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Case Studies on Fall from Elevated Devices among Fire Fighters

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ABSTRACT This chapter summarizes a number of incidents involving fire fighters falling from elevated devices such as aerial ladders and aerial platforms, from fire escapes, and from the top of fire apparatus. These incidents were investigated by the National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program, Division of Safety Research, located in Morgantown, West Virginia.

KEY WORDS: *fire fighters, fire apparatus, aerial ladder, aerial platform, fall restraint, ladder belts, training.*

25.1 Fire Fighter Fatality Investigation and Prevention

The United States currently depends on approximately 1.1 million fire fighters to protect its citizens and property from losses caused by fire. Of these fire fighters, approximately 336,000 are career and 812,000 are volunteers. The National Fire Protection Association (NFPA) and the US Fire Administration (USFA) estimate that on average, 80–100 fire fighters die in the line of duty each year.

The NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) conducts independent investigations of selected fire fighter line-of-duty deaths. Investigations are conducted to provide recommendations to prevent future deaths and injuries. The FFFIPP is a public health practice investigation program. NIOSH investigations are not conducted to enforce compliance with state or federal job safety and health standards. NIOSH does not attempt to determine fault or place blame on fire departments or individual fire fighters.

The goal of FFFIPP is to learn from these tragic events and prevent future similar events. NIOSH has investigated approximately 40% of fire fighter deaths since the program began in 1998.

Fire fighters are exposed to the risks of falling from heights and from elevated firefighting equipment, ladders, and fire apparatus. This chapter presents nine case reports that describe firefighter falls from height with recommended control measures to reduce the likelihood of reoccurrence.

25.2 Career Fire Fighter Dies after Falling from Aerial Ladder during Training: Florida

On January 6, 2012, a 49-year-old male career fire fighter (the victim) died from injuries sustained after falling from the tip of a 105 ft aerial ladder during training. The aerial ladder was set up behind the victim's fire station so that personnel could climb the ladder for training purposes. Fire fighters were dressed in station or exercise attire. All fire fighters, including the victim, were wearing ladder safety belts as they ascended and descended the ladder. Some personnel included the ladder climb into a physical fitness exercise routine. Prior to the victim's second climb, he complained of his legs being wobbly and feeling out of shape. After reaching the tip of the ladder on his second climb, the victim failed to come back down immediately. The fire fighters on the ground did not think anything of it till they heard a noise and looked up to see the victim tumbling down the rungs of the ladder. The victim tumbled out of the protection of the ladder rails and struck the passenger-side rear outrigger. Lifesaving measures were taken by fire fighters on scene, but the victim succumbed to his injuries at the hospital. The victim was wearing a ladder belt, and the belt appeared to be intact at the time of the fall.

Key contributing factors identified in this investigation include aerial apparatus standard operating procedures (SOPs) not being fully developed and implemented to include measures to protect training participants from inadvertent falls and the safe and proper use of aerial apparatus; fire apparatus used as part of an unstructured training evolution and circuit training exercise; and a possible unknown medical problem experienced by the victim (NIOSH, 2012).

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

- Ensure that SOPs regarding proper use and operation of aerial apparatus are developed, implemented, and enforced
- Ensure that a "safe discipline" is maintained at all times, including training
- Consider adopting a comprehensive wellness and fitness program, including annual medical evaluations consistent with NFPA standards and performing annual physical performance (physical ability) evaluations for all fire fighters

25.3 Volunteer Fire Fighter Dies after Falling From a Rope: Minnesota

On May 23, 2011, a 35-year-old male volunteer fire fighter (victim) died after falling from a rope he was climbing after the conclusion of a rope skills class. The department was conducting a ropes and mechanical advantage haul systems training session that consisted of classroom and practical skills training intended to provide the fire fighters with rope skills (Figure 25.1). The drill had concluded, and the students were in the process of breaking down the drill site and putting the equipment away. The victim and two fire fighters were standing in front of the tower ladder when the victim decided to climb one of two ropes suspended from the bottom of the tower ladder platform in an attempt to access the other suspended rope.

The victim was climbing up a rope, using a hand-over-hand technique that had been used to demonstrate rope haul systems, and attempted to grab another rope out of his reach. The victim likely lost his grip on the rope and fell to the asphalt pavement, striking his head. Emergency medical aid was administered by fellow fire fighters, and he was transported to a local hospital, where he died from his injuries. The medical examiner reported the cause of death as blunt force head trauma.

Key contributing factors identified in this investigation include lack of a safety officer, lack of proper personal protective equipment, and student to instructor ratio (NIOSH, 2011).

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

- Ensure that a qualified safety officer (meeting the qualifications defined in NFPA 1521) is appointed in practical skills training environments
- Ensure that minimum levels of personal protective equipment are established for practical skills training environments (as defined in NFPA 1500)
- Ensure that sufficient instructors or assistant instructors are available for the number of students expected to participate in practical skills training evolutions

FIGURE 25.1
Training site. (Photo courtesy of Fire Department.)

Additionally, states, municipalities, and authorities having jurisdiction should

- Take steps to ensure that ropes and equipment used in emergency services practical skills training are inspected and records are kept on the purchase, use, and inspection of the ropes and equipment (as defined in NFPA 1500 4.6.5)

25.4 Two Career Fire Fighters Die after Falling from Elevated Aerial Platform: Texas

On January 25, 2009, two male career fire fighters, age 28 (Victim #1) and age 45 (Victim #2), died after falling from an elevated aerial platform during a training exercise in Texas. The fire fighters were participating in the exercise to familiarize fire department personnel with a newly purchased 95 ft mid-mount aerial platform truck. A group of four fire fighters were standing in the aerial platform, which was raised to the roof of an eight-story dormitory building at a local college (Figure 25.2). The platform became stuck on the concrete parapet wall at the top of the building. During attempts to free the platform, the top edge of the parapet wall gave way, and the aerial ladder sprang back from the top of the

FIGURE 25.2
Aerial platform positioned at dormitory building to recreate incident scene. (Photo from NIOSH.)

building, then began to whip violently back and forth. Two of the four fire fighters standing in the platform were ejected from the platform by the motion. They fell approximately 83 ft to the ground and died from their injuries. None of the fire fighters in the elevated platform were wearing any type of fall restraint.

Key contributing factors identified in this investigation include the fire fighters being unfamiliar with the controls on the newly purchased aerial platform truck, training in a "high-risk" scenario before becoming familiar with new equipment, failure to use fall restraints, the design of the platform railing and integrated doors, and the location of the lifting eyes underneath the platform, which contributed to the platform snagging on the building's parapet wall (NIOSH, 2009).

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

- Ensure that fire fighters are fully familiar with new equipment before training under "high-risk scenarios"
- Ensure that fall protection is used whenever fire fighters and other personnel are working in elevated aerial platforms
- Follow SOPs for training, including the designation of a safety officer
- Ensure that SOPs covering the operation and use of fire apparatus (including aerial platform apparatus) are developed and followed during training exercises as well as in fire suppression activities
- Provide fall protection belts with all aerial ladder and platform apparatus and ensure that fall protection is used in both training exercises and emergency response events

Fire apparatus manufacturers should

- Include the use of fall protection in both demonstration and training programs
- Ensure that aerial platforms and other aerial devices are designed to reduce or eliminate the potential for snagging on buildings or other elevated surfaces
- Ensure that aerial platform doors or gates are designed to prevent opening in the outward direction

25.5 Fire Fighter (Captain) Dies after Fall from Ladder during a Training Exercise: California

On June 16, 1999, a 38-year-old male fire fighter/captain (the victim) died after falling approximately 20 ft from the top of a ladder that had been previously raised to the second-story window of a fire building at a fire training center. On the morning of the incident, several fire departments were involved in a multijurisdictional, multicompany training exercise. The exercise was conducted by three divisions performing separate evolutions simultaneously. Division A demonstrated proper tactics and procedures during live fire-attack operations and proper search-and-rescue techniques within a simulated single-family residential occupancy. Division B demonstrated proper search-and-rescue techniques

FIGURE 25.3
Forty-two inch window sill and ladder tip. (Photo from NIOSH.)

and ladder-rescue operations from a second-story elevated platform and/or window, and Division C demonstrated proper tactics and procedures for advancing a fire-attack hoseline to gain access to a third-floor fire by entering a second-floor window via a ladder and extending the hoseline up a stairwell to the fire (Figure 25.3). The evolutions were to be performed twice a day over a 3 day period (Session #1 in the morning and Session #2 in the afternoon). The incident occurred near the end of Session #1 on the first day of training. The victim, who was acting as a proctor for the training exercise and monitoring Division C, was positioned on the second floor of the training facility with Division C, who had just completed their evolution when the incident occurred. The victim and fire fighters from Division C were assembled on the second story when the air horn sounded to evacuate the building, as previously planned. At that time, and for unknown reasons, the victim announced that he was going to attempt a new procedure he had learned previously at a rescue intervention training course, which was referred to as the *bail out*. The new procedure involved a headfirst advance over the top of the ladder, hooking an arm through a ladder rung, and grasping a side rail, swinging the legs around to the side of the ladder and sliding down the ladder to the ground. Without hesitation or comment, the victim, who was about 3 ft away from the top of the ladder, took one step and leaped over the top of the ladder. The victim was unable to adequately hook the ladder rungs or grasp a ladder side rail and fell about 20 ft headfirst to the concrete landing. The victim received immediate attention from fire fighters and medics in the area and was transported to the local hospital, where he was pronounced dead about 40 min after the incident.

Key contributing factors identified in this investigation include the lack of an incident safety officer and an unpracticed emergency bailout procedure (NIOSH, 1999).

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

- Ensure that all new training programs undergo a comprehensive review prior to the implementation of the program
- Collaborate with other fire-related organizations regarding the feasibility of all new training procedures before the programs are implemented
- Ensure that all aspects of safety are adhered to per established standards and recommendations while training is being conducted
- Designate individual safety officers at all significant training exercises to observe operations and ensure that safety rules and regulations are followed

25.6 Volunteer Fire Fighter Dies after Ten-Foot Fall from Engine: Ohio

On July 24, 2007, a 38-year-old male volunteer fire fighter (victim) died after falling from the top of an engine. The victim had returned to the fire station after working a structure fire and was preparing the engine for future fire calls. Following the reloading of hose on the engine, the victim climbed on the driver's side of the engine to adjust and secure a vinyl hose bed cover (Figure 25.4). While attempting to adjust the cover, the victim slipped and fell onto the station's concrete apron. The victim landed on his head and lay supine

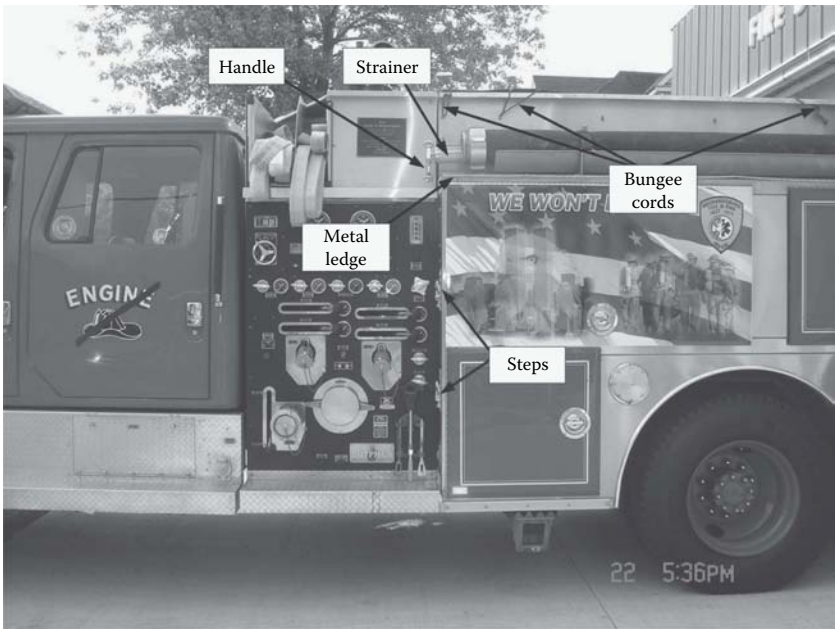

FIGURE 25.4
Side of the engine where the victim ascended and the incident occurred. (Photo from NIOSH.)

on the ground. The victim was transported to an area hospital, where he received medical care and was pronounced dead.

Key contributing factors identified in this investigation include the design of the engine, which introduced numerous potential fall risks when loading the hose bed and securing the vinyl protective cover; fire department practices in loading the hose bed and securing the vinyl hose bed cover, which were unwritten and inadequately addressed fall hazards; and damage to the mounting system of snaps, which made securing the vinyl hose bed cover more cumbersome (NIOSH, 2007a).

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

- Develop and implement SOPs on the correct procedures/safe methods for reloading hose and securing hose bed covers
- Consider requiring the use of a ladder when servicing items that are out of reach from ground level on the fire apparatus
- Ensure that hose bed covers on fire apparatus are maintained in good physical condition or are replaced when needed
- Consider, when purchasing a new fire apparatus, that it be equipped with available safety features to assist with hose loading and covering the hose bed (e.g., a hose bed that hydraulically lowers, or hose bed covers that are hydraulic, roll-up, or hinged metal)

Although it was difficult to substantiate the actual level of lighting when the incident occurred, NIOSH concluded that as a matter of prudent safe operations, fire departments should

- Ensure adequate exterior lighting for activities outside the fire station

25.7 Career Fire Fighter Dies from Fall off Fire Escape Ladder: Illinois

On August 9, 2010, a 31-year-old male career fire fighter (the victim) died from a fall while climbing a fire escape ladder. Crews were responding to an alarm at a four-story mixed occupancy structure. When crews arrived at 00:31, they noticed sparks being emitted from the top of the roof near an external exhaust duct that originated in a street-level restaurant. The victim and three other fire fighters were using an exterior fire escape to access the roof (Figure 25.5). At the fourth-floor landing, the victim started to ascend the vertical ladder to the roof carrying a 63 lb hand pump in his right hand while being supported by a fire fighter on the landing. When out of reach of the supporting fire fighter, the victim lost his grip on the ladder, falling 53 ft to the pavement. The victim was transported to the local medical center, where he was pronounced dead.

Key contributing factors identified in this investigation include using a fire escape to access the roof, rather than a safer means such as an aerial ladder or interior stairway, and the victim being unable to maintain a three-point contact with the vertical portion of the fire escape due to carrying the hand pump (NIOSH, 2010).

FIGURE 25.5
Fire escape post incident. The access ladder from which the victim fell can be seen at the upper left corner. (Photo from NIOSH.)

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

- Ensure that standard operating guidelines (SOGs) on the use of fire escapes are developed, implemented, and enforced
- Ensure that tactical-level accountability is implemented and enforced
- Ensure that companies are rigorously trained in safe procedures for roof operations and climbing ladders of any type
- Ensure that fire fighters are rigorously trained in safe procedures for carrying and/or hoisting equipment when ascending or descending elevations
- Evaluate the fire prevention inspection guidelines and process to ensure that they address high-hazard occupancies, such as restaurants, and incorporate operational crew participation

25.8 Career Fire Fighter Dies in Fall from Roof at Apartment Building Fire: New York

On June 21, 2007, a 23-year-old male career fire fighter (the victim) died after falling from the roof at a four-story apartment building fire. When fire fighters arrived on scene, light smoke and fire were showing from a fourth-floor window. The victim had just climbed the truck ladder to the roof bulkhead and was attempting to lower himself to the main roof when he fell (Figure 25.6). The roof saw (slung on the victim's back) shifted, causing the victim to lose his balance and fall to the ground. Fire fighters had been on scene less than 3 min when the victim fell. The victim was transported to a metropolitan hospital, where he succumbed to his injuries.

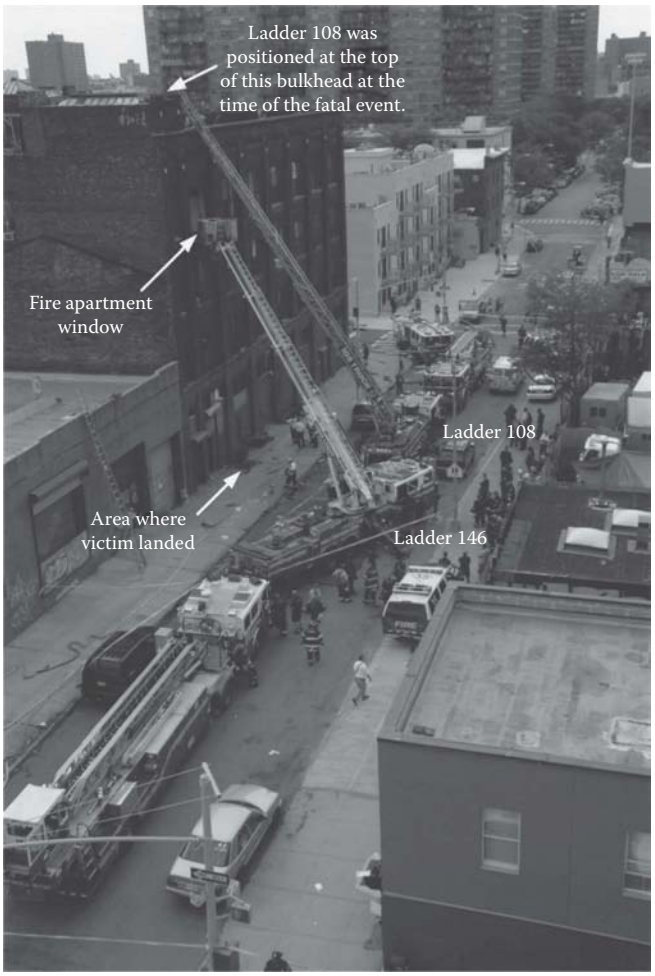

FIGURE 25.6
Aerial view of incident scene. (Photo courtesy of Fire Department.)

Key contributing factors identified in this investigation include the judgment of the fire fighter in deciding on a riskier means of moving from the roof bulkhead to the main roof; the placement of the ladder against the roof bulkhead rather than the main roof, which introduced additional fall risks for fire fighters; the hazardous task of climbing a ladder while laden with tools and equipment; and the method by which the saw was carried, which allowed the shifting saw to put the fire fighter off balance (NIOSH, 2007b).

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

- Stress to fire fighters the importance of exercising caution when working at elevation
- Consider the location and placement of aerial ladders to prevent fire fighters from climbing from different elevations during fireground operations

- Consider the use of portable scissor ladders to facilitate access from an aerial ladder to the roof
- Ensure that fire fighters communicate any potential hazards to one another and ensure that team continuity is maintained during roof operations
- Evaluate the manner in which equipment is harnessed or carried by fire fighters to prevent loss of balance
- Consider reducing the amount of equipment that fire fighters must carry while climbing ladders

Manufacturers of fire service saws should

- Consider ergonomic design principles to reduce the weight of ventilation saws
- Consider developing improved carrying slings

25.9 Volunteer Training/Safety Officer Dies from Injuries Received in Fall from Pick-Up Truck Following Training Exercise: Tennessee

On May 18, 2003, a 28-year-old male volunteer training/safety officer (the victim) was seriously injured when he fell from a moving pick-up truck. He had completed a 3 day training course and at the time of the incident was being transported within the training grounds. The victim was riding on the lowered tailgate of a moving pick-up truck when he fell onto the road. He suffered severe head trauma and was treated at the scene by fellow fire fighters/emergency medical technicians (EMTs) and on-site emergency medical services. The victim was transported by medical helicopter to a local trauma center, where he died from his injuries on May 24, 2003.

Key contributing factors identified in this investigation include sitting on the open tailgate of a moving pickup truck and possible underlying medical conditions (NIOSH, 2003).

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

- Ensure that all personnel being transported when on duty be securely seated and restrained in approved vehicle passenger compartments

Although it is unclear whether a medical or physical condition contributed to this fatal incident, fire departments should consider implementing these safety and health recommendations based on the physical demands and medical requirements of fire fighting:

- Provide mandatory preplacement and annual medical evaluations, consistent with NFPA 1582, for all fire fighters to determine medical fitness for duty and training exercises
- Conduct periodic physical capabilities testing to ensure that fire department personnel meet the physical requirements for duty and training exercises

25.10 Volunteer Fire Fighter Dies after 9 ft Fall from Ladder: Pennsylvania

On January 17, 2000, a 53-year-old male volunteer fire fighter (the victim) died from injuries received the previous day after the extension ladder he was descending slipped out from under him while he was performing maintenance work (Figure 25.7). On the previous day (January 16, 2000), the victim had been working on replacing a garage door opener in the middle bay of the fire station. Access to the door opener was gained by placing a 14 ft fireground aluminum extension ladder against the side of a fire rescue truck (see Figure 25.7), climbing the ladder to the roof of the fire rescue truck, and then accessing the garage door opener. The victim had removed the existing door opener and was in the process of going to assist in getting the new door opener ready for installation. While he was descending the extension ladder, the ladder slipped out from under him, and the victim fell headfirst to the concrete floor. Another fire fighter, who was assisting the victim in the replacement of the door opener, saw the victim fall and immediately jumped down to the ground from the roof of the rescue truck to assist the victim. He summoned a civilian, who was on the ground putting the new opener together, to help. The fire fighter who had jumped from the roof of the rescue truck ran to a nearby house to inform the victim's wife, while the civilian called 911. Within a few minutes, paramedics and a police officer arrived on the scene. The victim was intubated

FIGURE 25.7
Fire rescue truck with ladder. (Photo from NIOSH.)

and transported via a helicopter to the local hospital, where he died the next day from his injuries.

Key contributing factors identified in this investigation include failure to properly position the ground ladder in a safe manner, use of the incorrect type of ladder, and failure to size up the work area to consider potential safety issues (NIOSH, 2000).

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

- Ensure that ladders are used in accordance with existing safety standards
- Designate an individual as the fire station safety officer for all in-house maintenance to identify potential hazards and ensure that those hazards are eliminated
- Consider the use of mobile scaffolding, personnel lifts, scissor lifts, or boom lifts, instead of the top surface of a fire truck

25.11 Summary

Fire fighters are at risk of falling from elevated devices such as aerial ladders and aerial platforms, ladders, and fire escapes and from the top of fire apparatus when performing their normal job duties. Fire fighters often have to carry hand tools such as axes, halogen tools, fire extinguishers, ventilation saws, and other heavy objects while climbing. Fire fighters cannot wear body harnesses or fall restraint systems as construction workers, roofers, and other workers do, because fire fighters must wear heavy turnout clothing and self-contained breathing apparatus. Fire fighters are required to wear ladder belts that are secured to attachment points while working in elevated aerial platforms, but it is not practical for fire fighters to tie off to an attachment point while climbing ladders.

To reduce the possibility of injury and death, fire departments and fighters should take the following actions:

- Develop, implement, and enforce SOPs regarding the proper use of safety equipment and procedures when climbing ladders and working at elevated heights
- Ensure that fall protection is used whenever fire fighters and other personnel are working in elevated aerial platforms
- Ensure that fire fighters are fully familiar with new equipment before training in high-risk scenarios
- Ensure that qualified incident safety officers are designated and in place at all practical skills training environments and at all incidents where fire fighters are working at height
- Ensure that fire fighters are trained and exercise caution when working at height

Fire departments, authorities having jurisdiction, equipment manufacturers, and researchers should consider ways to reduce the amount of equipment that fire fighters must carry while climbing ladders and working at height, where they are at risk of falling.

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