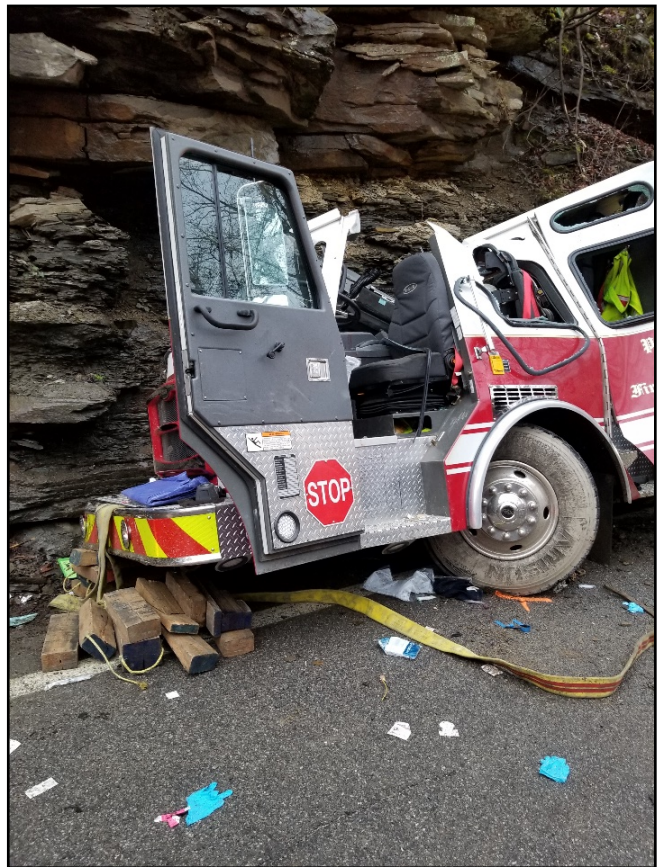




Two Fire Fighters Die and Three Fire Fighters Injured in a Fire Apparatus Crash—West Virginia

Executive Summary

On March 24, 2018, a pumper, Rescue 111 from county Fire Station 11 crashed while enroute to a report of an accident with injuries on an interstate. A 46-year-old assistant chief and a 40-year-old lieutenant died when the pumper struck a rock outcrop that paralleled the roadway. The 46-year-old fire chief (the fire apparatus operator), a 59-year-old fire fighter and a 17-year old junior fire fighter were injured. Fire Station 11 was dispatched by the county 9-1-1 center (Metro911) at 1733 hours for an accident with injuries on an interstate. At approximately 1741 hours, Metro911 received notification of a fire truck rollover. At 1742 hours, this information was updated that “a fire truck had crashed into a rock wall.” County Medic 147, who was responding behind Rescue 111 arrived on scene at 1743. Another pumper, Engine 113, from Fire Station 11 was responding and arrived on scene at approximately 1744 hours. The fire apparatus operator of Engine 113 and the county medics immediately started to assess the patients of Rescue 111. One fire fighter (lieutenant) was found deceased on the ground at the tailboard of Rescue 111 near the shoulder of the roadway. County Medic 147 advised the county dispatcher at 1747 hours there was one fire fighter fatality and two fire fighter injuries. The fire apparatus operator of Rescue 111 was unresponsive. At 1751 hours, this information was updated to another injured fire fighter was trapped between the pumper and a rock outcrop that paralleled the roadway. County Fire Station 12 Engine 122 arrived on scene at 1752 hours. They assisted with patient care and removing the two injured fire fighters from Rescue 111. County EMS personnel and a fire fighter from Engine 122 removed the fire apparatus operator from the pumper and placed him on a stretcher for transport in Medic 147. The junior fire fighter was standing on the engine cowling of Rescue 111 and was removed via an attic ladder. He was



The fire department pumper after the rescue of the three injured fire fighters. The damage to the pumper was done by the rock outcrop.
(Photo courtesy of the West Virginia State Police.)

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moved to Medic 64 for transport with minor injuries to the local trauma center. The fire fighter (left jumpseat) was trapped between the pumper and the rock outcrop. He was given advanced life support (ALS) care during the extrication process. Fire fighters were able to crawl through the cab of Rescue 111 and gain access to the fire fighter. An extrication tool was used to move the pumper approximately 3 – 4 inches away from the rock outcrop and allowed the injured fire fighter to be lowered onto a backboard and removed. He was then transported in Medic 141 to the local trauma center. The extrication process was completed by 1829 hours. During the extrication process, fire department members from county Fire Station 11 located the assistant chief, who was deceased. He was located on the right side of the pumper in the ditch line between the rock outcrop and Rescue 111. The assistant chief and lieutenant were pronounced deceased at 1902 hours.

Contributing Factors

- *Failure to wear seat belts*
- *Distraction of the fire apparatus operator*
- *Speed of the apparatus*
- *Road conditions – wet roadway*
- *Limited space between the roadway, roadway shoulder, and the rock outcrop*

Key Recommendations

- *Fire departments should require a written standard operating procedure (SOP) for the use of seat belts is implemented and enforced while riding on any fire department apparatus or vehicle*
- *Fire departments should ensure the vehicle operations training program includes topics such as road design, road conditions, and driving during inclement weather*
- *Fire departments should ensure that fire apparatus operators are trained in techniques for maintaining control of their apparatus at all times*
- *Fire departments should ensure all members that operate fire apparatus meet the requirements set forth in NFPA 1002, Standard for Fire Apparatus Driver/Operator Professional Qualifications.*

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 March 24, 2018, a 46-year-old male assistant chief and a 40-year old lieutenant died when the pumper they were riding in crashed into a rock outcrop that bordered a county roadway. *Note: A rock outcrop is defined as the part of a rock formation that appears above the surface of the surrounding land [Vocabulary.com].* Three other fire fighters were injured in the crash. On March 26, 2018, the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On May 13 – 18, 2018, one investigator from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to West Virginia to investigate this incident. The NIOSH investigator met with representatives from the deceased fire fighters’ fire department, mutual aid fire departments that responded to this incident, the county EMS agency, West Virginia State Police, the State Fire Marshal’s Office, the apparatus manufacturer, and the state’s two fire service training agencies. During the investigation, witness statements were reviewed and interviews were conducted with the fire fighters, fire officers, EMS personnel, and troopers from the West Virginia State Police involved in the incident. The NIOSH investigator also reviewed the training requirements for fire fighters in the state of West Virginia. The incident scene was visited and photographed, the investigator reviewed incident scene photographs, dispatch and fireground radio communications, and area maps. The investigator returned on June 21, 2019 to meet with the West Virginia State Police regarding the crash reconstruction report. The investigator returned on September 7 – 9, 2019 to complete fire department interviews and met with the West Virginia State Police.

Fire Department

The volunteer fire department, county Fire Station 11, consisted of 17 members at the time of this incident. Fire Station 11 operates two pumpers and one pick-up (utility vehicle). Their 1st due response area is 50 square miles. The department responded to 200 calls in 2017 and they serve a population of 1,500.

The fire chief had been a member of the Fire Station 11 from 1993 to 2003. He left to become a member at Fire Station 12 from 2003 to 2005. He returned to Fire Station 11 in 2005. He had been chief of the department since 2008.

The assistant chief joined Fire Station 11 in 1987 as a junior fire fighter. He moved out of the area and rejoined the department in 2006. He was appointed as assistant chief in 2008.

The lieutenant had been a member of Fire Station 11 since 2002. He was appointed as lieutenant in 2015.

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The fire fighter has been a member of Fire Station 11 since 1987.

The junior fire fighter had been a member of Fire Station 11 since 2016 and has now become a fire fighter with the department.

Training and Experience

The West Virginia State Fire Commission mandates that all fire fighters in the state of West Virginia be certified to NFPA 1001, *Standard on Fire Fighter Professional Qualifications, Fire Fighter I*. Fire fighters also have to be certified in Hazardous Materials Awareness, Hazardous Materials Operations, CPR, and Basic First Aid (120 hours).

The state also mandates that all fire officers be certified to NFPA 1021, *Fire Officer Professional Qualifications, Fire Officer I*. All fire chiefs and other chief officers must be certified to NFPA 1021, *Fire Officer Professional Qualifications, Fire Officer II*.

The fire department has the same training requirements as required by the West Virginia State Fire Commission.

The fire chief had the following training and certifications: WVU Fire Service Extension Fire Fighter Level I and Fire Fighter Level II; Hazardous Materials Awareness; Hazardous Materials Operations; West Virginia of Emergency Medical Services, *Emergency Medical Technician*; CPR; NFPA 1021, *Standard on Profession Qualifications for Fire Officer I* (ProBoard); West Virginia State Fire Commission Certificate of Equivalency – *Fire Officer II*; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*; IS-00700, – *National Incident Management System*; IS 00706 – NIMS Intrastate Mutual Aid and Introduction; IS-00800.B – *An Introduction to the National Response Framework*; VFIS *Emergency Vehicle Operations Classroom and Competency Course*; Water Sources and Hydrants; Basic Auto Extrication; Incident Safety Officer; Incident Command System; National Fire Academy *Managing Company Tactical Operations – Preparation, Tactics, and Decision Making*; Railroad Emergencies; Leadership 2; Leadership 3; Natural Gas Emergencies; Advanced Structural Firefighting; Bomb Threat Management; Weapons of Mass Destruction; Swift Water Awareness; Thermal Imaging; Arson Detection for First Responders; Arson 2; and Traffic Incident Management.

The assistant chief had the following training and certifications: WVU Fire Service Extension *Fire Fighter Level I and Fire Fighter Level II*; Basic First Aid and CPR; WV Department of Education *Hazardous Materials Awareness and Hazardous Materials Operations*; WV Department of Education, *Fire Officer I*; West Virginia State Fire Commission Certificate of Equivalency – *Fire Officer II*; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*; IS-00700, – *National Incident Management System*; IS-00800.B – *An Introduction to the National Response Framework*; Basic Wildfire Suppression and Safety; Arson Detection for First Responders; Arson 2; Thermal Imaging; Basic Auto Extrication;

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VFIS *Emergency Vehicle Driver Training – Participant Level*; Incident Safety Officer; Infectious Disease Control; and Vehicle Fires.

The lieutenant had the following training and certifications: WVU Fire Service Extension *Fire Fighter I*, WV Department of Education, Public Service Training *Fire Fighter II*; WV Department of Education Public Service Training Hazardous Materials Awareness and Operations; Basic First Aid and CPR; West Virginia State Fire Commission Certificate of Equivalency – *Fire Officer I and Fire Officer II*; IS-00200.a – *Basic ICS*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*; IS-00700, – *National Incident Management System*; IS 00706 – NIMS Intrastate Mutual Aid and Introduction; IS-00800.B – *An Introduction to the National Response Framework*; VFIS *Emergency Vehicle Driver Training – Participant Level*; Swift Water Awareness and Swift Water Operations; Thermal Imaging; Arson Detection of First Responders; Arson 2; Hazardous Materials Decontamination; Incident Safety Officer; Auto Extrication Awareness and Operations; Basic Wildfire Suppression and Safety; Traffic Incident Management.

The fire fighter had the following training and certifications: WVU Fire Service Extension *Fire Fighter Level I, Fire Fighter Level II, and Fire Fighter Level III*; National Registry of Emergency Medical Technicians *Emergency Medical Technician – Basic*; CPR; WV Department of Education Public Service Training Hazardous Materials Awareness and Operations; West Virginia State Fire Commission Certificate of Equivalency – *Fire Officer I and Fire Officer II*; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*; IS-00700, – *National Incident Management System*; IS-00800.B – *An Introduction to the National Response Framework*; VFIS *Emergency Vehicle Driver Training – Participant Level*; Emergency Vehicle Driving; Basic Auto Extrication; Thermal Imaging; the Incident Command System; National Fire Academy, *Leadership I – Strategies for Company Success*; WV Department of Education – *Leadership III*; Fire/Arson Detection; Arson Detection of First Responders; National Fire Academy *Managing Company Tactical Operations – Preparation, Decision Making*; Incident Safety Officer; Rural Water Supply; Emergency Scene Management and Operations; and Traffic Control Management.

The junior fire fighter had the following training and certifications: NFPA 1001, *Standard of Professional Qualifications for Fire Fighter*, Fire Fighter I and Fire Fighter II; Basic First Aid and CPR; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness and Hazardous Materials Operations; NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications*, Rescue Core Prerequisites; and VFIS *Emergency Vehicle Driver Training – Participant Level*.

Equipment and Personnel

On March 24, county Fire Station 11 was dispatched to an accident with injuries northbound on an interstate. Rescue 111 responded with five fire fighters, which included the fire chief (fire apparatus operator), assistant fire chief, lieutenant, a fire fighter, and a junior fire fighter. County Fire Station 13 was dispatched to respond southbound on the interstate to this incident.

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Apparatus

The apparatus involved in this incident was a 2004 Typhoon pumper built to conform to the requirements of the 1999 edition of NPFA 1901, *Standard on Automotive Fire Apparatus*. The pumper had a 1250 gallon pump, a 760 gallon booster tank, and 20 gallons of Class B foam. The pumper had a gross vehicle weight rating (GVWR) of 42,000 lbs., 2 axles, was 32-feet, 8-inches in length, 8-feet wide, and had a 210-inch wheelbase. The apparatus was designed with a top-mounted pump panel and open walkway (See **Photo 1**).



**Photo 1. Rescue 111 in quarters. Rescue 111 was a 2004 custom built pumper.
(Photo courtesy of the fire department.)**

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The cab consisted of 2 front seats separated by the engine cowling. The rear seats consisted of two jumpseats – one behind each of the front seats. Also, in the rear was a bench seat facing forward with seating for three fire fighters. Each seat was equipped with a shoulder and lap belt (4-point harness) (See Photos 2, 3, and 4).



Photo 2. The layout of the front seating of Rescue 111. *Note: This photo was taken of a cab of a similar 2004 Typhoon pumper.*
(NIOSH Photo.)

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Photo 3. The layout of the jumpseats of Rescue 111 from the passenger side of the apparatus. *Note: This photo was taken of a cab of a similar 2004 Typhoon pumper. (NIOSH Photo.)*

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Photo 4. The layout of the jumpseats of Rescue 111 from the driver's side of the apparatus. *Note: This photo was taken of a cab of a similar 2004 Typhoon pumper. (NIOSH Photo.)*

Rescue 111 had a state inspection completed in November 2017.

Timeline

The following timeline is a summary of events that occurred as the incident evolved. Not all incident events are included in this timeline. The times are approximate and were obtained by studying the dispatch records, audio recordings, witness statements, and other available information. All times are approximate and rounded to the closest minute.

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Dispatch Communications & Fire Department Response	Time	Incident Communications & Incident Operations
March 24, 2018		
County 9-1-1 Center (Metro911) received a 9-1-1 call which reported an accident with injuries (AWI) on an interstate highway, northbound involving 3 vehicles.	17:31:15 Hours	
Metro911 dispatched county Fire Station 11, county Fire Station 13 and county Medic 120 to the AWI in the northbound lanes on an interstate highway.	17:32:34 Hours	
Rescue 111 from county Fire Station 11 was enroute to the AWI on the interstate.	17:34:46 Hours	Rescue 111 staffed with 5 members.
Rescue 133 from county Fire Station 13 was enroute with to the AWI on the interstate highway.	17:36:06 Hours	
County Medic 147 enroute to the AWI on the interstate highway.	17:37:08 Hours	
Engine 113 from county Fire Station 11 was enroute to the AWI on the interstate highway with two members.	17:38:40 Hours	
	1739 Hours	Rescue 111 struck a rock outcrop along a county roadway, which parallels the roadway.

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Dispatch Communications & Fire Department Response	Time	Incident Communications & Incident Operations
Metro911 received 9-1-1 calls which reported two emergency vehicles wrecked on a county roadway.	17:40:31 Hours	The mayor of the town where county Fire Station 11 is located arrived on scene of the fire engine crash.
Case updated by Metro911 to a fire truck rollover.	17:41:08 Hours	
Metro911 case notes updated to “a fire truck crashed into a rock wall”. County Medic Supervisor 511 was enroute to fire truck crash.	17:42:30 Hours	
County Medic 147 arrived on scene.	17:43:54 Hours	The two paramedics from Medic 147 conducted a scene and patient assessment.
Engine 113 arrived on-scene. The driver of E113 called Metro911 and requested county Fire Station 12 respond, which is the next due company to this location.	17:44:23 Hours	The driver of Engine 113, a captain, found the lieutenant from Rescue 111, deceased behind the right bumper of the pumper. He covered the lieutenant with a tarp.
Engine 122 from county Fire Station 12 was enroute to the fire engine crash with 3 members.	17:45:05 Hours	
County Medic 147 advised Metro911 of one fire fighter fatality and two injured fire fighters.	17:47:54 Hours	
County Medic Supervisor 511 arrived on scene at the fire truck crash.	1748 Hours	The paramedics initiated patient care on the fire apparatus operator of Rescue 111. The fire apparatus operator of Engine 113, accounted for 4 of the 5 members riding on Rescue 111.

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Dispatch Communications & Fire Department Response	Time	Incident Communications & Incident Operations
Rescue 126 from county Fire Station 12 responding to the fire engine crash.	1750 Hours	The fire apparatus operator of Engine 113 found the fire fighter from the left jumpseat of Rescue 111 unconscious and pinned between the pumper and the rock outcrop. The junior fire fighter was still standing on the engine cowling of Rescue 111 asking for help.
Engine 102, Rescue 105, and Utility 107 dispatched from county Fire Station 10.	17:51:21 Hours	
Engine 122 arrived arrived on scene.	1752 Hours	
County Medic 131 was dispatched and responding to the fire engine crash.	17:53:12 Hours	
The deputy chief from county Fire Station 11 was enroute to the fire engine crash in Utility 112.	17:54:02 Hours	
	1757 Hours	The fire apparatus operator of the Rescue 111 was removed from Rescue 111 and moved to Medic 147 for transport.
Squad 126 arrived on scene.	17:58:37 Hours	

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Dispatch Communications & Fire Department Response	Time	Incident Communications & Incident Operations
The deputy chief from county Fire Station 11 arrived on scene and assumed Command.	1759 Hours	Engine 122 removed the junior fire fighter from Rescue 111 by a ground ladder. The junior fire fighter was moved to Medic 64 for treatment and transport.
	1801 Hours	The rescue process was being continued to remove the fire fighter pinned between Rescue 111 and the rock outcrop.
Medic 147 was enroute to the local trauma center with the driver of Rescue 111.	18:02:38 Hours	
Engine 102, Rescue 105, and Utility 107 on scene.	1810 Hours	
Medic 64 was enroute to the trauma center with the junior fire fighter.	18:16:42 Hours	
	1817 Hours	The extrication was completed on the trapped fire fighter. He was moved to Medic 141 for treatment and transport.
Command advised Metro911 that the assistant fire chief has been located and was deceased.	18:17:09 Hours	
Medic 141 was enroute to the trauma center with the left jumpseat fire fighter	18:19:52 Hours	
	18:29:33 Hours	Extrication process was completed.

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Dispatch Communications & Fire Department Response	Time	Incident Communications & Incident Operations
	1902 Hours	The assistant chief and lieutenant are pronounced deceased. The operations moved from rescue to recovery. All incident operations are stopped per the state police.
	1910 Hours	Command was transferred from the deputy chief from county Fire Station 11 to the Assistant Fire Chief from county Fire Station 10.
	2200 Hours	The recovery process was started for the assistant fire chief and lieutenant.
	2250 hours	The recovery process was completed. The assistant chief and lieutenant are moved to Medic 66 for transport to the Office of the State Medical Examiner.
Medic 66 enroute to the Office of the State Medical Examiner.	22:53:49 Hours	
Medic 66 arrived at the Office of the State Medical Examiner.	23:46:37 Hours	
March 25, 2018		
Command is dissolved and all units are clear and available.	02:38:11 Hours	

Personal Protective Equipment

The assistant chief, lieutenant, and junior fire fighter were wearing turnout gear. The fire chief (fire apparatus operator) and the fire fighter in the left jumpseat were not wearing turnout gear. The turnout gear was not a contributing factor in the two fire fighter fatalities or the three fire fighter injuries.

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Weather and Road Conditions

At 1730 hours on March 24, 2018, the following weather conditions were reported. The temperature was 38 degrees Fahrenheit (38°F), the dew point was 31 degrees Fahrenheit (31°F), the relative humidity was 76%, and the winds were calm. The sky was cloudy with 10 miles visibility. Snow had been falling with little or no accumulation. The roadways were wet [Weather Underground 2018] (See **Photo 5**).



Photo 5. The crash scene. Rescue 111 struck the rock outcrop in the foreground and continued along the ditch line for approximately 300+ feet. County Medic 147 and E113 are on scene. The time is approximately 1745 hours.

(Photograph courtesy of the West Virginia State Police.)

Investigation

On March 24, 2018 at approximately 1630 hours, 5 members of county Fire Station 11 were discussing the purchase of a new brush truck with an apparatus manufacturer at the fire station. The members included the fire chief, an assistant chief, a lieutenant, a fire fighter and a junior fire fighter. As the meeting was being concluded, the members heard the West Virginia State Police dispatched to an accident with injuries northbound on an interstate highway located in the eastern section of the county.

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All five fire fighters responded on Rescue 111. Rescue 111 responded to the interstate on a county roadway in order to get to the nearest onramp of the interstate northbound. The fire fighter assigned to the left jumpseat of Rescue 111 was going to respond in Engine 113, but the fire chief told him to ride on Rescue 111. The fire fighter got his turnout gear bag out of his car and got on Rescue 111, riding in the left jumpseat. The fire chief was the fire apparatus operator, the assistant chief was in the right front seat, the lieutenant was in the right jumpseat, and the junior fire fighter was riding on the bench seat in the middle riding position. The assistant chief, lieutenant, and junior fire fighter were wearing turnout gear. Approximately one mile from where Rescue 111 crashed, the fire fighter in the left jumpseat unbuckled his seatbelt, stood up to put on his turnout pants, and then sat back down. He did not put his seat belt back on at this point. The junior fire fighter was the only fire fighter riding on Rescue 111 that was wearing a seat belt when the crash occurred.

County Fire Station 13 was dispatched to the interstate for the accident with injuries. Units from county Fire Station 13 responded southbound on the interstate. Once Metro911 advised the crash was in the northbound lanes, Units from Fire Station 13 would have to respond to the same exit that Rescue 111 was responding to in order to access the northbound lanes.

As Rescue 111 was responding, the fire chief contacted the West Virginia Turnpike Commission via the apparatus's mobile radio regarding the exact location of the crash. Also, the fire chief was talking on the fire department radio to the county dispatch center (Metro911). Rescue 134 approached the crash responding southbound on the interstate highway. Rescue 134 advised Metro911 that there were 3 vehicles involved in the crash. One vehicle was off the road. A passenger vehicle was underneath a box truck. The occupants in both vehicles were trapped. The fire fighter in the left jumpseat and the junior fire fighter both stated when this information was announced on the radio, the fire chief accelerated Rescue 111. The left jumpseat fire fighter said the engine was having a rough ride, but didn't see or notice anything unusual. He braced himself in the jumpseat, but did not put on his seat belt. The speed limit for the county two lane roadway was 45 miles per hour. The speed of Rescue 111 at the time was approximately 45 miles per hour according to the junior fire fighter and the fire fighter in the left jumpseat. The fire chief accelerated the apparatus to 55+ miles per hour. It was at this time, the fire chief started having difficulty controlling Rescue 111 due to the roadway being wet from earlier precipitation as well as the contour of the roadway.

As Rescue 111 traveled southbound, the right rear tires of R111 went off the road onto the dirt shoulder and struck a rock outcrop. The fire chief got the pumper back on the roadway, but the pumper was fishtailing. Approximately 10 – 20 seconds later, the pumper went off the roadway, on the right shoulder, and was scrapping along the rock outcrop. The right side of Rescue 111 scraped along the rock outcrop for approximately 300 feet before coming to a stop. The time was approximately 1738 hours.

As the fire chief struggled with control of Rescue 111, the junior fire fighter stated that he closed his eyes. When he opened his eyes, Rescue 111 had stopped. No one was in the cab of the Rescue 111 except himself and the fire chief. The roof of the cab was peeled back. The junior fire fighter stated he

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got out of his seatbelt and stood up on the engine cowling, as there was no visible means to get out of or off of Rescue 111. The assistant fire chief was pulled out of the cab by the force of the Rescue 111 striking and running along the rock outcrop. He was pulled along the rock outcrop between the pumper. He died on impact. The assistant fire chief was located in the ditch line near the rear of the pumper. The lieutenant was pulled out of the right jumpseat and pulled along the rock outcrop. He also died on impact. When the pumper came to a stop, he was behind Rescue 111 on the roadway.

As the apparatus was scraping along the rock outcrop, the fire fighter in the left jumpseat was ejected out of the cab landing between Rescue 111 and the rock outcrop. This was the position he was found in by members of the department when they arrived on scene after the crash. He was pinned between the front bumper of Rescue 111 and the rock outcrop. The fire fighter was approximately 18 – 20 inches off the ground. When rescuers arrived, the fire chief was unconscious and sitting in the driver's seat.

County Medic 147 was assigned to a medical transport call. Medic 147 was removed from this case and assigned the accident with injuries on the interstate highway. Medic 147 was responding on a state highway when they saw Rescue 111 responding. Medic 147 turned around and followed Rescue 111. The time was approximately 1737 hours. They were approximately 20 – 30 seconds behind Rescue 111. Medic 147 was ahead of Engine 113. Medic 147 arrived at the crash site and notified Metro911 at approximately 1744 hours. The two paramedics started their scene assessment. They found the lieutenant, who was deceased and advised Metro911. Then, the two paramedics started patient care on the fire apparatus operator of Rescue 111 (fire chief).

Engine 113 arrived on scene and requested county Fire Station 12 respond to the crash. The fire apparatus operator of Engine 113 was a captain. He located the lieutenant behind Rescue 111. The captain had to sit down on the bumper of Rescue 111 for a moment to compose himself. The captain got up and accounted for the fire fighters on Rescue 111. The junior fire fighter was standing on the engine cowling. The junior fire fighter could not get out of Rescue 111 due to the amount of damage to the apparatus, his arm was injured, and he was in shock. Medic 147 was conducting patient care on the fire apparatus operator of Rescue 111, who was still in the driver's seat. The captain found the fire fighter from the left jumpseat trapped between the pumper and the rock outcrop. He was unconscious and angled head down. He was approximately 18 – 20 inches off the ground. At this point, the captain had accounted for the fire apparatus operator, the lieutenant, the fire fighter, and the junior fire fighter of Rescue 111. The time was approximately 1751 hours (**See Photo 6**).

The deputy chief from the county Fire Station 11 arrived on scene at approximately 1759 hours and assumed Command of the incident. The fire apparatus operator of Rescue 111 had been removed from the cab and moved to Medic 147 and prepared for transport to the hospital. Engine 122 was on scene and in the process of removing the junior fire fighter from Rescue 111. The fire fighters from Engine 122 removed the junior fire fighter from the cab via a ground ladder. The junior fire fighter was moved to Medic 64 for treatment and transport.

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Photo 6. This photograph was taken after the extrication of the fire fighter that was pinned against the rock outcrop and Rescue 111. None of the damage to Rescue 111 was done by the extrication process.

(Photo courtesy of the West Virginia State Police.)

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The incident priority was the extrication of the fire fighter pinned between the Rescue 111 and the rock outcrop. The captain and the deputy chief got into the cab of Rescue 111. Medics had placed a backboard underneath the fire fighter so he would not fall on the ground. A wrecker was hooked up to Rescue 111 to stabilize the apparatus and move it away from the rock outcrop if necessary. Fire fighters placed an extrication ram between the cab of Rescue 111 and the rock outcrop. The ram moved Rescue 111 about 4 – 6 inches away from the rock outcrop, which was enough for the fire fighter to be lowered onto the backboard and moved away from the apparatus. The fire fighter was immediately moved to Medic 141. The fire fighter was transported to the local trauma hospital. The time was approximately 1817 hours.

The assistant chief was located during the extrication of the pinned fire fighter. His lower torso was located under the fire fighter, pinned against the apparatus and the rock outcrop. His upper torso was located towards the rear of Rescue 111. The incident commander stopped all operations after the three injured fire fighters were transported. The fire chief was transported for a head injury and other trauma. The fire fighter assigned to the left jumpseat was transported for internal injuries. The junior fire fighter was transported and treated for a dislocated elbow.

The West Virginia State Police asked that all fire fighters be moved to a staging area while they conducted their investigation of the crash. The time was approximately 1830 hours. Also a request for a medical examiner to respond was made at this time. Paramedics from the county ambulance authority pronounced the assistant chief and lieutenant deceased at 1902 hours.

Command was transferred to the assistant chief from county Fire Station 10. The operations were changed from rescue to recovery. While operations had been ceased, a command officer was sent to the home of the fire fighter that was pinned between the rock outcrop and Rescue 111. His home was less than a ½ mile from the incident scene. The purpose was to notify his family, that he was being transported to the local trauma center.

A medical examiner arrived on scene at approximately 2100 hours. The medical examiner had to respond from a neighboring county. Once the medical examiner and the West Virginia State Police had completed their investigations, the recovery process started at approximately 2200 hours. The recovery process was completed at approximately 2250 hours. The assistant chief and the lieutenant were moved to Medic 66 for transport to the Office of the State Medical Examiner. At 2254 hours, Medic 66 was enroute to the Office of the State Medical Examiner. Medic 66 was escorted by members of the West Virginia State Fire Marshal's Office and Rescue 92 from county Fire Station 9. Medic 66 arrived at the Office of the State Medical Examiner at 2346 hours.

Command started the demobilization process at approximately 2300 hours. All units were cleared and Command was dissolved at 0238 hours on March 25, 2018.

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Crash Reconstruction

The West Virginia State Police reconstructed the crash of Rescue 111. The investigating trooper from the West Virginia State Police requested a State Police crash reconstructionist to respond. The state trooper crash reconstructionist, who responded, is assigned to Troop 5 of the West Virginia State Police.

The state trooper reconstructionist attempted twice (March 26 and March 29) to retrieve data from Rescue 111's Engine Modular Control System. Both attempts were unsuccessful. Power could not be restored to Rescue 111 in order to obtain the data. Rescue 111 was not equipped with an event data recorder.

The accident reconstructionist stated in his conclusions that the combination of the vehicle speed, wet road conditions, and the weight/displacement of the water carried on Rescue 111 (760 gallons) were the external contributing factors leading to the fire apparatus operator losing control of Rescue 111 and colliding with the rock outcrop.

Rescue 111 was removed from the incident scene and taken to a local salvage yard (**See Photo 7**).

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Photo 7. This photograph shows the magnitude of the damage to Rescue 111. The photograph was taken the next day at a local salvage yard.
(Photo courtesy of the fire 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:

- Failure to wear seat belts
- Distraction of the fire apparatus operator
- Speed of the apparatus
- Road conditions – wet roadway
- Limited space between the roadway, roadway shoulder, and the rock outcrop

Cause of Death

According to the death certificates, the state medical examiner listed the cause of death for both the assistant chief and lieutenant as multiple blunt force injuries. The manner of death was accidental.

Recommendations

Recommendation #1: Fire departments should require a written standard operating procedure (SOP) for the use of seat belts is implemented and enforced while riding on any fire department apparatus or vehicle.

Discussion: The fire department involved in this incident had a standard operating guideline (SOG) (*Section 4: Response*) requiring the use of seat belts during the response of the four department apparatus and vehicles (Rescue 111, Engine 113, Utility 112, and Utility 115. The only exception to wearing a seat belt noted in the SOG was when donning SCBA. However, the only member wearing a seatbelt when the crash of Rescue 111 occurred was the junior fire fighter. The fire fighter in the left jumpseat was wearing his seatbelt, but took it off during the response to put on his turnout pants and did not refasten his seat belt.

Fire departments should strictly enforce standard operating procedures (SOPs) or standard operating guidelines (SOGs) on the mandatory use of seat belts anytime an apparatus or vehicle is moving or in operation. Training and enforcement should include all levels of the organization. This includes the fire apparatus operator, all fire fighters riding in the apparatus, and the officer on the apparatus. The SOPs/SOGs should apply to all persons driving or riding in all emergency vehicles. The SOPs/SOGs should state that all persons should be seated and belted in an approved riding position before an apparatus or vehicle is put in motion. Also, the SOPs/SOPGs should state that a seat belt is not to be unbuckled until the vehicle or apparatus is parked [NFPA 2018b].

On average, vehicle crashes are the second leading cause of fire fighter line-of-duty deaths. NFPA 1500 *Standard on Fire Department Occupational Safety, Health and Wellness Program*, states in **Chapter 6, Fire Apparatus, Equipment, and Drivers/Operators**, the following requirements:

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6.2.4 Drivers of fire apparatus shall be directly responsible for the safe and prudent operation of the vehicles under all conditions.

A.6.2.4 The driver of any vehicle has legal responsibility for its safe and prudent operation at all times. While the driver is responsible for the operation of the vehicle, the officer is responsible for the actions of the driver.

6.2.4.1 When the driver is under the direct supervision of an officer, that officer shall also assume responsibility for the driver's actions.

6.2.5 Drivers shall not move fire apparatus until all persons on the vehicle are seated and secured with seat belts in approved riding positions, other than as specifically allowed in this chapter [NFPA 2018b].

The development, implementation, and periodic review of standard operating procedures for driving any fire department vehicle is an important element in clearly identifying the fire department's policy on what is expected of fire apparatus operators. Safe arrival is of prime importance. Standard operating procedures should include a “challenge and response” dialogue between the vehicle driver making the emergency response and the officer or other member in the driver compartment. The “challenge and response” dialogue should be instituted to determine the driver's intentions when approaching any perceived or identified hazard on the response route, to remind the driver of the presence of the hazard and the planned procedures for managing the hazard, and to ensure that the driver is coping with stressors encountered during the response and not focusing only on arriving at the site of the emergency [NFPA 2018b].

The broad scope of the cultural issue becomes evident when it is applied to the question of why many fire fighters do not use seat belts when riding in fire apparatus. While the adoption and enforcement of a policy requiring the use of seat belts appears to be relatively uncomplicated, the issue is considerably more complex than it appears. The vast majority of fire and emergency service organizations have adopted official written policies that require fire fighters to use seat belts whenever vehicles are in motion [Daly 2015]. There are no known written policies in fire and emergency service organizations that allow for the nonuse of seat belts. Requirements to use seat belts are incorporated in many state vehicle codes, and the same policy is clearly stated in NFPA 1500, *Standard on Fire Department Occupational Safety, Health and Wellness Program*. In addition, tremendous efforts have been put forth to educate firefighters on the need to use seat belts and promote their use as a personal safety decision [NCCSI 2015].

Considering all of these efforts, it is appropriate to ask why so many fire fighters continue not to use seat belts. Below is a list of factors that have been identified as contributors to this problem:

- The belief that the urgency of emergency response requires donning protective clothing and equipment enroute.
- The belief that a fastened seat belt will delay the fire fighter's ability to exit the vehicle upon arrival at the scene of the emergency.
- The difficulty of manipulating inadequately designed seat belts in the limited seating space that is available and in the presence of breathing apparatus straps.

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- The sense of personal invincibility that comes from riding in a vehicle that is larger and heavier than most other vehicles on the road.
- The fear of being viewed as nonconforming when others are not using their seat belts.
- The failure to enforce officially adopted policies creates the impression that compliance is not a high priority for managers and supervisors [NCCSI 2015].

While all of the noted rationalizations apply to emergency response, they often carry over to nonemergency situations. Fire fighters may easily develop the attitude that if it is acceptable to ride to an emergency without a seat belt, then there is no need to wear a seat belt when returning from the emergency or when riding in a fire and emergency service organization vehicle for any other reason.

One key factor appears to be the priority that is directed toward seat belt use by the fire chief and senior level officers of the fire and emergency service organization. A strong policy statement accompanied by a serious enforcement policy is usually effective in achieving a high level of compliance. In larger organizations, the policy must be enforced at each successive level of supervision down to individual fire fighters [Daly 2015; NCCSI 2015].

Use of seatbelts in department apparatus and personal vehicles is included in 16 Fire Fighter Life Safety Initiatives, a comprehensive list of steps established in 2004 to reduce fire fighter line-of-duty injuries and deaths. Starting in 2011, the National Fallen Firefighters Foundation (NFFF), through its *Everyone Goes Home*® program, has led this nationwide effort and provided additional resources and support for this program. The program also relaunched in 2011 the *International First Responder Seatbelt Pledge program*, makes it even easier for first responders and departments to participate in this process [NFFF 2011].

“Motor vehicle crashes are the second-leading cause of firefighter fatalities in the United States and this effort (16 Fire Fighter Life Safety Initiatives) aims to reduce the number of preventable fatalities,” said Chief Ronald J. Siarnicki, Executive Director of the National Fallen Firefighters Foundation. “Just as you need to get to the scene of a call quickly, you need to get there safely; buckling your seatbelt is the easiest safety measure you can take” [NFFF 2011].

In addition to the support of the National Fire Academy, fire service partners including the National Fallen Firefighters Foundation, the International Fire Chiefs Association (IAFC), National Volunteer Fire Council (NVFC), National Fire Protection Association (NFPA), and the National Institute for Occupational Safety and Health (NIOSH) have also joined the national effort to eliminate fire fighter injuries and line-of-duty deaths that can be prevented by seatbelt use.

At this incident, the junior fire fighter was the only fire fighter wearing a seat belt when the crash of Rescue 111 occurred. The left jumpseat fire fighter had his seat belt on, but unbuckled his seat belt to put on his turnout pants and did not refasten his seat belt prior to the crash.

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Recommendation #2: Fire departments should ensure the vehicle operations training program includes topics such as road design, road conditions, and driving during inclement weather.

Discussion: The fire apparatus operator is responsible for safely and effectively driving and operating a piece of fire apparatus under emergency response conditions as well as during non-emergency response.

Apparatus and vehicle crashes are a leading cause of fire fighter fatalities. In 2017, a total of 60 fire fighters died in the line of duty. Nine fire fighters (15%) were killed responding to or returning from alarms[NFPA 2017a]. Under all circumstances, fire apparatus operators of any piece of fire apparatus must exercise extreme care and caution when driving. This is not only for the other members on the apparatus but for the citizens they serve.

The key to the safe operation of fire department vehicles is to implement a comprehensive driving training program. An excellent resource is a *Guide to IAFC Model Policies and Procedures for Emergency Vehicle Safety* which was developed by the International Association of Fire Chiefs and the United States Fire Administration [IAFC 2009]. This document provides guidance for developing the basic policies and procedures required to support the safe and effective operation of all fire and emergency vehicles; this includes fire apparatus, rescue vehicles, ambulances, command and support units, privately owned vehicles (POVs), and any other vehicles operated by fire department members in the performance of their duties.

- **Basic Driving Policies** – Driver qualifications and training, skills maintenance; duties and responsibilities; general traffic laws; reporting safety problems and violations.
- **Emergency Response Policies** – Authorized emergency response, special driver qualifications, applicable traffic laws and fire department driving policies, and the use of warning devices.
- **Riding Emergency Vehicles** – Permitted vehicle occupants, passenger behavior, and safety in emergency vehicles.
- **Special Safety Considerations** – Scene safety, backing up, parking, operation in high-risk areas.
- **Vehicle Accident Reporting and Investigation** – Accident scene procedures (information gathering, injury assessment, notification, etc.), reporting forms and documentation requirements, post-accident investigation (examination of scene, interviews with participants and witnesses, etc.), report preparation and dissemination.
- **Use of Personal Vehicles** – Authorized use and response, driver behavior, roadway operations, permitted vehicle occupants, reporting safety problems and violations [IAFC 2009].

One section of the guide deals with emergency response. Responding to emergency incidents does not in any manner reduce the responsibility to operate vehicles safely. While prompt response to emergency incidents is an organizational priority, safety is always a higher priority. The responding units must arrive safely at the location where they are needed before they can deliver the required services. Unsafe operation of an emergency vehicle creates an unacceptable risk to fire department members, to the public, and to the individuals who are in need of assistance. Another section of this

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program deals with the speed of fire apparatus. The fire apparatus operator should never exceed a speed that is safe and prudent, based on road conditions, weather conditions, and other circumstances, including the design and capabilities of the vehicle. The posted speed limit may be exceeded only when the required warning devices are in use and when weather, traffic, and road conditions are favorable [IAFC 2009].

Another important element to consider and incorporate into the fire department vehicle operations program is driving during inclement weather. Driving a fire apparatus in inclement weather can be difficult at best. Listed below are some guidelines for fire apparatus operators to consider:

- Braking — Start braking sooner than you would under normal driving conditions.
- Speed — Slow down! No one should expect the apparatus to show up in the same amount of time with wet pavement versus dry pavement.
- Steep or long grades — Know your response area, slow down long before arriving at a steep or long grade, have the apparatus in the lowest gear and cover the brake. Always have a way out.
- Slippery pavement — On slippery, snowy or icy pavement, reduce your speed, drive slowly and with a heightened state of situational awareness.
- Winding and narrow roads — Keep well to the center of the lane; do not drift off the edge of the road. Drive slowly and scan ahead as far as you can.
- Corners — Slow down well in advance of the corner. Understand that the weight of the vehicle pushing you forward may well overpower your ability to maintain traction, control and steer the apparatus; it may just go straight.
- Turning — Slow down and signal your intentions long before the turn to warn others around you. As with cornering, understand that the weight of the vehicle pushing forward may well overpower the fire apparatus operator's ability to maintain traction, control and steer the apparatus.
- Losing control when cornering — Most defensive-driving experts will advise you to steer into the turn, although human nature may have you react differently [Wilbur 2010].

The safe operation of a fire department vehicle is essential for a successful outcome of any emergency incident. If the fire department vehicle or apparatus does not arrive at an incident due to a crash, the fire fighters involved are no longer in a position to help individuals in need of assistance and may require additional resources to respond to their emergency.

The fire chief had completed the Volunteer Fireman's Insurance Services (VFIS) *Emergency Vehicle Operations Classroom and Competency Course* in 2013. It is unknown how much actual driving time the fire chief had operating fire apparatus during emergency response.

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Recommendation #3: Fire departments should ensure that fire apparatus operators are trained in techniques for maintaining control of their apparatus at all times.

Discussion: A segment of a fire department's driver training program should include practical training for fire apparatus operators in techniques for maintaining control of the vehicle or apparatus they are operating.

The *Guide to IAFC Model Policies and Procedures for Emergency Vehicle Safety* [IAFC 2009] provides the following guidance about returning vehicles or apparatus to the roadway. Fire apparatus operators should be aware of the actions to be taken if the wheels of a vehicle leave the paved surface of the roadway. In these situations, the vehicle shall be slowed to a speed below 20 miles per hour before any attempt is made to return it to the roadway. Depending on road conditions and the condition of the off-road surface on which the vehicle is moving, it may be necessary to carefully bring the vehicle to a complete stop before attempting a return to the roadway. Under many circumstances, particularly involving heavy apparatus, this may be the safest course of action [IAFC 2009].

During training, the driver must develop a sense of what the safest maximum speed is for operating the vehicle is under a variety of conditions, which comes with knowledge, skills, abilities and competencies. This is accomplished through training, education, and a certification process for fire apparatus operators (e.g. NFPA 1002). Training must begin at low speeds and increase only as the fire apparatus operator becomes more comfortable driving the vehicle. Difficult routes of travel within the response district must be included in road testing so that the fire apparatus operator will understand how the vehicle will handle when making an emergency response in that area. In truth, there is little fire service tactical advantage to be gained by increasing the apparatus speed by 10-15 miles per hour. At a constant speed, the difference between 40 miles per hour and 50 miles per hour on a two-mile response is only about 25 seconds. When you take into account acceleration and deceleration times, weaving through traffic, and stopping at intersections, this difference is almost negated. On the other hand, the chances of becoming involved in a collision at the higher speed grow at a much higher rate. Fire departments who wish to decrease response times will have much better results by improving dispatch handling times, station turnout times, and other factors than they will by increasing the speed of the apparatus [IAFC 2009].

Fire apparatus operators must recognize dangerous conditions and adjust for them accordingly. The vehicle must always be driven at a speed that allows it to be maintained under control, on the roadway, and able to stop within a reasonable distance. This speed will need to be reduced if the road is wet, icy, or unpaved. Regardless of the agency or vehicle being driven, it all boils down to a couple of simple facts. The faster a vehicle is driven, the more likely the driver is to lose control of it for one reason or another. The loss of control may be due to an issue with the driving surface, driver distraction, people or vehicles entering the travel path, and any number of other reasons. The increased speed reduces the reaction time needed to adjust for these situations. Secondly, the faster the speed, the longer the stopping distance. As a rule-of-thumb, doubling the speed of a vehicle *quadruples* the distance it takes to stop the vehicle on dry surface. This distance is further increased on wet, snowy, or icy roads. An

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increased stopping distance increases the likelihood of running into some type of other object before the vehicle can be brought to a stop [IAFF 2010].

If the fire apparatus operator is driving the vehicle at a speed that places him just at the edge of the friction circle, an unplanned activation of an engine or driveline retarder may create a longitudinal g-force that uses up the remaining friction of the roadway resulting in a loss of control. Fire departments should check with the manufacturer of their auxiliary braking device to determine its recommended use during inclement weather. Fire department driver training programs should include drive time with the auxiliary braking device deactivated. The stopping distance and behavior of the vehicle will be different when the auxiliary braking device is not turned on. Fire apparatus operators must understand and anticipate these differences should they have to drive the apparatus in wet weather with the auxiliary braking device deactivated [Commonwealth of Pennsylvania 2017]. *Note: The first step in understanding advanced vehicle dynamics is to understand the concept of “g-force”. There are two types of g-force: longitudinal g-force and lateral g-force. Longitudinal g-force will act on the fire apparatus from front to back. A fire apparatus will experience a longitudinal g-force when it is braking or accelerating. The harder the fire apparatus operator applies the brakes or accelerator pedal, the more longitudinal g-force the fire apparatus will experience. Lateral g-force will act on the fire apparatus from side-to-side. A fire apparatus will experience lateral g-force anytime the driver turns the steering wheel, such as rounding a curve or turning from one road onto another. The amount of lateral g-force a fire apparatus will experience as it rounds a curve will depend on how fast the vehicle is traveling and how sharply the driver turns the steering wheel (also referred to as the **radius** of the vehicle’s path of travel). Lateral g-force will increase as the speed of the vehicle increases, or as the driver continues to turn the steering wheel more sharply, thereby reducing the radius of the path of travel. A fire apparatus can only absorb so much lateral g-force before it begins to lose control or rollover [Daly 2019].*

Generally, the simple act of the tires leaving the paved surface does not create a significant hazard in and of itself. It is possible that if the shoulder is very soft, this can throw the vehicle toward the right into an object along the roadway or perhaps into a rollover situation. Most crashes that occur when the right side wheels leave the paved surface are as a result of an “overcorrection” and the resultant panic by the driver when attempting to bring the right side wheel(s) back onto the paved surface. Often, there will be a lip of 4 to 8 inches where the paving drops off onto the soft shoulder. When the driver attempts to bring the right side tires over this lip and back onto the paved surface at too high a speed, the vehicle will often shoot quickly (and sometimes violently) towards the left. In other cases, the vehicle may stay on the roadway, but the jerking action of jumping back onto the paved surface causes the rear end of the vehicle to swing out in a counterclockwise motion, causing the vehicle to slide and/or overturn. The best way to avoid these collisions is to simply keep all the wheels on the road surface at all times. This may be easier said than done. During a response the driver may be faced with unpredictable civilian drivers, debris or potholes in the roadway, narrow roads, or other conditions that may force the vehicle towards the right edge of the road. The following are a few tips for keeping the vehicle from drifting off the right side of the road:

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- First and foremost, operate the vehicle at a safe and reasonable speed. This will minimize swaying and drifting. It will also avoid loss of control on curves in the road.
- Do not operate warning devices, talk on the vehicle's radio, use a cell phone, read map books or computer monitors, or perform other activities while driving the vehicle as that may result in drifting due to lack of attention.
- Never pass slowed or stopped vehicles on their right side [IAFF 2010].

Even though the goal is to keep the vehicle on the road, fire apparatus operators must be trained in how to react should the wheels drift off the right side of the paved surface. When either or both of the right-side wheels/tires drift off of the paved surface the driver must gradually slow the vehicle to a safe speed or come to a complete stop before attempting to bring the wheel(s) back onto the paved surface. There is no defined speed at which this is always safe, as it will depend on many factors, including the size of the lip, the characteristics of the vehicle, and driver's skill level. However, most experts agree that the appropriate speed to remount the paved surface is 20 miles per hour or less, especially for larger vehicles such as fire apparatus or law enforcement tactical vehicles. By significantly slowing or stopping the vehicle prior to bringing the wheel(s) back onto the road surface, the driver will avoid the violent reaction that often occurs when trying to do this at a higher speed [IAFF 2010]. *Note: A sample standard operating procedure on fire department vehicle safety is provided in **Appendix One**.*

In this incident, the fire apparatus operator of Rescue 111 was responding on a two-lane road that was wet. As Rescue 111 entered a curve, the vehicle's right wheels dropped off the pavement and traveled in the ditch line for more than 300 feet before coming to a stop. The right side of the apparatus was scraping the rock outcrop causing the assistant chief and lieutenant to be pulled out of the cab (**See Photo 5 and Diagram 1**).

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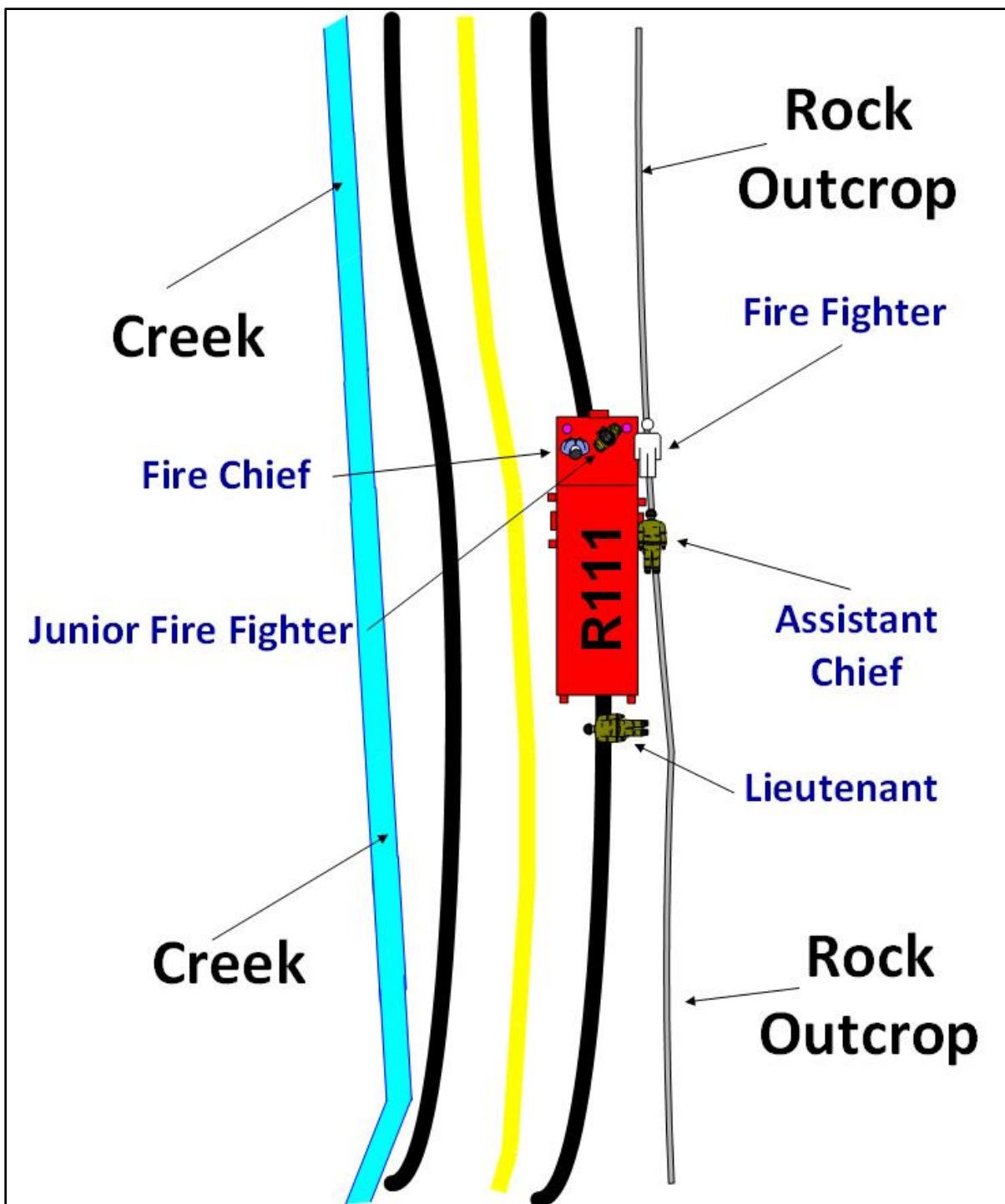


Diagram 1. The location of the five members of Rescue 111 after the crash.

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Recommendation #4: Fire departments should ensure all members that operate fire apparatus meet the requirements set forth in NFPA 1002, Standard for Fire Apparatus Driver/Operator Professional Qualifications.

Discussion: NFPA 1500, *Standard on a Fire Department Occupational Safety, Health, and Wellness Program*, Paragraph 5.2.2 states, “All fire apparatus operators shall meet the requirements of NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications*” [NFPA 2018b]. The purpose of NFPA 1002 states that fire fighters who drive and operate fire apparatus shall remain current with the general knowledge, skills, and job performance requirements (JPRs) for each level or position of qualification. Fire fighters who drive and operate fire apparatus shall remain current with practices and applicable standards and shall demonstrate competency on an annual basis.

Statistics presented by the National Fire Protection Association (NFPA) and the United States Fire Administration (USFA) indicate an alarming trend in the increased number of fire fighter fatalities and injuries associated with fire department vehicle operations. Fire departments respond with a variety of apparatus. Fire apparatus operators must have the appropriate knowledge, skills, and abilities to operate the variety of apparatus.

The first step in this process is to properly train and educate members on the various types of apparatus they could be required to operate. NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program* provides the curriculum for members to develop the necessary knowledge, skills, and abilities to meet the requirements of 5.2.2 of NFPA 1500. The second step is to ensure fire departments perform an annual proficiency evaluation of all fire apparatus operators as required by Section 5.5 of NFPA 1500. Also, the training and education should address the standard operating procedures associated with vehicle operations, especially emergency response [NFPA 2018b].

These are necessary components of the department's plan to reduce the risks associated with vehicle operations. This is a systems approach to ensure the safety and health of members and the citizens they serve. NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications* provides the minimum job performance requirements for fire fighters that drive and operate fire apparatus [NFPA 2017b].

In this incident, the fire apparatus operator of Rescue 111 had completed a classroom and practical training course on emergency vehicle operations. It is unknown how much actual driving time the fire chief had operating fire apparatus during emergency response.

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Recommendation #5: Fire departments should ensure all fire apparatus operators successfully complete a comprehensive driver's training program which meets the requirements set forth in NFPA 1451, Standard for a Fire Service Vehicle Operations Training Program, before allowing a member to drive and operate a fire department vehicle.

Discussion: Fire departments need to ensure that their members are trained appropriately for the duties and job functions they are expected to perform. In the fire service, this is required by NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*. Specific minimum training requirements are then spelled out within the various professional qualifications standards (e.g., NFPA 1002).

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program* is a comprehensive standard that covers all components of a fire apparatus operator training program [NFPA 2018a]. NFPA 1451 was developed based upon a request from the National Transportation Safety Board (NTSB). The lack of fire apparatus inspections in this country was a problem that was pointed out in a 1991 National Transportation and Safety Board Special Investigative Report of eight separate fire apparatus accidents. The two leading recommendations to the fire service were the mandatory use of seatbelts and an annual apparatus inspection program [Wilbur 1996]. NTSB requested NFPA “emphasize the safe arrival of apparatus at a scene of an emergency a priority.” The first edition of NFPA 1451 was issued in 1997.

The scope of NFPA 1451 standard is to outline the development of a written fire department vehicle operations training program, which includes organizational procedures, maintaining vehicles, identifying equipment deficiencies, design, financing, and other areas. The knowledge, skills, and abilities required for safety, training, maintenance, and administrative officers charged with developing and implementing a fire department vehicle operations training program shall be outlined within this standard.

The standard includes the following requirements:

- General Rules and Considerations
 - Risk Management
- Training and Education
 - Training Frequency
 - Basic Training and Education Requirements
 - Instructor Qualifications
 - Training Program Safety
- Laws and Liabilities
- Crash and Injury Prevention
- Crash Review
- Vehicle and Apparatus Care.

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The basic training and education requirements for a fire apparatus operator should be to complete the requirements of Chapters 4 through 10 of NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications* and Section 4.2 *Risk Management Plan* in NFPA 1500, *Standard on a Fire Department Occupational Safety, Health, and Wellness Program*. Other requirements include having the proper licensing for operating fire apparatus; perform vehicle inspections and maintenance per fire department policy and state law; know the department procedures for non-emergency response and actual response to an incident non-emergency; know the department procedures for operating a vehicle on other than paved or hard surfaces; the fire department should provide training for operating vehicles or apparatus during inclement weather, with an emphasis on handling the apparatus when an auxiliary braking devices are to be used; the training program should discuss various types of braking devices (e.g. antilock braking system (ABS)); and review crash scenarios, both local and national, to serve as an objective learning experience [NFPA 2018a].

One of the most important aspects of operating any vehicle or apparatus is defensive driving. The defensive driver adjusts his or her driving to fit the weather conditions and the actions of other drivers and pedestrians. Where a dangerous situation is identified, the defensive driver takes preventive action. The defensive driver does not assume the actions of others will prevent a crash. Fire apparatus operators should continually scan the sides and rear of the vehicle or apparatus to prevent tunnel vision.

The keys to defensive driving include the following:

- Aiming high in steering (this means look further ahead instead of looking at the road just in front of the vehicle or apparatus)
- Getting the big picture
- Maintaining eye movement
- Leaving an “out”
- Making sure others see you [NFPA 2018a].

NFPA 1451 provides the necessary foundation and training for a fire apparatus operator to safely and effectively operate fire apparatus.

The fire chief had completed the Volunteer Fireman’s Insurance Services (VFIS) *Emergency Vehicle Operations Classroom and Competency Course* in 2013. It is unknown how much actual driving time the fire chief had operating fire apparatus during emergency response.

Recommendation #6: Fire departments should utilize the components of the Crew Resource Management/Human Error Avoidance System as a method for reducing fire fighter fatalities and occupational injuries. This process should also be used for the safe operation of fire department vehicles and apparatus.

Discussion: Civil aviation *Crew Resource Management* (CRM) began in the United States in 1979. Due to concerns over the magnitude of aviation accidents attributed to “pilot error,” the National

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Aeronautics and Space Administration (NASA) sponsored an industry workshop that year, entitled *Resource Management on the Flightdeck*. Originally titled “Cockpit Resource Management” (CRM), each of the major air carriers in attendance departed the conference committed to the development of cockpit resource management training. In its broadest sense, CRM is the use of all available resources, information, equipment, and people to achieve safe and efficient flight operations. Since the 1979 conference, the CRM concept has evolved through several generations [Helmreich RL, Merritt AC, and Wilhelm JA 1999].

Simply put, crew resource management is the effective use of all resources. The Federal Aviation Administration’s (FAA) Advisory Rule expands the definition to include software, hardware and human ware in its definition. The ultimate goal for the FAA is achieving safe and efficient flight operations. Their specific listing of software, hardware and human ware is meant to emphasize the point that problem solving involves using all available tools. CRM is not an attempt to undermine the legal ranking fire officer’s authority, nor is CRM management by committee. In fact authority should be enhanced through the use of CRM. All team members direct information flow to the officer. While opinions are valid, the final decision on a course of action still rests with the officer. Using CRM provides for:

- better teamwork
- newly acquired communication and problem solving skills
- an operating philosophy that promotes team member input while preserving legal authority
- proactive accident prevention [IAFC 2002].

The concept introduced in the crew resource management manual has a proven history in reducing errors in two industries with parallel work group structures to the fire and emergency service—aviation and the military. Communication failures, poor decision making, lack of situational awareness, poor task allocation and leadership failures are listed as the contributing factors in many fire fighter line of duty deaths. Since the factors are similar to those cited in aviation disaster reports, applying crew resource management to the fire and emergency services is logical. Crew resource management requires a commitment to change fire and emergency service’s leadership and operating cultures that have evolved over generations. The crew resource management goals are to minimize the effect that human error has on operations and maximize human performance. Crews trained in crew resource management learn skills that:

- Enhance communication
- Maintain situational awareness
- Strengthen decision-making
- Improve teamwork [IAFC 2002].

In fact, after a few years of use, the system was re-named to “Crew Resource Management” and incorporated training and procedures for everyone that had responsibilities for the safe departure and arrival of a commercial aircraft. As this critical decision making process was gaining wide acceptance in the United States and in the worldwide aviation community to eliminate human errors, the United States Military took notice. All of the various branches of the United States Military Service have

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applications of CRM to eliminate human error when there is a chance that the wrong decision could have a negative impact on the operation, such as a loss of life, injury, or loss of property. CRM is time tested (more than four decades worth now) and statistically/scientifically proven to be tremendously effective in reducing human error.

When a fire apparatus or vehicle is operated too fast for the road, weather, and traffic conditions, the likelihood of disaster looms large. Both the fire apparatus operator and the officer in charge of the vehicle must agree on a safe and proper speed for the conditions. If there is a disagreement on the proper speed, the slower of the two opinions must prevail. Although the member in charge of the vehicle generally sits in the right front seat without vehicle controls, the fire apparatus operator and the officer are fully responsible for the safe operations of the apparatus. To emphasize and reinforce the level of direct responsibility of the officer in charge, all new fire apparatus purchased should include an additional speedometer installed directly in front of the officer in the right front seat position. The point being is the officer should ensure that a safe speed is never exceeded. In aviation terms, the captain is the captain and has the final decision and the full and complete authority to ensure that flight operations are as safe as achievable. Failure to follow policy and established procedure could cost the pilots both their job and life.

Fire apparatus should only be allowed to exceed the posted speed limit when it is safe and practical to do so considering the road, weather, and traffic conditions, as well as the limitations of the apparatus or vehicle being driven to the incident. This can only occur if the conditions allow the fire apparatus operator to do so. Stopping at all negative right-of-ways is not optional and a requirement. The driver and officer must both agree that the vehicle has total control of the roadway before proceeding through a controlled intersection. Traffic preemption devices are of great assistance with traffic light maneuvers during responses. However, defensive driving is always required by the fire apparatus operator and must be enforced by the officer-in-charge of the unit, **arrive alive when you are needed the most** [IAFC 2002].

One of the most significant rules of crew resource management is known as “Sterile Cockpit”. What is meant by this phrase is that all extraneous discussion, information or distractions are removed from the flight deck during all of the critical times while in flight. The requirement is thirty minutes before take-off, thirty minutes before landing, and during any unplanned event (such as an in-flight emergency) the cockpit crew must focus solely on the flying operations, and the avionics of the aircraft. The three functional words that pilots associate with this procedure are: **aviate** (fly the plane); **navigate** (know where you are going) and **communicate** (keep all critical role players informed of what is happening and what support is needed). The fire rescue equivalent is to operate the **vehicle under control** at all times, **know where you are responding to**, and the **most effective and efficient route to the scene**. Finally, **maintain effective communications with the crew members** during the transit time as well as on-scene operations [Blanchet 2017].

There cannot be personal laptop computers, cell phones, camera, personal voice recorders or even unrelated discussion to flight operations during “sterile cockpit” time. Remember, that there is always

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a cockpit voice recorder in operation during flight, catching every word that the pilots utter in the cockpit, so it would be highly unlikely that this rule could be broken without being noticed by flight operations, which includes the associated punitive action to correct the errant crew's behavior and decision making process. These same restrictions must apply in the cab of every fire apparatus, ambulance, support, and command vehicle to prevent unnecessary distractions.

Sterile cab rule should apply to all fire apparatus while responding to and returning from alarms of all types, considering the typical amount of time the vehicle is underway and the risks that weigh in the balance. The sterile cab rule is clearly required to prevent distracted driving. All distractions should be eliminated from the time the apparatus starts up until it is safely back into the station. The voice discussion between the crew members needs to focus on the work at hand and avoid all non-essential discussions. All electronic devices that can distract the driver or crew members should not be allowed to be used during apparatus drive time including but not limited to the fire department radio, cell phones, cameras, and any other electronic devices that can draw attention away from proper and safe vehicle operations. The company officer may use a properly mounted and secured mobile computer terminal to review operational details and continue to size-up the incident, but only the information that is associated and essential to the alarm. A windshield mounted video camera may provide training and after action review information without being distracting to the driver or crew. Personal cameras to include helmet-cams should not be used during response times [Blanchet 2017].

Some pilots have pushed their aircraft to the limits, unnecessarily challenging both weather and operational conditions, to arrive at a certain location at the pre-determined time. There is organizational pressure to have on-time arrival performance in the industry. However, "Get Homeitis" is the type of poor decision making that is more personal than to simply fly on scheduled time. This situation is simply hurrying to arrive at a destination regardless of the consequences. However, it is a real life phenomenon that must be addressed when discussing safe vehicle operations. Pilots have been known to take exceptional risks to simply get back to their home base after a long work trip, hence the title of this negative decision making trait [IAFC 2002].

When a fire apparatus response results in a collision, the members aboard the apparatus are no longer in a position to help the customer and may require additional resources to respond to their emergency. Fire Fighter Sandy Lee of Prince George's County (MD) Fire Department may have said it best. Fire Fighter Lee's devastating and life-altering injury happened when she fell off Truck 22 leaving Fire Station 22 responding to a structure fire. Fire Fighter Lee indicated that because of the resources needed to take care of her, this created response issues to the structure fire. In fact, several fire and EMS companies were required to stabilize Fire Fighter Lee's injuries to save her life and unable to respond to the structure fire [Rubin 2012].

Perhaps Chief Alan V. Brunacini said it best in his textbook entitled, "Command Safety". The Chief's comments were, when responding to alarms, members should exhibit a **controlled hustle** to balance operational safety with the need to prevent harm in the community. When an alarm is received by a company or unit, the focus must be on keeping the response time to the shortest duration obtainable

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within the parameters of safety for all. Chief Brunacini goes on to point out that all fire and rescue operations must start under control, stay under control and end under control. No one should be allowed to be out of control/balance with the overwhelming need to be unsafe during operations [Brunacini 2004]. There is a tremendous amount of information about crew resource management to be found on the internet.

In this incident, the fire chief had difficulty controlling Rescue 111 due to the speed of the apparatus, the roadway being wet from earlier precipitation, and the contour of the roadway.

Recommendation #7: Fire departments should implement preventative maintenance programs which includes evaluation of the condition, age, and air pressure of fire apparatus tires.

Discussion: Old or worn tires can create significant safety issues due to worn tread depth and aged or brittle materials. Underinflated tires can have a significant effect on vehicle handling, while also increasing the chance of a tire blowout. Fire apparatus maintenance managers should also understand the difference between steer, drive, and all-position tires.

Fire departments must also understand the safety issues related to placing mismatched tires on a vehicle, as mismatched tires can create a vehicle dynamic that leads to a loss of control. Mismatched tires can include tires with different types of construction (radial vs bias tires), tires with a different size or tread depth, or tires that have a significant difference in inflation pressure. Regular apparatus safety checks should include a close inspection of the tires, including the inside dual tires which are often overlooked [NFPA 2017c].

Fire department apparatus maintenance programs should consider a replacement schedule for fire apparatus tires. While tires are expensive, fire departments should consider a budget plan that allows the tires on an apparatus to be replaced at intervals no longer than every seven years. In the event that a tire must be replaced due to damage or excessive wear, the fire department should consult with the tire manufacturer to ensure that the new tire(s) will not affect vehicle handling or safety. If financial constraints preclude the replacement of all of the vehicle tires at the same time, the fire department should consult with the tire manufacturer to ensure that the tires are of similar construction, condition, and design so as to maintain a stable vehicle platform and reduce the chance of the vehicle losing control [NFPA 2017c].

In this incident, Rescue 111 had passed a state vehicle inspection in November 2017. Based upon the information from the investigation by the West Virginia State Police, the tires were not a contributing factor. Due to the importance of an apparatus preventive maintenance program, all apparatus and vehicles are inspected on a regular basis and checked for the proper operation of all safety features. This inspection should include tires, brakes, warning lights and devices, headlights, clearance lights, windshield wipers, and mirrors. ***Note: Even though conditions of the tires in this incident were not a contributing factor, this information is provided as part of a fire department vehicle maintenance program.***

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Investigator Information

This incident was investigated by Murrey E. Loflin, Investigator, 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 Brad Sprague, a Sergeant with the Illinois State Police and the Deputy Chief of Operations with the Minooka, IL Fire Protection District and Christopher Daly, a Sergeant with the West Chester Police Department in West Chester, PA, former fire department officer, and founder of the “Drive to

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Survive” training program. Also, a technical review was provided by the NFPA Public Fire Protection Division.

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Appendix One Sample Standard Operating Procedure: Fire Department Vehicle Safety

FIRE DEPARTMENT STANDARD OPERATING PROCEDURE FIRE DEPARTMENT VEHICLE SAFETY EMERGENCY AND NON-EMERGENCY RESPONSE SAFE EMERGENCY OPERATIONS ON ROADWAYS		
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PURPOSE:		
<p>Fire Department responses to and from emergency incidents as well as emergency operations on roadways present a high level of risk to fire fighter safety. This procedure identifies requirements for the implementation of a safe Fire Department vehicle operations program. This procedure shall be enforced for all Fire Department vehicle operations. The company officer and the driver of the vehicle are responsible for the safety of all vehicle operations and managing compliance of this standard operating procedure.</p>		
POLICY:		
<p>Fire Department vehicles shall be operated in either an emergency mode utilizing vehicle emergency lights and sirens (e.g. Code 3, Priority 1) or a non-emergency mode (e.g. Code 2 or Priority 2). Regardless of the vehicle operation mode, it is the responsibility of the driver of each Fire Department vehicle to drive safely and prudently. It is the responsibility of the company officer to ensure that the driver is operating the Fire Department vehicle in a safe and prudent manner.</p>		
<p>All employees are required to use seat belts at all times when operating a Fire Department vehicle. All personnel shall ride only in regular seats provided with seat belts. Riding on tailboards or other exposed positions is not permitted on any vehicle at any time. The company officer and driver of the vehicle shall confirm that all personnel and riders are on-board, properly attired, with seat belts on, before the vehicle is permitted to move. This confirmation shall require a positive response from each rider, as in "ready."</p>		
<p>Vehicles shall be operated in compliance with the Federal, State and/or Provincial Motor Vehicle Code. This code provides specific legal exceptions to regular traffic regulations that apply to Fire Department vehicles only when responding to an emergency incident or when transporting a patient to a medical facility in an emergency mode. Emergency response does not absolve the driver or the company officer of any responsibility to drive with due caution. The driver of the emergency vehicle and its officer are responsible for its safe operation at all times.</p>		

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When responding in the emergency mode, warning lights must be on and sirens must be sounded to warn drivers of other vehicles, as required by the Federal, State and/or Provincial Motor Vehicle Code. When responding or returning in a non emergency mode, warning lights and sirens shall not be used.

The use of sirens and warning lights does not automatically give the right-of-way to the emergency vehicle. These emergency devices simply request the right-of-way from other drivers, based on their awareness of the emergency vehicle presence. Emergency vehicle drivers and company officers must make every possible effort to make their presence and intended actions known to other drivers, and must drive defensively to be prepared for the unexpected or inappropriate actions of others.

Fire Department vehicles are not authorized to exceed posted speed limits when responding in any mode and under any conditions.

Federal, State and/or Provincial Motor Vehicle Codes prohibit travel in oncoming traffic lanes (i.e. beyond double yellow lines). However, when emergency vehicles must travel in oncoming traffic lanes, the maximum permissible speed shall be 20 mph. On limited access roadways (e.g. interstates, freeways, toll roads) the use of oncoming traffic lanes shall only be used at the request of the Police and only after it is assured that all oncoming traffic is stopped. The Fire Department shall confirm the traffic has been stopped before entering any roadway against traffic.

Intersections present the greatest potential danger to emergency vehicles. When approaching a negative right-of-way intersection (red light, stop sign, yield sign) the vehicle shall come to a complete stop and shall proceed only when the driver can account for all oncoming traffic in all lanes yielding the right-of-way. When emergency vehicles must use center or oncoming traffic lanes to approach controlled intersections, (traffic light or stop sign) they must come to a complete stop before proceeding through the intersection, including occasions when the emergency vehicle has a green light. When approaching and crossing an intersection with the right-of-way, drivers shall not exceed the posted speed limit.

Emergency response is authorized only in conjunction with emergency incidents. Unnecessary emergency response shall not be permitted. When the first unit reports on the scene and establishes and confirms that there is no emergency, the incident commander will advise Dispatch/Communications and all additional responding units shall be alerted by Dispatch/Communications and shall continue to the scene in the non-emergency mode.

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During an emergency response, fire vehicles shall avoid passing other emergency vehicles. If passing is necessary, the vehicle being passed must be contacted by radio and shall, when possible, move to the right lane.

Radios, cellular phones, mobile data terminals, mobile computer terminals or other communication devices shall not be used by the vehicle operator while the emergency vehicle is in motion.

Drivers shall avoid backing whenever possible. Where backing is unavoidable, at least one spotter shall be used. If no spotter is available, the driver shall dismount and walk completely around apparatus to determine if obstructions are present before backing. Members shall not be permitted to ride on tailboard or running board while backing the vehicle.

The unique hazards of driving on or adjacent to the fireground requires the driver to use extreme caution and to be alert and prepared to react to the unexpected. Drivers must consider the dangers their moving vehicle poses to fireground personnel and spectators who may be preoccupied with the emergency, and may inadvertently step in front of, or behind, a moving vehicle.

When stopped at the scene of an incident, vehicles shall be placed to protect personnel who may be working in the street and warning lights shall be used to make approaching traffic aware of the incident. During emergency operations, vehicles shall be angled to block at least one lane of traffic and, where applicable, the road's shoulder. All personnel working in or near traffic lanes shall wear high visibility vests.

At night, vehicle mounted floodlights and any other lighting available shall be used to illuminate the scene. The total amount of lighting used at nighttime emergencies shall be managed to prevent blinding other drivers as they approach the scene.

Emergency Response Criteria

- All personnel seated and belted
- Warning lights and sirens activated
- Maximum 10 mph over posted speed limit.
- Travelling in center or oncoming traffic lanes, 20 mph maximum and complete stop at all traffic lights/stop signs.
- Posted speed limit when entering intersections with green light.
- Complete stop at all red lights, stop signs and yield signs.
- No driver use of communication or texting equipment when vehicle in motion

This information provides guidance for the safe response of fire department vehicles by department fire apparatus operators.

(Diagram courtesy of the IAFF.)