Volunteer Fire Fighter Dies and Three Fire Fighters are Injured during Wildland Fire -Texas

Executive Summary

On April 9, 2011, a 49 year-old male volunteer fire fighter (the victim) suffered third-degree burns over 60% of his body while operating at a wildland fire. The victim was riding in one of two fire department brush trucks that became stuck in sand. The four fire fighters abandoned their apparatus and walked southeast towards the nearest road to escape the fire. Approximately 300 yards from the apparatus, the fire fighters became separated due to poor visibility. The Incident Commander (IC) and the driver of the victim's brush truck later found the victim approximately 1–1½ miles from the abandoned brush truck. The victim was lying on a "dozer" road, suffering from severe burns to his upper torso. The IC transported the victim to the "Medical Group" for treatment and transport to the local hospital. The victim was later transferred to a large metropolitan hospital burn center where he died on April 20, 2011.

Brush truck (Brush 51) that the victim abandoned at the incident when the apparatus became stuck in sand. The fire damage to the apparatus occurred after the driver and victim left the apparatus.
(Photo by NIOSH)

Contributing Factors

- *Ineffective situational awareness*
- *Ineffective training on wildland fire-fighting*
- *Ineffective personnel accountability system*
- *Ineffective personal protective equipment*
- *A safety zone and escape route were not effectively communicated to all fire fighters*

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- *Failure to use a fire shelter from the approaching fire.*

Key Recommendations

- *Ensure that the Incident Commander conducts a continuous risk assessment of the incident in terms of savable lives, savable property, and fire fighter safety*
- *Fire fighters who engage in wildland fire-fighting should be trained to meet the minimum training requirements as required by the National Wildfire Coordinating Group (NWCG) or NFPA 1051, Standard for Wildland Fire Fighter Professional Qualifications*
- *Fire departments and fire service agencies should ensure that fire fighters fully comply with "The Standard Fire Orders "and are aware of the "18 Watchout Situations" and "Common Denominators of Fire Behavior on Tragedy Fires"*
- *Lookouts, communications, escape routes, and safety zones (LCES) should be established and communicated to all fire fighters*
- *Fire fighters who engage in wildland fire-fighting should use personal protective equipment that meets NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Fire Fighting*
- *A personnel accountability system should be used to account for all fire fighters and first responders assigned to any incident*
- *Provide fire fighters with approved fire shelters and provide training on the proper deployment of the fire shelters*
- *Fire departments should ensure apparatus driver/operators are familiar with the operation of their apparatus, especially when driving off-road.*

Additionally, governing municipalities (federal, state, regional, and local) should:

- *consider requiring mandatory training for wildland fire fighters.*

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In 1998, Congress appropriated funds to NIOSH to conduct a fire fighter initiative that resulted in the NIOSH "Fire Fighter Fatality Investigation and Prevention Program" which examines line-of-duty-deaths or on duty deaths of fire fighters to assist fire departments, fire fighters, the fire service and others to prevent similar fire fighter deaths in the future. The agency does not enforce compliance with State or Federal occupational safety and health standards and does not determine fault or assign blame. Participation of fire departments and individuals in NIOSH investigations is voluntary. Under its program, NIOSH investigators interview persons with knowledge of the incident who agree to be interviewed and review available records to develop a description of the conditions and circumstances leading to the death(s). Interviewees are not asked to sign sworn statements and interviews are not recorded. The agency's reports do not name the victim, the fire department or those interviewed. The NIOSH report's summary of the conditions and circumstances surrounding the fatality is intended to provide context to the agency's recommendations and is not intended to be definitive for purposes of determining any claim or benefit.

For further information, visit the program Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On Saturday, April 9, 2011, a 49-year-old male volunteer fire fighter (the victim) suffered third-degree burns over 60% of his body during wildland fire-fighting operations. After getting burned by a fast moving wildland fire, the victim was transported from the incident scene to a local hospital and later transferred to a large metropolitan hospital burn center. The victim remained in critical condition until his death on April 20, 2011. That day, the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On May 4–6, 2011, one safety and occupational health specialist and one investigator from the NIOSH Fire Fighter Fatality Investigation and Prevention Program and one occupational safety and health specialist from the NIOSH Western States Office traveled to Texas to investigate this incident. The NIOSH investigators met with representatives from the victim's fire department, other responding fire departments, local law enforcement, and the Texas Department of Insurance, State Fire Marshal's Office. During the investigation, witness statements were reviewed and interviews were conducted with the fire fighters and officers involved in the incident. NIOSH investigators also reviewed the training requirements of all local fire departments and the training records of the Incident Commander. The victim's turnout gear was inspected and photographed, the apparatus that was damaged or destroyed by the fire were inspected and photographed, the incident scene was visited and photographed, and investigators reviewed incident scene photographs, fire ground dispatch records, and area maps.

Fire Department

The victim's fire department is a volunteer fire department with one fire station staffed by 17 volunteer fire fighters. The fire department provides fire protection for an incorporated area of two square miles, serving approximately 2,600 residents. The fire department maintained limited records and could not substantiate the number of responses or incidents they responded to annually, nor could they produce training records for members.

Training and Experience

In Texas, all volunteer fire fighter training requirements, certification requirements, and standards are determined by local fire departments. The victim's fire department reported that they did not have training or certification requirements for an individual to join and participate as a member of their department. The department was also unable to provide documentation of any formal fire training or certifications for the victim during his tenure as a volunteer fire fighter. It was unknown or documented how long the victim was a member of the fire department.

The Incident Commander (IC) was a career Lieutenant from a combination fire department in the municipality that serves as the county seat. The IC had completed the following incident management training: IS-00100, *Introduction to ICS*; IS-00200, *Basic ICS*; ICS 300, *Intermediate ICS*; ICS 400, *Advanced ICS*; and IS-00800A, *National Response Plan*. In addition, he has completed Texas Fire Fighter Basic, Fire Fighter Intermediate, Fire Service Instructor I, Fire Inspector Basic, Hazardous

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Materials Technician, Public Fire Educator II, and Emergency Medical Technician. The lieutenant received 8 hours of wildland fire-fighting training during Texas Fire Fighter Basic (NFPA 1001, Fire Fighter I). Interviews with fire fighters indicated that formalized wildland fire-fighting training is not a requirement for fire fighters in this region.

Equipment and Personnel

On April 9, 2011, three county fire departments were alerted for a wildland fire that was burning into their fire protection area. The following apparatus and personnel, from the two fire departments directly involved in the fatality, responded to this incident.

Resource Designation	Resource Type	Staffing	Time Dispatched
Combination Fire Department			
Booster 2 (B2)	**Type 6 Wildland Engine**	**Two fire fighters**	**1357 Hours**
Tanker 54 (T54)	**Type 2 Water Tender**	**One fire fighter**	**1415 Hours**
Engine 57 (E57)	**Type 1 Structural Engine**	**Two fire fighters**	**1800 Hours**
Booster 58 (B58)	**Type 6 Wildland Engine**	**Two fire fighters**	**1357 Hours**
Unit 5 (U5)	**Command Vehicle**	**Lieutenant**	**1357 Hours**
Unit 300 (U300)	**Command Vehicle**	**Fire Chief**	**1530 Hours**
Volunteer Fire Department			
Brush 51 (B51)	**Type 6 Wildland Engine**	**Three fire fighters (assistant chief, the victim, and a fire fighter)**	**1357 Hours**

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Personal Protective Equipment

Following the incident, the personal protective equipment (turnout pants, helmet, boots) worn by the victim was secured by the city police department. The victim was wearing structural turnout pants and boots over street clothes, a T-shirt, safety glasses, and a structural fire-fighting helmet. When the victim was located, he was wearing only turnout pants, T-shirt, safety glasses, and the helmet. His rubber turnout boots had been removed and were lying in the road behind him. The victim was seen carrying his turnout coat when he exited the brush truck to escape the fire; however, when found, the victim was not wearing the turnout coat and investigators were unable to locate the turnout coat. NIOSH investigators inspected the turnout pants and boots worn by the victim. Also, the turnout pants and boots were shipped to the NIOSH National Personal Protective Testing Laboratory (NPPTL) for evaluation and testing. The PPE evaluation report will be added when the report is available.

Timeline

Note: This timeline is a summary of events that occurred as the incident evolved. Not all events are included in this timeline. The times are approximate and were obtained by studying the dispatch records, witness statements, and other available information. In some cases, the times are rounded to the nearest minute.

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
April 9 A county fire dispatcher receives a 911 call regarding a wildland fire which is burning in the county's fire protection area. The dispatcher notifies fire personnel from local fire departments of the fire.	**1357**	A lieutenant from a combination fire department responds to the wildland fire in Unit 5. Four fire fighters from the same fire department also respond in Booster 2 and Booster 58.
	1416	Unit 5 arrives on scene. He establishes "Command".
	1420	Booster 2 and Booster 58 arrive on scene.

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Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
	1428	Tanker 54 arrives on scene at the staging area near Highway 287 South and CIG Road; Driver of Tanker 54 is designated as staging area manager.
Fire is moving in a northern direction and is primarily wind driven. The size of the fire is unknown.	1430	"Command" uses CIG Road as a natural fire break; divides the fire into Division A and Division B.
	1435	Brush 51 with three fire fighters (including the victim) arrives on scene at the staging area. One fire fighter from Brush 51 is assigned to assist the staging area manager with filling brush trucks with water.
	1455	Two fire fighters in Brush 51 (including the victim) leave the scene to fill up their vehicle with fuel.
Fire jumps CIG Road.	1515	"Command" divides the fire into Division North and Division South; requests additional resources including two county road graders; "Command" re-directs and reassigns fire-fighting personnel in an attempt to control the fire.
	1535	Brush 51 (including the victim) arrives on-scene again.

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Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
Fire jumps County Road U.	**1630**	Fire fighters from Brush 51 (including the victim) arrive at the fire near County Road U. Fire fighters in Booster 58 and Brush 51 attempt to extinguish the fire by driving north, off-road through a field along the fire's eastern border.
	1650	While driving through the field, Booster 58 and Brush 51 become stuck in sand, and fire fighters are unable to move the vehicles. A fire fighter in Booster 58 advises "Command" via the radio that they are unable to move their vehicle. All four fire fighters from Booster 58 and Brush 51, including the victim, exit their vehicles and attempt to escape the encroaching fire by walking in a southeastern direction towards County Road U.
	1700	While trying to escape the fire, all four fire fighters become separated because of poor visibility. A rapid intervention crew (RIC) is formed to search for the missing fire fighters. The team consists of the Incident Commander and occupants of Booster 2. A fire fighter from Booster 58 is finally able to make radio contact and advises the RIC of his position.
	1715	Booster 2 locates the two fire fighters from Booster 58 in separate locations.

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Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
	1720	The Incident Commander locates the driver of Brush 51 but is unable to locate the victim and continues to search for him.
	1730	The victim is located in the middle of a "dozer" road, north of County Road U. The victim has been badly burned but is still coherent and is transported to emergency medical personnel in Unit 5.
	1750	Victim is transported to hospital.
	1750	The Fire Chief from a combination fire department assumes "Command."
April 10, 2011	0031	The wildland fire is declared under control.
	1030	The wildland fire is declared out.

Weather and Fire Conditions

The weather on April 9, 2011, was hot, dry, and windy. The temperature at the time of the incident was approximately 87 degrees Fahrenheit, relative humidity was 9%, barometric pressure was 29.68, and the wind speed was 31 miles per hour (MPH) gusting to 42 MPH.[1]

Investigation

On April 9, 2011, at 1357 hours, a county fire dispatcher alerted local fire departments of a wildland fire. The area of the wildland fire is normally lush green grass for raising beef cattle, but at the time of the incident, the area was considered desert grassland and fuels consisted of prairie grass, yucca plants,

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and sage. The Texas Panhandle was experiencing extreme wildfire conditions due to the combination of drought, dry vegetation, high temperatures, low humidity, and high winds.

This wildland fire started when high winds caused power lines to arc, igniting the brush. The fire was primarily wind driven as it burned north/northeast into the county were the fire fighter fatality occurred.

A lieutenant from a local combination fire department was first to respond to the wildland fire in a command vehicle (Unit 5). He responded with two brush trucks (Booster 2 and Booster 58) from his department.

Upon arriving at the wildland fire at 1416 hours, the lieutenant established himself as "Command" and reports the fire as manageable. Booster 2 began fire-fighting operations using CIG Road as a natural fire break. A tanker (Tanker 54) was also dispatched and responded with a driver only. Upon arrival at the incident, the driver was designated as the staging area manager. The Texas Forest Service was also notified and responded with a variety of resources; however, they did not engage in the fire until later. *Note: Per the National Incident Management System (NIMS) and the Incident Command System (ICS), the term for an apparatus that carries water is a tender. A tender is defined as a truck with a permanently mounted water tank with the capabilities of dispensing potable or non-potable water. The dispensing is handled through gravity or a pump. A tanker is defined as a fixed-wing aircraft certified by the Federal Aviation Administration as being capable of transport and delivery of fire retardant solutions. During this incident, responding fire departments referred to the fire apparatus that carried water as a tanker, which is the term used throughout this report.*

At approximately 1430 hours, the IC reported that he drove to a vantage point to get a better view of the fire. At this time, fire suppression resources were split into Division A and Division B, each engaging separate portions of the fire. The IC reported that, at this time, he thought they were going to be able to contain the fire at CIG Road

Arriving on scene at the incident at approximately 1435 hours in Brush 51, three fire fighters including the victim checked in with the staging area manager at CIG road. It was reported the staging area manager needed assistance filling the brush trucks with water, so a fire fighter from Brush 51 remained at the staging area with the staging area manager. It was also reported that Brush 51 was almost out of diesel fuel, so the two remaining fire fighters, including the victim, left the incident and drove approximately 10–15 miles to get diesel fuel.

At approximately 1515 hours, a local sheriff's deputy, who had also responded to the fire and was acting as a lookout at another vantage point, radioed to the IC and told him that the fire had crossed CIG road and was burning north. Upon hearing this, the IC activated an "All Call" (the reverse calling system used to activate additional resources from his fire department), requested two road graders from the county road maintenance department to assist with building a fire line, redirected some of the

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resources north to County Road U, and then requested that the Fire Chief from his fire department go scout north of the fire. When the two fire fighters on Brush 51 returned at approximately 1535 hours, the fire had already breached CIG road, so they were instructed to proceed to County Road U and meet with Booster 58.

At this point, "Command" divided the fire into three separate divisions with a variety of resources (engines, dozers, and personnel). The North Division which was made up of the fire fighters on the victim's brush truck (Brush 51) and fire fighters on three other brush trucks, drove west to Highway 287, north for approximately eight miles, and then proceeded east nine miles on County Road U towards the fire. The South Division was working to anchor the fire at CIG Road. A third division proceeded to another section of the fire not relevant to this investigation.

At approximately 1630 hours, the IC and the brush trucks arrived at the edge of the fire on County Road U. By that time, sections of the fire had already crossed the road and were burning north. After assessing the situation, the IC sent one of the brush trucks east on County Road U to scout the path of the fire. Fire fighters on Booster 58 and Brush 51 engaged the fire along the eastern fire line. The Texas Forest Service was staged at County Road U but was sent by "Command" to another fire that had been reported in the area. The IC staged at County Road U, near a natural gas pipeline compressor station.

To engage the eastern edge of the fire, fire fighters in Booster 58 and Brush 51 left County Road U and drove north, off-road, along a barbed-wire fence. The terrain was rough and was comprised of rolling, sandy hills with sparse grass and yucca plants dispersed intermittently throughout the fields. Two fire fighters were riding in Booster 58, which was a two-wheel drive, Type 6 Wildland Engine. Two additional fire fighters, including the victim, were in Brush 51, following Booster 58. Brush 51 was a four-wheel drive, Type 6 Wildland Engine.

At approximately 1650, Booster 58 became stuck in the sand, approximately 0.7 miles north of County Road U. The driver of Brush 51 drove beside Booster 58 and also became stuck in the sand (see Photo 1). *Note: According to information obtained during the NIOSH interviews, Brush 51 was a four-wheel drive apparatus but was not operating in four-wheel drive when the apparatus became stuck in the sand.*

After several unsuccessful attempts to free the vehicles, one of the fire fighters on Booster 58 contacted the IC on the radio to tell him that they had gotten their brush truck stuck, the fire was approaching, and the apparatus was in danger. The IC replied that the apparatus was not a priority and their safety was the priority. At this point, the fire fighters exited both vehicles and headed south/southeast on foot back towards County Road U in an attempt to escape the fire. It was reported that the two fire fighters in Booster 58 were first to exit their vehicle, followed by the driver of Brush 51 and, lastly, the victim. Due to the poor visibility and the intense heat caused by the encroaching fire, all four fire fighters attempted to escape the fire but became separated when the fire was about to

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overtake them. Fire fighters reported that they saw the victim on foot approximately 300 yards from the apparatus; however, he was not seen again until after the fire had passed over him.

Upon hearing that the fire fighters had abandoned their apparatus, the IC declared a "fire fighter lost situation" and requested additional personnel to assist with locating and rescuing the fire fighters. The two fire fighters from Booster 2 were designated as the rapid intervention crew (RIC) to search for the missing fire fighters. They were not aware that two other fire fighters from Brush 51 were with Booster 58 and had also gotten their apparatus stuck. The RIC began searching by entering the black (burned) area and moving east along County Road U. They stated that visibility was poor, approximately 5 feet, due to the extreme winds blowing smoke, ash, and sand. They reported that they did not have communication with any of the missing fire fighters and were unaware whether the fire fighters were

Photo 1. Location where Booster 58 and Brush 51 became stuck in sand. The remnants in the sand are from the cab of Brush 51 that had burned after the fire overran both apparatus. When this photo was taken, almost one month after the fire, the vegetation had not grown back due to a severe drought in this area. ***(NIOSH Photo)***

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in their vehicle or on foot or of which direction they had proceeded to escape the fire. At approximately 1700 hours, they were able to make contact by portable radio with one of the fire fighters from Booster 58. They learned that there were four fire fighters on foot, headed east/southeast towards a windmill.

At approximately 1715 hours, fire fighters in Booster 2 were able to locate both fire fighters from Booster 58. One of the fire fighters, wearing full structural turnout gear, had been overrun by the fire. He sustained very minimal injuries. The other fire fighter from Booster 58, who was wearing wildland fire-fighting pants and boots, was able to outrun the fire and sustained only smoke inhalation injuries. The fire fighters in Booster 2 informed the IC on the radio that they had located two of the missing fire fighters from Booster 58 and then attempted to drive back on County Road U towards Highway 287 where emergency medical personnel were waiting. A larger section of the fire had burned over County Road U, preventing them from returning in this direction, and, as a result, they were forced to find another route to Highway 287. The IC drove east through the burned area until he located the driver of Brush 51 standing on a ridge near a windmill. At approximately 1720 hours, he picked up this fire fighter and, after a rapid assessment, determined the fire fighter had suffered smoke inhalation injuries, but had not been burned. The fire fighter from Brush 51 had not been wearing any personal protective equipment (PPE) and had managed to outrun the fire. He was able to find safety in an area that had already been burned. The fire fighter reported he did not know where the other fire fighters were and that his portable radio and cell phone did not work.

Realizing that one fire fighter (the victim) was still missing, the IC and the driver/fire fighter from Brush 51 drove towards the location of Booster 58 and Brush 51 in an attempt to locate the victim. Upon arriving at the apparatus, Brush 51's front tire was on fire, and Booster 58's lights and paint had melted. They were unable to locate the victim, so they continued to drive through the field in the same direction that the fire fighters had traveled to escape the fire.

At approximately 1730 hours, they located the victim, lying face down on a "dozer" road, north of County Road U, approximately 1-1 ½ miles southeast of his truck. *Note: A "dozer" road is made by a bulldozer for utility company vehicles to travel to work sites.* **(**See Diagram 1**)**

The victim was still wearing a structural fire-fighting helmet, bunker pants, T-shirt, and the remains of his metal frames from his safety glasses. His rubber turnout boots had been removed and were lying in the road behind him. He had experienced severe third degree burns on his torso and head; however, he was conscious and coherent. The IC unbuckled the victim's helmet to improve his airway and loaded him into the back seat of his vehicle. The other fire fighter from Brush 51 rode in the back seat with the victim to assist him as they traveled west on County Road U, towards the emergency medical personnel. It was reported that the victim was very communicative and in extreme pain during the drive back. The victim's primary language was Spanish, though he could speak and understand English. The victim kept asking for someone he could speak to in Spanish. Neither the IC nor the other fire fighter spoke or understood Spanish; as a result, it is not known what the victim said or wanted to

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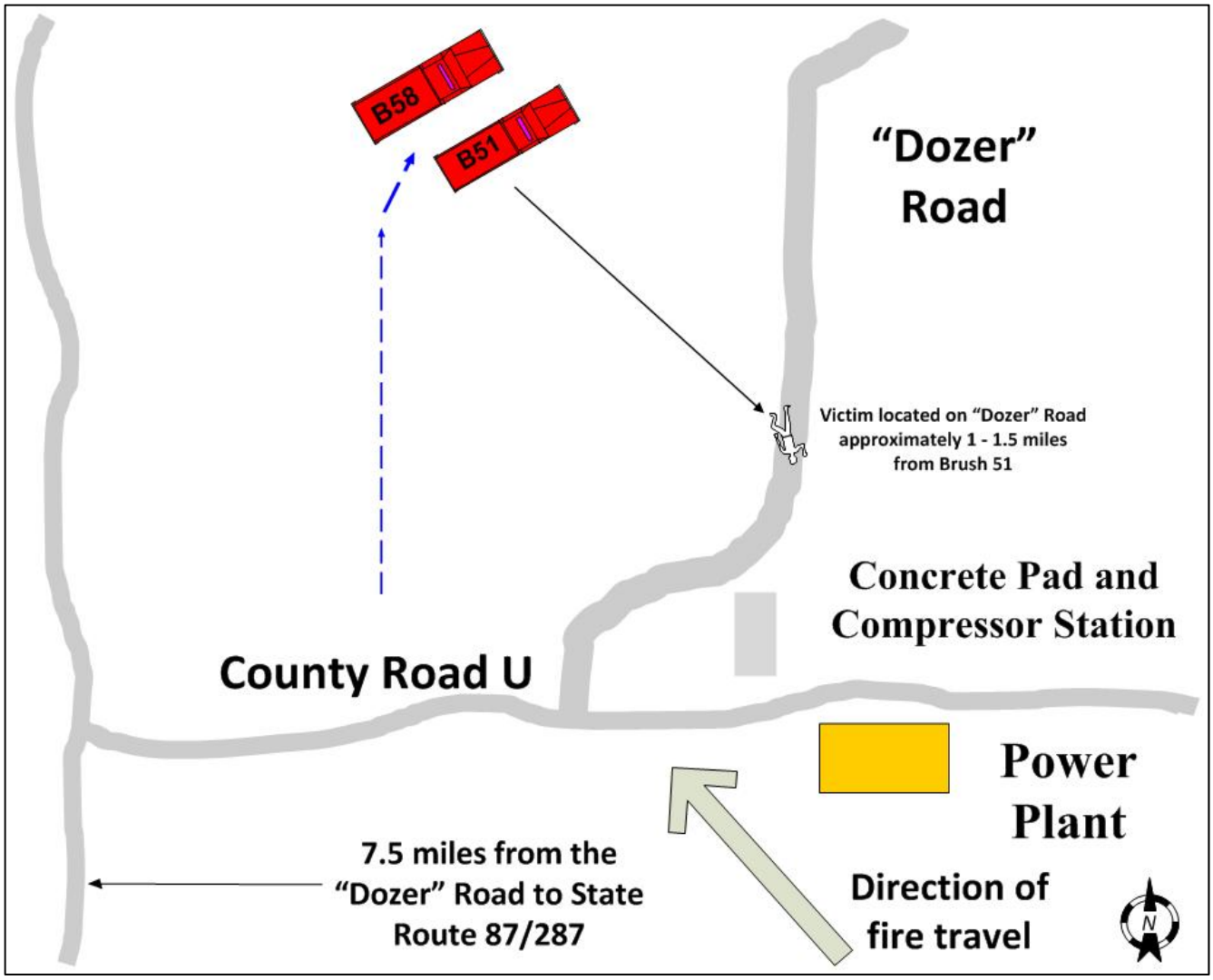

Diagram 1: Location of apparatus and the victim after personnel from Booster 58 and Brush 51 abandoned their vehicles when their vehicles became stuck.

say during the ride. The IC attempted to ask the victim questions about what happened. The only words they understood were a request from the victim in English for someone to speak Spanish with him.

When the fire fighters reached emergency medical personnel at approximately 1750 hours, the victim was put into an ambulance. The lieutenant, who was also an emergency medical technician (EMT), assisted the other EMTs with treatment and transport of the victim. None of the EMTs who responded spoke or understood Spanish; as a result they were unable to communicate with the victim regarding

the incident and his injuries. The lieutenant also transferred command of the incident to the fire chief of his department.

The victim was transported to a local hospital and was later transferred to a large metropolitan hospital burn center where he died 11 days later due to his injuries.

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 that ultimately led to the fatality in this incident:

- Ineffective situational awareness
- Ineffective training on wildland fire-fighting
- Ineffective personnel accountability system
- Ineffective personal protective equipment
- A safety zone and escape route were not effectively communicated to all fire fighters
- Failure to use a fire shelter from the approaching fire.

Cause of Death

According to the autopsy report, the medical examiner listed the victim's cause of death as complications of thermal injuries due to exposure to fire.

Recommendations

Recommendation #1: Ensure that the Incident Commander conducts a continuous risk assessment of the incident in terms of savable lives, savable property, and fire fighter safety

Discussion: The initial size-up conducted by the first arriving officer allows the officer to make an assessment of the situation and conditions for developing an Incident Action Plan for the incident. The first arriving officer on the scene must conduct an initial size-up and risk assessment which will establish the proper strategy and tactics. The initial size-up determines the number of fire fighters, the amount of apparatus and equipment needed to control the fire, and assists in determining the most effective fire-fighting operations. [2]

The Incident Commander needs to make a continuous risk assessment as to what is at risk – civilian lives, property, and/or fire fighters. This will help determine the risk profile for the incident. The Incident Commander must perform a risk analysis to determine what hazards are present, what the risks to personnel are, how the risks can be eliminated or reduced, and the benefits to be gained.

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According to NFPA 1500 A-8.3.3, "The acceptable level of risk is directly related to the potential to save lives or property. Where there is no potential to save lives, the risk to the fire department members must be evaluated in proportion to the ability to save property of value. When there is no ability to save lives or property, there is no justification to expose fire department members to any avoidable risk." [3] The International Association of Fire Chiefs (IAFC) *Rules of Engagement for Firefighter Survival* stresses the need to consider and determine the occupant survival profile when sizing up the incident scene. [4]

At this incident, the Incident Commander conducted an initial scene size-up and risk assessment. The Incident Commander reported he felt the fire was going to be contained at CIG Road at 1430 hours. However, the fire jumped CIG Road and continued to move in a northwest direction. It is unclear whether the Incident Commander reevaluated the incident action plan at that time. In this situation there are two significant issues that would require a reevaluation of the incident – one, the fire jumped a natural firebreak (CIG Road) and two, what are the risks to life, property, and the fire fighters. Is this an opportunity to allow the fire to burn to another natural firebreak, contain the fire with man-made fire breaks, or can the fire run out of fuel? The Incident Commander must consider these options based upon the incident priorities of life safety, incident stabilization, and property conservation.

This continuous risk assessment is based upon endangered civilians and threatened structures; fire conditions; weather conditions; available staffing and resources; and apparatus. This information factors into the revision of the Incident Action Plan and the development of effective strategy and tactics in terms of containing the fire versus allowing the fire to burn. The fire consumed 30,000 acres, did not damage any of the five or six structures in its path, or injure any civilians.

Recommendation #2: Fire fighters who engage in wildland fire-fighting should be trained to meet the minimum training requirements as required by the National Wildfire Coordinating Group (NWCG) or NFPA 1051, Standard for Wildland Fire Fighter Professional Qualifications

Discussion: Rural and volunteer fire fighters increasingly manage and provide fire-fighting operations for wildland fires. As previously mentioned, few fire fighters interviewed during this incident reported having participated in any formalized wildland fire-fighting training.

The National Wildfire Coordinating Group (NWCG) provides leadership specific to the wildland fire community regarding training, standards, equipment, fire-fighting qualifications, and other fire functions specific to wildland fire-fighting. From a training standpoint, the *National Interagency Incident Management System Wildland Fire Qualification System Guide* describes the minimal qualifications and training recommended, and even required in some cases, when engaging in wildland fire operations.[5] NWCG recommends the minimum training for fire fighters (NWCG Fire Fighter Type II) involved with WUI incidents should be I-100, *Introduction to the Incident Command System*, S-130, *Fire Fighter Training*, L-180, *Human Factors on the Fireline*, and S-190, *Introduction to Wildland Fire Behavior*.[5] It is recommended that all rural and volunteer fire fighters, who engage

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grass and wildland fires, meet the NWCG minimal training requirements. These qualifications also meet the requirements of NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications*, Wildland Fire Fighter I. [6]

Fire fighters, especially those trained in structural fire-fighting need to meet the requirements for wildland fire fighter training to ensure they have the necessary knowledge, skills, and competencies that ensure their safety during wildland urban interface fires.

Recommendation #3: Fire departments and fire service agencies should ensure that fire fighters fully comply with "The Standard Fire Orders" and are aware of the "18 Watchout Situations" and "Common Denominators of Fire Behavior on Tragedy Fires."

Discussion: Fire fighter and public safety is the first priority of the wildland fire management program. To ensure wildland fire fighter safety, it is important to follow the standard FIRE ORDERS, recognize the "Watch out situations", and recognize the "common denominators of fire behavior on tragedy fires." [7] (**For the complete list of each, please see Appendix One**)

The original ten Standard Firefighting Orders were developed in 1957 by a task force commissioned by the USDA-Forest Service Chief Richard E. McArdle. The task force reviewed the records of 16 tragic fires that occurred from 1937 to 1956. The Standard Firefighting Orders were based in part on the successful "General Orders" used by the United States Armed Forces. The Standard Firefighting Orders are organized in a deliberate and sequential way to be implemented systematically and applied to all fire situations.

Shortly after the Standard Firefighting Orders were incorporated into fire fighter training, the 18 Situations That Shout Watch Out were developed. These 18 situations are more specific and cautionary than the Standard Fire Orders and described situations that expand the 10 points of the Fire Orders. If fire fighters follow the Standard Firefighting Orders and are alerted to the 18 Watchout Situations, much of the risk of fire-fighting can be reduced. [7]

In the mid-1970s, fire researcher Carl Wilson identified four common denominators of fire behavior that caused fatalities and near-misses on wildland fires. These four common denominators have been cited for decades in fire safety training, in the "Fireline Handbook" (PMS No. 410–1), and in the "Incident Response Pocket Guide" (PMS # 461). [7]

Recommendation #4: Lookouts, communications, escape routes, and safety zones (LCES) should be established and communicated to all fire fighters

Discussion: In the wildland fire-fighting community, establishing and using lookouts, communications, escape routes, and safety zones (LCES) are critical to ensure the safety of wildland fire fighters. This includes selecting a lookout or lookouts, setting up a communication system, choosing escape routes,

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and selecting a safety zone(s). LCES is built on two guidelines: before safety is threatened, each fire fighter must know the LCES system will be used, and LCES must be continuously reevaluated as fire conditions change. *Note: LCES works well in other emergency responses such as hazardous materials mitigation, civil unrest, and flooding.*

The LCES systems approach to fireline safety is an outgrowth of analyses of fatalities and near misses for over 20 years of active wildland fire suppression duties. LCES simply focuses on the essential elements of the standard FIRE ORDERS (**See Appendix One**). Use of LCES should be automatic in wildland fire-fighting operations, and all fire fighters should know the LCES interconnection. LCES functions sequentially—it is a self-triggering mechanism. Lookouts assess—and reassess—the fire environment and communicate threats to safety; fire fighters use escape routes to safety zones. All fire fighters should be alert to changes in the fire environment and have the authority to initiate communication. [8]

To take the process a step further, situational awareness enhances the LCES system by being aware of what is happening around you at an incident scene to understand how information, events, and your own actions will impact operational goals and incident objectives, both in the present and in the near future. [8] Situational awareness becomes especially important in the fire-fighting operations and fire fighter domains where the information flow can be quite high and poor decisions can lead to serious consequences. The dynamic management of risk is all about effective, informed, and decisive decision making during all phases of an incident at a wildland fire. [9]

Situational awareness is a combination of attitudes, previously learned knowledge, and new information gained from the incident scene and environment that enables the Incident Commander, tactical level managers, and company officers to gather the information they need to make effective decisions that will keep their fire fighters and resources out of harm's way, reducing the likelihood of adverse or detrimental effects.[10]

The key is that the lookout(s) must be qualified individual(s) that follow the checklist provided in the NWCG "Incident Response Pocket Guide" (NWCG PMS #461):
• Experienced, competent, trusted;
• Enough lookouts at good vantage points;
• Knowledge of crew locations;
• Knowledge of escape and safety locations;
• Knowledge of trigger points;
• Equipped with a map, weather kit, watch, and Incident Action Plan.[7]

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Recommendation #5: Fire fighters who engage in wildland fire-fighting should use personal protective equipment that meets NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Fire Fighting

Discussion: Fire fighters involved in wildland fire-fighting activities should be provided, at a minimum, the personal protective equipment (PPE) as described by NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*. NFPA 1977 covers approved PPE and clothing specific to wildland fire-fighting, including fire resistant shirts and pants, gloves, boots, hard hat, and fire shelter. The goal of this PPE is to protect fire fighters against adverse environmental effects during wildland fire-fighting operations and provide radiant heat protection for the wildland fire fighter using flame-resistant clothing and equipment without causing excessive internal heat stress.[11]

Structural turnout gear is approved for wildland fire-fighting, however this PPE is designed to perform differently than the PPE used by wildland fire fighters. Structural PPE may actually increase heat stress and be a disadvantage for fire fighters engaged in wildland fire suppression activities due to the weight and composition of structural turnout gear, the high temperatures and low humidity associated with wildland fires, the duration of wildland incidents, and the amount of physical activity required to extinguish wildland fires. Research studying the physiological effect of PPE during wildland fire-fighting activities has indicated that the majority of heat stress related to wildland fire-fighting was internally generated. As a result, wildland fire fighter PPE is "designed to let heat out, not keep heat in." [12]

All fire fighters who respond to wildland fires should be provided with and use NPFA approved protective clothing that is designed for the unique conditions found in wildland fire-fighting operations.

Recommendation #6: A personnel accountability system should be used to account for all fire fighters and first responders assigned to any incident

Discussion: Personnel accountability on a fireground means identifying and tracking all personnel working at the incident. A fire department should develop its own system and standardize it for all incidents. National Fire Protection Association (NFPA) 1561 *Standard on Emergency Services Organizations Incident Management*, 2008 Edition, Paragraph 4.5.1, states, “The emergency service organization (ESO) shall develop and routinely use a system to maintain accountability for all resources assigned to the incident with special emphasis on the accountability of personnel.” [13]

The function of personnel accountability should be assigned to personnel who are responsible for maintaining the location and status of all assigned resources at an incident. This function is separate from those of the Incident Commander who is responsible for overall command and control of the incident. Due to the importance of responder safety, this function would be assigned to a personnel accountability officer. This function can be staffed by the chief’s aide, staff assistant, or field incident

technician, a chief officer, or other responder. The intent is to track the fire fighters and first responders by function and location. The components of the personnel accountability system should be modular and expand based on the size and complexity of the incident. [14]

Many different methods are used for the accounting of resources:

- ICS 201 – *Incident Briefing*
- Tactical worksheet
- Command board
- Apparatus riding lists
- Electronic bar-coding systems
- Accountability tags or keys (e.g., PASSPORT System)
- T-card system

The *ICS Form 201, Incident Briefing* provides the Incident Commander with basic information regarding the incident situation and the resources allocated to the incident. It also serves as a permanent record of the initial response to the incident. All initial attack Incident Commanders should use ICS Form 201. This is particularly true for chief officers, but is more difficult for company officers due to their encompassing responsibilities. Fire departments should require the regular use of ICS Form 201 on all working incidents having more than two companies. ICS Form 201 is primarily a document for tracking first alarm or initial attack activities. The ICS Form 201assists the Incident Commander in completing the necessary incident management functions (Management Cycle):

- Planning
- Organizing
- Staffing
- Directing
- Controlling
- Evaluating

One of the most important purposes of the ICS Form 201 is that it enables situation status and resource status tracking. This tracking of fire fighters on scene is an essential task for assuring the function and the location of fire fighters assigned to an incident, are properly documented. Another benefit of the ICS Form 201 is that regular use facilitates consistent command and control activities. Also, the ICS Form 201 provides a medium for briefing a command transition, should the incident require a transfer of command. [15, 16]

Accountability is much more than a hardware tracking system and must be addressed by all levels at the incident. The incident commander addresses the strategic level of accountability by tracking all crews and divisions/groups by location and function on a tactical worksheet. The Incident Commander must know who is in charge of each tactical level management unit, what crews are assigned to each division/group, where each division/group is located, and the assignment of each division/group.

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Division/group supervisors address the tactical level of accountability by tracking crews assigned to them. To maintain close supervision, division/group supervisors must know the location and function of assigned crews and be in the assigned area. Company officers must address the task level of accountability by knowing where each fire fighter is located and what each fire fighter is doing. Accountability is everyone's responsibility. All members operating on the incident must actively participate in the personnel accountability system. Each person involved in an incident whether at the strategic, tactical, or task level of an incident must make a strong personal commitment to follow all policies and procedures regarding accountability. [14]

A personnel accountability system must be able to be integrated into any existing incident command system plus this system must be used at every incident and drill so that it becomes routine. Fire departments that respond with one another due to automatic or mutual aid agreement must use the same compatible personnel accountability system. Personnel accountability is a simple and effective key component to keep fire fighters safe while operating at an emergency incident. [14]

From a wildland fire-fighting perspective, the personnel accountability system can function properly when fire fighters are spread out over a large area versus structural fire-fighting when fire fighters are operating in a single structure. One of the necessary components of accountability during wildland fire-fighting operations is to ensure for unity of command and effective span of control. Unity of command ensures that all fire fighters report to one person and maintain contact with their supervisor. Additionally, the supervisor should have a span of control of 3 to 7 resources with 5 being the optimum. To maintain this effective span of control, the organization should be expanded whenever the need is identified. This can be accomplished by adding levels or reassigning responsibilities within existing levels or a combination of both. The Incident Commander also should consider activating additional levels within the command structure where activities become highly complex or are conducted over a large geographical area.[5]

Some procedures to consider for personnel accountability during wildland fire-fighting operations:

- Wildland fire fighters shall work in teams of two or more while working on or near the fireline of an active fire unless they are in visual or voice contact with an officer.
- On initial attack fires, the Incident Commander shall:
  - Maintain the name and location of all personnel on the incident;
  - On extended attack fires, ensure to maintain the name and location of all personnel within their unit, division, or branch;
  - Document/record the status and location of personnel and unit information to the Staging Area Manager. The Staging Area Manager will maintain the status and location until the incident is controlled, a personnel accountability officer is assigned, or an incident management team is in place.[7]

Another critical element that is essential to the success of the personnel accountability system is effective fireground or incident scene communications. The fire department should have a

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communications standard operating procedure (SOP), written in clear, plain language, coupled with an effective training program.

Recommendation #7: Fire fighters should be provided with approved fire shelters and annual training on the proper deployment of the fire shelters

Discussion: Fire shelters are crucial pieces of safety equipment allowing fire fighters to protect themselves should they be overrun by a fire with no option for escape. Fire shelters are effective life saving devices that primarily protect fire fighters by reflecting radiant heat and trapping breathable air.[17] According to the National Wildfire Coordinating Group's (NWCG) *Fireline Handbook*, fire shelters should always be carried when on the fire line and be used after planned escape routes or safety zones become inadequate and entrapment is imminent.[7]

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, Paragraph 5.3.6 states: "Members who perform wildland fire-fighting shall be trained at least annually in the proper deployment of an approved fire shelter".[3] Not only should fire fighters always carry fire shelters, but all personnel should participate in hands-on training describing when, where, and how to use their shelter. Training should emphasize that although a fire shelter can save a fire fighter's life, carrying a fire shelter should never be considered an alternative to safe fire-fighting. Avoiding entrapment should always be a fire fighter's first priority and fire shelters are intended to be deployed only as a last resort.[17]

Though used as a last resort, fire shelters greatly enhance the chances of survivability in the event of being overrun by a wildland fire. The deployment of a fire shelter can be due to changing conditions which may compromise planned escape routes and safety zones. If an entrapment occurs the most likely solution is to deploy the fire shelter.

There is discussion about sheltering in the cab of fire apparatus in the event of being overrun by a wildland fire. The United States Forest Service published a study in 1997 which looked at the issues of fire entrapment comparing conditions inside vehicles and fire shelters. [18] Due to the significant risk of the fire consuming the vehicle and the byproducts of combustion from components (e.g. plastic) of the vehicle's interior, the risks may outweigh the potential benefits. [18]

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Recommendation #8: Fire departments should ensure apparatus driver/operators are familiar with the operation of their apparatus, especially when driving off-road

Discussion: NFPA 1500, *Standard for a Fire Department Occupational Safety and Health Program* states in Paragraph 6.2.1 that "Fire apparatus shall be operated only by members who have successfully completed an approved driver training program commensurate with the type of apparatus the member will operate or by trainee drivers who are under the supervision of a qualified driver." [3]

The apparatus driver/operators must have a thorough understanding and knowledge of the apparatus they operate, especially if this apparatus is going to be operated off-road during emergency conditions. Booster 58, a two-wheel drive, 1,000 gallon tanker with a pump was staffed with two fire fighters. Brush 51 was a four-wheel drive, 1,000-gallon, four-door brush truck with a 250-gallon-per-minute (gpm) pump. The vehicles were being driven off-road in rough terrain, which was comprised of rolling, sandy hills with sparse grass and yucca plants dispersed intermittently throughout the fields.

Several factors may have caused the apparatus to become stuck in the sand:

- operating heavy apparatus in sandy, hilly terrain
- improper size tires for operating in sandy terrain
- apparatus had only two-wheel drive
- apparatus with four-wheel drive not placed in four-wheel drive once apparatus is driven off-road.

As part of the training program, apparatus driver/operators should be trained in conditions they are expected to operate. This includes weather extremes, off-road driving, and any other conditions that the apparatus driver/operator might encounter while operating fire department apparatus. [3] NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program* can be used as a resource to ensure proper training for apparatus driver/operators.

Recommendation #9: States, municipalities, and authorities having jurisdiction should consider requiring mandatory wildland fire training for fire fighters.

Discussion: Fire fighters encounter significant risks and hazards during emergency operations which can lead to an occupational injury or even death. Fire fighters must be provided with the necessary knowledge, skills, and abilities to ensure that they can perform their job task safely and effectively.

One of the most important risk management control measures used to prevent occupational injuries, illnesses, and fatalities is a viable training and certification program. Each fire fighter must be properly trained to complete the necessary job functions and tasks they are expected to perform during emergency operations. As each state is different in the mandatory requirements for training and certifying fire fighters, there should be a consistent model which requires that **all** fire fighters complete at least NFPA 1001, *Standard for Professional Qualifications for Fire Fighters*, Fire Fighter I.[3]

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The state of Texas does not have minimal qualifications for structural fire-fighting for volunteer fire fighters. Most volunteer fire departments in Texas do not have minimal requirements for wildland fire-fighting although 60% of their calls involve wildland fire-fighting operations. To ensure the safety of the fire fighters, all states should have mandatory requirements that **all** fire fighters meet the training requirements as defined by NFPA 1001, *Standard for Professional Qualifications for Fire Fighters*, Fire Fighter I and the National Wildfire Coordinating Group and NFPA 1051, *Standard on Wildland Fire Fighters Professional Qualifications*, Wildland Fire Fighter I.

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Investigator Information

This incident was investigated by Jay Tarley, Safety and Occupational Health Specialist, and Murrey E. Loflin, Investigator, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH, Morgantown, WV, and Corey Campbell, Occupational Safety and Health Specialist from the NIOSH Western States Office, Denver, CO. An expert technical review was provided by Rich Olson of Wildfire Risk Management Group. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division. This report was authored by Murrey E. Loflin and Corey Campbell.

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Additional Information

The Texas State Fire Marshal's Office conducted a separate investigation of this incident. Their investigation report will be available at http://www.tdi.state.tx.us/fire/fmloddinvesti.html.

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Appendix One

"The Standard Fire Orders" "18 Watchout Situations" and "Common Denominators of Fire Behavior on Tragedy Fires."

The **Standard FIRE ORDERS** are:

1. Keep informed on fire weather conditions and forecasts.
2. Know what your fire is doing at all times.
3. Base all actions on current and expected behavior of the fire.
4. Identify escape routes and safety zones and make them known.
5. Post lookouts when there is possible danger.
6. Be alert. Keep calm. Think clearly. Act decisively.
7. Maintain prompt communications with your forces, your supervisor, and adjoining forces.
8. Give clear instructions and insure they are understood.
9. Maintain control of your forces at all times.
10. Fight fire aggressively, having provided for safety first.

The **18 Watchout Situations** are:

1. Fire not scouted and sized up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.
4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics, and hazards.
6. Instructions and assignments not clear.
7. No communication link with crewmembers/supervisors.
8. Constructing line without safe anchor point.
9. Building fireline downhill with fire below.
10. Attempting frontal assault on fire.
11. Unburned fuel between you and the fire.
12. Cannot see main fire, not in contact with anyone who can.
13. On a hillside where rolling material can ignite fuel below.
14. Weather is getting hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across line.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near the fire line.

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There are **four major common denominators** of fire behavior on fatal and near-fatal fires. Such fires often occur:

1. On relatively small fires or deceptively quiet areas of large fires.
2. In relatively light fuels, such as grass, herbs, and light brush.
3. When there is an unexpected shift in wind direction or wind speed.
4. When fire responds to topographic conditions and runs uphill.

Alignment of topography and wind during the burning period should always be considered a trigger point to re-evaluate strategy and tactics.