



A summary of a NIOSH fire fighter fatality investigation

February 28, 2011

Volunteer Chief and Fire Fighter Die After Being Ejected During a Rollover Crash—Virginia

Executive Summary

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



Crash photo. (Courtesy of the Franklin News Post.)

Contributing Factors

- Nonuse of seat belts.
- Failure of the motorist to yield the right-of-way to an approaching emergency vehicle with audible and visual signals in use.
- Failure to ensure that all approaching vehicles had yielded the right-of-way before advancing through an intersection.
- Use of an older apparatus with minimal safety features.
- Lack of intersection control device on emergency vehicle and traffic light.

Key Recommendations

- Ensure that written standard operating procedures (SOPs) regarding seat belt use are established and enforced.
- Ensure that fire fighters use extreme caution while responding through intersections by coming to a full stop before entering a negative right-of-way intersection (red light, flashing red light, or stop sign) and by accounting for all lanes of traffic before proceeding through the intersection.
- Consider upgrading, retiring, or replacing older fire apparatus.

• Consider rollover protection for the crew areas of fire apparatus when upgrading or purchasing new apparatus.

Additionally, states, municipalities, and authorities having jurisdiction should

- Take steps to ensure that motorists are aware of, understand, and follow state traffic codes/laws pertaining to yielding the right-of-way to approaching, authorized emergency vehicles using audible and visual signals.
- Consider the use of intersection control devices on emergency vehicles and selected traffic lights.

Fire apparatus manufacturers, researchers, and standard setting bodies should

- Continue to improve fire apparatus safety standards and designs for increased crashworthiness of compartments for fire fighter survivability in rollover crashes.
- Continue to evaluate apparatus seating and seat belt design to ensure that riding positions and seat belts are comfortable and effective for fire fighters wearing personal protective equipment.

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 Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).



Death in the line of duty...



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Introduction

On July 26, 2010, a 59-year-old male volunteer fire chief (victim 1) and a 67-year-old male volunteer fire fighter (victim 2) died from injuries sustained after they were ejected when their engine was involved in a crash and rolled over while responding to an emergency. On July 27, 2010, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On August 10–13, 2010, a general engineer and a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Virginia to investigate this incident. The NIOSH investigators interviewed the acting fire chief, town manager, and assistant town manager. The NIOSH investigators also met with a representative of the Virginia Department of Fire Programs and spoke with the Virginia State Police. The NIOSH investigators visited the incident scene and conducted interviews with officers and fire fighters of the involved department, the county coroner, and the director of the surrounding county department of fire and emergency medical services. The NIOSH investigators examined and photographed the fire engine involved in this incident at the town's secure storage facility. The NIOSH investigators reviewed the fire department's standard operating guidelines, the victims' training records, and dispatch audio tapes.

The state of Virginia criminal and traffic law, chapter 8, article 2, section 46.2-829^{$\frac{1}{2}$}, describes the right-of-way requirements for approach of fire fighting vehicles. The right-of-way law states, "Upon the approach of any emergency vehicle as defined in 46.2-920 giving audible signal by siren, exhaust whistle, or air horn designed to give automatic intermittent signals, and displaying a flashing, blinking, or alternating emergency light or lights as provided in 46.2-1022 through 46.2-1024, the driver of every other vehicle shall, as quickly as traffic and other highway conditions permit, drive to the nearest edge of the roadway, clear of any intersection of highways, and stop and remain there, unless otherwise directed by a law-enforcement officer, until the emergency vehicle has passed. This provision shall not relieve the driver of any such vehicle to which the right-of-way is to be yielded of the duty to drive with due regard for the safety of all persons using the highway, nor shall it protect the driver of any such vehicle from the consequences of an arbitrary exercise of such right-of-way." Chapter 8, article 15, section 46.2-920, describes emergency vehicle exemption from regulations in certain situations, such as those involving steady or flashing red traffic signals: "Proceed past any steady or flashing red signal, traffic light, stop sign, or device indicating moving traffic shall stop if the speed of the vehicle is sufficiently reduced to enable it to pass a signal, traffic light, or device with due regard to the safety of persons and property."

Fire Department

The victims' department is a volunteer department with 2 stations and 26 members, serving a population of approximately 12–14,000 residents within an area of about 20 square miles, and responds to approximately 350 emergency incidents per year. The department does not provide emergency medical services.

In addition to the incident vehicle, the department has the following apparatus in service:

- 2008, 1,250-gallon-per-minute (gpm) custom engine
- 2000, 1,250-gpm commercial engine
- 1992, 1,250-gpm custom engine
- 2001, 85-ft aerial platform
- 2002, custom-chassis utility truck
- 1996, commercial utility truck
- 1984, commercial brush truck

All fire department apparatus are maintained by the department and are checked twice per month for safe operating conditions. The department sends the apparatus to a truck maintenance facility for annual safety inspections and oil changes.

The fire department has written policies and procedures, which are available to all department members within their stations. Policies and procedures on emergency vehicle operations, incident command structure, and SCBA and turnout gear use were in place.

Training and Experience

The victims' fire department requires members to attain a minimum level of training, consisting of Fire Fighter I, within 1 year of membership. Driver operators must have a minimum of 1 year of experience, complete Fire Fighter I and Emergency Vehicle Operators Course (EVOC), and pass a road test supervised by the chief of the department.

| Fire Fighter | Training Courses | Years Experience |
|--------------|---|------------------|
| Victim 1 | Emergency Vehicle Operations 1, 2, 3 | 33 |
| | Driver/Operator-Pumper, -Aerial | |
| | Fire Fighter I, II | |
| | Instructor 1, 2; Train the Trainer, Adjunct Instructor, | |
| | Hazardous Materials Awareness and Operations | |
| | Trench, Rope, Confined Space | |
| | Vehicle Rescue Awareness | |
| | ICS-100, -200, -195, -700 | |
| | NFA Strategy and Tactics | |
| | CPR; First Responder Medical Training | |
| Victim 2 | Emergency Vehicle Operations 1, 2, 3 | 47 |
| | Driver/Operator-Aerial | |
| | Fire Fighter I, II | |
| | Hazardous Materials Awareness and Operations | |
| | ICS-100, -195, -700 | |
| | CPR; First Aid | |

The table lists the training and experience of the primary fire fighters involved in the incident.

Note: Both victims' training records met the criteria for National Fire Protection Association (NFPA) 1001 Standard for Fire Fighter Professional Qualifications², which requires completion of Fire Fighter I and Fire Fighter II courses.

Equipment and Personnel

The engine involved in this incident was a 1988, 1,250-gpm custom engine with a 1,000-gallon water tank (see Photo 1 and Photo 2). The fire department purchased this pumper as a used vehicle from another department approximately 10 years prior to the incident. The gross vehicle weight rating of the engine was 37,180 lbs. The engine had an automatic transmission, diesel engine, air-actuated drum brakes with no auxiliary braking devices, and two axles with six wheels (two in the front and four in the rear). The engine had an electronic siren, air horns, and emergency lights. The engine had seat belts for the driver and passenger. The water tank was inspected at the town's storage facility and appeared intact, although the configuration of the tank baffles could not be verified at the time of the inspection. The two victims were the only personnel on board the engine at the time of the crash.

There were no recorded or reported complaints from members of the department regarding braking, steering, or performance with the engine.



Photo 1. Side view of the apparatus, post incident at the storage facility. (NIOSH photo.)



Photo 2. Front view of apparatus post incident with top of cab sheared off by crash impact. (NIOSH photo.)

Timeline

The timeline for this incident is limited to the initial response of the apparatus to a mutual aid structure fire on July 26, 2010. The driver (victim 1) and the passenger (victim 2) responded to the station to pick up the engine and had driven approximately 1.8 miles when the crash occurred.

• 1616 Hours

Structure fire in neighboring jurisdiction was dispatched. Comments from the callers indicated a house fire with an explosion, heavy smoke and fire.

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- **1619 Hours** Engine was dispatched as third due mutual aid for the fire incident.
- **1624 Hours** Engine en route.
- **1630 Hours** Engine involved in a rollover crash with 2 civilian vehicles at an intersection.

Personal Protective Equipment

Victim 1 (driver) was wearing his bunker pants, boots, and T-shirt. Victim 2's personal protective equipment was not reported.

Weather and Road Conditions

The fire truck was traveling downgrade toward a traffic light-controlled intersection on a four-lane state highway with a posted speed limit of 35 mph. The road surface was asphalt, in good condition, and was dry.

At the time of the crash (approximately 1630 hours), the weather was clear with an approximate temperature of 90°F. The relative humidity was 57% and the wind was calm.³

Investigation

On July 26, 2010, a 59-year-old male volunteer fire chief (victim 1) and a 67-year-old male volunteer fire fighter (victim 2) died from injuries sustained in a fire engine rollover crash, responding to a mutual aid residential structure fire. The engine was dispatched to assist on a mutual aid house fire at 1619 hours. Both victims responded to the station and at 1624 hours were en route on the engine. The engine was responding with its lights and siren activated.

A county fire marshal was responding with lights and siren to the same mutual aid structure fire, traveling east on the same road just ahead of the victims' engine. The fire marshal stopped at the red light and then successfully traveled through the intersection in the direction of the response (see Photo 3). Note: The fire marshal told NIOSH investigators that he was 5–10 seconds in front of the victims' engine, and he estimated that the engine would have caught the same red light as his vehicle. The fire marshal did not see the SUV strike the engine, and he was not aware of the crash until he heard a dispatch for a motor vehicle accident involving a fire truck that was dispatched at 1633 hours.

The engine had traveled approximately 1.8 miles when it encountered the red light at the intersection. The engine entered the intersection and was struck on its left rear side by an SUV that was entering from the north (left) side of the intersection. The engine struck the curb on the south (right) side and then rolled over; both victims were ejected. The engine rested on its top facing northwest and impacted a car in the opposing lane (see Photo 4).

The county director of public safety was nearby and responded to the crash scene. He stated during interviews that he was one of the first emergency responders on the crash scene and, after arriving, he provided emergency medical care to victim 1 who still had a pulse but was unresponsive and suffering from a head wound and general trauma. Victim 1 was transported to a local hospital and pronounced dead. Victim 2 was pronounced dead at the scene. The county coroner reported the cause of death for both victims as blunt force trauma. Both victims were reported to not be wearing their seat belts.



Photo 3. Intersection where crash occurred (same direction of travel as incident apparatus, eastbound). (NIOSH photo.)



Photo 4. Crash scene. (Photo courtesy of the Franklin News Post.)

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 ultimately led to the fatalities:

- Nonuse of seat belts.
- Failure of the motorist to yield the right-of-way to an approaching emergency vehicle with audible and visual signals in use.
- Failure to ensure that all approaching vehicles had yielded the right-of-way before advancing through an intersection.

- Use of an older apparatus with minimal safety features.
- Lack of intersection control device on emergency vehicle and traffic light.

Cause of Death

According to the medical examiner, the cause of death for each victim was blunt force trauma.

Recommendations

Recommendation #1: Fire departments should ensure that written standard operating procedures (SOPs) regarding seat belt use are established and enforced.

Discussion: The fire department involved in this incident had a verbal policy that required all fire fighters to use their seat belts but did not have a written standard operating procedure (SOP) requiring the use of seat belts. Both victims, one being the chief of the department, were not wearing seat belts at the time of the crash. The medical examiner noted that the fatal injuries for both victims were injuries from ejection and, although it is uncertain if either of the men if restrained by seat belts would have survived, they would have had a greater chance of survival.

Fire departments should develop, train upon, and strictly enforce (at all levels of the organization, from the apparatus driver and fire fighters riding in the apparatus, to the officer on the apparatus and chief officer levels) SOPs on the use of seat belts. The SOPs should apply to all persons driving or riding in all emergency vehicles, and they should state that all persons should be seated and secured in an approved riding position before the vehicle is in motion. Although there is no evidence in this incident that the nature of the emergency call (house fire with an explosion, heavy smoke and fire) had an effect on the decision to not use the seat belts, dispatch data or radio traffic can lead to an increase in adrenalin, which can cause responders to skip important safety steps such as using seat belts and "driving with due regard." Training on SOPs should reinforce the need for drivers and fire fighters to recognize when an increased adrenalin response (caused by radio traffic or dispatch information) may cause them to inadvertently omit an important safety step, such as the use of seat belts. During interviews, fire fighters reported that the chief (victim 1) was known for using his seat belt and encouraging other fire fighters to use theirs.

Vehicle crashes are the second leading cause of fire fighter line-of-duty deaths. The driver/operator must always ensure the safety of all personnel riding on the apparatus. NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program*,⁴ 6.3.3.1, states, "all persons seated in fire apparatus shall wear seat belts any time the vehicle is in motion." NFPA 1500, 6.2.5,⁴ also states, "drivers should not move fire apparatus until all persons on the vehicle are seated and secured with seat belts in approved riding positions." Seat belts are not only important for protecting occupants in the event of a crash, but they may be useful in helping to avoid crashes. The U.S. Fire Administration's *Safe Operation of Fire Tankers* states, "Some crash reconstruction specialists have speculated that particular incidents may have occurred after the unrestrained driver of a truck was bounced out of an effective driving position following the initial contact with a bump in the road or another object."⁵ Any person not wearing a seat belt while riding in a vehicle can become a positional projectile that can cause injury or death to others in the vehicle as demonstrated in the following video link provided by

Michael Wilbur's Emergency Vehicle Response⁶: <u>http://www.emergencyvehicleresponse.com/videos/showlink/vid/1573</u>.

A seat belt policy that is followed and/or enforced by fire department personnel achieves the benefit of the safety device. To increase the use of seat belts by fire fighters, the National Fire Service Seat Belt Pledge Campaign was created.⁷ The National Institute for Occupational Safety and Health, United States Fire Administration, International Association of Fire Chiefs, National Volunteer Fire Council, NFPA, and National Fallen Fire Fighters Foundation all support the campaign as a method of raising awareness of the importance of mandatory use of seat belts by all fire fighters. Fire fighters wearing seat belts are an essential component of efforts to ensure the safety of fire fighters in fire apparatus and vehicles.⁸ Fire fighters who take the pledge and fire departments who achieve 100% pledge participation show their individual and organizational commitment to fire fighter safety.⁹ The International Association of Fire Chiefs has guidance on developing SOPs for emergency vehicle safety.¹⁰

The state of Virginia criminal and traffic laws, chapter 10, section 46.2-1094, requires occupants of the front seat of a motor vehicle to wear the appropriate safety belt system at all times while the vehicle is in motion on any public highway. The section does give exceptions for law enforcement officers in certain circumstances, rural mail carriers, waste collection vehicles, and utility meter reader vehicles. Fire fighting vehicles are not exempt from these seat belt provisions.

Recommendation #2: Fire departments should ensure that fire fighters use extreme caution while responding through intersections by coming to a full stop before entering a negative right-of-way intersection (red light, flashing red light, or stop sign) and by accounting for all lanes of traffic before proceeding through the intersection.

Discussion: While the goal of any fire department responding to an emergency is to get there quickly, if the apparatus does not arrive, the initial goal of responding is negated. Emergency vehicle driver/operators should be aware of the regulations describing how vehicles should be operated when audible and visual warning devices are in use.⁴ Virginia criminal and traffic laws, chapter 8, article 15, section 46.2-920, describes emergency vehicle exemption from regulations in certain situations such as steady or flashing red traffic signals: [An emergency vehicle may] "proceed past any steady or flashing red signal, traffic light, stop sign, or device indicating moving traffic shall stop if the speed of the vehicle is sufficiently reduced to enable it to pass a signal, traffic light, or device with **due regard** to the safety of persons and property" [emphasis added].

The International Association of Fire Chiefs (IAFC) has developed a guide for writing policies and procedures for emergency vehicle safety.¹⁰ One of the areas noted in the guide is a policy for emergency response through intersections and how departments can improve emergency vehicle safety. Although emergency vehicle response laws may vary from state to state, NFPA 1500⁴ and the IAFC recommend this approach to response through intersections:

"**Intersections:** The fire department emergency vehicle shall come to a full stop before entering a negative right-of-way intersection (red light, flashing red light, or stop sign), blind intersection, or any

intersection where hazards are present and/or the driver cannot account for all oncoming traffic lanes. The emergency vehicle shall not enter the intersection until all approaching traffic has yielded the right-of-way and it is safe to proceed. The emergency vehicle driver shall ensure that all approaching vehicles in all lanes have yielded the right-of-way before advancing.

"If necessary, due to traffic conditions or visual obstructions, the emergency vehicle driver shall cross the intersection in stages, treating each lane as a separate intersection. The driver shall stop the vehicle, as necessary, to ensure that each lane may be crossed safely. When passing through an intersection where the emergency vehicle has the right-of-way, by virtue of a green light in the direction of travel and/or a stop signal (stop sign) for cross-traffic, the emergency vehicle shall not exceed the posted speed limit. Emergency vehicle drivers should not assume that oncoming/opposing traffic has stopped, even when facing a green signal or "clear" route; emergency vehicle drivers must visually confirm that oncoming/opposing traffic is stopped while approaching any intersection, and be prepared to stop immediately, if necessary."¹⁰

During this incident, the fire engine was approaching an intersection with a red light in their direction. One emergency vehicle had just passed through the red light in the same direction, and the light was reported to still be red for the fire engine. The sport utility vehicle that struck the fire engine was second in line of the cross street and had a green light to enter the intersection. The vehicle in front of the sport utility vehicle was not involved in the crash.

Recommendation #3: Fire departments should consider upgrading older fire apparatus in accordance with NFPA 1912 Standard for Fire Apparatus Refurbishing¹¹ and retire or replace older apparatus in accordance with current standards such as NFPA 1901 Standard for Automotive Fire Apparatus.¹²

Discussion: To maximize fire fighter safety as well as the safety of the traveling public, fire apparatus must be equipped with the latest safety features and operating capabilities. In the last 15 to 20 years, much progress has been made in upgrading the safety features and capabilities of fire apparatus. Significant improvements in fire apparatus safety have been the standard since 1991, and fire departments should consider the value (or risk) to fire fighters of keeping pre-1991 fire apparatus in first-line service. Apparatus manufactured prior to 1991 usually conformed to only a few of the safety standards for fire apparatus set by the NFPA.¹²

The length of a vehicle's life depends on many factors, including mileage and engine hours, quality of the preventive maintenance program, quality of the driver training program, whether the fire apparatus was used within the design parameters, whether the apparatus was manufactured on a custom or commercial chassis, quality of workmanship by the original manufacturer, quality of the components used, and the availability of replacement parts, to name a few.¹²

Fire departments should consider upgrading older fire apparatus in accordance with NFPA 1912 *Standard for Fire Apparatus Refurbishing*¹¹ and retire or replace older apparatus in accordance with current standards such as NFPA 1901 *Standard for Automotive Fire Apparatus*.¹² Fire departments should also consider retiring apparatus sooner if the apparatus becomes obsolete or unreliable due to age or use. NFPA 1901, Annex D.1,¹² provides explanatory material for fire departments that

recommends placing an apparatus in reserve status when the apparatus is greater than 15 years old and properly maintained and upgraded in accordance with NFPA 1912.¹¹

In this incident, the fire truck was a 1988, two-door, open jump-seat custom chassis that met all the minimum requirements for fire truck safety standards and design in effect on the date of manufacture.

Recommendation #4: Fire departments should consider rollover protection for the crew areas of fire apparatus when upgrading or purchasing new apparatus.

Discussion: Fire departments should consider rollover and crash avoidance/protection systems when upgrading or purchasing new fire apparatus. Many features are available that can add to the safety of fire fighters involved in crashes. Many of the new rollover protection components are integrated systems designed to increase protection for the fire fighters riding inside the apparatus. Strengthened cabs, combined with roll protection systems that sense the moment a vehicle is in a side roll, provide passenger protection through air bag systems and automatic seat belt pretensioners that retract the seat downward to increase the clearance between the fire fighter's head and the ceiling of the apparatus and therefore improve survivability.

In this incident, the driver and the passenger were not wearing seat belts and were ejected. The roof of the cab was crushed down significantly (see Photo 2 and Photo 4). The driver's seat and passenger seat lacked a mechanism to automatically retract the seats down, and the cab roof was not strong enough to prevent the intrusion into the driver and passenger's compartment.

Recommendation #5: States, municipalities, and authorities having jurisdiction should take steps to ensure that motorists are aware of, understand, and follow state traffic codes/laws pertaining to yielding the right-of-way to approaching, authorized emergency vehicles using audible and visual signals.

Discussion: Motorists and emergency vehicle driver/operators should know the rules and regulations that govern the operation of the vehicle(s) they drive. Motorists need to be aware of and understand the traffic codes/laws pertaining to yielding the right-of-way to approaching emergency vehicles. The state of Virginia criminal and traffic law, chapter 8, article 2, section 46.2-829, describes the right-of-way requirements for approach of fire fighting vehicles. The right-of-way article states, "Upon the approach of any emergency vehicle ... giving audible signal by siren, exhaust whistle, or air horn ... and displaying a flashing, blinking, or alternating emergency light or lights ..., the driver of every other vehicle shall ... drive to the nearest edge of the roadway, clear of any intersection of highways, and stop and remain there ... until the emergency vehicle has passed. This provision shall not relieve the driver of any such vehicle to which the right-of-way is to be yielded of the duty to drive with due regard for the safety of all persons using the highway, nor shall it protect the driver of any such vehicle from the consequences of an arbitrary exercise of such right-of-way."

Motorists should be aware that multiple emergency units may be passing through an intersection and not assume that just because one emergency unit has come through the intersection, another one will not be following the first. Many departments respond with multiple emergency vehicles out of a single

fire house, and civilian traffic must use caution and proceed only when the emergency vehicles have cleared the intersection and all lanes of traffic are accounted for and it is safe to proceed. Some drivers may not see the emergency vehicle due to other stopped traffic or viewing obstructions; others may be unable to hear the siren due to radios, closed windows, air conditioners, talking on a cell phone, or hearing loss; others may simply ignore warning signals. Emergency vehicle driver/operators should pay close attention to motorists and anticipate other drivers' actions.

During this incident, the fire engine was approaching an intersection with a red light in their direction. One emergency vehicle had just passed through the red light in the same direction, 5–10 seconds prior, and the light was reported to still be red for the fire engine. The civilian SUV that struck the fire truck was second in line of the crossing traffic, and the vehicle in front of the SUV had made it across the intersection.

Motorists can be reminded of specific traffic codes/laws through public service announcements, electronic message boards, or posted roadway signs. State and federal rulemaking entities should consider development and promulgation of a standard set of traffic code/laws to offset any potential confusion motorists may encounter when traveling in different states.¹³

Recommendation #6: Municipalities and authorities having jurisdiction should consider the use of intersection control devices on emergency vehicles and selected traffic lights.

Discussion: Electronic traffic control devices can allow approaching emergency vehicles to change the intersection lights from a red signal to green in their direction of travel, providing an intersection rightof-way that increases safety when crossing intersections. The electronic preemptive devices have a transmitting device on the emergency vehicle and a receiver mounted on or near the traffic signal. The approaching emergency vehicle has an automatic transmitting device that emits a visible light and/or an invisible signal to the control device requesting a green light. Some electronic preemptive systems have a flashing flood light mounted in the intersections that can warn vehicles an emergency vehicle is approaching the intersection from a different direction, either toward the vehicle or from the side. NFPA 1451, A.7.1.3, *Standard for a Fire Service Vehicle Operations Training Program*¹⁴ states, "Crashes at intersections can contribute to both civilian and fire department personnel deaths and injuries while fire department vehicles are responding to or returning from an emergency incident. Coming to a complete stop where there are any intersection hazards and proceeding only when the driver can do so safely can reduce crashes and risk of injury or death. It is recommended that intersections."

In this incident, the driver of the sport utility vehicle had a green light and reportedly did not see or hear the approaching fire engine. The sport utility vehicle was second in line to cross the intersection and entered the intersection on a green light and after the first emergency vehicle had successfully passed through the intersection. The driver possibly did not anticipate another emergency vehicle coming through the intersection. If the traffic signal had a preemptive device, it could have turned the opposing signal lights red and cleared the intersection for the fire engine. *Note: If two or more emergency vehicles are approaching the same intersection from different directions, the signal will*

only preempt the first signal received and won't preempt the additional signal(s) until the first signal is through the intersection or turned off.

Since this incident, the community has raised \$233,000.00 to date in a memorial fundraiser to equip all emergency vehicles and traffic signals with the devices needed to allow emergency vehicles to change traffic signals from some 800 feet away when approaching intersections.

Recommendation #7: Fire apparatus manufacturers, researchers, and standard setting bodies should continue to improve fire truck safety standards and designs for increased crashworthiness of compartments for fire fighter survivability in rollover crashes.

Discussion: The minimum requirements for crashworthiness in rollover incidents should be improved to increase the survivability of fire fighters involved in rollover crashes. Minimum cab roof strength should be reviewed and evaluated with other protection systems to prevent cab intrusion into the passenger compartments. Rollover fatalities and injuries in the fire service may be reduced by increasing the crashworthiness of fire apparatus. NFPA 1901, annex A,¹² section A.14.3.2, notes, "The U.S. standards developed by SAE and the United Nations ECE regulation mirror each other except that SAE J2422 requires a roof preload impact prior to the roof crush. The ECE standard was established in 1958, while the SAE standards did not add performance criteria until 2003. Both the SAE and ECE standards are viable minimum measures of cab integrity. Manufacturers may test in excess of the standards."

Section A.4.13.1 of NFPA 1901, annex A,¹² notes, "Several features and factors affect vehicle safety in a rollover." The features and factors are listed below:

- *"Custom Fire Apparatus Cab.* The nature of the custom fire apparatus cab makes it much stronger in rollover than typical conventional commercial cabs. There is much anecdotal evidence to indicate that the crashworthiness of a typical custom fire apparatus cab is significantly greater than a typical commercial cab, and most custom chassis manufacturers can provide test data on cab integrity.
- *"Lateral Acceleration Alert Device.* There are both mechanical and electronic devices available that will measure the lateral acceleration of a vehicle. Although these devices will not prevent rollover, they can be used effectively as a driver training tool to indicate when the vehicle is approaching the roll threshold and as a reminder to the driver that excessive lateral acceleration can lead to a rollover event.
- *"Side Roll Protection.* Many custom fire apparatus manufacturers offer side air bags or curtains that inflate during a roll event and that are usually combined with seat belt pretensioning devices and suspension seat pull-down devices. This option can reduce injury during a rollover as long as the occupants are seated and belted.
- *"Roll Stability Control.* This technology electronically senses the lateral acceleration of the vehicle and takes action by depowering the engine and applying the brakes if the vehicle approaches a roll threshold. The effectiveness of this product is limited to events on relatively flat pavement, since it cannot do much to help the situation once a vehicle is off the road and leaning into a ditch.

- *"Electronic Stability Control (ESC).* ESC uses a steering wheel position sensor, a vehicle yaw sensor, a lateral accelerometer, and individual wheel brake controls in conjunction with the antilock brake system (ABS). The system tracks the direction that the driver intends to steer and uses brake application at individual wheels to help straighten out the vehicle.
- "*Driver Skill and Experience*. While the design and features of the vehicle are important to safe driving, the most important aspect of crash prevention is the skill and experience of the operator. The operator's attitude, training, experience, qualifications, and the application of those qualities are the most important elements in crash prevention. The operator must ensure that the physical limits of the vehicle are not exceeded. Driver skill is developed only through training and practice."

In this incident, the fire truck was a 1988, two-door, open jump-seat custom chassis that met all of the minimum requirements for fire truck safety standards and design in effect on the date of manufacture.

Recommendation #8: Fire apparatus manufacturers, researchers, and standard setting bodies should continue to evaluate apparatus seating and seat belt design to ensure that riding positions and seat belts are comfortable and effective for fire fighters wearing personal protective equipment.

Fire apparatus manufacturers, researchers, and standard setting bodies should also continue to evaluate apparatus seating and seat belt design to ensure that riding positions and seat belts for those positions are sized to accommodate fire fighters clothed in personal protective gear and the seat belts are easy to wear and effective. The National Institute for Occupational Safety and Health is currently funding a study on "Collection of Anthropometric Information on Fire Fighters for Fire Apparatus Design and Standards Update" to collect measurements on fire fighters and to utilize this data to analyze different body shapes in the design of fire and rescue equipment and cab design in the apparatus. More information on the study can be obtained at the program Web site http://www.cdc.gov/niosh/fire/.

References

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Investigator Information

This incident was investigated by Stephen Miles, Safety and Occupational Health Specialist, and Matt E. Bowyer, General Engineer, 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 Deputy Fire Chief William Goldfeder of the Loveland-Symmes (OH) Fire Department and editor of <u>FireFighterCloseCalls.com</u> and Michael Dallessandro, Fire Department Management, Safety & Training Consultant, and editor of <u>www.respondsmart.com</u>. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

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