northbound over interstate to be shut down.

- **2024.32 Hours**
  Engine 12, blocking northbound, requests to shut down southbound lanes of bridge, Dispatch contacts sheriff and relays the request.

- **2024 Hours**
  T-33 arrives and Fire Fighter #1 is assisting two stranded motorists in separate vehicles on the bridge but he is still in the protected area of the northbound lanes shut down by E-12 blocking.

- **2024-2030 Hours** Fire Fighter #1 has crossed over the concrete barrier into the unprotected southbound lanes.

- **2030 Hours**
  2 civilians call dispatch and report a fire fighter has fallen from the bridge and is not moving. A PASS device can be heard sounding in the background of the phone message.

Note: The NIOSH investigator examined Fire Fighter #1's stand-alone PASS, but this particular model did not have data logging capability and event data could not be retrieved from the device.

- **2032 Hours**
  Dispatch calls E-12 on Channel 1 asking if they have an injured fire fighter on location, E-12 acknowledges and will check.

- **2038 Hours**
  E-50 requests shut down of Spur southbound exit ramp to eastbound interstate (the underpass where Fire Fighter #1 was located). Dispatch contacts sheriff and relays the request.

- **2039 Hours**
  E-12 calls dispatch to confirm they know Fire Fighter #1 is missing but they are unable to locate him.

- **2042 Hours**
  E-50 requests all entrance and exits for the Spur and interstate be shut down. Dispatch contacts

sheriff and relays the request.

- **2042.38 Hours**
  E-50 personnel locate Fire Fighter #1 on the underpass, (Spur ramp) and begin resuscitation

- **2050 Hours**
  R-50 transports Fire Fighter #1 to a local hospital where he was pronounced dead at 2120 hours.

Weather

At approximately 2024 hours, the weather in the immediate area was reported to be 32 degrees Fahrenheit, a dew point of 23.6 degrees Fahrenheit, and the relative humidity was 87%. Wind conditions were up to 10 miles per hour from the north and light freezing rain.[1]

The fire department reported weather in the area as cloudy conditions with light precipitation and fog throughout the day with temperatures dropping below freezing during the evening hours.

The weather conditions in the city close to the time of dispatch for this incident were reported to be dropping into the freezing temperatures with fog and light freezing rain.

Investigation

On the day of the incident, the dispatch center was handling a large volume of calls related to motor vehicle crashes on the city's elevated road surfaces with much of the call volume concentrated in the southern part of the city. The volume of calls related to motor vehicle crashes were reported to be 650 calls in one two hour period between 1900 and 2100 hours. Many of these calls were for multiple crashes. Prior to being dispatched for the motor vehicle crash, the E-12 officer reported that dispatch had announced icing conditions on bridges and overpasses throughout the city.

E-12 and R-26 were dispatched to a reported motor vehicle crash at the northbound side of the bridge. At close to the same time, multiple reports came into the dispatch center for a number of crashes occurring at the same location. T-33 and E-50 were added to the incident. R-26 was removed from the incident and replaced by R-50.

On arrival, the officer of E-12 observed several vehicles stranded on the south side of the bridge and also saw an SUV in the southbound lanes of the bridge strike the guard rail at the base of the bridge. There were other vehicles in the northbound lanes on the bridge with one vehicle sideways in front of E-12. He had the driver of E-12 (Fire Fighter #2) block both northbound lanes to the bridge. The officer then notified dispatch that they had icing conditions, requested a sand truck, and also asked for the southbound lanes to be shut down.

The E-12 fire fighters started to assess the vehicles for injuries. Fire Fighter #2 checked on and removed the civilian from the vehicle directly in front of E-12 in the northbound lanes. Another fire

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fighter (Fire Fighter #3) placed flares behind E-12 where it was blocking the roadway approach to the bridge. Fire Fighter #1 notified the officer that he was going to check on the other stranded motorist further up the bridge in the northbound lanes (see photo 1). Fire Fighter #1 checked on those civilians and radioed back to the E-12 officer that they would not need medical assistance. The E-12 officer then told Fire Fighter #3 to assist Fire Fighter #1 on the northbound lanes of the bridge.

E-50 arrived and radioed the E-12 officer and advised that they would not need T-33. E-12 was blocking T-33's return route in the northbound lanes so they stayed on the scene.

At approximately 2030 hours, 2 civilians called dispatch and reported a fire fighter had fallen from the bridge and is not moving. The dispatch center radioed the E-12 officer to ask if they had an injured fire fighter on the scene. The officer performed a Personal Accountability Report (PAR) and received a PAR from T-33, E-50 and all of his crew except for Fire Fighter #1. A city police officer then knocked on the window of E-12 and told them that a man was down in the middle of the east-west interstate under the bridge. Fire and rescue units then started searching for Fire Fighter #1.

Fire Fighter #1 was located on an underpass below the bridge but above the east-west interstate. He was unconscious and unresponsive (see photo 2). Rescue personnel provided immediate ALS (advanced life support) care on the scene. A medivac helicopter was called for but could not respond due to weather. Fire Fighter #1 was transported by ambulance to a local hospital where he died from his injuries.

The activities of Fire Fighter #1 after he walked further north on the bridge were not witnessed by other fire fighters. However, statements from civilians indicate that Fire Fighter #1 was in the northbound lanes on the other side of the concrete barrier and that he told the civilian who had spun out in the southbound lane to stay in his vehicle.

The police crash report indicated that Fire Fighter #1 had crossed over the concrete divider where he was struck by another vehicle and ejected off the bridge approximately 56' to the underpass below. Fire Fighter #1's flashlight was found in the back seat of the striking vehicle, indicating he was initially thrown through the rear window and then ejected over the guardrail.

All personnel operating at the scene were very busy with multiple crashes occurring due to the icy bridge conditions. Fire Fighter #1 was initially operating in the safe zone resulting from E-12 having shut down the northbound lanes, but the southbound lanes had not been shut down when Fire Fighter #1 was struck and killed (see Diagram 1). It is unknown why he crossed over the concrete barrier, but it most likely was to aid a civilian in the southbound lanes.

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Photo 1. E-12 had stopped and blocked traffic in this direction. Fire Fighter 1 had walked up the bridge in the blocked lanes to assist the stranded motorist. Note the limited view due to the rise of the bridge.
(Photo courtesy of the fire department.)

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Photo 2. Fire Fighter 1 was struck on the upper most bridge and fell 56' to the underpass.
(Photo courtesy of the fire department.)

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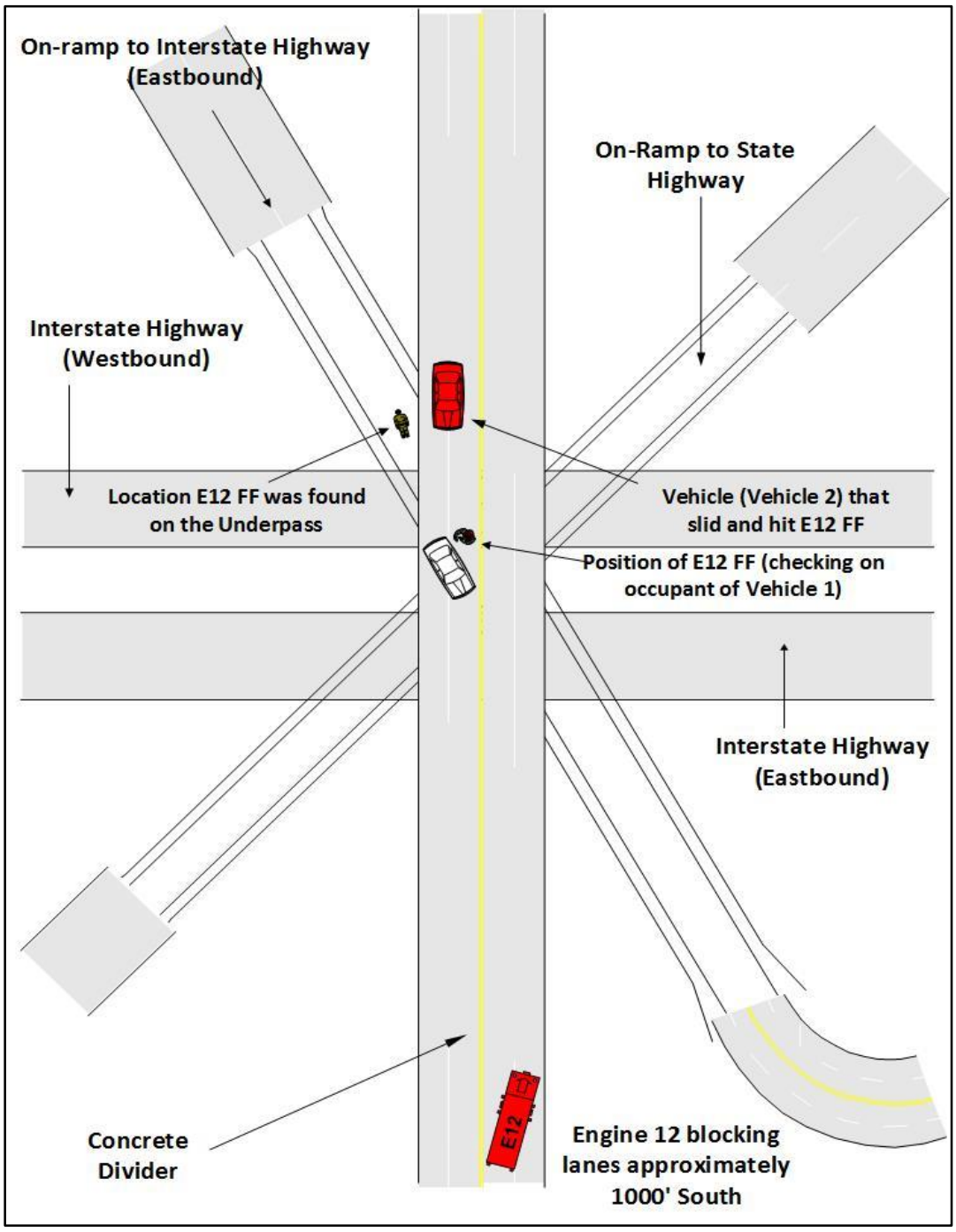

Diagram 1. Positioning of E-12 and crash scene.

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Contributing Factors

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. NIOSH investigators identified the following items as key contributing factors in this incident that led to the fatality:

- *Weather conditions (ice)*
- *Scene/Traffic Management*
- *Operating in an unprotected zone (Situational Awareness)*
- *Inattentive motorist.*

Cause of Death

According to the office of the medical examiner, the fire fighter died from blunt force injuries.

Recommendations

Recommendation #1: Fire departments should ensure that officers, fire fighters and emergency responders are properly trained and receive annual training on conducting emergency operations at highway incidents.

Discussion: Adopting a comprehensive training program that includes periodic refresher training as well as initial training can help to ensure that fire fighters understand the importance of following policies and procedures designed to make operating at a highway incident safer for all emergency responders.

An excellent training resource for emergency response organizations is the Emergency Responder Safety Institute/Cumberland Valley Volunteer Firemen's Association. They offer an 8 hour class titled *"Managing Emergency Incidents on the Roadway"*.[2] The class covers the following topics: fire fighter fatality and injury statistics related to highway/roadway incidents; case studies dealing with fire fighter fatalities, injuries, and near misses; types and use of personal protective equipment; federal regulations (e.g., Section 6I, "*Control of Traffic through Traffic Incident Management Areas"* of the Manual on Uniform Traffic Control Devices);[3] positioning of apparatus and emergency vehicles; safety procedures for operations on highway/roadways; use of traffic signs and warning devices; use of the Incident Command System including Unified Command; pre-incident planning with law enforcement, state/local department of transportation, emergency medical services, tow and recovery operators, and product recovery contractors; and table top exercises. This no cost training program is available at http://www.respondersafety.com.

Emergency responders need to understand the risks involved when conducting emergency operations on any highway/roadway. Initial training on operating safely at highway incidents will help them identify the risks and methods to control the hazards they encounter. This training should be regularly updated and provided to all emergency responders on a re-occurring basis. Re-occurring training is

essential to help keep emergency responders up to date with the latest safety measures as well as lessons learned from actual responses.

Fire departments and emergency response organizations should ensure that the training includes the critical elements of highway safety and those elements are benchmarked for regular refresher training. Some of those elements and benchmarks include, crash scene size-up, risk assessment, apparatus positioning and creating a safe zone for emergency response personnel to work, never crossing over barriers from a safe zone into an uncontrolled area until it can be accomplished by making that zone safe (see example in Appendix 1). These tactical priorities must be included in the training:

- Establish Command and Communications
- Establish a Safe Work Zone
  - Responder Safety
  - Scene Safety
  - Traffic Safety
- Incident Mitigation
- Facilitate Investigation/Evidence Protection
- Vehicle/Debris/Cargo Removal
- Incident Demobilization/Termination[4]

The department in this incident is very large and regularly responds to major highway incidents. The department has a very comprehensive 17-page Standard Operating Procedure (SOP) on traffic incident management that covers safe operations at highway incidents.

Some of the areas covered in the department's SOP are:

- Size up and scene management, designation of a safety officer
- Incident command and response personnel benchmarks
- Positioning apparatus to protect scene benchmarks
- Establishing and maintaining a lookout with radio microphone in hand to monitor approaching traffic
- Establishing advance warning and transition area through deployment of traffic control measures, including working with other resources such as law enforcement

Fire departments need to ensure that SOPs and Standard Operating Guidelines (SOGs) dealing with highway incident safety are reviewed regularly by all members (see example SOP in Appendix 2).

Upon arrival to the scene, the E-12 officer immediately blocked the northbound lanes on the bridge creating a safe zone for crew members in front of E-12, and also requested blocking of the southbound lanes. However, the southbound lanes had not been blocked when Fire Fighter #1 crossed over the concrete barrier where he was struck by a southbound motorist.

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Recommendation #2: Fire departments should ensure that officers, fire fighters and emergency responders are trained in situational awareness, risk assessment, fire fighter and command safety responsibilities.

Discussion: All officers, fire fighters and emergency responders operating at an incident should maintain situational awareness and conduct a continuous risk assessment throughout the incident, reporting unsafe or changing conditions to the incident commander. Maintaining situational awareness is just as important on highway crash scenes as on the fire ground. Officers, fire fighters and emergency responders need to understand the importance of maintaining situational awareness in relation to personal safety on the incident scene.

The book *Essentials of Fire Fighting and Fire Department Operations*[5] defines situational awareness as an awareness of the immediate surroundings. Situational awareness can be described as a heightened consciousness of what is currently developing or occurring. The opposite of situational awareness is tunnel vision where the emergency response personnel become so focused on operational assignments that they fail to sense changes in their environment.

Fire fighters and emergency responders should be trained to be constantly on the alert for changing and unsafe conditions at highway crash scenes. Even though a safety officer may have been designated for an incident, it should be the obligation of all personnel to remain alert to their immediate surroundings. When responding to a roadway emergency incident, officers, fire fighters and other first responders must ensure their personal safety, as well as the safety of individuals they are trying to assist. Emergency responders need to maintain a heightened sense of awareness to detect impending dangerous situations and recognize warning signals such as screeching tires, horns, smoke or dust, and the sound of a crash or impact. Responders need to do a quick survey of the location where they are working and mentally prepare an escape strategy.[4]

Approaching traffic may not be aware that a crash has occurred due to the size of the crash area and limited visibility. Drivers may be tired, vision impaired, be under the influence of alcohol and/or drugs, or have a medical condition that affects their judgment or abilities. The approaching traffic may be completely oblivious to fire fighters presence due to distractions caused by cell phone use, loud music, conversation, inclement weather, terrain, and/or building obstructions. Approaching motorists will often be looking at the scene and not the roadway in front of them. Nighttime incidents requiring personnel to work in or near moving traffic are particularly hazardous because visibility is reduced and driver reaction time to hazards in the roadway is slowed.[4]

The International Association of Fire Chiefs (IAFC), Safety, Health and Survival section developed the *"Rules of Engagement for Structural Fire Fighting"*. Although the rules of engagement were developed for structural fires, they can be very useful for emergency response personnel at other incident scenes**.**

Responding to highway crashes poses a significant risk to fire fighters and other emergency responders. Incident commanders and command organization officers are responsible for minimizing emergency responder exposure to unsafe conditions and stop unsafe practices.[6]

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The rules of engagement can assist the incident commander, company officers, fire fighters and emergency responders who are at the highest level of risk in assessing their situational awareness.

One principle applied in the rules of engagement is fire fighters and the company officers are the members most exposed to risks for injury or death and will be the first to identify unsafe conditions and practices. These rules integrate the fire fighter and emergency responder into the risk assessment decision making process. These members should be the ultimate decision makers as to whether it's safe to proceed with assigned objectives. Where it is not safe to proceed the rules allow a process for that decision to be made while still maintaining command unity and discipline. The following are excerpts from the IAFC rules of engagement that apply to highway incidents:

Rules of Engagement for Fire Fighter Survival:

- Size-up your tactical area of operation. This causes the company officer and fire fighters to pause for a moment and look over the area of operation and evaluate their individual risk exposure and determine a safe approach to completing their tactical objectives.
- Go in together, stay together and come out together. For example, two or more fire fighters operating as a team
- Maintain continuous awareness of your situation, location and emergency scene conditions
- Constantly monitor communications for critical radio reports.
- You are required to report unsafe conditions or practices that can harm you. Stop, evaluate, then decide; prevent exposure to unsafe conditions or practices. Allow any member to raise an alert about a safety concern without penalty and mandate that the supervisor address the question to ensure safe operations.
- You are required to abandon your position and retreat before deteriorating conditions can harm you. Be aware of, and cause an early exit to a safe area when fire fighters are exposed to deteriorating conditions, unacceptable risk and a life threatening situation.
- Declare a mayday as soon as you think you, or another fire fighter is in danger. Ensure the fire fighter is comfortable with declaring a mayday as soon as they think they are in trouble.[6]
- Tactical and task level communications need to be clear and concise and require feedback when they are accomplished.

The Incident Commander's rules of engagement for fire fighter safety:

- Rapidly conduct or obtain a 360 degree situational size-up of the incident. Determine the safest approach to tactical operations as part of the risk assessment plan and action development plan before fire fighters are placed at substantial risk.
- Conduct an initial risk assessment and implement a safe action plan. This causes an incident commander to develop a safe action plan by conducting a size-up, assess the survival profile and completing a risk assessment before fire fighters are placed in high risk positions on the emergency scene.
- If you do not have the resources to safely support and protect fire fighters, seriously consider a defensive strategy. This prevents the commitment of fire fighters to high risk tactical objectives

that cannot be accomplished safely due to inadequate resources on the scene. For example, not crossing over a barrier and out of a safe zone until control measures can be put in place.
- Maintain frequent two-way communications and keep interior crews informed of changing conditions. Having a safety person with a portable radio watching for traffic encroachment into a crash zone. The department in this incident had an SOP that called for such a consideration, but this action had not yet occurred when Fire Fighter 1 was struck and killed.
- Obtain frequent progress reports and revise the action plan.
- Ensure accountability of every fire fighter, their location and status. This causes the incident commander and command organizational officers to maintain a constant and accurate accountability of the locations and status of all fire fighters within the hazard zone and to be aware of who is presently in or out of the hazard zone.[6]
- Early in an incident when a formal command structure may not be established, the first arriving officer needs to ensure accountability at the task level. This in-formal command assignment is later formalized by arriving command officers at the command post.
- Strategic, tactical and task level communications need to be clear and concise and require feedback when they are accomplished.

One of the most comprehensive emergency vehicle safety training programs available to every emergency responder is the International Association of Fire Fighters Emergency Vehicle Safety Program.[4] This program, Improving Apparatus Response and Roadway Operations Safety in the Career Fire Service, was developed by the Division of Occupational Health, Safety and Medicine of the International Association of Fire Fighters (IAFF) through a cooperative agreement from the United States Fire Administration, part of the U.S. Department of Homeland Security. As a result of this course, emergency responders will be able to apply basic strategies to safeguard their health and safety while responding to and returning from an incident and while operating on roadways.[4]

In this incident, the first arriving engine company recognized the icing conditions and immediately stopped all traffic in the two lanes in their direction of travel. The scene was extremely active with other cars crashing while the engine crew was assessing crashed vehicles for injuries. Fire Fighter #1 walked out in the safe zone blocked by the engine and checked a motorist who had lost control and then proceeded toward the middle area of the overpass where another car had just spun out in the opposite direction. Fire Fighter #1 was separated from that car by the concrete barrier and communicated with the driver inside the vehicle. For unknown reasons, he then climbed over the concrete barrier, possibly to aid another civilian, and was struck by another vehicle traveling in the southbound lanes. Fire Fighter #1 was thrown over the striking vehicle and landed into its back seat. The car continued to travel and then crashed, ejecting Fire Fighter #1 over the side of the overpass and onto the underpass below.

Fire Fighter #1 was an experienced fire fighter with extensive training. This incident was still evolving in a dynamic way that challenged responders. Situational awareness must be maintained by all personnel on all emergency scenes. Crossing over the protective concrete barrier and out of the safe zone required a more thorough risk assessment and should be discouraged. All emergency responders

should consider maintaining a personal escape route as an important part of their situational awareness in the event of another crash into their emergency scene.

Recommendation #3: Municipalities and local authorities having jurisdiction should develop strategies for pre-treating bridges, overpasses and roadways subject to early freezing.

Discussion: Agencies responsible for highway safety and maintenance should develop strategies that ensure rapid response to roadways that are susceptible to early freezing (i.e., bridges, overpasses and approach and off ramps). Although weather forecasting can be a challenge, areas and roadways that routinely freeze should be identified and strategies developed to either pre-treat or close down access until the proper resources can be employed to treat them. Pre-treating targeted roadways can allow for greater coverage before a forecast condition occurs.

One type of roadway treatment that can be used up to 72 hours prior to an ice or snow storm is pre-treating with a salt brine solution. Salt brine is water saturated with sodium chloride. It is a pro-active approach that when applied before an ice or snow storm will stick to the surface of a dry roadway. Salt and sand applied to a dry roadway before a storm may be pushed or moved off the roadway by vehicle movement. A salt brine solution pre-treatment will stick to the dry roadway better and delay the accumulation of snow and ice. Some of the advantages of pre-treating with a salt brine solution[7] are:

- Pre-treating with a liquid ice melt such as brine, jumpstarts the melting process because salt needs moisture to be effective
- Brine doesn't bounce or blow off the road surface so the material is used more efficiently
- After a pre-treatment, if a storm is delayed then the residue remains on the roadway and will start to work once the precipitation begins
- Roadway crews can cover more territory by starting the roadway treatments well in advance of the forecast conditions
- Anti-icing returns road surfaces to normal conditions faster
- Increased efficiency results in less salt being used which is beneficial for the environment

In this incident, the first arriving officer asked for a sand truck on arrival. Sand trucks did not arrive until after Fire Fighter #1 had been struck.

The large geographical area combined with a large number of bridges and overpasses would challenge most agencies that respond only after weather conditions affect the roadways. It is not known if the bridges and underpasses in this area had been pre-treated, but it appears unlikely.

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Investigator Information

This incident was investigated by Stephen T. Miles with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, located in Morgantown, WV. An expert technical review was provided by John Tippett, Deputy Chief of Operations for the City of Charleston (South Carolina) Fire Department. He is a 40-year veteran of the fire service. Chief Tippett spent 34 years with the Montgomery County (MD) Fire and Rescue Service, retiring as the department's safety battalion chief in 2009. He has been involved in a number of fire fighter health and safety initiatives over the last decade including introducing crew resource management to the fire service and working closely with the International Association of Fire Chief's National Fire Fighter Near-Miss Reporting System. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division. This report was authored by Stephen T. Miles.

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Additional Information

- USFA Emergency Vehicle Safety - http://www.usfa.fema.gov/fireservice/research/safety/vehicle.shtm Date accessed, June 2015.

- USFA Roadway Operations Safety - http://www.usfa.fema.gov/fireservice/research/safety/roadway.shtm Date accessed, June 2015.

- Situational Awareness: Think past, present and future. http://www.samatters.com/situational-awareness-think-past-present-future/ Date accessed, June 2015.

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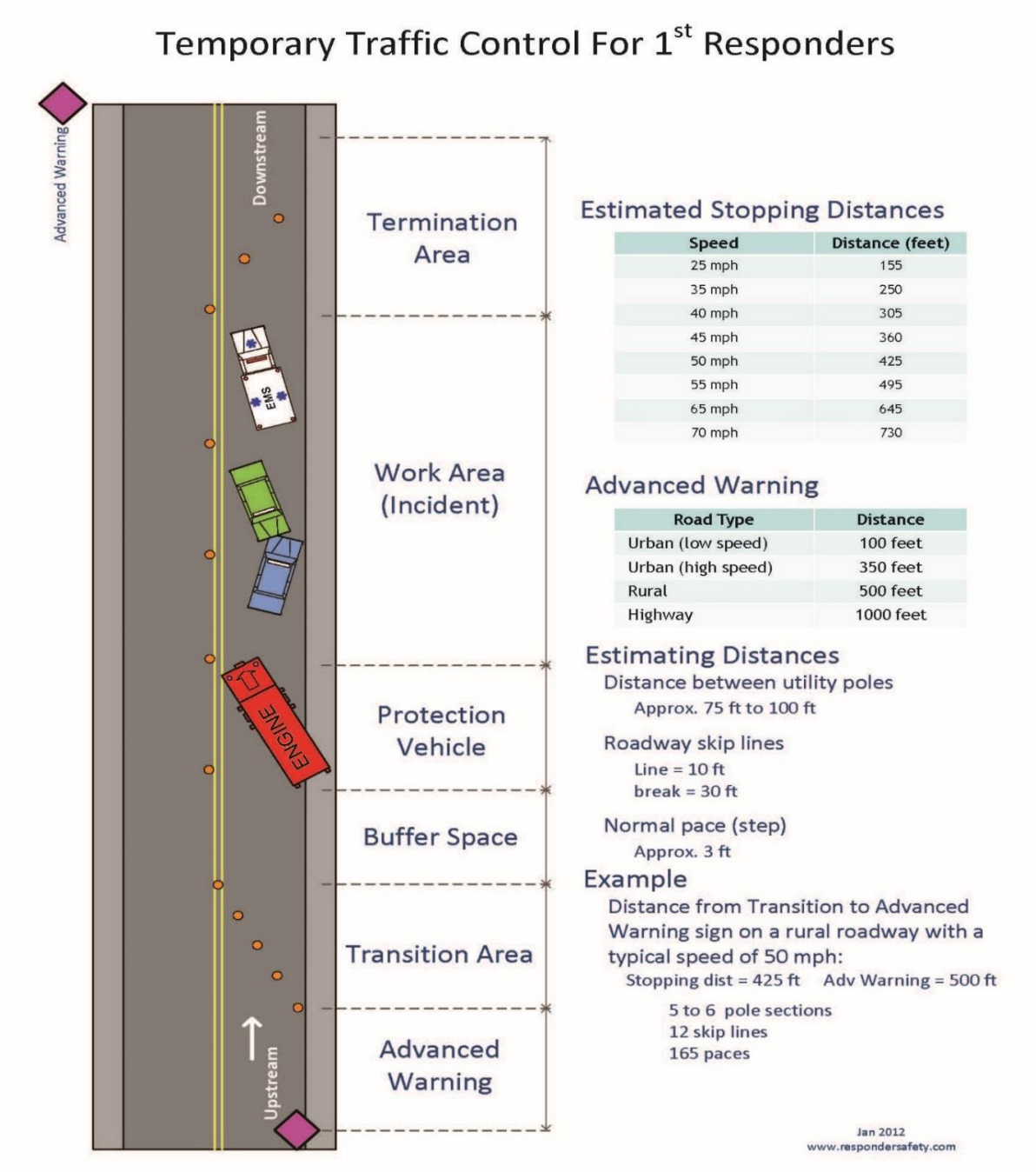
Appendix 1

Sample Traffic Control Scenario from Temporary Traffic Control for First Responders, Emergency Responder Safety Institute [1]



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Appendix 2

Sample Standard Operating Guideline from Operations for Highway/Roadway Incidents and Safe Positioning of Fire Apparatus and Vehicles, Emergency Responder Safety Institute [2]

Purpose: To provide a systematic method of conducting emergency operations at highway/roadway incidents.

Scope: These operations shall apply to, and be used by, all fire department members involved in emergency and non-emergency operations on highway/roadway incidents and by those agencies that respond to support fire department operations.

Overview: This standard operating guideline (SOG) identifies the necessary actions needed to be taken while operating at the scene of an incident on a highway/roadway. Additionally, this SOG covers vehicle positioning practices for XYZ Fire Department apparatus and emergency vehicles that provides maximum protection and safety for personnel operating in or near moving vehicle traffic.

This guideline emphasizes efforts to maintain lanes of moving traffic around the incident scene to minimize the traffic queue and the inherent probability of secondary collisions. Efforts to complete safe and efficient clearance of the incident scene in as short a timeframe as possible are recommended. It shall be the policy of the **XYZ Fire Department** to initially position apparatus and other emergency vehicles at an incident on any street, road, highway, or expressway in a manner that best protects the incident scene while at the same time providing for traffic movement past the incident scene as much as reasonably possible. Such positioning shall afford protection to fire department personnel, law enforcement officers, tow or recovery service operators, and other emergency personnel while working in or near moving traffic.

All personnel should understand and appreciate the significant risk that personnel are exposed to when operating *in* or *near* moving vehicle traffic. First responders should always operate within a protected environment at any roadway incident.

Always consider moving vehicles as a threat to your safety. At every roadway emergency scene, personnel are exposed to passing motorists of varying driving abilities. First responders must accept that motorists approaching the incident scene on the roadway may be a "D" driver; drunk, drugged, drowsy, distracted, or just plain dumb. It is the "D" driver that may be completely oblivious to your presence due to distractions or impairments. Distracted motorists will often be looking at the scene and not the roadway in front of them where you might be operating. Assume that all approaching traffic is a "D" driver and is out to get you until proven otherwise.

Nighttime incidents and inclement weather conditions are particularly hazardous. Visibility is reduced and driver reaction time to hazards in the roadway is slowed. Adjust operations accordingly.

Terminology

Advance Warning: notification procedures that advise approaching motorists to transition from normal driving status to that required by the temporary emergency traffic control measures ahead of them.

Block: positioning a fire department apparatus on an angle to the lanes of traffic creating a physical barrier between upstream traffic and the work area, which includes "block to the right" or" block to the left."

Buffer Zone: the distance or space between personnel and vehicles in the protected work zone and nearby moving traffic.

Downstream: the direction traffic is moving as it travels away from the incident scene.

Flagger: fire department member assigned to monitor or direct approaching traffic and activate an emergency signal if the actions of a motorist do not conform to established traffic control measures in place at the highway scene

Linear: positioning a fire department apparatus parallel to or within a travel lane or shoulder of a roadway, linear positioning only creates a physical barrier within that lane or shoulder of the roadway.

Taper: the action of merging lanes of moving traffic into fewer moving lanes.

Temporary Traffic Control Zone: the physical area of a roadway within which emergency personnel perform their fire, EMS and rescue tasks at a vehicle-related incident.

Transition Zone: the lanes of a roadway within which approaching motorists change their speed and position to comply with the traffic control measures established at an incident scene.

Upstream: the direction traffic is traveling from as the vehicles approach the incident scene.

"Move It" Incidents
All emergency personnel are at great risk of injury or death while operating in or near moving traffic. There are several specific *tactical procedures* that should be taken to protect all responders and emergency service personnel at the incident scene:

- Consider all approaching drivers are "D" drivers.
- Establish an initial "block" with the first arriving emergency vehicle or fire apparatus while the initial size-up survey is complete.
- Always wear high visibility, florescent and reflective garments (vest or jacket) during roadway operations. When full protective NFPA-compliant clothing is required by department SOP, high-visibility vests must be worn over structural turnout gear except for members combating a fire situation or dealing directly with hazardous materials.

- All fire department members must wear structural fire-fighting helmet with chinstrap donned properly.

- Operators of emergency vehicles at the scene should complete "light shedding"; Turn off all lights such as vehicle headlights, forward-facing warning lights, or spotlights that might create vision impairment to approaching motorists at nighttime incidents.

- Employ the 'Move It' or 'Work It' strategy. Determine if vehicles involved can be moved out of the travel lanes to an off-roadway location. Moving to an off-roadway location improves responder, safety, minimizes congestion, and assists with safe, quick clearance.

- If vehicles can be moved out of the travel lanes of the roadway, attempt to clear the travel lanes in less than 30 minutes; (Minor duration incident).

"Work It" Incidents

The following are benchmarks for safe positioning of **apparatus** and **emergency vehicles** when the crash-damaged vehicle cannot be moved out of the travel lanes of the roadway and crews must work the incident at the location found upon arrival. If incident is a 'Work It' situation, establish "Command" according to the Incident Command System protocols, employ upstream advance warning and temporary traffic control transition measures to warn approaching motorists, and attempt to reduce their vehicle speed. When the incident duration is anticipated to exceed 30 minutes, the process should be as follows:

- Position first-arriving apparatus to protect the scene, patients, and emergency personnel.

    - Initial apparatus placement should create an initial incident area protected from traffic approaching in at least one direction. Intersections or where the incident may be near the middle lanes of a multi-lane roadway require two or more sides of the incident to be Angle apparatus on the roadway with a "block to the left" or a "block to the right" to create a physical barrier between the crash scene and approaching traffic. Block at least one additional traffic lane more than those already obstructed by the crashed vehicle(s); obstructed lane + 1 strategy. The shoulder of the highway can be counted as a lane.

    - The front wheels of blocking vehicles should be turned away from the downstream work area;

    - For first arriving fire department units where a charged hoseline may be needed, block so that the pump panel is downstream, on the opposite side of on-coming traffic. This will protect the pump operator.

- Ambulances should be positioned within the protected work area and have their rear patient loading area angled away from the nearest lanes of moving traffic.

- Additional responder vehicles and personnel working the incident should either support advanced warning efforts or be positioned within the protected area created by the blocking apparatus.

- "Command" shall stage unneeded emergency vehicles off the roadway, place them in a staging area on the downstream side of the incident, or return these units to service.

- Lanes of traffic shall be identified numerically as "Lane 1", "Lane 2", etc., beginning from the left to the right when considered from the motorist's point of view driving in those lanes.

- Traffic cones or cones with flares alongside should be deployed upstream to increase the advance warning for approaching motorists. Cones and flares identify but only suggest the transition and tapering actions that are requested of the approaching motorist.

- Personnel shall place cones and flares as well as retrieve cones while facing oncoming traffic. A Buddy system is recommended for deployment and retrieval.

- Adequate advance warning to approaching motorists should be put in place using flares or traffic cones deployed at intervals of no greater than 40 feet apart and upstream of the blocking apparatus. The furthest traffic cone that begins the taper and closing of a travel lane should be positioned upstream along the edge or shoulder of the roadway.

- Additional personnel may extend the advanced warning area by placing additional emergency vehicles, traffic cones, flares, deployable signs, and arrow boards to build upon initial traffic control measures as the incident duration exceeds 30 minutes. Placing flares, where safe to do so, adjacent to and in combination with traffic cones for nighttime operations greatly enhances motorist warning and scene safety.

- Progressively open lanes of traffic as safely and efficiently as practical as the incident is dealt with. Once cleared of vehicles, patients and debris, opening of a traffic lane will reduce the queue and minimize the chances of secondary collisions.

Incident Command Benchmarks

The initial-arriving company officer and/or the Incident Commander must complete critical benchmarks to ensure that a safe and protected work environment for emergency scene personnel is established and maintained:

- *Ensure* that the first-arriving apparatus establishes an initial block to create an initial safe work area;

- Determine if the incident is a *"Move It"* situation where vehicles can be relocated out of the normal travel lanes thereby reducing responder exposure to moving traffic and improving incident clearance time.

- Determine if the incident is a "*Work It"* situation in which the vehicles involved must remain in their present location as fire, rescue, and medical activities take place.
- *Ensure* that all ambulances on-scene are placed within the downstream, protected work area of the larger apparatus.
- *Ensure* that all patient-loading into ambulances is done from within a protected work area.
- The initial company officer and/or Incident Commander must operate as the *safety officer* until this assignment is delegated.
- Command shall assure that *light-shedding* protocols including "OpticomTM", strobe systems, and high-beam headlights are turned **OFF** and that other emergency lighting remains **ON** as necessary.

Emergency Crew Personnel Benchmarks
Listed below are benchmarks for safe actions of individual personnel when operating in or near moving vehicle traffic.

- Always maintain an acute *awareness* of the high risk of working in or near moving traffic. They are out to get you!
- Never trust the "D" driver in the moving traffic that is approaching you.
- Always look before you move!
- Avoid turning your back to moving traffic.
- Personnel arriving in crew cabs of fire apparatus should exit and enter the apparatus from the protected, downstream side, away from moving traffic.
- Officers, apparatus operators, crew members in apparatus with individual jump seat configurations and all ambulance personnel must exit and enter their units with extreme caution remaining alert to moving traffic at all times.
- Protective clothing, high-visibility safety garment, and helmet with chin strap in position should be donned prior to exiting the emergency vehicle.
    - During normal daylight conditions, don helmet and high visibility garment or NFPA-compliant turnout PPE and high-visibility vest when operating *in* or *near* moving traffic.
    - During dusk to dawn operations or when ambient lighting is reduced due to inclement weather conditions, don helmet, full NFPA-compliant protective clothing and high-visibility vest.

  - All staff personnel and any other personnel arriving on an apparatus or emergency vehicle should don assigned helmet and high-visibility garment prior to exiting their vehicle.

- Always look before opening doors and stepping out of apparatus or emergency vehicle into any moving traffic areas. When walking around fire apparatus or emergency vehicle, be alert to your proximity to moving traffic.

  - Stop at the corner of a blocking position unit, check for moving traffic, and then proceed along the unit remaining as close to the emergency vehicle as possible.

- Maintain a 'reduced profile' when moving through any area where a minimum 'buffer zone' condition exists.

High-Volume, Limited Access Highway Operations
High-volume, limited access divided highways include expressways, turnpikes, freeways, toll ways, and other multi-lane roadways within the response area. A desire to keep the traffic moving on these high-volume thoroughfares is inherent in all operations. When in the judgment of Command (or Unified Command), it becomes essential for the safety of operating personnel and the patients involved, any or all lanes, shoulders, and entry/exit ramps of these limited access highways can be completely shut down. This, however, should rarely occur and should be for as short a period of time as practical.

Unique Safe Positioning procedures at locations such as expressway, freeway, and limited-access, high- volume multi-lane roadway incidents include the following:

- Travel lanes are typically 12 feet in width. First-arriving engine company apparatus should establish an initial lane +1 block position.

- A large and heavy second fire apparatus such as a ladder truck shall be automatically dispatched to all incidents on all limited-access, high-volume expressways, toll ways, freeways, turnpikes, and highways.

- The primary assignment of this second unit shall be to:

  - Establish an upstream block occupying a minimum of two 12-foot lanes plus the paved shoulder of the highway or blockage of three 12-foot driving lanes of traffic upstream of the initial block provided by the first-due apparatus.

  - The position of this apparatus shall take into consideration all conditions that might limit sight distance of the approaching traffic including ambient lighting conditions, weather-related conditions, road conditions, curves, bridges, hills, and over-passes, or underpasses.

- Traffic cones and/or cones illuminated by flares and the NFPA-compliant retro-reflective pink "Emergency Scene Ahead" deployable sign should be placed upstream of the second vehicle by its crew at the direction of the company officer.

- Traffic cones on limited-access, high-volume roadways can be placed at 40-foot intervals with the furthest cone and or flare approximately 200-feet "upstream", to allow adequate warning to drivers. When incident duration exceeds two hours, advance warning efforts should be as compliant with the Manual of Uniform Traffic Control Devices (MUTCD) requirements as possible.

- A flagger/spotter person should be positioned, if available, to monitor the response of approaching motorists as they are directed to transition to a slower speed and taper into merged lanes of traffic.

- Command should be notified by this flagger/spotter on the incident operating channel of any approaching traffic that is not responding to the speed changes, transition, tapering and merging directions.

- Flagger/spotter should have the capability of activating a pre-determined audible warning (e.g. air horn (can)) to alert operating personnel of a non-compliant motorist approaching.

- Vehicles from law enforcement and transportation departments can be used to provide additional blocking of additional traffic lanes as needed as incident duration exceeds 30 minutes (defined by the MUTCD as "minor duration incident".) **Note:** *Regardless of the time or duration of the incident, the faster channeling devices are deployed, the safer the work area becomes.*

- When the incident duration exceeds 30 minutes, it becomes an "intermediate duration incident" as defined by the MUTCD. During this period of time, efforts should evolve around clearing the scene as expeditiously as possible. For extended duration incidents such as hazardous materials situations, Command should request appropriate traffic incident management personnel and resources. When the lane or road closure exceeds 2 hours in duration, MUTCD-compliant traffic control measures should be in place. This can include traffic control center protocols, transportation department arrow board trucks, road detours, changeable message sign notifications, media contacts, etc., as appropriate.

- Fire Department Incident Commander should establish a liaison with law enforcement supervising officer as soon as possible. This Unified Command Team will jointly coordinate activities and determine how to most efficiently resolve the extended duration incident and clear the obstructed travel lanes in as safe and efficient manner as practical.

- Termination of the incident should be managed with the same aggressiveness as initial actions. Crews, apparatus, and equipment must be removed from the highway in a coordinated process to reduce exposure to moving traffic and minimize traffic congestion.

Officer's Safe Parking "Cue Card"

- **"Block"** with first-arriving apparatus to protect the scene, patients, and emergency personnel.
- "Block" one additional lane if it is required to ensure a safe working area. If the incident is completely on the shoulder and off the travelled portion of the road it may not be necessary to close the adjacent lane. This decision should always be made based on where the responders will be working to mitigate the incident and if a protected work area can be maintained so moving traffic will not enter.
    - "Block" so pump panel is "downstream"
    - "Block" *most critical* or *highest traffic volume* direction first
    - Consider requesting additional law enforcement assistance
- **Crews wear proper PPE with helmet**
    - High-visibility garments at all times
    - Helmet at all times
    - Full PPE plus high-visibility vest between dusk and dawn or inclement weather
    - NFPA-compliant turnout gear is appropriate PPE whenever the crew is directly exposed to fire, heat, flame and/or hazardous materials.
- **Establish more than adequate advance warning**
    - Deploy a minimum of 5 traffic cones upstream at up to 40-foot intervals.
    - Cones only "suggest" they don't "block"!
    - Expand initial safe work zone as temporary traffic control devices are available
- **Direct placement of ambulances**
    - Ensure ambulances park within shadow of blocking apparatus as directed
    - Lane 1 is the lane furthest from the left from approaching motorist's point of view. Moving to the right of Lane 1 is Lane 2, Lane 3, etc.
    - Direct ambulance to "block to the right" or "block to the left," placing ambulance patient loading area facing away from closest lane of moving traffic.
    - All patient loading into ambulances is done from within a protected work zone

- **Limited access, high-volume highway incidents**
    - Establish initial block: minimum two lanes.
    - Ladder truck establishes upstream block.
    - Two lanes plus paved shoulder or
    - Three driving lanes
    - Place cones and/or cones illuminated by flares upstream of larger upstream blocking vehicle with the furthest cone approximately 200 feet "upstream" of apparatus.
    - Establish flagger position.
    - Monitor approaching traffic
    - Sound emergency signal as necessary
    - Use police department and/or transportation department vehicles for additional blocking, advance warning, and traffic incident management.
    - Stage additional companies off highway.
    - Establish liaison with Police Department to form Unified Command at scene.
    - Terminate incident aggressively with safe, quick clearance strategies.
- **You are the Safety Officer**
    - Consider assigning fire fighters as upstream "Spotter" as necessary for approaching traffic;
- **Night or Reduced Light Conditions**
    - Turn **OFF** vehicle headlights.
    - Turn **OFF "**Opticom**TM**".
    - Provide overall scene lighting.
    - All personnel wear appropriate PPE with helmets.
    - Illuminate cones with flares.
    - Consider an additional truck company for additional upstream "block".

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Safety Consideration: Responders, who have completed their work assignment or who are waiting for another assignment, should never congregate in an area where moving traffic might enter and endanger them. This is especially important when responders are waiting for additional resources such as a utility company or towing and recovery when there can be a delay in response.

Studies indicate that for each minute on the scene, responders are subject to an increasing likelihood of being involved in a secondary incident. Often these incidents are much more serious than the initial incident that generated the emergency response.

The Incident Commander should move these responders to a staging area away from moving traffic or an area that might endanger them.

References for Appendices 1 and 2:

1. ERSI [2012]. Temporary traffic Control for first responders. Chambersburg, PA. Cumberland Valley Volunteer Firemen's Association, Emergency Responder Safety Institute http://www.respondersafety.com/DownloadCategories/SOPs_SOGs.aspx. Date accessed: June 2015.

2. ERSI [2012]. Operations for highway/roadway incidents and safe positioning of fire apparatus and vehicles. Chambersburg, PA. Cumberland Valley Volunteer Firemen's Association, Emergency Responder Safety Institute http://www.respondersafety.com/DownloadCategories/SOPs_SOGs.aspx. Date accessed: June 2015.

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