



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

March 7, 2000

Downed Power Line Claims the Life of One Volunteer Fire Fighter and Critically Injures Two Fellow Fire Fighters - Missouri

SUMMARY

On October 4, 1999, a 20-year-old male volunteer fire fighter (the victim) was electrocuted and two other fire fighters were injured when they contacted an electric fence while fighting a grass fire. Central Dispatch notified the fire department at 0700 hours of a fire which was started when a downed power line ignited the surrounding grass. The Chief was the first to arrive on scene, and he confirmed that a power line was down. He also indicated to Central Dispatch and to the responding fire fighters that the electric fence bordering the area was energized by the downed power line. The Chief parked his truck on the road near the end of the downed line to warn arriving units of its location. Engine 1, with a driver and one fire fighter (Injured #1), was next to arrive and was positioned in a driveway on the north flank

of the fire (Figure 3). Two fire fighters (the victim and Injured #2) arrived in their privately owned vehicles and assisted the driver of Engine 1 and Injured #1 pull a booster line off Engine 1. After the victim, the driver of Engine 1, and Injured #1 and #2 pulled a booster line, they crawled underneath the bottom wire of the electric fence. Injured #1 and Injured #2 positioned themselves approximately 50 feet from the downed power line and attacked the primary fire. To prevent the fire from spreading to brush piles in the adjoining piece of property, the driver of Engine 1 rolled back under the energized fence to get a rake and create a fire control line around the brush piles. After approximately 15 minutes on the fire ground, the Chief yelled for assistance to the driver of Engine 1, stating that he had three fire fighters down. The three fire fighters were lying in the area of a secondary fire (Figure 1). The Chief grabbed Injured #1 by the collar of her bunker coat and pulled her from the fire. The driver of Engine 1 grabbed Injured #2 and the victim and removed them from the fire. Basic first aid procedures were administered until the ambulance arrived. Injured #1 was transported by helicopter to an area hospital, and Injured #2 was transported



Incident Site

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

<http://www.cdc.gov/niosh/firehome.html>

or call toll free 1-800-35-NIOSH



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by ambulance to the local hospital and then moved to the burn unit of an area hospital. The victim was transported by ambulance to a local hospital and pronounced dead on arrival. NIOSH investigators concluded that to minimize the risk of similar occurrences fire departments should:

- ***ensure that the Incident Commander conveys strategic decisions to all suppression crews on the fire ground and continually reevaluates fire conditions***
- ***ensure that fire fighters stay away from downed power lines a distance equal to at least one span between poles until the power line is de-energized***
- ***ensure fire fighters are aware of the hazards when working around energized parts or equipment***
- ***ensure fire fighters are equipped with the proper personal protective equipment and monitor to ensure its use***

INTRODUCTION

On October 4, 1999, a volunteer fire department responded to a grass fire at a local residence that had been started by one phase of 3-phase, 7200-volt, downed power line. A 20-year-old male fire fighter (the victim), a 59-year-old female fire fighter (Injured #1), and a 37-year-old male fire fighter (Injured #2) made contact with an electric fence that was energized by the downed power line which was lying across it. On October 7, 1999, The United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of the incident. On October 19-20 two Safety and Occupational Health Specialists from NIOSH, Division of Safety Research, investigated the incident. Interviews were conducted with the Chief, the Lieutenant, and other members of the fire

department who were at the fire scene. The incident site was visited and the fire scene was photographed. Copies of witness statements, training records, standard operating procedures (SOPs), the death certificate, and a map of the fire scene were obtained. The volunteer department consists of 2 stations and 26 uniformed fire fighters. The department serves a population of 30,000 in an area of 160 square miles. At the time of the incident the victim was wearing cotton jeans, a cotton shirt, and leather work boots. Injured #1 was wearing a bunker coat, polyester pants, leather tennis shoes, and leather gloves. Injured #2 was wearing a cotton jacket, cotton pants, cotton shirt, and leather work boots.

The incident occurred on a 1/4-acre grassy field (approximately 1/8 of an acre was burned) that was surrounded by an electric fence used to control livestock. At the time of the incident the resident did not have the electric fence energized. The weather conditions that affected this fire included a relative humidity of 93%, an ambient air temperature of 44^o F, and a wind speed of 9 mph with gust speeds of up to 20 mph. The victim had 4 months of fire fighting experience; Injured #1 and Injured #2 have 4 and 6 years of experience respectively.

The State requires that all fire fighters complete training equivalent to National Fire Protection Association (NFPA) Level I. Injured #1 and #2 both completed NFPA Level I training through the State of Missouri. Because the victim had recently joined the department, he had not completed NFPA Level I training. The fire department provides training opportunities both in-house and through the University of Missouri at Columbia. Injured #1 received the following training: instrument qualification, liquefied petroleum gas, water supply, emergency vehicle driver training, incident safety officer, building construction (wood and ordinary frame), specialist instrument, auto rescue, basic pump, introduction to fire, confined space, school bus rescue, and incident command



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system, and attended a mutual aid meeting with the local power company. Injured #2 received the following training: emergency vehicle driver, propane fire safety, and in-house training opportunities. The victim received liquefied petroleum gas training and varying hours of in-house training.

INVESTIGATION

On October 4, 1999, at 0658 hours, a property owner notified Central Dispatch of a grass fire. The fire was started when one phase of a 3-phase, 7200-volt, overhead power line separated from the connection on a utility pole (Figure 2) and fell to the ground, igniting the surrounding grass area (Figure 1). When the power line fell, it crossed the road and a grassy field and came to rest on an electric fence, which it energized. At 0700 hours, Central Dispatch notified the fire department of a grass fire with a downed energized power line. At 0704 hours, the Chief was first to arrive on scene in his privately owned vehicle (POV) and parked approximately 20 feet from the end of the downed power line to alert arriving units of its location (Figure 3). The Chief conducted a scene size-up, and he reported a grass fire with a slow rate of spread and light fuel. He confirmed to the arriving units that a power line was down, and he indicated that the electric fence was energized due to the downed power line. (Note: This was an electric fence used to control live stock. However, the fence was not operable at this time.) He then radioed Central Dispatch and asked the power company to de-energize the line. Engine 1, which has a 1,000-gallon tank, arrived at 0706 hours with two fire fighters (the driver and Injured #1). The Chief directed the driver to pull the Engine into a driveway on the north flank of the fire (Figure 1). Truck 3 (brush/wildland truck with a 250-gallon tank), with a fire fighter/driver, arrived at 0707 hours and was directed by the Chief to a position on the south flank of the fire. Immediately after Truck 3's arrival, two fire fighters (the victim and Injured #2) arrived in their POVs, pulled into the driveway on the

north flank of the fire, and helped the driver of Engine 1 pull a 1-inch booster line. The driver of Engine 1 climbed on top of the apparatus and pulled the 150-foot booster line from the left side, crossing over the top of the apparatus and down over the right side. The driver fed the line to Injured #1, Injured #2, and the victim. Injured #1, Injured #2, and the victim crawled with the 1-inch booster line under the bottom wire of the electric fence (approximately 23 inches from the ground) into the field to attack the fire. Injured #2 grabbed the nozzle as Injured #1 and the victim served as back up. After the driver of Engine 1 finished helping pull the hose off the Engine, he then rolled under the electric fence into the field to aid in the attack. As the driver of Truck 3 drove the apparatus to the south flank of the fire to gain access to an adjoining field, he passed the downed power line. He radioed the Chief that the electric fence prevented him from gaining access to the field. The Chief told him not to cross the fence because it was energized. He ordered the driver to bring the apparatus back to the road and wait for the fire to burn its way to him. As Truck 3 started toward the road, a resident told the driver that he saw smoke in the southeast corner of the field.

The driver of Engine 1 again rolled under the electric fence and returned to the apparatus. He grabbed a rake off the Engine to create a fire control line around piles of brush on the south flank of the fire. At the same time, the driver of Truck 3 used a booster line to extinguish a small spot fire on the southeast corner of the field (Figure 1). At 0711 hours, the Chief called Central Dispatch for the power company's estimated time of arrival and was informed that they were en route. At approximately 0715 hours, a fire fighter assigned to Truck 3 arrived by POV, and passing the driveway on the north flank, saw two fire fighters (Injured #1 and the victim) working near the energized fence and Engine 1. The Chief directed him to drive his POV to the southeast flank of the fire and assist the driver of Truck 3. When he arrived



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at Truck 3, the driver was rolling the booster line back onto the apparatus. The Chief, still in position near the downed power line, was monitoring the crews on both the north and south flanks. A technician from the power company, arriving by POV, stated that he would wait for the utility truck to arrive to de-energize the line. As the technician pulled away, the Chief looked to the north and south flanks to check on the status of the crews and saw smoke on the north flank near the electric fence and Engine 1. He saw a fire in the field approximately 20 feet away from Engine 1. As he was moving toward the driveway on the north flank he did not see the three fire fighters. He then proceeded up the driveway and saw the fire fighters (Injured #1, Injured #2, and the victim) lying in a ring of fire (secondary fire). The Chief ran to Engine 1 and radioed Central Dispatch at 0722 hours, requesting an ambulance for three downed fire fighters. He then yelled to the driver of Engine 1, who was approximately 150 feet away from the Engine, for help. The driver of Engine 1 ran from his position on the south flank of the fire around the perimeter of the electric fence to the location of the Engine. *Note: The driver of Engine 1 jumped over the downed power line (positioned approximately 18 inches off the ground) where it crossed the east section of the electric fence.* After hearing the call (over the radio) for an ambulance, the driver and a fire fighter from Truck 3 left the south flank and drove the apparatus to the north flank of the fire. All three fire fighters were lying in the area of the secondary fire and their clothes were burning (see Figure 3). The Chief dragged Injured #1 out of the fire by the collar of her bunker coat. As the driver of Engine 1 pulled Injured #2 out of the fire, he began to pat his clothes, snuffing out the fire that was burning them. He then moved to the victim, pulled him from the secondary fire, and placed him a safe distance from the energized fence. The nozzle of the 1-inch booster line was approximately 10 feet from the fence inside the field. The Chief

pulled the nozzle toward himself, and after gaining control of the hose, he extinguished the fire near the apparatus. Using a fog spray, he then extinguished the fires on the three downed fire fighters. The remaining portion of the secondary fire burned itself out. At approximately 0718 hours, a power company technician arrived on scene with a utility truck and de-energized the line approximately 2 minutes later. At 0726 hours the Chief radioed Central Dispatch and requested two additional ambulances and a helicopter. The fire fighter from Truck 3 assessed the condition of Injured #1 and Injured #2, noting that both fire fighters had weak pulses and were breathing, and that they were gurgling and foaming at the mouth. He rotated from Injured #1 to Injured #2, keeping their airways open. The driver from Engine 1 checked the victim's vital signs and heard him breathing. Noting that the victim's airway was obstructed by his swollen tongue, the driver from Engine 1 used his fingers to keep the victim's airway open. While waiting for the additional emergency response personnel to arrive, the driver of Truck 3 continued to extinguish spot fires in the field. Approximately 3 minutes later the first ambulance arrived, and within minutes the second ambulance and helicopter arrived. Injured #1 was flown to an area burn center, and Injured #2 was transported by ambulance to a local hospital and then transferred to an area burn center. The victim was transported by ambulance to a local hospital where he was pronounced dead on arrival. *Note: Due to the extent of their injuries, the injured fire fighters have no memory of the incident. Although exactly what happened is unknown, it is possible that when Injured #1 was crawling on her back under the electric fence, a hook from her bunker coat may have made contact with the bottom wire of the fence. It is also believed that the victim and/or Injured #2 were shocked while trying to help Injured #1, who was still energized.*



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CAUSE OF DEATH/INJURY INFORMATION

According to the medical examiner's report, the victim's cause of death was electrocution. The attending physician listed the two fire fighter's injuries as follows:

Injured #1 received electrical burns over 30% of her body surface; injuries included

- eye, face, and hand involvement (posttraumatic amputation of the left hand)
- deep thermal and electrical burns to bilateral lower extremities, buttocks, and back

Injured #2 received electrical and thermal burns over 4% of his body surface area; injuries included

- burns to his head and face and multiple splatter burns across his arms and legs
- burns to his left posterior and lateral flank
- deep burn to his left elbow

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Fire departments should ensure that the Incident Commander conveys strategic decisions to all suppression crews on the fire ground and continually reevaluates fire conditions.^{1,4}

Discussion: The Incident Commander (IC) should develop fire ground strategies to support the incident action plan and manage assigned personnel. The IC should routinely evaluate the effects of his initial decisions, reevaluate fire conditions, and fine tune the attack plan, making significant changes when necessary. Upon reevaluating the fire conditions, the IC should convey safety-related information to all personnel and maintain incident command communications. On small fireground operations, this information could be relayed through face-to-face contact. However, on larger fireground operations, as crews become spread out, the use of two-way radios may be needed. To avoid the energized fence, the IC directed the driver of Truck

3 on the south flank to let the fire burn to him before trying to extinguish it. However, due to a breakdown in communication, the fire fighters on the north flank did not receive this information.

Recommendation #2: Fire departments should ensure that fire fighters stay away from downed power lines a distance equal to at least one span between poles until the power line is de-energized.²

Discussion: As stated in *Fundamentals of Wildland Fire Fighting*, when downed power lines come in contact with the ground, current flows outward in all directions from the point of contact (ground gradient), and the energized area can extend several feet from the point of contact. Therefore, walking in proximity to the energized area could electrocute fire fighters. To avoid this hazard, fire fighters should keep ample distance away from the downed power line (equal to at least one span between poles) until the power line is de-energized. If the fire has not burned past the distance equal to one span between poles, fire departments should delay their attack until the fire has burned past this recommended span.

Recommendation #3: Fire departments should ensure fire fighters are aware of the hazards when working around energized parts or equipment.³

Discussion: Training should be provided and include safe work practices for employees to avoid the risk of being injured or killed while working in areas with energized parts. The victim was a volunteer fire fighter and was not covered by OSHA regulation. However, fire departments could use OSHA safety standard 29 CFR 1910.332 (b) as a source of information and provide training to fire fighters who face the risk of electrical shock. The local power and gas company had provided training to the fire department. The utility company's training, offered



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free upon request to all departments, included information about electrical and gas safety, hazards of a downed power line, effects of arcing, etc. The last training conducted by the utility company was offered in 1998, before the victim was a member of the department.

Recommendation #4: *Fire departments should provide fire ground personnel with personal protective equipment and monitor to ensure its use.*⁴

Discussion: Fire departments should establish standard operating procedures for the use of wildland protective clothing and ensure its use by members who engage in or are exposed to the hazards of wildland fire fighting. All members of the volunteer department were issued the proper personal protective clothing for fighting wildland fires (Nomex IIIA ®). If Injured Fire Fighter #1 and #2 had been wearing Nomex ® clothing (NFPA 1977 compliant), they might have greatly reduced the severity of their burn injuries. Members who engage in or are exposed to the hazards of wildland fire fighting operations should be provided with and use a protective ensemble that meets the requirements of *NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Fire Fighting*.

REFERENCES

1. Brunacini, Alan V. [1985]. Fire command. Quincy, MA: National Fire Protection Association.
2. International Fire Service Training Association [1998]. Fundamentals of wildland fire fighting. 4th ed. Stillwater, OK: Oklahoma State University, Fire Protection Publications.
3. 29 Code of Federal Regulations 1910.332 (b), Training. Electrical Safety-Related Work Practices.
4. National Fire Protection Association [1997]. NFPA 1500, standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

INVESTIGATOR INFORMATION

This investigation was conducted by Kimberly L. Cortez and Thomas P. Mezzanotte, Safety and Occupational Health Specialists, NIOSH, Division of Safety Research, Surveillance and Field Investigations Branch.

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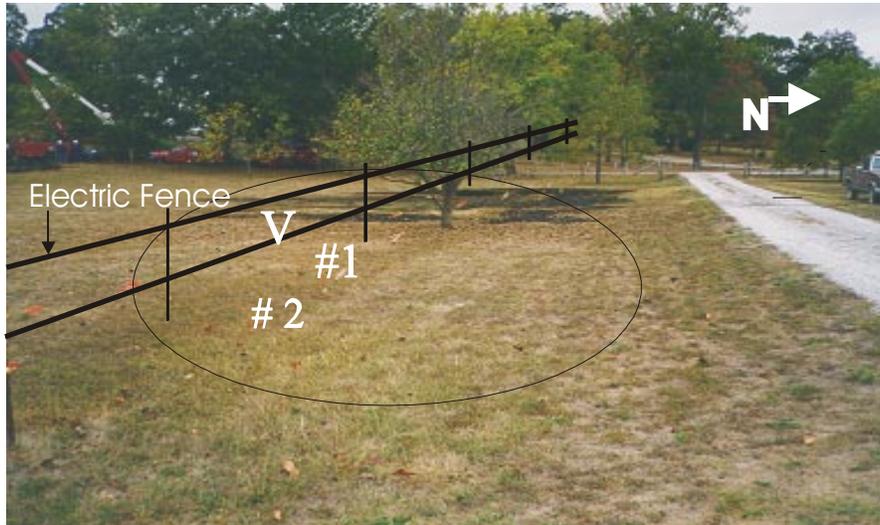


Figure 1. Secondary Fire Site: Location of Victim (V) and Two Injured Fire Fighters (#1 and #2) in Relation to Electric Fence



Figure 2. Point of Separation Between the Power Line and Connector

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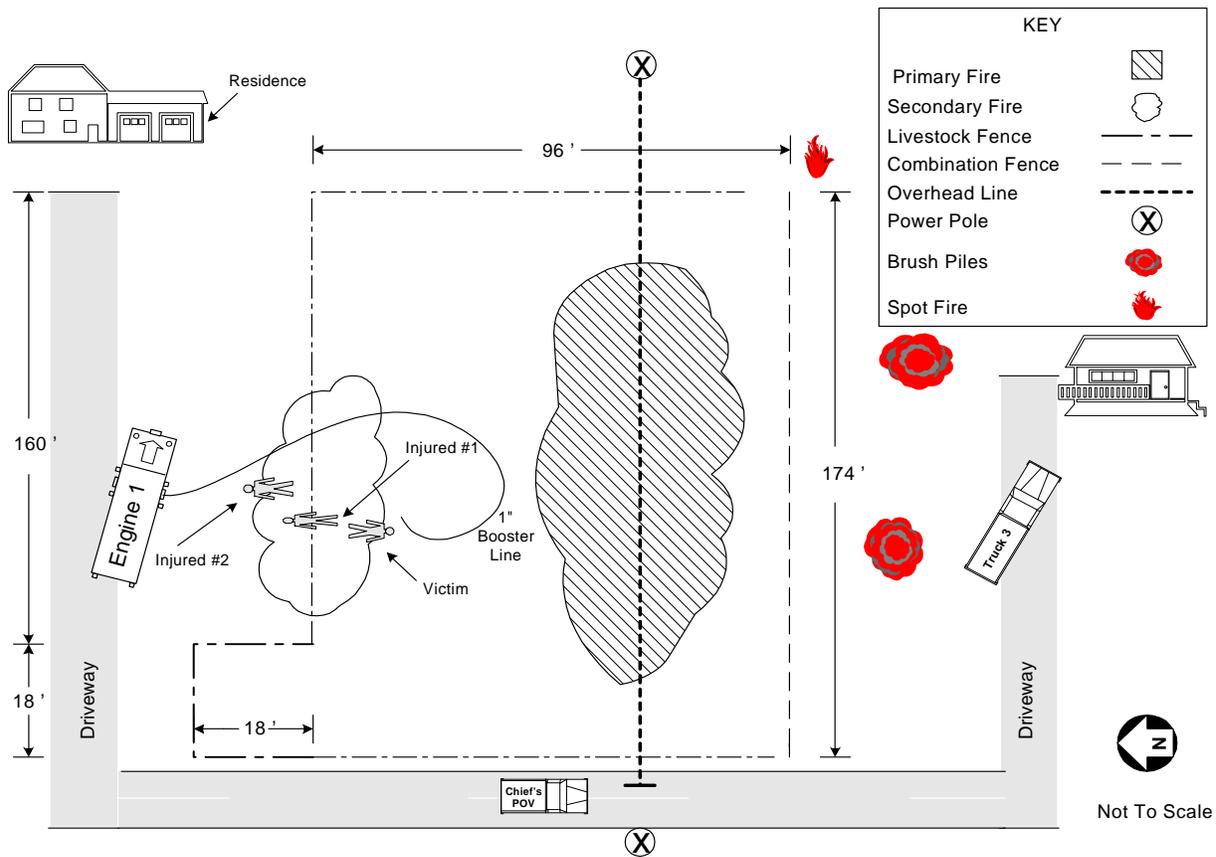


Figure 3. Aerial View of Incident Site