



Volunteer Fire Fighter Dies After Being Ejected From Rear Seat of Fire Department Pickup Truck – Iowa

Executive Summary

On February 24, 2017, a 52-year-old male volunteer fire fighter died after being ejected from the fire department's pickup truck. The pickup truck was transporting 3 fire fighters from a volunteer fire department to State Fire School training. The vehicle was traveling in adverse road and driving conditions due to a wintery mix of rain, snow, and ice. Approximately 117 miles from their station, a patch of ice/snow caused the driver to lose control of the vehicle on a four-lane divided highway. The pickup truck slid off the right side of the pavement hitting a soft grassy shoulder which pitched the truck into a roll. It rolled 2-3 times before coming to a stop on its roof (see Photo page i). The fire fighter sitting in the rear seat was not wearing his safety belt and was ejected through the driver's side rear seat window which was shattered during the roll. Both the driver and the other fire fighter sitting in the front seat were wearing their safety belts. The driver sustained significant bruising while the other fire fighter suffered only minor abrasions. After exiting the vehicle from the shattered driver's side rear seat window, they located the unresponsive ejected fire fighter and noted his agonal respirations and a weak peripheral pulse. The driver started cardiopulmonary resuscitation (CPR) while a passerby called 9-1-1. The driver and other fire fighter took turns performing CPR until other emergency personnel arrived. Despite CPR and other medical treatment provided by both fire fighters involved in the crash and responding emergency personnel, the fire fighter was pronounced dead at the scene due to head trauma. The driver was transported to the nearest emergency department for evaluation. After being evaluated and treated for bruising, the driver was released that evening. The other fire fighter in the front seat suffered minor abrasions. He refused treatment on scene, but accompanied the Driver in the ambulance to the emergency department.



Final position of fire department pickup truck after fatal rollover crash.

(Photo courtesy of Iowa State Patrol)

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Contributing Factors

- *Waiver of the department seat belt policy due to a recent surgical procedure on the fire fighter sitting in the rear seat*
- *State safety belt law with a back seat exemption*
- *Rapidly deteriorating weather-related road conditions*
- *Traveling at an unsafe speed given the rapidly changing weather and road conditions*
- *Lack of an electronic stability control (ESC) system in the pickup truck*
- *Lack of highway pre-treatment by State/County road crews.*

Key Recommendations

- *Fire departments should ensure policies regarding safety belt use in department apparatus, or in personally owned vehicles (POV) traveling for fire department business, are followed and enforced.*
- *Fire departments should prohibit waivers of department safety belt policies.*
- *States should consider revising state safety belt policies to require all fire fighters traveling in fire department vehicles to use their safety belts.*
- *States should consider requiring rear safety belt use regardless of age.*
- *Fire departments should provide initial and periodic refresher training to all drivers on each vehicle they may be called upon to operate.*
- *Fire departments should ensure fire department vehicles are equipped with electronic stability control (ESC) systems, if available.*
- *Local roadway crews should consider notifying fire departments with roadway treatment plans before and during hazardous weather.*

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 (1-800-232-4636).



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Introduction

On February 24, 2017, a 52-year-old male volunteer fire fighter died after being ejected from a fire department pickup truck. On February 27, 2017, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. NIOSH contacted the fire department on February 28, to initiate the investigation. On March 12, a NIOSH General Engineer and a Medical Officer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Iowa to investigate this incident. NIOSH investigators held an opening meeting with the fire chief, interviewed the two fire department probationary members traveling in the pickup truck (driver and front seat passenger), inspected the vehicle at the towing company's property, met with the Iowa State Patrol Troopers who completed the accident report and technical investigation, and spoke to the fire fighter's surgeon by telephone. In addition, NIOSH investigators reviewed the following documents:

- Iowa State Patrol crash report
- Iowa State Patrol technical report
- Fire department standard operating procedures
- Pickup truck maintenance records
- Medical Examiner's autopsy report

Fire Department and Equipment

The department involved in this incident is a paid-call volunteer fire department. The chief is a paid full-time position with 25 volunteer operational fire fighters. The department serves a residential population of 3,000 covering an area of 5 square miles with 15,000 - 18,000 daytime commuters and 7,000 - 9,000 nighttime commuters. In 2016, the fire department responded to 546 emergency calls, 60% being medical calls and 40% being fire calls. The department has 1 fire station which operates the pickup truck (Medic Truck #2) involved in this incident and the following 6 vehicles: 2 pumpers (1998 and 2007), 1 aerial truck (95 feet) (2011), 1 brush truck (2010), 1 heavy rescue (2011), and 1 super-crew pickup truck (medic truck #1)(2017).

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The vehicle involved in this incident (Medic Truck #2) was a 2004 heavy duty rear wheel drive pickup truck (see **Photo #1**). The truck was purchased new in 2004 under a Federal Emergency Management Agency (FEMA) grant and served as one of the fire department's medic trucks. The fire department ensured regular maintenance of the pickup truck every 3,000 to 5,000 miles by a local auto service garage. Its last maintenance occurred on February 25, 2016 which involved its regular oil change (45,172 miles), chassis lube, tire pressure check, and fluid levels check (brake, power steering, coolant, transmission, and battery). The truck was not equipped with an electronic stabilization control (ESC) system [NHTSA, 2007a].



Photo #1. Fire department pickup truck involved in fatal rollover crash.
(Photo courtesy of Iowa State Patrol)

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The Driver of the vehicle did not report any problems with the pickup truck operation during, or prior to, this incident. NIOSH investigators were unable to obtain an odometer reading at the time of this incident, but given its limited use over the past year, it was estimated to be less than 47,000 miles. While inspecting the vehicle at the towing company’s property, NIOSH investigators measured the tread depth of all four tires to be 9/32 of an inch (see **Photo #2**), suggesting the tire tread depth was not a contributing factor in this incident [Heaps 2016].



Photo #2. Front passenger side tire showing good tread depth (9/32”).
(Photo courtesy of Iowa State Patrol)

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The pickup truck had three-point safety belts for the Driver and front and rear seat passengers. A three-point safety belt is a Y shaped belt that is the combination of a lap belt and a sash (shoulder) belt. In a collision the 3-point belt spreads out the energy of the moving body over the chest, pelvis, and shoulders. At the towing company’s garage, NIOSH investigators noted the webbing of the front seat safety belts were extended (see **Photo #3**) strongly suggesting their use during the rollover; a finding confirmed by the “belt switch circuit status” contained in the pickup’s Event Data Recorder (commonly referred to as the vehicle’s “black box”).



Photo #3. Webbing of the Driver’s safety belt after the Driver exited the vehicle.
(Photo courtesy of Iowa State Patrol)

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In contrast, the webbing position of the rear passenger driver's side safety belt (see **Photo #4**) was undisturbed from the pillar loop.



Photo #4. Webbing position of the rear seat driver's side safety belt. Note the webbing's undisturbed position from the pillar loop.
(Photo courtesy of Iowa State Patrol)

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In addition the rear passenger's driver's side buckle was tucked under the seat (see **Photo #5**). Both photos (#4 and #5) suggest that the rear passenger safety belts were not used at any point during the drive. (**Note:** The Event Data Recorder does not monitor use of the rear safety belts.)



Photo #5. Rear seat driver's side safety belt buckle tucked under the seat.
(Photo courtesy of Iowa State Patrol)

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Training and Experience

The Driver was a 35 year-old female, who for the past 12 years, worked as a EMT-paramedic and ambulance driver for the local hospital. The Driver did not report a single crash or collision incident while driving the ambulance over her 12-year career. From 2004 to 2006, the Driver was a member of the volunteer fire department working as a fire fighter/EMT-paramedic. In April, 2016 she reapplied for membership. As required by Iowa law and fire service requirements, at the time of this incident the Driver was an active probationary fire fighter who was trained to the level of Fire Fighter I [National Fire Protection Association (NFPA) 1001 *Standard for Fire Fighter Professional Qualifications*], [NFPA 2013c]. She had also been trained to the *Operations Level* of the federal hazardous waste operations and emergency response standard [OSHA 2017], and received State certification as an EMT-paramedic. Fire department policy prohibits probationary fire fighters from driving fire department apparatus, however the Chief granted an exemption due to the Driver's experience driving the local hospital's ambulance for over 12 years without any driving violations, collisions, or crashes. The Driver had not taken any additional (e.g., Engine or Aerial apparatus) driver training since rejoining the fire department in April 2016.

The active probationary fire fighter/EMT sitting in the front seat was a 25 year-old male who, like the Driver, was trained to the level of Fire Fighter I [NFPA 1001 *Standard for Fire Fighter Professional Qualifications*], [NFPA 2013c]. He was also trained to the *Operations Level* of the of the federal hazardous waste operations and emergency response standard [OSHA 2017]. He was trained and certified in cardiopulmonary resuscitation (CPR) and had passed the EMT coursework with national EMT certification pending at the time of this incident. He had been with the department for 11 months.

The third fire fighter (victim) was sitting in the Driver's side rear seat. He was 52 year-old and had been a previous member of the fire department from 1998 to 2011 serving as a fire fighter I and II, and Driver/Operator. Recruited by the Chief, the fire fighter rejoined the department in November, 2016. He attended the State Fire School in December 2016 where he received national certification as Fire Fighter I and II [NFPA 1001 *Standard for Fire Fighter Professional Qualifications*], [NFPA 2013c]. He was also trained and certified to the *First Responder Awareness and First Responder Operations* level of the federal hazardous waste operations and emergency response standard [OSHA 2017]. He was trained and certified in CPR, awarded the "Rookie of the Year" by the State Fire School in 2016, and had emergency response duties.

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Timeline

- **1600 Hours**
Fire fighters gather at station to drive to State Fire School approximately 200 miles away. Weather conditions: temperature 40° Fahrenheit (F), overcast with a visibility of 10 miles, and winds of 8 miles per hour (mph). [Weather Underground 2017a]
- **1630 Hours**
Pickup truck departs city limits. Driver and front seat probationary fire fighter click into their safety belts. The Driver and probationary fire fighter sitting in the front seat could not recall if the fire fighter in the rear seat fastens his safety belt. Temperature 38°F, light mist falling, damp road surface, visibility 8 miles, with winds of 8 mph. Weather is forecasted to deteriorate into light to moderate snow with heavy winds.
- **1730 Hours**
Rain changes to wintry mix of snow and sleet. Roads are now wet, but not snow covered.
- **1750 Hours**
Sunset. Temperature 27°F, snowing with visibility down to 0.5 miles, winds of 18 mph.
- **1810 Hours**
Dark. Patchy snow on roadway. Temperature 26°F, light snow, winds 21 mph with gusts up to 28 mph [Weather Underground 2017b]. Pickup truck slides in a clockwise direction on the snow/ice. Pickup truck rolls as it leaves the gravel shoulder (see **Photo #6**). The driver's side rear seat side window is broken and the rear seat passenger is ejected from this shattered window.
- **1812-15 Hours**
CPR initiated by Driver of the pickup truck who is relieved by a nearby homeowner and the other front seat probationary fire fighter.
- **1815-20 Hours**
Ambulance arrives on scene and notes the lack of vital signs. CPR continues.
- **1824 Hours**
Fire fighter is pronounced dead and subsequently examined on-scene by the county medical examiner.

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Weather and Road Conditions

At the time of the motor vehicle crash, the pickup truck was traveling on a concrete 4-lane divided highway (two lanes in each direction) with a posted speed limit of 65 mph. The highway had a 2 part-shoulder: 12-18 inches of a paved surface, followed by 8 feet of sloping gravel, giving way to a grassy ditch/field (see **Photo #6**). The highway was dark with light snow falling. The road surface was concrete with a light cover of snow and ice on the roadway. The temperature was 26°F with winds of 21 mph and gusts up to 28 mph [Weather Underground 2017b].



Photo #6. Tire tracks of the pickup truck leaving the highway shoulder into a sloping ditch/field.
(NIOSH Photograph)

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Investigation

On February 24, 2017, a 52 year-old male fire fighter died after being ejected from a fire department pickup truck. The truck was transporting 3 fire fighters from a volunteer fire department to State Fire School training approximately 200 miles from their station. The fire fighters gathered at their station at 1600 hours, and started on the drive at approximately 1630 hours. Weather conditions at that time was a temperature of 38°F, light mist falling, damp road surface, visibility 8 miles, with winds of 8 mph. Weather was forecasted to deteriorate to light to moderate snow with heavy winds [Weather Underground 2017a].

The trio was traveling in a 2004 heavy duty club cab rear wheel drive pickup truck which served as one of the department's medic trucks. It had been properly maintained, had good tread on its tires, but was not equipped with an electronic stabilization control (ESC) system. Both the Driver and front seat passenger recall clicking into their safety belts, but could not recall if the fire fighter in the rear seat clicked into his safety belt. Neither the Driver or the front seat fire fighter could confirm that all passengers were belted-in prior to departure.

The fire fighter in the rear seat was two weeks removed from a right hernia repair via an open anterior approach under local anesthesia. The surgery was performed without any complications. The fire fighter was at the end of this post-operative restrictions of not lifting more than 20 pounds and was not on any anticoagulants (blood thinners). According to the surgeon who performed the operation, the fire fighter never asked about not using safety belts in vehicles during the post-operative period. However, if asked, the surgeon would have responded, "anyone traveling in a vehicle must always wear their safety belt" [Hales 2017]. Just prior to departing the fire department, the fire fighter told the Fire Chief that wearing a safety belt was uncomfortable due to his recent surgery. The fire fighter requested, and was granted, a waiver from the fire department safety belt policy by the Fire Chief.

At about 1730 hours the mist/rain changed to a wintery mix of snow and sleet making the roads wet, but not snow covered. At sunset (1750 hours), the driving conditions became more difficult. At about 1810 hours, the truck was proceeding up a slight grade when the truck hit a patch of snow and ice. The reported temperature was 26°F with winds of 21 mph and gusts up to 28 mph.

Loss of traction on the patch of snow and ice caused the back end of the truck to lose directional stability (yawing/rotating in a clockwise direction) (see **Diagram 1**). The truck slid off the paved shoulder and continued to slide off the 8 foot gravel shoulder (see **Photo #6**). Data from the Event Data Recorder was provided to NIOSH from the Iowa State Patrol. The Event Data Recorder reported that the pickup truck was traveling at 70 mph when it left the roadway (that section of the highway had a posted speed limit of 65 mph).

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As the vehicle slid off the gravel shoulder, the driver side tires (front and rear) continued to slide on the softer dirt surface sloping away from the roadway. After travelling about 10 feet on the dirt surface, the pickup truck was pitched into a lateral rollover in which the vehicle rotates around a longitudinal axis of the vehicle [El-Hennawy 2014] (see **Diagram 1**).

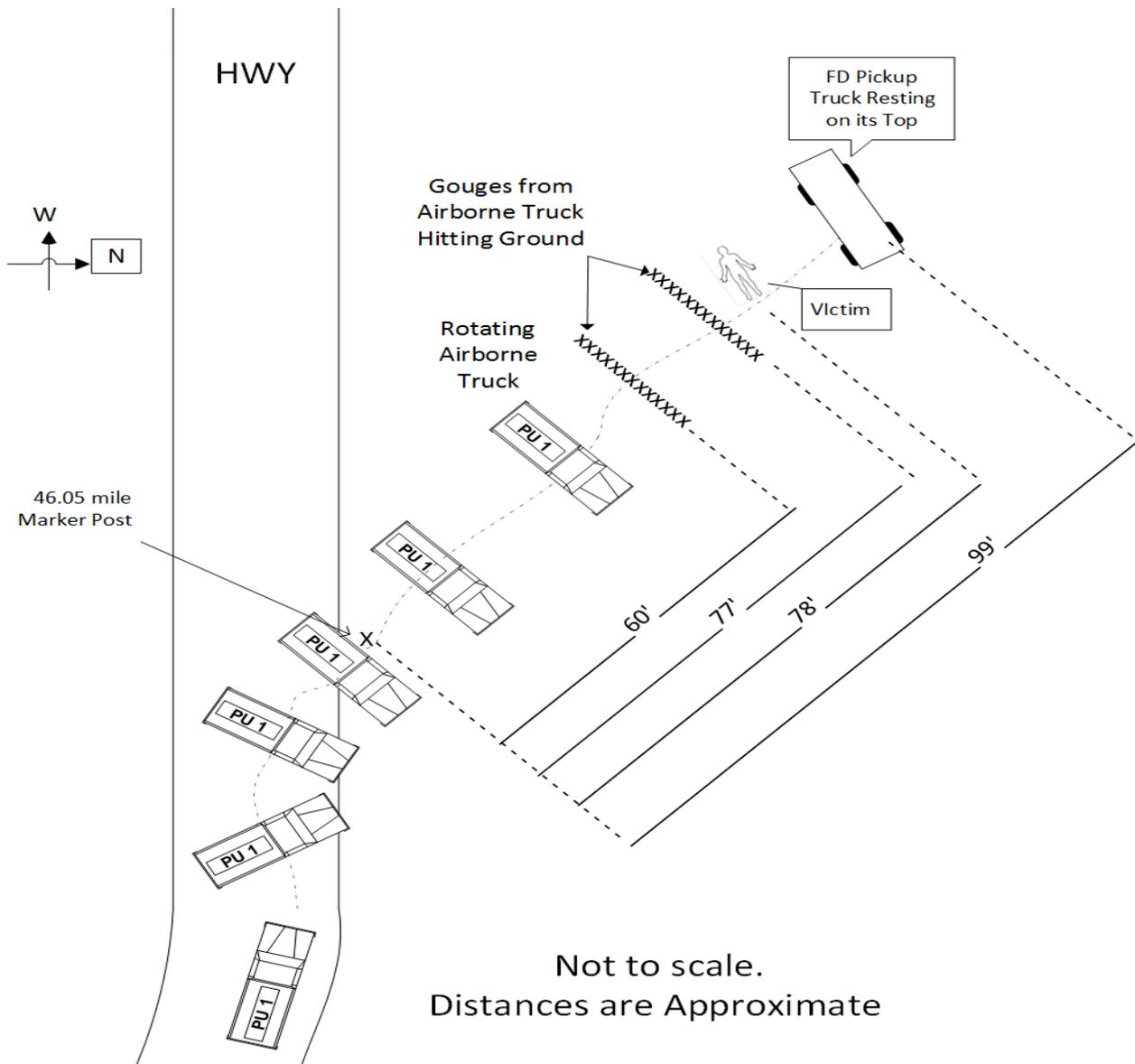


Diagram 1. Position of the Fire Department pickup truck during a longitudinal roll ejecting the fire fighter sitting in the rear seat.

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The truck rolled 2-3 times before coming to a stop on its roof approximately 100 feet from the where it left the roadway (see **Photo #7**). The front seat airbags did not deploy. During the roll, the driver's side rear seat side window shattered and the fire fighter sitting in the rear seat was ejected from this window. The ejected fire fighter was 21 feet from where the vehicle eventually stopped.



Photo #7. Final position of fire department pickup truck after fatal rollover crash.
(Photo courtesy of Iowa State Patrol)

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The Driver was stunned (possibly unconscious for a few moments), and then called out to the other fire fighters. The fire fighter in the front seat responded that he was ok, but there was no response from the rear seat. Both the Driver and the front seat fire fighter unbuckled their safety belts but were unable to open their doors due to damage from the crash. They crawled out through the shattered driver's side rear seat window and located the unresponsive ejected fire fighter. After noting agonal respirations and a weak, if any, peripheral pulse, they started CPR. Some travelers on the highway stopped and called 9-1-1. Hearing the crash, a nearby homeowner (who was a nurse) ran to the site and assisted with CPR. Approximately 10 minutes later the State Trooper arrived followed by the local ambulance company. The ambulance company took over patient management including CPR for the ejected fire fighter and treatment of the Driver for serious, but not life-threatening, traumatic injuries. The other front seat fire fighter sustained minor abrasions and refused on scene care. Despite continued CPR by emergency personnel, the fire fighter was pronounced dead at the scene due to head trauma at 1824 hours and later examined at the scene by the County Medical Examiner's Office.

The Driver, accompanied by the other front seat fire fighter, was transported to the local hospital's emergency department via ambulance. The Driver had X-rays taken (negative for fractures), was treated for significant bruising, and released that evening. In the emergency department, The Driver was given an breathalyzer test for alcohol which was negative ("0.000% blood alcohol concentration").

En route to the crash site, the responding Iowa State Patrol Officer reported several cars had spun out of control due to the snow and ice along the same stretch of highway. None of these other vehicles rolled or reported injuries. Shortly thereafter, the State Highway patrol closed this section of the highway due to the dangerous weather-related road conditions.

Finally, as mentioned previously, photographs taken by NIOSH and the Iowa State Patrol at the towing company's property suggest that the rear seat safety belt was not in use at the time of the crash/rollover, and that it was unlikely used during the entire trip (see **Photos #4 and #Photo #5**). Shortly after being informed of the loss, the Fire Chief provided access to professional counseling for the Driver, the passenger, and members of the entire department.

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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 ultimately led to the fatalities:

- *Waiver of the department safety belt policy due to a recent surgical procedure on the fire fighter sitting in the rear seat*
- *State safety belt law with a back seat exemption*
- *Rapidly deteriorating weather-related road conditions*
- *Traveling at a unsafe speed given the rapidly changing weather and road conditions*
- *Lack of an electronic stability control (ESC) system in the pickup truck*
- *Lack of highway pre-treatment by State/County road crews.*

Cause of Death

According to the autopsy report completed by the Office of the State Medical Examiner, the cause of death was “Blunt force craniocerebral [head] trauma” due to “Unrestrained passenger ejected following motor vehicle rollover crash.” No drugs or alcohol were detected.

Recommendations

Recommendation #1: Fire departments should ensure policies regarding safety belt use in department apparatus, or in personally owned vehicles (POV) traveling for fire department business, are followed and enforced.

Discussion: Safety belts dramatically reduce the risk of death and serious injury during motor vehicle crashes [CDC 2014a, Goodwin et al. 2015, Viano & Parenteau 2010]. Unfortunately, rear seat occupants are less likely to wear safety belts [Pickrell 2014], despite that “people are just as likely to be injured or killed in the back seat if they are not wearing seatbelts as they are in the front seat.” [NTSB Chairman Deborah Hersman aired June 24, 2015]. Among rear seat occupants, safety belt use can reduce the risk of crash death by 55-75 percent [Zhu et al. 2007].

The statistics for rollover incidents are even more alarming.

Rollover crashes have a higher fatality rate than other types of vehicle collisions [NHTSA 2010]

In a rollover incident, unbelted occupants are 30 times more likely to be ejected from the vehicle [CDC 2014a]

81% of completely ejected occupants are killed [NHTSA 2018].

Ejection is the most important injury and fatality risk in rollover crashes and safety belt use reduces the risk of ejection by 600 percent [Beck et al. 2014, El-Hennawy et al. 2014; Funk et al. 2012].

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From 1977 to 2006, 406 fire fighters died in the line of duty due to motor vehicle crashes. Seventy-six percent were known not to be wearing safety belts [Fahy et al. 2007]. Fire service organizations have recognized the importance of safety belt use by fire fighters and support the National Fire Service Seat Belt Pledge campaign which raises awareness of this issue [NFFF 2011]. A critical first step is the development of a department safety belt policy [NFPA 2018a, IAFC 2009]. Critical policy components include the following statements:

- 1) All persons riding in fire apparatus shall be seated and belted securely by safety belts in approved riding positions;
- 2) The driver shall not begin to move the vehicle until all passengers are seated and properly belted.
- 3) All passengers shall remain seated and belted as long as the vehicle is in motion.
- 4) Safety belts shall not be loosened or released while en route to dress or don equipment.

The fire department involved in this incident had an safety belt policy that stated, “Seat belts will be worn at all times when driving or riding in Fire Department vehicles” and “The driver will not move the vehicle until he/she has determined that everyone is wearing their seat belts.” Fire departments should raise awareness and enforce seat belt policies. Recommendation #5 lists potential educational and awareness opportunities.

Recommendation #2: Fire departments should prohibit waivers of department safety belt policies.

Discussion: Fire Chiefs should have the ability to waive some fire department policies, but not safety policies. As noted in the above recommendations, developing and enforcing safety belt policies has saved fire fighters lives [Fahy et al. 2007]. In this case, the fire fighter had a recent surgical procedure making the use of the safety belt uncomfortable. If this discomfort was enough to preclude the use of his safety belt, his training could have been rescheduled.

Recommendation #3: States should consider revising state safety belt policy to require all fire fighters traveling in fire department vehicles to use their safety belts.

Discussion: The state of Iowa has a primary safety belt law, but allows exemptions for passengers (not drivers) in emergency vehicles “during an emergency trip emergency response” [Iowa Code 2010]. This exemption is not consistent with the recommendations of the following fire service organizations:

- International Association of Fire Chiefs [IAFC 2009]
- International Association of Fire Fighters [USFA & IAFF 2006a]
- National Volunteer Fire Council [USFA 2006b, NVFC 2016]
- United States Fire Administration [Dickinson 2007, USFA 2014]
- National Fire Protection Association [NFPA 2016, 2017, 2018a, NFPA 2018b]
- National Fallen Firefighter Foundation [NFFF 2011]

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As stated in the discussion section of recommendation #1, safety belts save the lives of the public AND of fire fighters. The evidence is consistent, clear, and compelling. It should be noted, however, that the USFA and IAFC provides an exception for fire department members (or ambulance personnel) providing essential direct patient care inside an ambulance/medic unit. These members should be permitted to release momentarily the safety belt while the vehicle is in motion, but ONLY TO PROVIDE ESSENTIAL PATIENT CARE [IAFC 2009]. The NFPA does not allow this exemption, because many ambulances/medic units have been engineered to provide restraint systems (harnesses) for caregivers in the patient compartment [NFPA 2013a].

Recommendation #4: States should consider requiring rear safety belt use regardless of age.

Discussion: In this incident, the fire fighter riding in the rear seat was not wearing a safety belt. “People are just as likely to be injured or killed in the back seat if they are not wearing seatbelts as they are in the front seat.” [NTSB Chairman Deborah Hersman aired June 24, 2015]. Primary safety belt laws (police officers can stop and ticket someone for not buckling up) increase the percentage of passengers using safety belts by about 10% compared to secondary safety belt laws (police officers can only write tickets if they have pulled the driver over for another reason). However, these laws are most effective when they cover occupants in all seats of the vehicle [CDC 2015, Grant et al. 2015]. Evidence suggests that primary enforcement covering all seating positions (front and rear) is an effective intervention that can be employed to increase safety belt use and in turn prevent motor vehicle injuries to rear-seated occupants [Blat et al. 2015; Grant et al. 2015]. In 2018, 29 states and the District of Columbia required rear safety belt use [IIHS 2018]. The remaining 21 states, including Iowa, should consider enacting rear seat belt laws for all passengers.

Recommendation #5: Fire departments should provide initial and periodic refresher training to all drivers on each vehicle they may be called upon to operate.

Discussion: This incident involved a single vehicle, referred to as a “run-off-road” (ROR) crash. ROR crashes account for a significant percentage (about 70 percent) of all fatal single-vehicle crashes [NHTSA 2009]. Risk factors for fatal single-vehicle ROR crashes include young drivers, sleepy drivers, alcohol use, roadway curve, vehicle speed, passenger car, rural roadway, high-speed-limit [>60 mph] road, crash avoidance, and adverse weather [NHTSA 2009]. A number of these risk factors were present in this incident.

Motor vehicle crashes used to be the second most common type of fire fighter line of duty death, but significant progress has been made in reducing the number of fire fighter fatalities due to motor vehicle crashes [Fahy et al. 2007; USFA 2016]. From 2006 to 2015, there has been a 78 percent decline in fire fighter on-duty deaths due to vehicle collisions/crashes: 65 percent decrease for apparatus, 87 percent decrease for privately owned vehicles, and 90 percent decrease for aircraft [USFA 2016]. Reduction in the number of EMERGENCY response crashes/collisions has been responsible for most of the progress [Fahy et al. 2016]. This crash occurred during NON-emergency travel. Unfortunately, one or two on-duty collision/crash deaths still occur each year during NON-emergency activities [Fahy et al. 2016]. This incident is a reminder that safe driving practices are important during emergency AND NON-emergency responses.

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The programs responsible for the 2006-2015 reduction in fire fighter fatalities due to motor vehicle crashes were developed by multiple fire service organizations including:

- International Association of Fire Chiefs [IAFC 2009]
- International Association of Fire Fighters [USFA and IAFF 2006a]
- National Volunteer Fire Council [USFA and NVFC 2006b, NVFC 2016]
- United States Fire Administration [Dickinson 2007, USFA 2014]
- National Fire Protection Association [NFPA 2016, 2017, 2018a, NFPA 2018b]
- National Fallen Firefighter Foundation [NFFF 2011]

These programs help fire departments with policies and procedures for vehicle safety, safety belt use, and driver training. This volunteer fire department had a policy and procedure in place for vehicle maintenance, vehicle safety, driver training, and safety belt use. Additional training could focus on driving skills and decision-making when travelling during adverse road and weather conditions.

Despite this fire department's efforts to educate its members about vehicle safety, this incident shows that more work needs to be done. The minimum requirements for a fire service vehicle operations training program are contained in NFPA 1451 Standard for a Fire and Emergency Services Vehicle Operations Training Program [NFPA 2013b]. Additional opportunities to proactively discuss this topic could occur during:

- Safety Stand-Downs
- Company trainings
- Department meetings
- Daily or weekly apparatus checks (preventive maintenance)
- Weekly or monthly training sessions
- Family events
- Awards ceremonies
- Officer installations
- Current events or news articles
- Emergency Responder Safety Institute (www.respondersafety.com)

Recommendation #6: Fire departments should ensure fire department vehicles are equipped with electronic stability control (ESC) systems, if available.

Discussion: Many motor vehicle crashes occur when the driver loses control of the vehicle due to loss of traction [NHTSA 2007]. The reasons for loss of traction include high-speed maneuvers and slippery road conditions. ESC was designed to help drivers maintain vehicle control when loss of traction occurs. ESC systems “use automatic computer controlled braking of individual wheels to assist the

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driver in maintaining control in critical driving situations in which the vehicle is beginning to lose directional stability at the rear wheels (spin out) or directional control at the front wheels (plow out)” [NHTSA 2007].

Numerous studies have confirmed that ESC are highly effective in helping the driver maintain control of vehicles, thereby reducing the number and severity of crashes and saving lives [Ferguson 2007; Lyckegaard et al. 2015, Pai 2017]. This is particular true for single-vehicle crashes in vehicles with a high center of gravity that are prone to rollover (e.g., sport utility vehicles, vans, and pickup trucks) [MacLennan et al. 2008]. By model year 2007, ESC was standard equipment in 87% of sport utility vehicles, 58% of passenger cars, but only of 8% of pickup trucks [MacLennan et al. 2008].

The pickup truck involved in this incident was not equipped with an ESC system. ESC became optional for this truck model in 2009 and standard in 2011 [IHHS 2017]. It is unclear if the ESC system, by itself, could have prevented this rollover crash given the slippery road conditions; however, the ESC could have provided some extra stability, possibly preventing the loss of traction and preventing the crash [Padmanaban et al. 2008, Pai 2017].

Tire type and tread are also important for vehicle control in snow and ice conditions. Snow tires are designed with a deeper tread to cut through snow and reach the road surface. In addition, the rubber that makes up that tread is chemically formulated to be softer allowing it to grab the asphalt or concrete more efficiently in cold weather [Baruth 2015]. Tire tread is also important for traction in the snow. Most winter tires have wear bars at 6/32nd of an inch, rather than the typical 2/32th of an inch [Demere 2014]. In this case, all 4 tires of the pickup truck had adequate tread (9/32”) and the tires were not considered a contributing factor in this incident by NIOSH investigators.

Recommendation #7: Local roadway crews should consider notifying fire departments with roadway treatment plans before, and during, hazardous weather.

Discussion: In this incident, the highway was not pre-treated with a brine solution, salt, or sand. The NIOSH investigators realize that local fire departments do not determine which, or when, roadways will be treated. However, given their emergency response mission and need to travel on roadways during adverse weather conditions, roadway crews should notify first responders (e.g., fire and police departments) of their treatment plans and the hazardous conditions they encounter on roadways. This could be accomplished through the local dispatch system.

One type of roadway treatment is salt brine solution. Salt brine (water saturated with sodium chloride) solution sticks to a dry roadway before an ice or snow storm hits [Iowa DOT 2016]. Pre-treating the roadway up to 72 hours in advance of a storm allows road crews to provide greater roadway coverage. Some of the advantages of pre-treating with a salt brine solution over salt or sand 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

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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 forecasted conditions

Anti-icing returns road surfaces to safer conditions faster

Increased efficiency results in less salt being used which is beneficial for the environment.

NIOSH investigators acknowledge it is unlikely this recommendation would have prevented the death of this fire fighter because the crash occurred over 100 miles away from the fire fighters' jurisdiction. Therefore, even if road crews began notifying local fire departments of adverse road conditions, it is unlikely these fire fighters would have been included in that notification. On the other hand, this recommendation is appropriate for other fire departments where adverse road conditions (i.e., snow and ice) could impact their emergency response mission.

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Investigator Information

This incident was investigated by Thomas Hales, MD, MPH, Medical Officer and Matt Bowyer, General Engineer, both with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, West Virginia. An expert technical review was provided by Kevin Roche, Assistant to the Fire Chief (retired). A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

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