2018
07

Death in the line of duty...

National Institute for Occupational Safety and Health NIOSH

A report from the NIOSH Fire Fighter Fatality Investigation and Prevention Program July 22, 2019

One Fire Fighter Dies and One Fire Fighter Burned during Firefighting Operations at a Grass Fire-Texas

Executive Summary

On March 10, 2018, a 68-year-old male volunteer fire fighter was burned during firefighting operations at a grass fire. The fire fighter was transported from the scene to an Army Medical Center via air ambulance. The fire fighter died on March 23, 2018 from burn injuries sustained at the grass fire. At 1103 hours on March 10, a citizen called the county 9-1-1 center to report a controlled burn that had grown into a grass fire was spreading. The county 9-1-1 center dispatched Station 5 at 1105 hours to a report of a grass fire. When the call was dispatched, a fire fighter (Fire Fighter "A") was in his privately owned vehicle (POV) and responded to Station 5. He was wearing jeans, a tee shirt, and tennis shoes. Fire Fighter "A" did not have his turnout gear or brush gear, which were at home. He responded in Grass 5-1 with another fire fighter, who was the driver/operator of Grass 5-1. Grass 5-1 arrived on scene at 1112 hours. The driver/operator requested additional resources from Fire Station 5 and mutual aid from county Fire Station 2. Another fire fighter (Fire Fighter "B") from Station 5 responded in his POV to the scene. He arrived and parked behind Grass 5-1. Fire Fighter "B" parked his POV along a fence line and got onto Grass 5-1. He was not wearing turnout gear or brush gear, only civilian clothing similar to the other fire fighter. Both fire fighters were riding in a standing position behind the cab on either side of the water tank on Grass 5-1. This area is secured by a locking gate. Grass 5-1 was attempting to extinguish the fire in the tree line and fence line while moving north. Grass 5-1 was attacking the fire from the black (burned grass). A bulldozer was operating north of Grass 5-1. The wind suddenly shifted to the northwest, which was blowing smoke on Grass 5-1. The fire moved into the grass (Blue Stem Grass and Dallas Grass) that was not burned. As Grass 5-1 was moving, the two fire fighters riding in the back shouted for the driver/operator to stop Grass 5-1. The reel line hose was dragging behind Grass 5-1. Fire Fighter "A" gathered the hose and put the hose over his shoulder. He got back on Grass 5-1 but didn't latch the gate. Either the weight of the hose or the hose snagging caused Fire Fighter "A" to fall off Grass 5-1. Grass 5-1 moved about 15 yards when Fire Fighter "B" shouted to stop. Fire Fighter

The position on Grass 5-1 that the fire fighter (Fire Fighter "A") was riding on when he fell off and was overrun by the fire.
(NIOSH Photo.)

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"A" had stepped into a hole, fell, and could not get up before he was overrun by the fire. The driver/operator of Grass 5-1 turned the apparatus around and went back to Fire Fighter "A". Fire Fighter "B" and the driver/ operator got Fire Fighter "A" into the cab of Grass 5-1. They transported Fire fighter "A" to the Command Post and medical treatment was started on Fire Fighter "A". A county medic unit, Medic 2 arrived and started patient care on Fire Fighter "A" and requested the response from an air ambulance. Fire Fighter "A" was transported by air ambulance to an Army Medical Center in a Texas metropolitan city. Fire Fighter "A" died on March 23, 2018 from the burn injuries sustained at this incident.

Fire Fighter "B" was treated on scene for burns to his right elbow and right ear. He was also treated and released at the emergency room at a local hospital for these burns.

Contributing Factors

- *Lack of personal protective equipment*
- *Apparatus design*
- *Lack of scene size-up*
- *Lack of situational awareness*
- *Lack of training for grass/brush fires*
- *Lack of safety zone and escape route*
- *Radio communications issues due to incident location*

Key Recommendations

- *Fire departments should ensure fire fighters who engage in wildland firefighting wear personal protective equipment that meets NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Firefighting*
- *Fire departments should comply with the requirements of NFPA 1500, Standard on Fire Department Occupational Safety, Health, and Wellness Program for members riding on fire apparatus*

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Introduction

On March 10, 2018, a 68-year-old male volunteer fire fighter was burned during firefighting operations at a grass fire. Fire Fighter "A" was transported from the scene to an Army Medical Center via air ambulance. The fire fighter died on March 23, 2018 from his burn injuries sustained at the grass fire. On March 26, 2018, the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On April 22 – 25, 2018, an investigator from the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Texas to investigate this incident. The NIOSH investigator met with representatives from the deceased fire fighter's fire department, the mutual aid fire departments that responded to this incident, the county sheriff's office, and the State Fire Marshal's Office - Texas Department of Insurance. During the investigation, witness statements were reviewed and interviews were conducted with the fire fighters and officers involved in the incident. The NIOSH investigator also reviewed the training requirements for volunteer fire fighters in the state of Texas. During this investigation, the fire apparatus used in this incident was inspected and photographed plus the incident scene was visited and photographed.

Fire Department

Fire Station 5, which was formed in 1960, operates with 27 members, serves a population of 600, and has a first due response area of 34 square miles. Fire Station 5 responds to 20 – 30 alarms annually. Fire Station 5 operates from one fire station and has 1 pumper, 1 tanker (tender), and 2 grass trucks. Business meetings are the 1st Wednesday of each month and training is conducted on the 3rd Wednesday of each month.

There are 10 volunteer fire departments in the county. The county consists of 960 square miles with a population of 25,560. The town where the grass fire occurred is unincorporated.

Training and Experience

In Texas, all volunteer fire fighter training requirements, certification requirements, and standards are determined by each volunteer fire department. Fire Station 5 does not maintain files for each member that tracks their training and certifications. Training by the department is recorded on meeting rosters. There is no defined process for fire fighters to receive training within the department.

Equipment and Personnel

On March 10, 2018, county Fire Station 5 was alerted for a grass fire. Two mutual aid fire departments were requested by the fire department to respond to assist. The apparatus and personnel from the three fire departments directly involved in this incident are shown in the diagram below. (**See Diagram 1**).

One Fire Fighter Dies and One Fire Fighter Burned during Firefighting Operations at Grass Fire-Texas

Resource Designation	Staffing	Time Dispatched	On-Scene
Fire Station 5			
Grass 5-1	**2 fire fighters**	**1106 Hours**	**1112 Hours**
Grass 5-2	**2 fire fighters**	**1106 Hours**	**1121 Hours**
Tanker 5	**2 fire fighters**	**1106 Hours**	**1123 Hours**
Engine 5	**1 fire fighter**	**1154 Hours**	**1202 Hours**
Fire Station 2			
Grass 2	**2 fire fighters**	**1120 Hours**	**1134 Hours**
Grass 22	**2 fire fighters**	**1120 Hours**	**1138 Hours**
Tanker 2	**1 fire fighter and fire chief**	**1120 Hours**	**1138 Hours**
Fire Station 1			
Brush 1	**3 fire fighters**	**1147 Hours**	**1202 Hours**

Diagram 1. The deployment of resources to the grass fire on March 10, 2018

Apparatus

The two fire fighters (Fire Fighter "A" and Fire Fighter "B") riding on Grass 5-1 were riding in a standing position behind the cab of the apparatus. Grass 5-1 is considered a Type V/Type VI wildland engine. These riding positions are located on either side of the apparatus. The driver and passenger riding positions are connected by an open walkway (**See Photo 1)**. Access or egress is by opening a gate that is secured by lifting the gate and placing the pin in a receiver (**See Photo 1**). Additionally the gate opened outward. Grass 5-1 is a 2012 Ford F550 with a side step configuration. The apparatus has a 300 gallon booster tank with 150-foot 1-inch hose on a reel and several short "whip lines" (**See Photo 1**). The apparatus met the requirements of NFPA 1906, *Standard for Wildland Fire Apparatus*, and 2012 edition.

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Photo 1. The side step position on Grass 5-1 showing the gate latching mechanism and the short hoselines on each sided of the apparatus *(NIOSH Photo.)*

Fuel Load

The fuel involved in this incident was primarily Little Bluestem Grass. Most of the grass was between knee-high to waist high. Little Bluestem Grass (*Schizachyrium scoparium*) is a Texas native which has moved from the pasture into the home landscape in recent years. Once established, it is a drought-resistant, easy-care clumping grass that is attractive at any season. Little Bluestem Grass performs well as an accent in an garden and is also a very good choice for natural settings or wildscapes in the home

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landscape. Little Bluestem Grass provides random patches on slopes and dry areas associated with post oak and yaupon landscapes, and grows either in full sun or partial shade. Little Bluestem Gras is reported to have been the most common grass present in the original Post Oak Savannah and Cross Timbers parts of Texas, and is still a major feature of the tallgrass, midgrass and shortgrass prairies of Texas. It is suitable for planting throughout most of Texas, except for the very western portions of the state. [Texas A&M University 2001] (**See Photo 2)**.

Photo 2. An example of Little Bluestem Grass that was involved in the grass fire on March 10.
Photo from Texas A&M University, Texas Cooperative Extension

Timeline

The following timeline is a summary of events that occurred as the incident evolved. Not all incident events are included in this timeline. The times are approximate and were obtained by studying the dispatch records, audio recordings, witness statements, and other available information. This timeline also lists the changing fire behavior indicators and conditions reported, as well as fire department response and fireground operations. All times are approximate and rounded to the closest minute.

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
County Dispatch Center received a 9-1-1 call from a homeowner that a controlled burn was now out of control.	**1103 Hours**	
The County Dispatch Center dispatched Fire Station 5.	**1105 Hours**	
Grass 5-1 enroute to the grass fire.	**1108 Hours**	
Grass 5-1 arrived on-scene at the grass fire.	**1112 Hours**	
Grass 5-2 enroute to the grass fire.	**1116 Hours**	
Tanker 5 enroute to the grass fire.	**1117 Hours**	
Command requested mutual aid from Fire Station 2. The County Dispatch Center dispatched Fire Station 2 to respond to grass fire.	**1120 Hours**	The driver/operator of Grass 5-1 assumed Command. Grass 5-1 was conducting firefighting operations in the northwest section of the property.
Grass 5-2 arrived on-scene at the grass fire.	**1121 Hours**	A citizen is operating a bulldozer trying to cut a fire line.
Tanker 5 arrived on scene.	**1123 Hours**	

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Grass 2 enroute to the grass fire.	**1124 Hours**	The wind changed direction and the grass fire enveloped Grass 5-1. Grass 5-1 reaches the head of the fire and loses sight of the bulldozer.
	1126 Hours	The driver/operator attempts to turn around and the wind shifts, causing the smoke to obscure his vision. The driver/ operator inadvertently turns into the unburned grass. The driver/operator described the grass as two to three feet tall. The booster line comes loose and is being dragged behind Grass 5-1. Fire Fighter "A" gets off Grass 5-1, gets the hose, and gets back on Grass 5-1.
Command calls the County Dispatch Center and advised a "man down" at the grass fire.	**1127 Hours**	Fire Fighter "A" fell off of Grass 5-1 and was overrun by the grass fire and sustained significant burns. Fire Fighter "B" received burns on the right elbow and right ear. Fire Fighter "A is helped into the cab of Grass 5-1 by the driver/operator and Fire Fighter "B". ***NOTE:*** *Neither fire fighter were not wearing any PPE.*
Grass 5-1 requested automatic aid from Fire Station 1 for additional brush trucks.	**1128 Hours**	

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
The County Dispatch Center dispatched Fire Station 1 to respond to grass fire. The County Dispatch Center dispatched a county deputy sheriff, Unit 819 to the grass fire for a report of a "man down"	**1129 Hours**	
Grass 22 and Tanker 2 enroute to the grass fire.	**1130 Hours**	
The County Dispatch Center dispatched Medic 1 for a fire fighter down.	**1131 Hours**	
County Medic 2 responding to the injured fire fighter at the grass fire. EMS Supervisor (EMS3) responding to the injured fire fighter.	**1133 Hours**	Grass 5-1 arrived at the Command Post with the injured fire fighters. Fire fighters from Fire Station 5 start basic life support (BLS) care on Fire Fighter "A". Fire Fighter "B" was treated for burns on his right elbow and right ear.
The County Dispatch Center contacted the air ambulance to be on standby for response to the injured fire fighter at the grass fire. Command advised the County Dispatch Center of the injured fire fighter's condition. Grass 2 arrived at the grass fire.	**1134 Hours**	Firefighting operations continue with Grass 5-1, Grass 5-2, Grass 2, and Grass 22.

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
The County Dispatch Center advised the air ambulance (Air Evac 47) to launch. Grass 22 and Tanker 2 arrived on scene.	**1138 Hours**	Fire Fighter 597 from Fire Station 5 assumed Command of the incident.
Medic 2 (ALS) arrived at the grass fire.	**1141 Hours**	
The County Dispatch Center contacted the Texas Forest Service for response to the grass fire.	**1143 Hours**	Advanced life support (ALS) care initiated on Fire Fighter "A".
The County Dispatch Center paged Fire Station 1 to respond to the grass fire. Medic 1 arrived at grass fire.	**1147 Hours**	Medic 1 assisted with ALS patient care of Fire Fighter "A".
Brush 1 enroute to the grass fire.	**1150 Hours**	
Air Evac 47 landed at the scene of the grass fire.	**1151 Hours**	
Engine 5 enroute to the grass fire.	**1154 Hours**	
The Texas Forest Service advised the County Dispatch Center that available resources response would be 3 – 4 hours. Texas Forest Service was advised to disregard.	**1155 Hours**	
Grass 1 and Engine 5 arrived at the grass fire.	**1202 Hours**	

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Command advised Air Evac 47 was transporting patient to a burn hospital in San Antonio.	**1217 Hours**	Fire Fighter "A" loaded into Air Evac 47.
Command advised the grass fire in under control. "We are in the mop-up phase." Medic 1 cleared the scene of the grass fire.	**1226 Hours**	
EMS3 cleared the scene of the grass fire.	**1230 Hours**	
Grass 1 clear of the grass fire and returned to quarters.	**1301 Hours**	
Medic 2 cleared the scene of the grass fire.	**1328 Hours**	
Command advised fire is out and all units are clear of the grass fire. Command is dissolved.	**1358 Hours**	

Personal Protective Equipment

Fire Station 5 provides all members with a Nomex IIIA jumpsuit for grass fires. This garment meets or exceeds NFPA 1977 *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*, 2016 Edition (**See Photo 3**). The fire department also provides a helmet, gloves, and boots, which are used for both structural firefighting and for grass fires. Fire Fighter "A" was not wearing this PPE while fighting the grass fire. He was wearing a tee shirt, jeans, and tennis shoes. Also, Fire Fighter "B" was not wearing any PPE.

The fire department also provides fire fighters with structural turnout gear which meets the requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, current edition.

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Photo 3. An example of the jumpsuit that Fire Station 5 provides members to wear when fighting grass fires.
https://www.wfgear.com/

Weather Conditions

On March 10, 2018 at 1115 hours, the temperature was 77 degrees Fahrenheit, the dew point was 66 degrees Fahrenheit, the relative humidity was 69%, the barometric pressure was 29.82, visibility was

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10 miles, the winds were at 6 miles an hour (MPH), the skies were overcast, and there had been no precipitation in the past 24 hours [Weather Underground 2018].

Investigation

At 1103 hours on March 10, a citizen called the county 9-1-1 center to report a controlled burn that was now an uncontrolled grass fire and spreading. The citizen had been burning brush piles and the wind shifted and ignited the grass (Bluestem Grass) **(See Photo 4)**.

Photo 4. One of the brush piles that the citizen was going to burn when the fire extended into the grass. The grass fire burned north to the property line. This picture was taken 7 weeks after the fire occurred.
(*NIOSH Photo*)

The county fire dispatch center dispatched Fire Station 5 at 1105 hours for a report of a grass fire. When the call was dispatched Fire Figher "A" was in his privately owned vehicle (POV) and immediately responded to Station 5. He was wearing jeans, a tee shirt, and tennis shoes. Fire Fighter

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"A" did not have his turnout gear or brush gear, which was at home. Fire Figher "A" pulled Grass 5-1 out of the station and was waiting for another fire fighter to arrive at the fire station. Once the fire fighter arrived at the fire station, Fire Figher "A" got into the passenger seat of Grass 5-1. The other arriving fire fighter functioned as the driver/operator of Grass 5-1. Grass 5-1 responded at 1108 hours and arrived on scene at 1112 hours.

Upon arrival, Grass 5-1 entered a dirt driveway which led to the fire. Grass 5-1 went across a path along the tank dam and went directly to the fence line. A citizen was on a tractor cutting the grass in the field between the tank dam and the fence line to prevent the fire from moving any further south. Fire Fighter "B" from Fire Station 5 arrived on scene behind Grass 5-1 and parked his POV along the southeastern fence line. The fire was moving north across the tree line and fence line (**See Photo 5**). The fire was in the most eastern part of Fire Station 5's 1st due area and the county. This created issues trying to communicate with the County Dispatch Center and other fire department resources due to radios not being able to contact the radio repeater system.

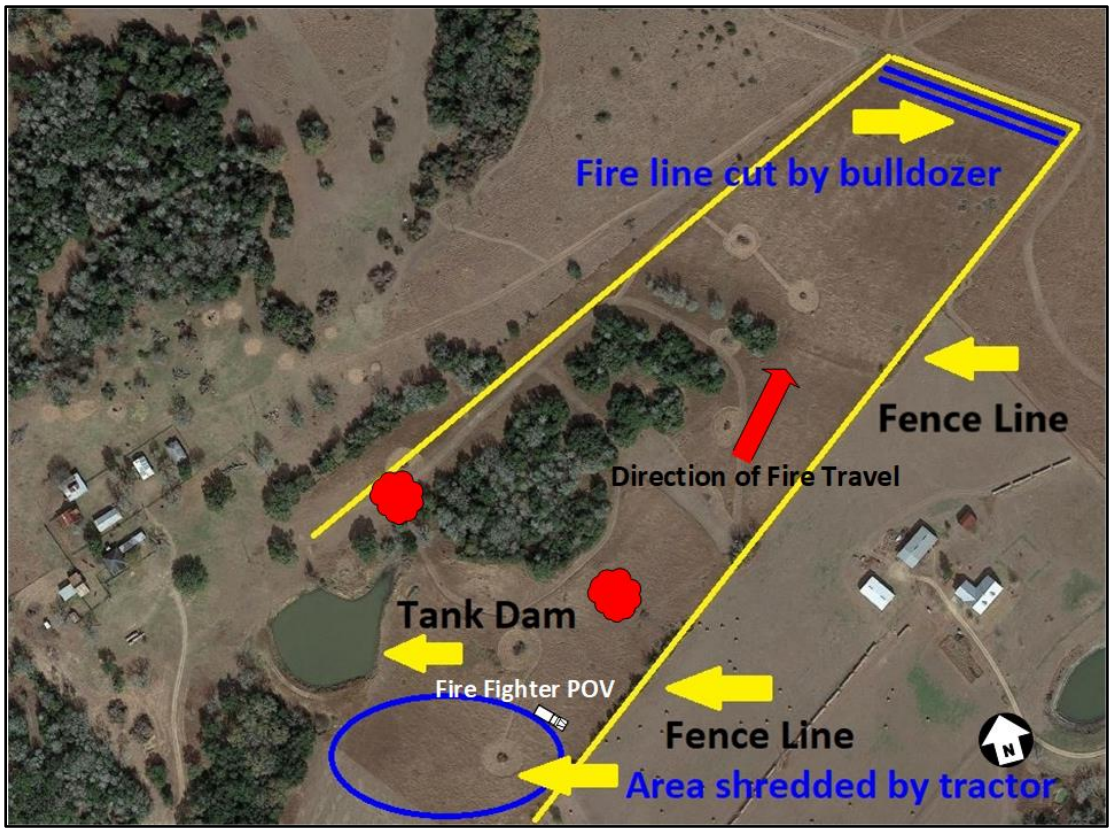

Photo 5. The solid yellow lines indicate the property boundaries and the area of the grass fire which was approximately 10 acres. The red indicates the location of where the fire started. (*Photo from Google Earth.*)

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The driver/operator of Grass 5-1 assumed Command of this incident. He requested additional resources from Fire Station 5, county Fire Station 2, and county Fire Station 1. At this time, the fire was approximately 10 acres in size.

Grass 5-1 began attacking the fire from the burned "black" area. Grass 5-1 was attempting to extinguish the fire in the tree line and fence line while moving north. A bulldozer was operating north of Grass 5-1. A citizen was operating a private bulldozer independent of the fire department operations. The bulldozer was attempting to cut a fire break in the very northern part of the property ahead of the fire.

Grass 5-2 arrived on scene at 1121 hours. Another fire fighter from Fire Station 5 had responded in his POV to the scene. He got in the cab of Grass 5-2 at the tank dam. Grass 5-2 went east in the field towards the fence line. The grass fire was near the POV owned by Fire Fighter "B" on Grass 5-1. Grass 5-2 extinguished the fire around the POV and moved north towards Grass 5-1.

Grass 5-1 reached the head of the fire and lost sight of the bulldozer. The driver/operator of Grass 5-1 attempted to turn around and the wind shifted, causing the smoke to obscure his vision. The driver/operator inadvertently turned into the unburned grass. The driver/operator described the grass as two to three feet tall. The time was approximately 1124 hours **(See Photo 6)**.

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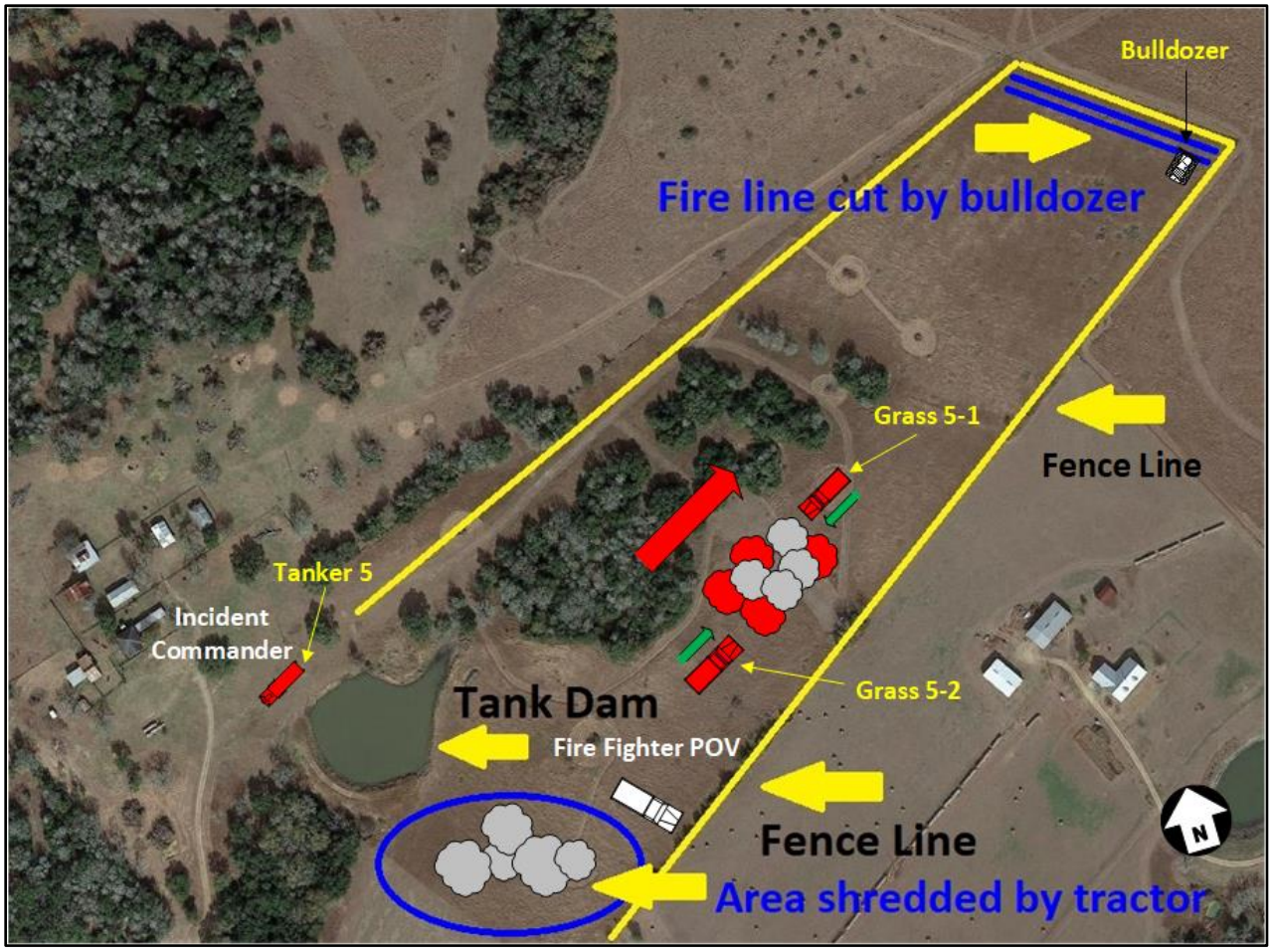

Photo 6. The initial firefighting operations with Grass 5-1 and Grass 5-2. The green arrows indicate the direction of travel for the brush trucks. The red arrow is the direction the fire is traveling. The time is approximately 1124 hours.

The wind shift caused the fire to head directly toward Grass 5-1. Grass 5-1 Fire Fighter "B" advised the driver/operator to stop because they were dragging the "red line" (booster line). Fire Fighter "A" and Fire Fighter "B" exited the vehicle to retrieve the hoseline. The driver/operator told them to "forget the line" and get back in the truck. Fire Fighter "B" entered the right side (passenger) side step and Fire Fighter "A" got back Grass 5-1 on the side step behind the driver. Fire Fighter "A" had a portion of the red line over his shoulder. When the driver accelerated to exit the area, Fire Fighter "A" was pulled from the apparatus by the red line that remained on the ground due to the gate not being properly latched. Fire Fighter "B" started pounding on the cab of Grass 5-1 to get the driver/operator to stop the apparatus. Grass 5-1 traveled approximately 35 – 45 feet before the driver/operator stopped the apparatus. The time was approximately 1127 hours.

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When Fire Fighter "A" fell off of Grass 5-1, he fell into a hole about 6 – 12 inches deep and was overrun by the fire. The driver/operator and Fire Fighter "B" found Fire Fighter "A" in the fire and suffering from burns to his face, arms and hands, chest, and legs. They helped Fire Fighter "A" into the cab of Grass 5-1 with assistance from the two fire fighters on Grass 5-2. The driver/operator of Grass 5-1 advised the County Dispatch Center of a "man down". Once Fire Fighter "A" was in the cab of Grass 5-1, the driver/operator drove Grass 5-1 to the command post, which was located near Tanker 5. Fire Fighter "B" was riding the right step position behind the cab of Grass 5-1. The time was approximately 1129 hours. At 1131 hours, the County Dispatch Center dispatched a county medic unit (Medic 2) to the scene for an injured fire fighter.

At 1133 hours, a county medic unit – Medic 1 responded to this incident due to time and distance. EMS 3, the EMS Supervisor, was dispatched plus Air Evac 47, the air ambulance was placed on standby at 1133 hours. Grass 5-1 arrived at the Command Post at approximately 1133 hours. Fire Fighter "A" was helped out of the cab of Grass 5-1 by department fire fighters and placed on a turnout coat on the ground. Basic life support (BLS) care was initiated on Fire Fighter "A" by fire department members.

While patient care continued on Fire Fighter "A" by fire fighters from, Grass 2 arrived on scene at 1134 hours. At this time, Grass 5-1, Grass 5-2, and Grass 2 are continuing firefighting operations in the field northwest of the command post and along most of the property fence line. The driver/operator of Grass 5-1 filled the booster tank with water from Tanker 5 before resuming firefighting operations.

At 1138 hours, Unit 597 from Fire Station 5 assumed Command of the incident. Command advised the County Dispatch Center to launch the air ambulance (Air Evac 47). Grass 22 and Tanker 2 arrived on scene on the property west of the fence line. Grass 2 assisted with controlling the grass fire along the fence line.

Medic 2 arrived on scene at 1141 hours and initiated advanced life support (ALS) care on Fire Fighter "A" at 1143 hours. Medic 1 arrived at 1147 and assisted with ALS care. The County Dispatch Center contacted the Texas Forest Service to respond with personnel and resources to this incident. Also, the County Dispatch Center dispatched Fire Station 1 to this incident. At 1150 hours, Brush 1 from Fire Station 1 responded to the grass fire with three fire fighters. At 1151 hours, Air Evac 47 landed at the scene.

The firefighting operations continue in the field with Grass 5-1 (two fire fighters), Grass 5-2 (two fire fighters), Grass 2 (two fire fighters), and Grass 22 (two fire fighters) primarily focused in the middle of the field and along the fence line (**See Photo 7**).

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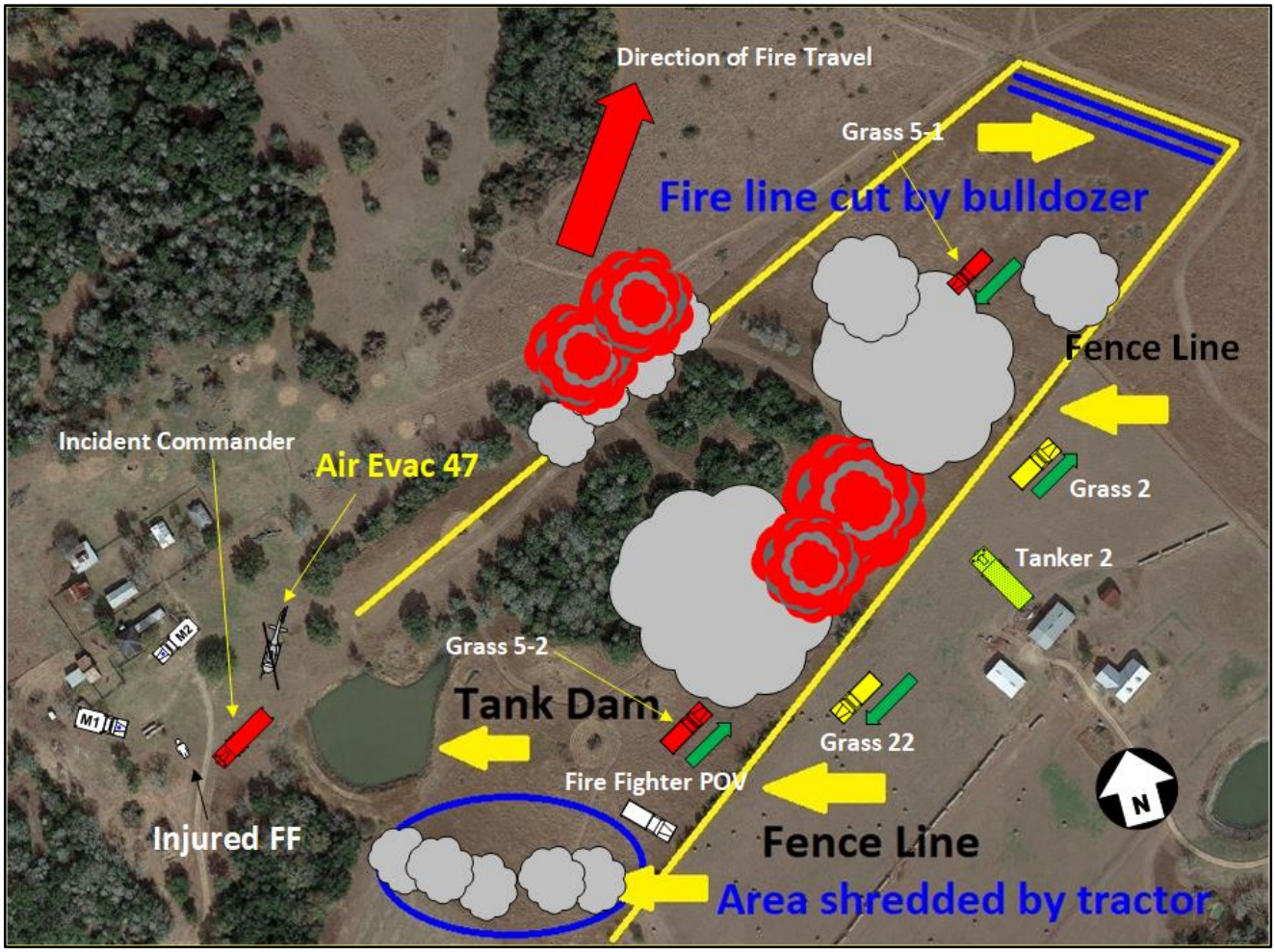

Photo 7. The firefighting operations continued while the injured fire fighter was being treated by EMS. The green arrows indicate the direction of travel of the brush trucks. The red arrow indicates the direction of fire and smoke travel. The time was approximately 1152

At 1155 hours, the Texas Forest Service advised that available resources had a 3 – 4 hour response. The County Dispatch Center advised the Texas Forest Service to disregard the request. At 1202 hours, Grass/Brush 1 and Engine 5 arrived on scene. At 1217 hours, Command advised the County Dispatch Center that Air Evac 47 was enroute to a burn hospital in San Antonio.

At 1226 hours, Command advised the fire dispatcher that the grass fire was under control and crews were operating in the mop-up phase (**See Photo 8**). Command advised the County Dispatch Center that the fire was out and all units were clearing the scene at 1358 hours.

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Photo 8. A picture taken by a county deputy sheriff from the Command Post. The view is looking due west across the tank dam, the fence line, and to adjacent farm. The white pick-up truck belongs to Fire Fighter "B". A civilian operated the tractor and cut (shredded) the grass between tank dam and the fence line. The time was approximately 1309 hours. The majority of the grass fire has been extinguished.
(*Photo courtesy of the County Sheriff's Office.*)

Grass 5-1 Fire Fighter "B" was treated on scene for burns to his right elbow and right ear. He was also treated and released at the emergency room at a local hospital for these burns.

Grass 5-1 Fire Fighter "A" was transported to an Army Medical Center Emergency Department by Air Evac 47, an air medical ambulance service. Grass 5-1 Fire Fighter "A" was stabilized and transferred

to the Burn Unit/ICU. On March 23, 2018, Grass 5-1 Fire Fighter "A" succumbed to his injuries and was pronounced deceased. An autopsy was conducted by the local county Medical Examiner's Office.

Contributing Factors

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. NIOSH investigators identified the following items as key contributing factors in this incident that ultimately led to the fatalities:

- Lack of personal protective equipment
- Apparatus design
- Lack of scene size-up
- Lack of situational awareness
- Lack of training for grass/brush fires
- Lack of safety zone and escape route
- Radio communications issues due to incident location

Cause of Death

According to the death certificate, the medical examiner listed the victim's cause of death as complications due to thermal injuries. The manner of death was accidental.

Recommendations

Recommendation #1: Fire departments should ensure fire fighters who engage in grass or brush firefighting operations wear personal protective equipment that meets NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Firefighting.

Discussion: The fire department involved in this incident provides all members with both structural turnout gear and wildland firefighting gear. The department's Standard Operation Procedure (SOP), Section *1 - Protective Clothing*, states: "The level of protective clothing required depends on the type of call, and the operations involved, as outlined in specific SOPs." However there is no additional SOP addressing the level of protective clothing required other than during vehicle fires and structural firefighting operations.

Fire fighters involved in wildland firefighting 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 2016a]. NFPA 1977 covers compliant PPE and clothing specific to wildland firefighting, including fire resistant shirts and pants, gloves, boots, and helmet. The goal of this PPE is to protect fire fighters against adverse environmental effects during wildland firefighting operations. Also, NFPA 1977 compliant PPE provides radiant heat protection for the wildland fire fighter using flame-resistant clothing and equipment without causing excessive internal heat stress.

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NFPA 1500, Standard on Fire Department Occupational Safety, Health, and Wellness Program states in *Paragraph 7.7.2,*"Members who engage in or are exposed to the hazards of wildland firefighting operations shall be provided with and use protective garments and protective equipment that meet the requirements of NFPA 1977" [NFPA 2018].

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

At this incident, the fire department provided each member with PPE for wildland incidents. The two fire fighters riding on Grass 5-1 responded to the grass fire in civilian clothing and had no PPE.

Recommendation #2: Fire departments should comply with the requirements of NFPA 1500, Standard on Fire Department Occupational Safety, Health, and Wellness Program for members riding on fire apparatus.

Discussion: NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness* addresses the riding on fire apparatus in **Chapter 6 - *Fire Apparatus, Equipment, and Drivers/Operators,*** Section 6-3: *Riding in Fire Apparatus*. The intent of the requirements in Section 6.3 is to ensure for the safety of all members riding on any type of fire apparatus and to prevent an incident such as the one investigated in this report.

The following are requirements regarding riding on fire apparatus from NFPA 1500, Chapter 6:

- **6.3.1*** All persons riding in fire apparatus shall be seated and belted securely by seat belts in approved riding positions at any time the vehicle is in motion other than as allowed in 6.3.4, 6.3.5, and 6.3.6.
- ***A.6.3.1** Fire fighters cannot be allowed to ride on the outside of apparatus in order to fight wildland fires. The Risk Management Committee (RMC) of the National Wildfire Coordinating Group (NWCG) represents the U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, National Park Service, National Association of State Foresters, Intertribal Timber Council, International Association of Fire Chiefs, and the U.S. Fire Administration. Their position is that the practice of fire fighters riding on the outside of vehicles and fighting wildland fires from these positions is very dangerous, and they strongly recommend this not be allowed. One issue is the exposure to personnel in unprotected positions. Persons have been killed while performing this operation. Also, the vehicle driver's vision is impaired. The second issue is that this is not an effective way to extinguish the fire, as it can allow the vehicle to pass over or by areas not completely extinguished. Fire can then flare up underneath or behind the vehicle and could cut off escape routes. The RMC and the NWCG strongly recommend that two fire fighters, each with a hose line, walk ahead and aside of the vehicle's path, both fire fighters on the same side of the vehicle (not one on each side), in clear view of the driver, with the vehicle being driven in uninvolved terrain. This allows the fire fighters to operate in an unhurried manner, with a clear view of fire conditions and the success

of the extinguishment. Areas not extinguished should not be bypassed unless follow-up crews are operating behind the lead unit and there is no danger to escape routes or to personnel.

- **6.3.2** Standing or riding on tail steps, sidesteps, running boards, fully enclosed personnel areas, or in any other exposed position shall be specifically prohibited [NFPA 2018].

The two fire fighters riding on Grass 5-1 were riding in a standing position behind the cab of the apparatus. These riding positions are located on either side of apparatus – driver and passenger connected by an open walkway. Grass 5-1 was not equipped with belts or tethering for fire fighters riding in the standing position. Access or egress is by opening a gate that is has secured by lifting the gate and placing the pin in a receiver. Additionally the gate opened outward. Grass 5-1 is a 2012 Ford F550 with a side step configuration. The apparatus met the requirements of NFPA1906, *Standard for Wildland Fire Apparatus*, 2012 edition. This apparatus is considered a Type V/Type VI wildland engine [NFPA 2012].

On August 17, 2017, a tentative interim amendment (TIA) was issued for NFPA 1906, *Standard for Wildland Fire Apparatus*, 2016 edition with an effective date of September 4, 2017. The TIA referenced the following: 2.3.8, 14.1.1, 14.4, A.14.4, A.14.4.3.4, A.14.1.1 (new), and E.1.2.4.

NFPA 1906 Paragraph **14.1.1** now reads, **"**Each crew riding position shall be within a fully enclosed personnel area."

A.14.1.1 states, "Typically, while engaged in firefighting operations on structural fires, apparatus are positioned in a safe location, and hose is extended as necessary to discharge water or suppressants on the combustible material." In wildland fire suppression, mobile attack is often utilized in addition to stationary pumping. In mobile attack, sometimes referred to as "pump-and-roll," water is discharged from the apparatus while the vehicle is in motion. Pump-and-roll operations are inherently more dangerous than stationary pumping because the apparatus and personnel are in close proximity to the fire combined with the additional exposure to hazards caused by a vehicle in motion, often on uneven ground. The personnel and/or apparatus could thus be more easily subject to injury or damage due to accidental impact, rollover, and/or environmental hazards, including burn over.

To potentially mitigate against the increased risk inherent with pump-and-roll operations, the following alternatives are provided for consideration:
(1) Driver and fire fighter(s) are located inside the apparatus in a seated, belted position within the enclosed cab. Water is discharged via a monitor or turret that is controlled from within the apparatus.
(2) Driver and fire fighter(s) are located inside the apparatus in a seated, belted position within the enclosed cab, but water is discharged with a short hose line or hard line out an open cab window.
(3) Driver is located inside the apparatus in a seated, belted position within the enclosed cab with one or more fire fighters seated and belted in the on-board pump-and-roll firefighting position as described in a following section.
(4) Driver is located inside the apparatus in a seated, belted position within the enclosed cab. Fire

fighter(s) is located outside the cab, walking alongside the apparatus, in clear view of the driver, discharging water with a short hose line.

Under no circumstances is it ever considered a safe practice to ride standing or seated on the exterior of the apparatus for mobile attack other than seated and belted in an on-board pump-and-roll firefighting position. [2016b].

The on-board pump-and-roll firefighting position should only be used when the following conditions are met:

1. The apparatus is actively engaged in mobile attack on the fire line,
2. The fuel model is characterized as fine fuels, which create hazardous fuel conditions in wildland urban interface areas.
3. The ground is level, flat, and free of obstacles,
4. Driver visibility is unobstructed,
5. Vehicle speeds are no greater than 10 mph, and
6. Fire fighters are wearing full protective NFPA 1977-compliant personal protective equipment and are equipped with a fire shelter.

Development of this Design.
Firefighting is an inherently dangerous operation. This is especially true of fighting a moving wildland fire in fine fuels. There are many techniques used and a great deal of discussion about the safest way to fight these fires. Over the years, many fire companies and apparatus manufacturers have developed techniques and equipment for fighting wildland fine fuel fires. These have included fighting fire from seats mounted to front bumpers, sitting on hoods or hose reels, standing on flat beds, standing in step wells on the side of apparatus, or standing on running boards. All of these approaches are extremely dangerous. The Fire Department Apparatus Technical Committee did extensive work to try to come up with a safer solution based upon the available apparatus and techniques that have been historically used in the industry. The preceding suggestions are safer than any of these ad-hoc techniques. *The NFPA Fire Service Occupational Safety and Health Technical Committee does not approve of any fireground operations that permit the fire fighter to ride outside the fully enclosed cab of a moving apparatus* [NFPA 2018].

At this incident, neither fire fighter riding on Grass 5-1 were wearing PPE, neither fire fighter was seated and secured by a seat belt, and the gate protecting the fire fighters on Grass 5-1 opened outward.

Recommendation #3: Fire departments should ensure that the incident commander develops and communicates the strategy and incident action plan (tactics) during the initial stages of the incident. The incident action plan should be updated when benchmarks are met/not met.

Discussion: Brush or grass firefighting operations are very dynamic and fast-paced. An incident commander must determine a strategy and then develop the incident action plan (IAP) to ensure that the proper actions to take control of the incident. The incident commander must follow the decision

making model that includes identifying incident critical factors (through a situational evaluation or "size up"), consider the standard risk management plan, declare the strategy (offensive or defensive), and then set tactical objectives. This model will lead to the development of the IAP, which serves as the tactical road map to effectively manage the incident. The IAP defines where and when resources will be assigned throughout the incident, along with tasks and objectives [NFPA 2014].

To ensure a standard outcome of each incident, the incident commander should match the standard conditions to standard actions. This is the core of the incident command system and is the basis for all operations. Standard conditions are identified as the incident's ***current*** critical factors:

- Identify the incident's critical factors, which can include type of incident, type of occupancy, life safety considerations, etc., before taking any action.
- Initial and ongoing size-up of the incident's critical factors must produce the information that becomes the basis for the current incident strategy and IAP.
- Current, accurate, and relevant information provides the foundation for effective initial and ongoing action.
- The goal of this systematic evaluation process continually produces standard, safe, well-managed incident outcomes [Blue Card 2018].

The IAP should match the defined strategy established by an incident commander for a particular incident. The defined strategy describes the overall approach to incident operations and drives the IAP. The IAP provides the tactical assignments required to achieve the offensive/defensive objectives. The order of occurrence is key—the strategic goals are developed first and then followed by the tactical objectives. At each incident, the incident commander should start with a standard placement-oriented operational plan that develops a strong, dependable beginning for command and control of the incident. While developing the strategic goal for the incident is the first component, the incident commander needs to produce detailed tactical objectives that can be assigned to responding companies. This is the purpose of the IAP [Brunacini 2002; Fire and Rescue Departments of Northern Virginia 2013].

The initial incident commander, most often, is a company officer who arrives on-scene prior to a chief officer. The company officer should provide a detailed size-up, which is communicated to all responding resources including the dispatch center. The company officer assumes command and makes a decision regarding the strategy and IAP. The company officer may not have the ability or time to record the IAP on paper and provide documentation when transferring command. In this case, a verbal IAP is appropriate. As with this or any incident, events can occur very quickly before a detailed tactical worksheet or written IAP is developed [Brunacini 2002].

The IAP can be as simple as a verbal transmission to all units assigned to an incident. Once an officer assumes command, the overall strategy – either offensive or defensive is communicated. Command can make specific assignments to arriving companies along with tactical objectives such as search, rescue, fire attack, ventilation, utility control, and exposure protection. The responding chief officer should be monitoring radio communications and documenting tactical objectives on a tactical

worksheet if possible. When the chief officer arrives on-scene, an update from the initial incident commander can occur (face-to-face or by radio). The chief officer will then assume command at a stationary location. By following this process, the initial and subsequent incident commanders will be in a stronger position to manage an incident should an emergency event occur [NFPA 2014].
NFPA 1561 defines an IAP as a verbal plan, tactical worksheet, written plan, or combinations thereof that reflects the overall incident strategy, tactics, risk management, and member safety that are developed by an incident commander. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2014] requires the following regarding an incident action plan:

- 5.3.12.1 The incident commander shall be responsible for developing and/or approving an incident action plan (IAP).
- 5.3.12.2 This IAP shall be communicated to all staged and assigned members at an incident.
- 5.3.20 The incident commander shall be responsible for reviewing, evaluating, and revising the IAP and overall strategy of the incident (**See Diagram 2**).

At this incident, the driver of Grass 5-1 assumed Command of the incident at 1120 hours, which was later transferred to the driver of Tanker 5. It is imperative the incident commander develop and announce the strategy and incident action plan.

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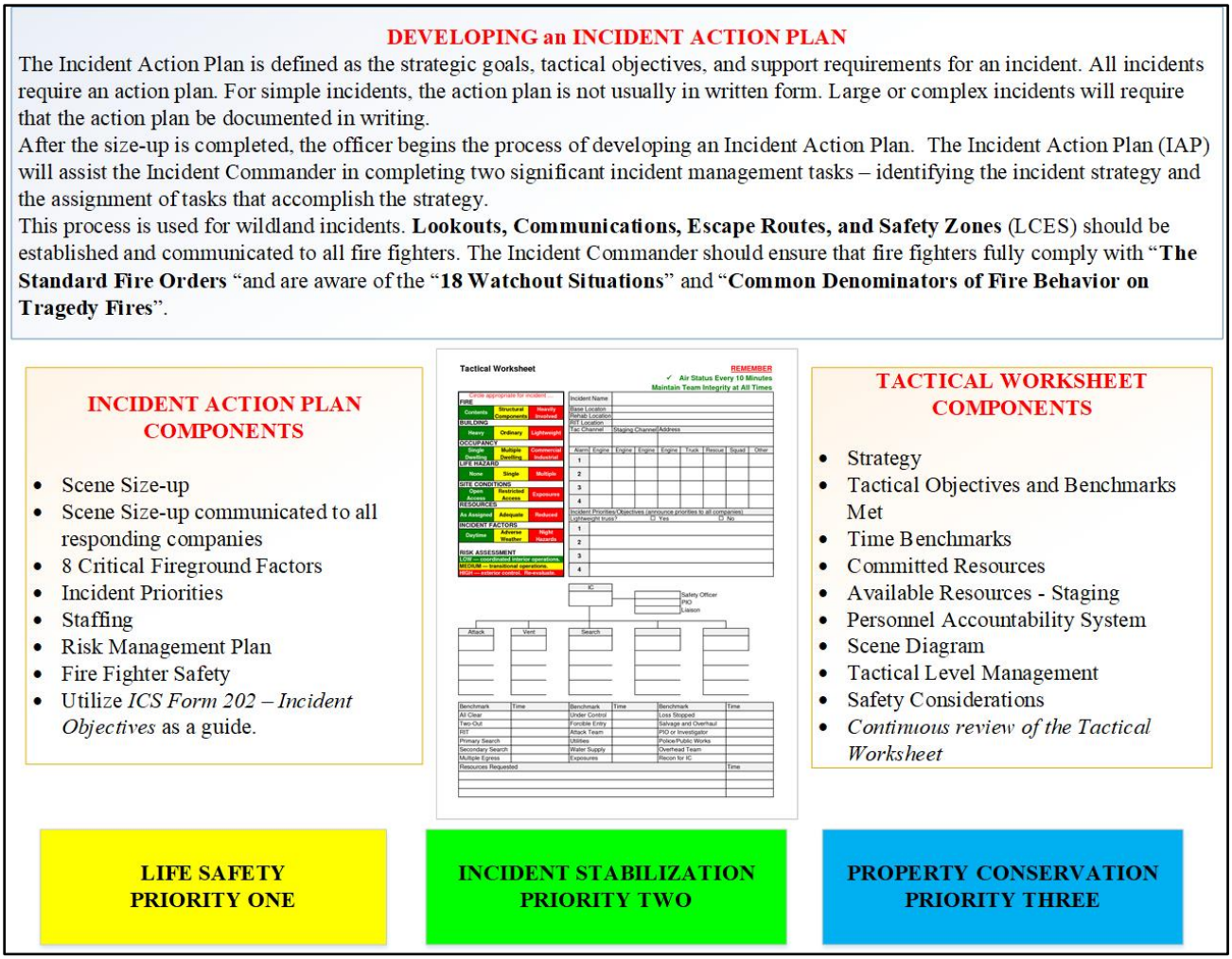

Diagram 2. A guide for developing an incident action plan at Type V and Type IV incidents. For these types of incidents, the incident action plan is most often communicated verbally.
(*Courtesy of FireFighterCloseCalls.com.*)

Recommendation #4: Fire departments should ensure that the principles of fireground risk management are implemented and followed at all incidents.

Discussion: While it is recognized that firefighting is an inherently hazardous occupation, established fire service risk management principles are based on the philosophy that greater risks will be assumed when there are lives to be saved and the level of acceptable risk to fire fighters is much lower when only property is at stake. Established risk management principles suggest that more caution should be exercised in situations where there is no clear evidence indicating a life safety issue or property is threatened. Risk management is one of the most important tools fire fighters can use to help reduce the

level of risk to responders operating at a fire. The incident commander must consider all factors and their associated risks prior to committing crews to firefighting operations [Chadwick 2014].

At any incident, life safety is always the 1st priority, followed by incident stabilization (2nd priority) and then property conservation (3rd priority). The ability to ensure for the safety of fire fighters is a continuous process throughout the incident. A sound risk management plan ensures that the risks are evaluated and matched with the actions and conditions. The incident commander should use the following risk management principles:

- Activities that present a significant risk to the safety of fire fighters shall be limited to situations that have the potential to save endangered lives.
- Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of fire fighters, and the actions shall be taken to reduce or avoid these risks.
- No risk to the safety of fire fighters shall be acceptable where there is no possibility to save lives or property [Brunacini 2002].

NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness*, **Chapter 8 – Emergency Operations**, Section 8.4, *Risk Management During Emergency Operations*, Paragraph A.8.4.2.1 states, "The risk to fire department members is the most important factor considered by the incident commander in determining the strategy that will be employed in each situation. The management of risk levels involves all of the following factors:

1. Routine evaluation of risk in all situations,
2. Well-defined strategic options,
3. Standard operating procedures,
4. Effective training,
5. Full protective clothing ensemble and equipment,
6. Effective incident management and communications,
7. Safety procedures and safety officers,
8. Backup crews for rapid intervention,
9. Adequate resources,
10. Rest and rehabilitation,
11. Regular evaluation of changing conditions.
12. Experience based on previous incidents and critiques" [NFPA 2018].

A vital component in a successful risk management program involves the development of a proactive and aggressive training program with a focus on the identification of risks and hazards during size-up, the ability to maintain situational awareness throughout the life of the incident, and the capability to execute fireground survival procedures when placed in a deadly situation. Rare are the instances in which fire fighters find themselves in a life-threatening situation, but it is at this time when survival training can prove so very valuable.

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As with any firefighting operation, the scene size-up is critical component for ensuring a successful outcome. The United States Department of Forestry has a five-step risk management process for wildland firefighting:

Step 1 – Situation Awareness

- Gather information
  - Objectives
  - Communications
  - Who's in charge?
  - Previous Fire Behavior
  - Weather Forecast
  - Local Factors
- Scout the Fire

Step 2 – Hazard Assessment

- Estimate Potential Fire Behavior Hazards
  - Look Up/Down/Around Indicators
- Identify Tactical Hazards
  - Watch Outs
- What other safety hazards exist?
- Consider Severity vs. probability

Step 3 – Hazard Control

- Fire Orders->LCES Checklist- **MANDATORY**
  - Anchor Point
  - Downhill Checklist (if applicable)
- What other controls are necessary?

Step 4 – Decision Point

- Are controls in place for identified hazards?
  - **NO**- Reassess situation **YES**- Next Question
- Are selected tactics based on expected fire behavior?
  - **NO**- Reassess situation **YES**- Next Question
- Have instructions been given and understood?
  - **NO**- Reassess situation **YES**- Initiate Action

Step 5 - Evaluate

- Personnel
  - Low experience level with local factors?
  - Distracted from primary task?
  - Fatigue or stress reaction?
  - Hazardous attitude?
- The Situation:

- What is changing?
- Are strategy and tactics working [NWCG 2018a]?

This information provides the necessary foundation for fighting a grass or wildland fire. As with structural firefighting, there are necessary steps to take to ensure for the successful outcome of an incident, but most importantly ensure for the safety of all fire fighters (NWCG 2018a).

Wildland fire operations should be conducted from the burned or "black" portion of the fire ground. With the majority of the fuel already consumed this provides a safe area to operate and a safe escape route. The Texas A&M Forest Services provides training and videos for fire departments. The *Attack from the Black* training video encourages firefighters to think ahead—not just in the moment—while fighting wildfires, and stresses the importance of wearing proper PPE. The video is available to fire departments across the country at no charge. ***Note**: The training video stresses the importance of wearing proper personal protective equipment (PPE). The DVD includes fire re-enactment on sand tables, which are proven training tools used by the Texas Forest Service. This learning tool helps firefighters think about initial attack strategies, contingency plans, and safety zones. The DVD is available by sending an email to: AttackFromTheBlack@tfs.tamu.edu requesting a DVD and include your name, fire department name and mailing address.*

At this incident, Grass 5-1 arrived on the scene and immediately went to the fence line of the property and started firefighting operations. This location created issues with radio communications. Grass 5-1 moved to the far east side of the property. The driver of Grass 5-1 assumed Command of the incident at 1120 hours, which was later transferred to the driver of Tanker 5.

It is imperative the incident commander develop and announce the strategy and incident action plan.

Recommendation #5: Fire departments should ensure that an incident commander utilizes the three levels of the command structure at incidents based upon the size and complexity of an incident.

Discussion: An incident commander should ensure that the Incident Command System (ICS) organization is developed at a pace that stays ahead of the tactical deployment of personnel and resources at an incident. In order for the Incident Commander to manage the incident, they must first be able to direct, control, and track the position and function of all resources. Building an ICS organization is the best support mechanism the Incident Commander can utilize to achieve the balance between managing personnel and incident needs. Simply put, this means:

- Large scale and complex incidents = Large ICS organization;
- Small scale and "simple" incidents = Small ICS organization.

The basic configuration of command includes three levels:

- Strategic level – Overall direction of the incident,
- Tactical level – Assigns operational objectives,
- Task level – Specific tasks assigned to companies (FIRESCOPE 2015].

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The strategic level involves the overall command of the incident. The incident commander (IC) is responsible for the strategic level of the ICS organization. The incident action plan should cover all strategic responsibilities, all tactical objectives, and all support activities needed during the entire operational period. The incident action plan defines where and when resources will be assigned to the incident to control the situation. This plan is the basis for developing an ICS organization, assigning all resources, and establishing tactical objectives [FIRESCOPE 2015].

The tactical level directs operational activities towards specific objectives. Tactical level officers include branch directors, division/group supervisors, who are in charge of specific resources. Tactical level officers are responsible for specific geographic areas or functions, and supervising assigned personnel. A tactical level assignment comes with the authority to make decisions and assignments, within the boundaries of the overall plan and safety conditions. The accumulated achievements of tactical objectives should accomplish the strategy as outlined in the incident action plan [FIRESCOPE 2015].

The task level refers to those activities normally accomplished by individual companies or specific personnel. The task level is where the work is actually done. Task level activities are routinely supervised by company officers. The accumulated achievements of task level activities should accomplish tactical objectives [FIRESCOPE 2015].

Each of these levels is distinct and has their own set of responsibilities. For the majority of incidents that fire departments respond to, the initial responsibility for managing all three organizational levels is handled by the initial IC, which is most often a company officer. The first arriving officer will assume the role as incident commander and will size-up the incident's critical factors, declare the incident strategy, assume Command, and communicate the incident action plan. The IC has initial command and control responsibility for the entire incident operation on the strategic level until command is transferred or terminated. On the tactical level, the fast attacking IC will implement and execute an incident action plan that addresses the incidents critical factors in order to facilitate the completion of the tactical priorities [Blue Card 2018].

A fast attacking company officer IC will also directly supervise and assist their crew members with the tasks required to bring the incident's problems under control. In most cases, this initial attack wave eliminates the incident hazards. For incidents that are not quickly controlled, are escalating, or are significant in scope and size upon arrival of the fire department, the strategic and tactical operational levels should be upgraded with a chief officer.

The strategic level of command on these types of incidents will be the 1st operational level that is upgraded. This command transfer significantly improves the IC's position and ability to perform and manage the *8 Functions of Command* and the corresponding strategic safety requirements for the entire incident operation. Placing the IC in a standard command post (CP) position where they can exclusively focus on incident management, enhances and facilitates both the completion of the tactical

priorities (the incident action plan) and fire fighter task level safety [Blue Card 2018]. The 8 Functions of Command are:

- Deployment
- Assume, Confirm and the Positioning of Command
- Situation Evaluation
- Strategy and Incident Action Planning
- Communications
- Organization
- Review, Evaluate, Revise
- Continue, Support, & Terminate Command [Blue Card 2018].

The first fire department member to arrive at the scene shall establish command of the incident. The initial incident commander shall remain in command until command is passed, transferred or the incident is stabilized and terminated:

- The first member on the scene must initiate the parts of ICS necessary to effectively manage the incident.
- For incidents that require the commitment of multiple companies, the first member on the scene must establish and announce "Command", and initiate an ICS organization appropriate for the incident. This includes accountability and the SAFETY of members working under Command.
- When a chief officer arrives at the scene at the same time as the initial arriving company, the chief officer should establish command of the incident [FIRESCOPE 2015].

It is the responsibility of Command to develop an organizational structure, using standard operating procedures, to effectively manage the incident scene. The development of the organizational structure should begin with deployment of the first arriving fire department unit and continue through a number of phases, depending on the size and complexity of the incident. In order for the incident commander to manage the incident, they must first be able to direct, control, and track the position and function of all operating companies [NFPA 2014].

At this incident, the driver of Grass 5-1 assumed Command of the incident at 1120 hours and maintained Command until relieved at 1138 hours.

It is imperative that the incident commander develop and announce the strategy and incident action plan.

Recommendation #6: Fire departments should operate a personnel accountability system to account for all fire fighters and first responders assigned to any incident.

Discussion: A personnel accountability system is a system that readily identifies both the location and function of all members operating at an incident scene [NFPA 2014]. The philosophy of the personnel accountability system starts with the same principles of an incident management system—company

unity and unity of command. Unity can be fulfilled initially and maintained throughout the incident by documenting the situation status and resource status on a tactical worksheet.
An integral part of the accountability system is to make sure that the fire fighters who are assigned and operating in the hazard zone are accounted for, starting with the initial operations through the entire incident. Also, a process should be in place to periodically check to make sure that all members operating in the hazard zone are accounted for by this system.

One of the most important functions of command safety is for the incident commander to initiate a personnel accountability system that includes the functional and geographical assignments at the beginning of operations until the termination of the incident. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety*, states in Paragraph 8.12.4, "The incident commander and members who are assigned a supervisory responsibility that involves three or more companies or crews under their command shall have an additional member(s) (e.g., staff aide) assigned to facilitate the tracking and accountability of the assigned companies or crews" [NFPA 2014].

A functional personnel accountability system requires the following:

- Development and implementation of a departmental SOP
- Necessary components and hardware, such as an accountability board, individual name tags, and company name tags
- Training for all members on the operation of the system
- Strict enforcement during emergency incidents.

A functional personnel accountability system should:

- Be able to identify all members operating in the hazard zone (who)
- Be able to identify where all members are in the hazard zone (where)
- Be able to identify the conditions in the hazard zone (conditions)
- Be able to identify what actions are being taken in the hazard zone (actions)
- Be able to identify paths of access and egress in and out of the hazard zone (exits)
- Be able to identify and assign rapid intervention crew(s) (RIC).

There are many different methods and tools for resource accountability. Some examples are:

- Tactical worksheets
- Command boards
- Apparatus riding lists
- Company responding boards
- Electronic bar-coding systems
- Accountability tags or keys (e.g., PASSPORT System) [NFPA 2014].

Resource accountability should be assigned to personnel who are responsible for maintaining the location and status of all assigned resources at an incident. As the incident escalates, resource status would be placed under the Planning Section. This function is separate from the role of the incident commander. The incident commander is responsible for the overall command and control of the

incident. Due to the importance of responder safety, resource status should be assigned to a dedicated member as the size and complexity of the incident dictates. A number of positions could function in this role including an incident command technician, staff assistant, chief officer, or other designated member. As the incident escalates and tactical-level management components (e.g., divisions or groups) are assigned, the resource status officer (accountability officer) works with the division or group supervisors to maintain an on-going tracking and accountability of members [FIRESCOPE 2015]. A properly initiated and enforced personnel accountability system enhances fire fighter safety and survival. It is vital that resources can be identified and located in a timely manner.

An important aspect of a personnel accountability system is the personnel accountability report (PAR). A PAR is an organized on-scene roll call in which each supervisor reports the status of their crew when requested by the incident commander [NFPA 2014]. **The PAR should be conducted every 15–20 minutes or when benchmarks are met.**

In order for the personnel accountability system to properly function, the process should include a standard operating procedure that defines each function's responsibility and the necessary hardware required to ensure this process is successful on the fireground. Also a training component—both classroom and practical—should be conducted to ensure this process functions properly during emergency incidents.

At this incident, a personnel accountability system was never established or used. Each mutual aid fire department had little or no contact with Command from a personnel accountability standpoint.

Recommendation #7: Lookouts, communications, escape routes, and safety zones (LCES) should be established and communicated to all fire fighters during wildland firefighting operations.

Discussion: In the wildland fire environment establishing and utilizing Lookouts, Communications, Escape Routes, and Safety Zones (LCES) are critical to ensure the safety of wildland fire fighters (**See Appendix One**). This includes selecting a lookout or lookouts, setting up a communication system, choosing escape routes, and selecting a safety zone(s). LCES is built on two guidelines: before safety is threatened, each firefighter must know the LCES system will be used, and LCES must be continuously reevaluated as fire conditions change. ***Note:*** *LCES works well in in other emergency responses such as hazardous materials mitigation, civil unrest, and flooding*.

The LCES systems approach to fire line safety is an outgrowth of analysis of fatalities and near misses for more than 20 years of active wildland firefighting operations. LCES simply focuses on the essential elements of the standard FIRE ORDERS (**See Appendix Two**). LCES should be automatic in wildland firefighting operations, and all fire fighters should know LCES. LCES functions sequentially - it's a self-triggering mechanism. Lookouts assess - and reassess - the fire environment and communicate threats to safety to affected members; 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 [NWCG 2018a].

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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 now and in the near future. Situational Awareness becomes especially important in the firefighting operations and fire fighter domains where the information flow can be quite high and poor decisions can lead to serious consequences [Naum 2011].

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 [Naum 2011].

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 2018a]:
• 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 [NWCG 2018a].

At this incident, there was no indication that lookouts, communications, escape routes, and safety zones (LCES) were established and communicated to all fire fighters.

Recommendation #8: Fire departments and fire service agencies should ensure that fire fighters fully comply with "The Ten Standard Fire Orders" and are aware of the "18 Watchout Situations" and "Common Denominators of Fire Behavior on Tragedy Fires" when fighting wildland 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 *Te*n *Standard Fire Orders*, recognize the "Watchout Situations", and recognize the "common denominators of fire behavior on tragedy fires" [NWCG 2018a]. ***Note: "The Ten Standard Fire Orders", "18 Watchout Situations", and "Common Denominators of Fire Behavior on Tragedy Fires"*** *are listed in* ***Appendix Two***.

The original *Ten Standard Fire Orders* were developed in 1957 by a task force commissioned by the United States Department of Agriculture's Forest Service . The task force reviewed the records of 16 tragic fires that occurred from 1937 to 1956. The *Ten Standard Fire Orders* were based in part on the successful "General Orders" used by the United States Armed Forces. The *Ten Standard Fire Orders* are organized in a deliberate and sequential way to be implemented systematically and applied to all fire situations.

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Shortly after the *Ten Standard Fire Orders* were incorporated into fire fighter training, the *18 Watchout Situations* [NWCG 2018a] were developed. These *18 Watchout Situations* are more specific and cautionary than the *Ten Standard Firefighting Orders* and describe situations that expand the ten points of the Fire Orders. If fire fighters follow the *Standard Fire Orders* and are alerted to the *18 Watchout Situations*, much of the risk of firefighting can be reduced.

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 "Wildland Fire Incident Management Field Guide" (PMS 210) and in the "Incident Response Pocket Guide" (PMS # 461) [NWCG 2014, NWCG 2018a].

At this incident, there was no indication of compliance with "The Ten Standard Fire Orders" and an awareness of the "18 Watchout Situations" and "Common Denominators of Fire Behavior on Tragedy Fires".

Recommendation #9: Fire fighters who engage in wildland firefighting 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 firefighting operations for wildland fires. As previously mentioned, few fire fighters interviewed during this incident reported having participated in any formalized wildland firefighting training.

The National Wildfire Coordinating Group (NWCG) provides leadership specific to the wildland fire community regarding training, standards, equipment, firefighting qualifications, and other fire functions specific to wildland firefighting. 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 [NWCG 2018b]. NWCG recommends the minimum training for fire fighters (NWCG Fire Fighter Type II) involved with wildland 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* [NWCG 2018b]. It is recommended that all rural and volunteer fire fighters, who engage 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 [NFPA 2016c]

Fire fighters, especially those trained in structural firefighting 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.

At this incident, there was no defined process for fire fighters to receive training within the department.

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Recommendation #10: Fire departments should develop, implement, and manage a comprehensive training program to ensure knowledge, skills, abilities, and competencies are maintained for emergency response.

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 tasks 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 [NFPA 2019].

The state of Texas does not have minimal qualifications for structural firefighting for volunteer fire fighters. Most fire departments in Texas do not have minimal requirements for wildland firefighting although 60% of their calls involve wildland firefighting operations. To ensure the safety of the fire fighters, the state should consider developing 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.

There was no defined process for fire fighters to receive training within the department.

Recommendation#11: Fire departments that operate Type V or Type VI Wildland Apparatus should have radio or intercom communications between the driver/operator and fire fighters.

Discussion: The safety of fire fighters riding on and operating around wildland fire apparatus (Type V and Type VI) is paramount. Fire fighters operating from the side step position on a wildland engine are exposed to the elements and surrounding noise. This includes the operation of the vehicle's fire pump, apparatus engine and other equipment that may be operating. The driver/operators of the wildland engine are exposed to the same noise as well as noise of radio traffic. Communication between the fire fighters and driver/operator is vital for safe operations of the apparatus as well as the safety of all members riding on the apparatus.

Communications between other fire apparatus, the dispatcher, and the incident commander are impacted by the type of incident, location of the fire, terrain, and operation of equipment. The fire fighters can help direct the driver/operator as necessary, provide a warning if the fire is near the apparatus, and any other safety issues that need to be communicated [USFA 2016].

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Fire departments should acquire the necessary radio or intercom equipment to provide proper communications between the driver/operator of the apparatus and the fire fighters operating on the side step. There are a variety of commercially available products.

Fire Station 5 Update

Since the incident on March 10, 2018 which resulted in a fire fighter fatality, Fire Station 5 has implemented several changes:

- All members must wear wildland PPE when responding to wildland fires. If wildland PPE is unavailable the member must wear structural turnout gear.
- The department is meeting two times each month. One meeting is composed of a business meeting followed by training. The second meeting is composed solely of training. Training attendance and the subject matter is documented and based on the State Firefighters' and State Fire Marshals' Association of Texas curriculum or is EMS based.
- A complete set of Standard Operating Procedures and Standard Operating Guidelines are being developed for all fire department operations

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Investigator Information

This incident was investigated by Murrey E. Loflin, Investigator, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, West Virginia. An expert technical review was provided by Scott D. Kerwood, Fire Chief of Hutto, TX Fire Rescue. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

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.

Disclaimer

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Appendix One
Lookouts, Communications, Escape Routes, and Safety Zones (LCES)

LOOKOUT

- Experienced / Competent / Trusted
- Enough lookouts at good vantage points
- Knowledge of crew locations
- Knowledge of escape and safety locations
- Knowledge of trigger points
- Map / Weather Kit / Watch / IAP

COMMUNICATIONS

- Radio frequencies confirmed
- Backup procedures and check-in times established
- Provide updates on any situation change
- Sound alarm early, not late

ESCAPE ROUTES

- More than one escape route
- Avoid steep uphill escape routes
- Scouted: Loose soils / Rocks / Vegetation
- Timed: Slowest person / Fatigue & Temperature • Marked: Flagged for day or night
- Evaluate: Escape time vs. Rate of spread
- Vehicles parked for escape

SAFETY ZONES

- Survivable without a fire shelter
- Back into clean burn
- Natural Features: Rock Areas / Water / Meadows
- Constructed Sites: Clearcuts / Roads / Helispots
- Scouted for size and hazards
- Upslope?
- Downwind? → More heat impact → Larger Safety Zone
- Heavy Fuels?

NOTE: Escape time and safety zone size requirements will change as fire behavior changes. More heat impact LARGER safety zone

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

The **Ten 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.

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.