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NIOSH
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

March 22, 2010

Volunteer Fire Chief and Fire Fighter Killed When a Wildland Engine Plummeted From a Fire-Damaged Wooden Bridge Into a Dry Creek Bed – Colorado

SUMMARY

On April 15, 2008, at approximately 1535 hours, a 30-year-old volunteer chief and a 38-year-old volunteer fire fighter died while driving their apparatus through thick black smoke onto a bridge that had collapsed from fire damage caused by a wildfire. They were responding as mutual aid to the wildfire in a neighboring community. Key contributing factors identified in this investigation include: excessive speed for reduced visibility/smoke conditions, lack of traffic control, lack of coordination between responding agencies and departments, and inadequate driver and multi-agency response training.

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***ensure that fire fighters receive essential training on the emergencies that they will respond to and how to respond safely***

Additionally, fire departments, municipalities, and authorities having jurisdiction should:

- ***establish pre-incident plans regarding traffic control for emergency service incidents and pre-incident agreements with public safety agencies, traffic management organizations, and private sector responders***
- ***train on utilizing the national incident management system to effectively respond to and manage multi-agency incidents***
- ***be aware of programs that provide assistance in obtaining alternative funding, such as grant funding, to replace or purchase fire fighting equipment***

Volunteer Fire Chief and Fire Fighter Killed When a Wildland Engine They Were Driving Plummeted Through a Wooden Bridge That Had Collapsed From Fire Damage Into a Dry Creek Bed - Colorado

INTRODUCTION

On April 15, 2008, at approximately 1535 hours, a 30-year-old volunteer chief and a 38-year-old volunteer fire fighter died while driving their apparatus through thick black smoke onto a bridge that had collapsed from fire damage caused by a wildfire. On April 16, 2008, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health of this incident. On May 19-23, 2008, a Safety and Occupational Health Specialist and a General Engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated this incident. Meetings were conducted with the fire department, county sheriff's department, state police, and the state forest service. Interviews were conducted with fire fighters and officers and law officers who were involved with this incident, and the dispatch center. The investigators reviewed witness statements, dispatch logs, and the death certificates. The incident site was visited and photographed.

FIRE DEPARTMENT

This volunteer department consisted of seven members in one station that served a population of more than 450 people in a mostly rural geographic area of approximately 242 square miles. At the time of the incident, the department did not have any written standard operating procedures (SOPs), including procedures on driver training and vehicle operations.

INCIDENT COMMAND

Through local planning with the U.S. Forest Service, the sheriff's office was deemed to be the command post for any large wildland fire incidents that may happen within the county. The county sheriff's office was determined to be the best possible option to handle the personnel and communications needs for a multi-agency response.

WILDLAND ENGINE

The wildland engine involved in this incident was a 1988, 4-wheel drive pickup truck with a Gross Vehicle Weight of less than 10,000 lbs. It was equipped to fight wildfires with a 400 gallon water tank with associated pump, hose, and reel.

TRAINING and EXPERIENCE

The rural fire department did not have any formalized training for their members. It was unknown how many years of experience the volunteer chief had with the department. The volunteer fire fighter had less than one year of experience. Neither of the victims had any driver training for a vehicle of

that size and weight. The local sheriff had been trained on IS-700, which is an introductory course on the National Incident Management System (NIMS). The sheriff stated that his office had not received any other formalized training regarding the responsibilities of responding to or managing this type of incident.

FIRE ORIGIN

The fire originated in an agricultural burn pile that had been a controlled burn the previous day by a local resident. The fire continued to smolder and was re-ignited by windy conditions which blew embers into dry vegetation nearby. The fire grew out of control and burned approximately 9,000 acres including multiple residences, buildings, and vehicles.

WEATHER CONDITIONS

At the time of the incident, the temperature was 88-degrees F°. The relative humidity was 4%, with winds out of the west at 28 mph with gusts at 33 mph.

BRIDGE

The timber bridge that was consumed by fire in this incident was built in 1937 with west coast Douglas fir treated with a creosote product. The timber bridge spanned a dry creek bed and was approximately 47 feet long by 30 feet wide. The abutments and middle pier consisted of 12-inch piles 20 feet long. The girders were 6-inches wide by 20-inches tall and were approximately 25 feet long. The caps were also 6-inches by 20-inches. The bridge deck was constructed of 6-inch planks that were nail laminated. The deck was covered with a 5-inch overlay of asphalt (see Photo 1 and 2). The bridge was located on a state road and maintained by the State Department of Transportation.

INVESTIGATION

On April 15, 2008, at approximately 1344 hours, the county deputy sheriff called in a wildfire that had started at a residence several miles southwest of a state highway leading into a rural community. The command post was set up at the county sheriff's office in the rural community as the sheriff collected information about the wind driven fire that was spreading rapidly. *Note: The command office was overwhelmed due to the fact that they did not have enough phone lines to answer and distribute the volume of calls needed to manage the incident.* At 1410 hours the sheriff's office requested assistance from the state patrol's office for a large wildfire. At this time the county sheriff was operating command out of his vehicle as he quickly attempted to assess the fire and wind situation and the safety of the town's members before returning to the sheriff's office to resume command there. At 1445

hours a radio transmission confirmed that the fire had gained momentum and had crossed the state highway west of the local community. At approximately 1447 hours, the State Department of Transportation made a transmission that the bridge west of town might be out due to fire damage. *Note: This transmission was not acknowledged nor confirmed.* At 1449 hours, the county put out a page for mutual aid from the surrounding communities as the sheriff began to evacuate the local community.

Mutual aid companies had received the page and were enroute to their respective companies to respond to the call. *Note: They did not have the means to monitor any of the transmissions regarding the fire or command channels.* The two victims were at their fire station donning their bunker gear to report to the command post approximately seven miles to the east on the state highway. At approximately 1510 hours the two victims responded in Truck 205. Three other members of the mutual aid department waited for another member as the victims left the station. At approximately 1530 hours, a civilian who was leaving the local community traveling west on the state highway drove through the smoke and into the dry creek bed where the bridge had collapsed from fire.

At approximately 1535 hours, the other four members responded from the mutual aid fire station in Truck 204. *Note: It is estimated that this is approximately the same time the victims crashed into the dry creek bed.*

At approximately 1545 hours, the members in Truck 204 encountered thick black smoke and dirt blowing across the state highway from the wind driven wildfire. The driver was forced to slow Truck 204 in an attempt to find the lines on the road for guidance. As they were creeping through the smoke they noticed fire directly in front of them in the road. They stopped approximately 60 feet from the bridge and noticed the back end of a vehicle sticking out of the dry creek bed. The crew primed the pump and the driver walked to the hole and noticed that the bridge had collapsed and that Truck 205 had crashed into the dry creek bed. (see Photo 3).

Due to the high fire intensity and damage to the vehicle, recovery efforts of the victims were concluded the following day.

CAUSE OF DEATH

The death certificates listed the cause of death for Victim #1 and Victim #2 as multiple injuries and thermal injuries from the motor vehicle accident and subsequent fire.

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 fatality:

- Excessive speed for reduced visibility/smoke conditions
- Lack of traffic control
- Lack of coordination between responding agencies and departments
- Inadequate driver and multi-agency response training

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that fire fighters receive essential training on the emergencies that they will respond to and how to respond safely.

Discussion: Fire departments should provide adequate resources and training to ensure that the safe arrival (and return from) an emergency scene is their first priority. Fire departments should develop, implement, and enforce written standard operating procedures and ensure fire fighters are thoroughly trained and qualified before being allowed to drive and operate emergency vehicles. Fire departments should ensure that fire fighters are trained on the tasks that fire fighters will encounter on the fireline or fireground which is essential for fire fighter safety and survival. Two essential tasks relevant for this incident are defensive driving and wildland fire fighter training.

The minimum requirements for a fire service vehicle operations training program are contained in NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*.[1] Fire departments should also use the Bureau of Land Management Engine Operator course, PMS 419 to train and certify engine operators on the safe and effective use of wildland engines.[2] The objective of the training program is to prevent crashes, injuries, and fatalities (both civilian and fire service) involving fire service vehicles. Fire departments must also ensure that fire fighters are familiar with all of the different models of fire apparatus that they may be expected to operate. The members should be trained to operate specific vehicles or classes of vehicles before being authorized to drive or operate such vehicles.[1] Defensive driving skills are one of the most important aspects of safe driving. All fire department drivers should be trained on the basic concepts of defensive driving techniques such as visual lead time and braking and reaction time.

Visual Lead Time

Visual lead time interacts directly with reaction time and stopping distances. As stated in the International Fire Service Training Association (IFSTA), Fire Department Pumping Apparatus Handbook, by “aiming high in steering” and “getting the big picture” it is possible to become more

keenly aware of conditions that may require slowing or stopping.[3] The driver/operator is responsible for 360-degree driving.

Braking and Reaction Time

Speed directly affects the distance required to stop a vehicle. A driver/operator should know the total stopping distance of the emergency vehicle/apparatus. The total stopping distance is the sum of the driver/operator reaction distance and the vehicle braking distance. The driver reaction distance is the distance a vehicle travels as the driver is transferring the foot from the accelerator to the brake pedal after perceiving the need for stopping. The braking distance is the distance the vehicle travels from the time the brakes are applied until it comes to a complete stop (Figure).[3]

In this incident, the circumstances suggest the apparatus was being driven too fast for the limited visibility created by the fire and smoke conditions. The driver was unable to stop the apparatus before it plummeted into the dry creek bed where the bridge had been consumed by fire. In order for fire fighters to be effective and to remain safe on the fireline, adequate training is paramount. NFPA 1051, *Standard for wildland fire fighter professional qualifications* identifies requisite knowledge for wildland fire fighters including fireline safety, use, and limitations of personal protective equipment, agency policy on fire shelter use, basic wildland fire behavior, fire suppression techniques, basic wildland fire tactics, the fire fighter's role within the local incident management system, and first aid.[4]

The fire department involved in this incident did not have any type of formalized training for their members.

Recommendation #2: Fire departments, municipalities, and authorities having jurisdiction should establish pre-incident plans regarding traffic control for emergency service incidents and pre-incident agreements with public safety agencies, traffic management organizations, and private sector responders.

Discussion: Pre-incident planning is fundamental to effective traffic control and management. A preplan should: (1) account for possible use of detours; (2) anticipate the likelihood of vehicles transporting hazardous materials or of extraordinary weight or size; (3) accommodate the need to keep commerce flowing; (4) minimize the possibility of secondary incidents; and (5) account for possible impact on neighboring jurisdictions. [5]

According to the US Fire Administration, specific concepts that should be addressed in pre-incident planning for roadway incident operations include the following:

- all agencies that may respond to roadway incidents should be fully involved in the process, formatting and development of the plan, and ensure that the final plan is easily understood and implemented within their agency
- each agency involved must provide initial and refresher training, and ensure that individual and organizational roles are understood

- each agency should make sure that personnel are at least minimally briefed on the roles and procedures of other plan participants to avoid on-scene confusion and conflict. [6]

In this incident, a wooden bridge on the main highway into the town that was threatened by fire had collapsed due to fire. A highway patrol officer had reported the bridge's condition to the command post which was staffed by the local sheriff. Command was overwhelmed and understaffed with attempting to coordinate all the necessary tasks related to this incident. There weren't any temporary traffic control or warning devices put into place to alert motorists that the bridge was out of service. States and municipalities in conjunction with fire departments, emergency medical responders, law enforcement, and private sector responders should develop pre-incident plans that include automatic response protocols that include traffic control. These municipalities and departments should inventory and map critical structures like wooden bridges that may be compromised by wildfire prior to an incident occurring. Governing entities should ensure that adequate funding is available to staff and equip emergency response protocols once jointly established and agreed upon by all parties involved.

Recommendation #3: Fire departments, municipalities, and authorities having jurisdiction should train on utilizing the national incident management system to effectively respond to and manage multi-agency incidents.

Discussion: The National Incident Management Systems (NIMS) is a comprehensive, nationwide, systematic approach to incident management, including the Incident Command System, Multiagency Coordination Systems, and Public Information. Incidents are typically local events that only require management from the lowest geographical, organizational, and jurisdictional level. There can be local incidents that require response from multiple jurisdictions, levels of government, and functional agencies. These incidents will require someone to effectively and efficiently communicate and coordinate the different organizations and activities. [7]

Within NIMS, the following elements are critical for its success: planning; procedures and protocols; training and exercises; personnel qualifications, licensure, and certification; and equipment certification.[7] In this incident, the local sheriff's office was set up to be the incident command center. The sheriff was the only person from his office that had NIMS training, which was IS-700 the introductory course. The sheriff's office did not have the capacity or manpower to handle the communications and coordination needed to manage this multi-agency incident. Effective adoption, implementation, and training of all NIMS components and personnel in advance of an event will facilitate a cohesive response between the multiple agencies and emergency management. Elements of NIMS that could have assisted during this incident include: (1) conducting joint training with all agencies and departments that will respond together within a geographical response district annually to foster and ensure an understanding of command and control and communications; (2) utilizing a Liaison Officer to coordinate police and emergency medical services that are responding to the incident; and (3) pre-assigning mutual aid radio frequencies between all emergency responders that could work together in a specific geographical area. [7]

Recommendation #4: Fire departments, municipalities, and authorities having jurisdiction should be aware of programs that provide assistance in obtaining alternative funding, such as grant funding, to provide for critically needed resources such as training.

Discussion: The primary goal of the Assistance to Fire Fighters Grant (AFG) Program is to provide critically needed resources such as emergency vehicles and apparatus, equipment, protective gear, training for responders, communication equipment, and other needs to help fire departments protect the public and emergency workers from fire and related hazards. The Grant Programs Directorate of the Federal Emergency Management Agency (FEMA) administers the grants in cooperation with the USFA.

Additionally, there are organizations that can assist fire departments in researching, requesting, and writing grant applications. Useful resources include the following:

Federal Emergency Management Agency (FEMA), Assistance to Firefighters Grant (AFG) Program
www.firegrantsupport.com
FEMA grants are awarded to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards. This Web site offers resources to help fire departments prepare and submit grant requests.

National Fire Protection Association (NFPA), Safer Act Grant
www.nfpa.org/SAFERActGrant
NFPA provides excerpts and other online resources to assist fire departments with the grant application process.

National Volunteer Fire Council (NVFC), Grants & Funding
www.nvfc.org/page/638/Grants__Funding.htm
The NVFC provides an online resource center to assist departments applying for AFG and SAFER grants, including narratives from successful past grant applications and a listing of federal grant and funding opportunities.

FireGrantsHelp.com
www.firegrantshelp.com
A nongovernmental group, FireGrantsHelp.com provides an extensive database of information on federal, state, local, and corporate grant opportunities for first responders.

REFERENCES

1. NFPA [2007]. NFPA 1451 standard for a fire service vehicle operations training program. Quincy, MA: National Fire Protection Association.

2. BLM [2009]. Engine Operator. U.S. Department of the Interior, Bureau of Land Management. August 2009

3. International Fire Service Training Association [1999]. Pumping apparatus driver operator handbook. 1st ed. Stillwater, OK: Oklahoma State University.

4. National Fire Protection Association [2007]. NFPA 1051, standard for wildland fire fighter professional qualifications. Quincy, MA: National Fire Protection Association.

5. Cumberland Valley Volunteer Firemen's Association. [1999]. A White Paper: Protecting Emergency Responders on the Highways. Emmitsburg, MD: U.S. Fire Administration.

6. US Fire Administration [2008]. Traffic Incident Management Systems. Emmitsburg, MD: Federal Emergency Management Agency, US Fire Administration.

7. FEMA [2008]. National Incident Management System. http://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf . Date accessed: March 2010.

INVESTIGATOR INFORMATION

This incident was investigated by Jay Tarley, Safety and Occupational Health Specialist and Matt Bowyer, General Engineer, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH. The primary author of this report was Jay Tarley. Expert technical review was provided by Dick Mangan, Blackbull Wildfire Services. A review of parts of the report that described the incident was provided by Captain Brian Lyons, Colorado State Patrol.

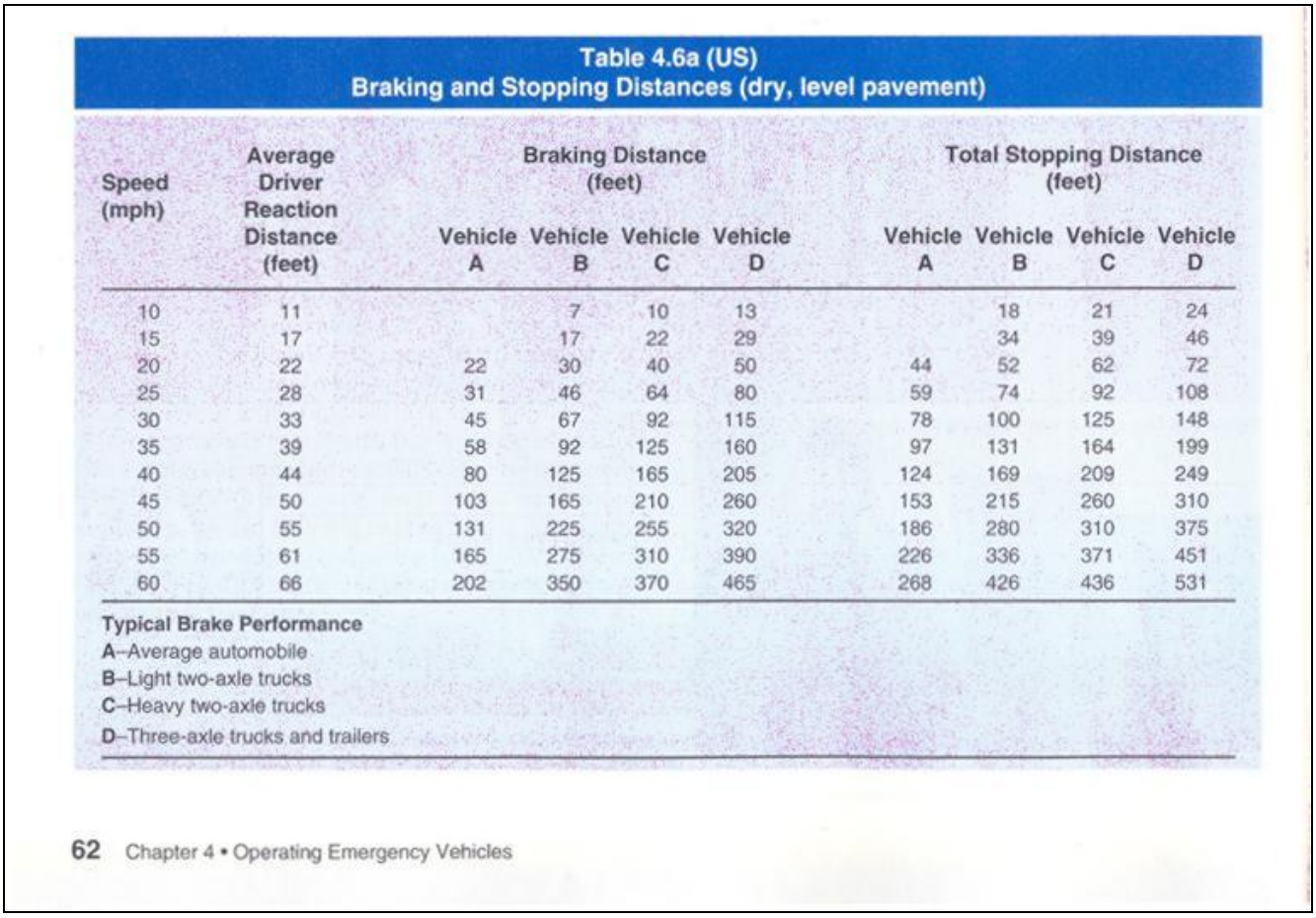

Table 4.6a (US)
Braking and Stopping Distances (dry, level pavement)

Speed (mph)	Average Driver Reaction Distance (feet)	Braking Distance (feet)				Total Stopping Distance (feet)			
		Vehicle A	Vehicle B	Vehicle C	Vehicle D	Vehicle A	Vehicle B	Vehicle C	Vehicle D
10	11		7	10	13		18	21	24
15	17		17	22	29		34	39	46
20	22	22	30	40	50	44	52	62	72
25	28	31	46	64	80	59	74	92	108
30	33	45	67	92	115	78	100	125	148
35	39	58	92	125	160	97	131	164	199
40	44	80	125	165	205	124	169	209	249
45	50	103	165	210	260	153	215	260	310
50	55	131	225	255	320	186	280	310	375
55	61	165	275	310	390	226	336	371	451
60	66	202	350	370	465	268	426	436	531

Typical Brake Performance
A–Average automobile
B–Light two-axle trucks
C–Heavy two-axle trucks
D–Three-axle trucks and trailers

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Figure. Stopping distances for vehicles while driving on dry pavement.[3]
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Photo 1. Photo of bridge taken in 2004.
(Photo courtesy of state Department of Transportation.)

Photo 2. Photo of timber bridge construction shown from underneath the bridge that collapsed during this incident. Photo taken in 2006.
(Photo courtesy of state Department of Transportation.)

Photo 3. Condition of wildland engine after crashing due to the collapsed bridge and subsequent fire damage.
(Photo courtesy of state forestry department.)