



NIOSH ALERT

**Preventing Deaths and Injuries of
Fire Fighters When Fighting Fires in
Unoccupied Structures**



DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



This document is in the public domain and may be freely copied or reprinted.

DISCLAIMER

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these Web sites.

ORDERING INFORMATION

To receive documents or other information about occupational safety and health topics, contact NIOSH at

1-800-CDC-INFO (1-800-232-4636)

TTY: 1-888-232-6348

E-mail: cdcinfo@cdc.gov

or visit the NIOSH Web site at **www.cdc.gov/niosh**

For a monthly update on news at NIOSH, subscribe to NIOSH eNews by visiting **www.cdc.gov/niosh/eNews**

DHHS (NIOSH) Publication Number 2009-XXX

February 2009

SAFER • HEALTHIER • PEOPLE™

Preventing Deaths and Injuries of Fire Fighters When Fighting Fires in Unoccupied Structures

WARNING!

Fire fighters are often killed or injured when fighting fires in unoccupied structures.

Fire fighters should take the following steps to minimize their risk of death and injury while fighting fires in unoccupied structures:

- Report conditions and hazards encountered to your officer, incident commander, or incident safety officer.
- Recognize that maintaining your safety is a shared responsibility. Comply with your department's SOPs and safety rules.
- Be constantly aware of your surroundings.

Fire departments (chief officers, company officers and policy makers) should take the following steps to protect fire fighters:

- Develop and enforce risk management plans, policies, and standard operating procedures and guidelines (SOPs/SOGs) for risk management.
- Train incident commanders, incident safety officers, and fire fighters in the fire department risk management plans and SOPs/SOGs for risk management.
- Develop and implement fire department policies and SOPs/SOGs for emergency response and fire-fighting activities in and around unoccupied structures. No offensive interior attacks should be made in unoccupied or unsafe structures.

- Have a rapid intervention team (RIT) in place anytime personnel are in a fire.
- Inspect and preplan buildings within your jurisdiction. Note the type of construction, materials used, presence of trusses and/or lightweight construction in the roof and floor, type of occupancy, fuel load, exit routes, and other distinguishing characteristics.
- Enter preplan information into the dispatcher's computer so that when a fire is reported at preplanned locations, the dispatcher can radio all first responders with critical information.





- Make sure that the incident commander or incident safety officer conducts an initial size-up before beginning fire-fighting efforts and continuously during all fireground operations.
- Ensure those in charge of fire incidents (i.e. incident commanders, chief officers, safety officers, etc.) fulfill their responsibilities and obligations in the execution of their duties.

Incident commanders and incident safety officers should do the following:

- Establish, clearly mark, and monitor an exterior collapse zone at structure fires where there is a risk of collapse.
- Consider all manual fire-suppression activities within the collapse zone to be an offensive attack.
- Use effective and universal evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building as well as during overhaul and salvage operations.
- Consider the number of fire fighters, the amount of equipment available, and the stage of the fire when determining the type of fire attack.

- Follow departmental policies (risk management plans, SOPs/SOGs) for risk management.
- Conduct an initial size-up of the incident before beginning firefighting efforts and continually throughout the operation.
- Use appropriate criteria for deciding on an offensive or defensive strategy for fire attack during operations at an incident.



For additional information, see ***NIOSH Alert: Preventing Deaths and Injuries of Fire Fighters When Fighting Fires in Unoccupied Structures*** [DHHS (NIOSH) Publication No. 2009-XXX]. To request single copies of the Alert, contact NIOSH at

1-800-CDC-INFO (1-800-232-4636)

TTY: 1-888-232-6348

E-mail: cdcinfo@cdc.gov

or visit the NIOSH Web site at

www.cdc.gov/niosh

For a monthly update on news at NIOSH, subscribe to NIOSH *eNews* by visiting **www.cdc.gov/niosh/eNews**

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



Preventing Deaths and Injuries of Fire Fighters When Fighting Fires in Unoccupied Structures

WARNING!

Fire fighters are often killed or injured when fighting fires in unoccupied structures.

The National Institute for Occupational Safety and Health (NIOSH) requests assistance in preventing deaths and injuries of U.S. fire fighters working in or around unoccupied structures or structures where no clear evidence indicates that people are trapped inside. Interior (inside a structure) and offensive (aggressive) fire-fighting operations increase the risk of traumatic injury and death from structural collapse, burns, and asphyxiation. Unoccupied structures, whether in current use, under construction, under renovation, or condemned, must be considered expendable in order to decrease the risk to fire fighters.

This Alert describes four incidents that resulted in the deaths of five fire fighters and injuries to seven others during offensive operations in and around unoccupied structures. NIOSH recommends that fire departments review their occupational safety and health programs, risk management plans, and standard operating procedures and guidelines (SOPs/SOGs) to ensure that they include appropriate safe-work practices and policies to avoid the loss of fire fighters' lives when civilian lives are not in immediate danger.

NIOSH requests that the information in this Alert be brought to the attention of all U.S. fire departments and fire fighters. To bring the recommendations in this Alert to the attention of the fire service community, NIOSH requests help from fire commissioners, fire chiefs, state and local fire district administrators, state fire marshals, incident safety officers, trainers, fire investigators, unions, professional organizations, trade associations, insurance companies, and editors of trade journals and other publications.

BACKGROUND

According to the National Fire Protection Association (NFPA) statistical database, 250 fire fighters died on the fire ground at structure fires between 1997 and 2006 [Fahy 2008]. Of these 250 fire fighters, 142 were killed inside the structure and 9 were killed on the roof. Of the 142 killed inside the structure, 72 died from asphyxiation, 25 from burns, 22 from sudden cardiac death,

18 from crushing injuries, 4 from internal trauma, and 1 from drowning [Fahy 2008].

NIOSH Investigation of Structure Fires

The NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated 71 trauma-related incidents at structure fires between January 1998 and February 2007. In these incidents, 96 fire fighters died and 106 were injured.

Fifty-four of the 71 incidents occurred at unoccupied structures. These 54 incidents accounted for 75% of the deaths (72 of 96) and 89% of the injuries (94 of 106) sustained during the 71 incidents. Nine (12.5%) of the 72 fire fighters killed at unoccupied structures were operating within the collapse zones and were struck by falling debris. Of the 71 incidents, 54 involved offensive fire-fighting tactics.

Determining Safe Tactics for Fire Fighting

The incident commander or the assigned incident safety officer is responsible for evaluating conditions at a structure fire and determining safe tactics for fighting the fire. Risk to fire fighters versus gains in saving lives and property must always be considered when deciding whether to use an offensive or defensive attack. An *offensive fire attack* is one that normally includes aggressive interior operations that take the attack to the fire. It is aimed at extinguishing the fire and preventing fire extension. A *defensive fire attack* is one in which operations are conducted at a safe distance from a structure (outside the structure and collapse zone*) and may focus on containing the fire rather than extinguishing it. Special hazards such as the risk of explosion may require an even larger safety

zone. The incident commander should routinely evaluate and re-evaluate conditions and report progress in reaching objectives. This process allows the incident commander to determine whether to continue or revise the strategy and attack plans. Failure to revise an inappropriate or outdated attack plan is likely to result in an elevated risk of death or injury to fire fighters [NFPA 2007].

According to NFPA 1500 §A.8.3.3 [NFPA 2007], “the acceptable level of risk is directly related to the potential to save lives or property. Where there is no potential to save lives, the risk to the fire department members should be evaluated in proportion to the ability to save property of value. When there is no ability to save lives or property, there is no justification to expose fire department members to any avoidable risk, and defensive fire suppression operations are the appropriate strategy [NFPA 2007].” Retired New York City Deputy Fire Chief Vincent Dunn states the following: “When no other person’s life is in danger, the life of the firefighter has a higher priority than fire containment” [Dunn 1992].

CURRENT STANDARDS

National Fire Protection Association (NFPA)

The NFPA develops consensus codes, standards, recommended practices, and guides for protecting fire fighters and civilians from fire-related injuries and deaths. The following NFPA standards address fire fighter safety related to performing offensive and

*NIOSH recommends that a collapse zone be equal to the height of the building plus allowance for scattering debris—usually, at least 1½ times the height of the building [Fire Fighter’s Handbook 2000].

defensive fire-fighting activities, including operations involving unoccupied structures:

- NFPA 220, *Standard on Types of Building Construction*, defines types of building construction based on the combustibility and the fire resistance rating of a building's structural elements [NFPA 2006]. The standard also specifies methods of classifying types of construction and fire resistance ratings.
- NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, specifies (1) the minimum requirements for a fire department's occupational safety and health program; (2) the safety procedures for members involved in rescue, fire suppression, and related activities; and (3) the integration of risk management into regular functions of the incident commander [NFPA 2007]. NFPA 1500, Chapter 4.2, identifies information that should be included in each department's risk management plan, including risk identification, risk evaluation, establishment of priorities, risk control techniques, and risk management monitoring. Annex A, Section 8, also includes guidelines for the incident commander to consider when evaluating risk versus gain.
- NFPA 1521, *Standard for Fire Department Safety Officer*, defines the minimum requirements for the assignment, duties, and responsibilities of a safety and health officer and incident safety officer related to organizations providing rescue, fire suppression, emergency medical, and hazmat (hazardous materials) operations [NFPA 2008].
- NFPA 1561, *Standard on Fire Department Incident Management System*, defines the essential elements of an incident management system [NFPA 2008].

International Code Council (ICC)

The ICC is a membership association dedicated to building safety and fire prevention. The ICC was established in 1994 as a non-profit organization dedicated to developing a single set of comprehensive and coordinated model construction codes. The ICC was founded by the joint efforts of the Building Officials and Code Administrators (BOCA) International, the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI). The ICC provides for one consistent set of building and construction requirements throughout the United States. The ICC maintains the International Building Code or IBC. The International Building Code addresses design and installation of building systems with requirements that focus on performance. The IBC is updated every 3 years.



CASE REPORTS

The following case reports describe incidents involving fire fighter injuries and deaths that occurred during offensive attacks at structure fires in buildings known to be vacant or unoccupied. The incidents were investigated through the NIOSH Fire Fighter Fatality Investigation and Prevention Program [www.cdc.gov/niosh/fire/].

Case 1

On February 19, 2005, a 39-year-old male career fire captain died after being trapped by the partial collapse of the roof on a vacant, one-story, wood frame dwelling. The 50-year-old house was abandoned and known by residents in the area to be a “crack house” at the time of the incident.

Crews arriving on the scene could see fire venting through the roof at the rear of the house. The victim was the captain on the first-arriving engine crew, which was assigned to perform a “fast attack”: They were to take a hose line into the house, locate the seat of the fire, and begin to extinguish it.

The victim and a fire fighter advanced the initial attack line through the front entrance and made their way toward the rear of the house. Conditions deteriorated rapidly as they advanced toward the rear. The fast attack crew



had just begun to direct water onto the burning ceiling in the kitchen and den areas when the roof at the rear of the structure collapsed, trapping the captain under burning debris.

The collapse pushed fire toward the front of the house. Soot and combustible dust

particles suspended in the air were quickly ignited along with combustible gases, sending a fireball rolling toward the front of the structure. Before the collapse, two other crews had entered through the front. The rapidly deteriorating conditions following the collapse quickly engulfed the other crews with fire, and five fire fighters received burns requiring medical attention. The victim was pronounced dead on the scene by medical examiners [NIOSH 2005a].

Case 2

On June 25, 2006, a 34-year-old male volunteer deputy fire chief died after falling through a failed section of floor at a residential structure fire. A neighbor had called 911 to report that lightning had struck next door and that light smoke was coming from the residence. The caller indicated that the residents were gone for the day.

The victim was the first to arrive on the scene and conducted an initial size-up. When additional apparatus arrived, the victim and another fire fighter entered the front door with a 1¾-inch, preconnected hand line to search for the seat of the fire. Once inside the door, the two fire fighters noticed that the floor felt spongy and was very hot. The interior conditions were deteriorating rapidly, with intensifying heat and near-zero visibility. The two fire fighters backed outside, and the victim stayed at the front door with the hose line while the other fire fighter went to retrieve a light and another hand line. When he returned, the victim instructed the fire fighter to take the second hand line around to the B-side and to put water through a basement window. The victim reportedly remained at the front door to put water through a hole in a failed section of the floor.



Shortly thereafter, the assistant chief arrived on the scene and discovered that the victim had fallen into the basement. Attempts to reach the victim using a 14-foot roof ladder were unsuccessful because of the debris in the basement, fire and smoke conditions, and the angle of the failed floor. Fire fighters entered the house, traversed the floor, and gained interior access to the basement to retrieve the victim. The victim was immediately found but was unresponsive. The crews had difficulty moving him up the basement stairs. But after approximately 20 minutes, they were able to remove him, provide medical treatment, and transport him to the hospital, where he was pronounced dead [NIOSH 2007].

Case 3

On May 3, 2002, two male, 38-year-old career fire fighters died while performing offensive operations at a commercial structure fire. The structure was vacant, all businesses in the building were closed, and burglar bars and gates were installed and locked on all windows and doors of this structure. Many windows were boarded over.

During the first scheduled member accountability roll call conducted 10 minutes into the incident, a fire fighter who had been conducting a primary search and checking for fire extension on the second floor was identified to be missing. After the roll call, a fire fighter who had been working on the second floor (Victim 1) immediately re-entered the structure to search for the missing fire fighter (Victim 2) as part of a search-and-rescue team. Shortly after re-entering, Victim 1 became lost and radioed Mayday several times.

After extensive searches for the missing fire fighters, both were found, removed from the structure, and given medical attention on the scene. They were then transported by emergency medical services to a local hospital. Victim 1 was pronounced dead on arrival and Victim 2 died the following day [NIOSH 2003].



Case 4

On April 8, 2004, a 71-year-old male volunteer chief was fatally injured and two fire fighters were injured by a collapsing church façade. The church was locked and unoccupied.

The victim had arrived at the scene of the fire 1 minute after the first alarm and approximately

15 minutes before the collapse. He assumed incident command and immediately performed a 360-degree size-up of the scene. Fire fighters forced entry through the front of the structure, since all doors were closed and locked. They began an offensive, interior attack. But as conditions worsened, the chief walked toward the front door and shouted to the fire fighters to evacuate the structure. Two fire fighters were injured when they exited from the doorway as the collapse occurred. The chief was fatally injured when he was struck by bricks and burning debris that fell from the outward collapse of the brick facade. He was transported by helicopter to a hospital and later transferred to a rehabilitation center where he remained until August 1, 2004, when he died from his injuries [NIOSH 2006].

CONCLUSIONS

Results of the NIOSH investigations suggest that fire departments, incident commanders, incident safety officers, and fire fighters may not fully consider information related to building occupancy before performing offensive operations or entering structures to initiate interior operations. NIOSH investigations have identified numerous cases in which fire crews entered and remained in high-risk fire situations when it was known that no occupants needed to be rescued.

Fire departments should review or develop occupational safety programs, risk management plans, and SOPs/SOGs to ensure that they include appropriate safe work practices and policies to avoid the loss of fire fighters' lives in unoccupied buildings. The top priority at all fire scenes should be saving and preserving lives—both civilian lives and the lives of all fire fighters at the scene.

When considering risk management and initiating offensive or interior operations, fire departments should consider the following rules of engagement, which are outlined in Annex A, Section 8.3.2, of NFPA 1500 [NFPA 2007]:

1. We will risk our lives a lot, in a calculated manner, to save SAVABLE LIVES.
2. We will risk our lives a LITTLE, in a calculated manner, to save SAVABLE property.
3. We WILL NOT risk our lives at all for a building or lives that are already lost.

The incident commander or the incident safety officer is responsible for evaluating conditions at a structure fire and determining tactics for fighting the fire. Risks to fire fighters' lives must be balanced against gains when deciding whether to use an offensive or defensive attack.

RECOMMENDATIONS

NIOSH recommends that fire fighters, fire departments, incident commanders, and incident safety officers take the following actions to minimize the risk of fire fighter injury and death when performing fire-fighting operations in unsafe, unoccupied structures.

Fire fighters should do the following:

- **Report conditions and hazards encountered to your officer, incident commander, or incident safety officer.**
 - Keep the officer, incident commander, or incident safety officer informed about the conditions and hazards found as work is performed.

- **Recognize that maintaining your safety is a shared responsibility. Comply with your department's SOPs and safety rules.**

- Wear the appropriate personal protective clothing and equipment for the task at hand. Maintain crew discipline, avoid obvious safety hazards, avoid unnecessary risk taking and encourage your crew members to do the same.

- **Be constantly aware of your surroundings.**

- When operating in an unoccupied building, NO RISK is worth your life or injury.

Fire departments should do the following:

- **Develop and enforce risk management plans, policies, and SOPs/SOGs for risk management [Cook 1998].**

- Make sure that risk management plans and SOPs/SOGs are appropriate for your department and take into account your department's capabilities and limitations.

- Place all risk management plans and SOPs/SOGs in writing.

- Require that risk management plans and SOPs/SOGs be followed.

- Make certain that risk management plans and SOPs/SOGs aid rather than hinder decision making. These plans and SOPs/SOGs should not restrict the ability to react to changing fire-ground conditions.

- Assure that risk management plans and SOPs/SOGs are officially endorsed and enforced by the department.

- **Train incident commanders, incident safety officers, and fire fighters in**

the fire department risk management plans and SOPs/SOGs for risk management [Cook 1998; NFPA 2007].

- **Develop and implement fire department policies and SOPs/SOGs for emergency response and fire-fighting activities at unoccupied structures.**

- No offensive interior attacks should be made in unoccupied or unsafe structures.

- **Have a rapid intervention team (RIT) in place anytime personnel are operating at any structure fire.**

- **Inspect and preplan buildings within your jurisdiction. Note the type of construction, materials used, presence of trusses and other lightweight construction in the roof and floor, type of occupancy, fuel load, exit routes, and other distinguishing characteristics [Brannigan 1999; Klaene and Sanders 2000; NIOSH 2005b].**

- Work with municipal agencies such as the local housing authority to identify and mark unsafe and unoccupied buildings. When appropriate, such buildings should be condemned, demolished, or repaired at the owner's expense.

- Check the structural integrity of walls, roofs, and floors.

- Share this information with other departments who provide mutual-aid response in the same area.

- **Enter preplan information into the dispatcher's computer so that when a fire is reported at preplanned locations, the dispatcher can radio all first responders with critical information [Dunn 1992; NIOSH 1999].**

- Include the age of the structure, structural integrity, the type of roof structure and supports (such as lightweight trusses, bowstring trusses, and heavy timber construction), the type of interior support structures (such as floor trusses, wooden l-joints, and support columns), the type of materials used in the structure (such as wood, steel, plastics, foam, or materials that produce toxic gases when subjected to heat), storage of flammable or toxic materials, the amount of load on roof structures that could weaken the supports (for example, heavy heating and cooling units), water supply, and the presence of automatic sprinkler systems.
- **Make sure that the incident commander or incident safety officer conducts an initial size-up of the incident before beginning fire-fighting efforts and continuously during all fireground operations.**
 - Determine whether the building is unoccupied. Signs to look for include windows and doors boarded up; vehicles in garage, driveway or parked nearby; people at windows of apartment or office buildings calling for help; time of day; type of occupancy; and reports from neighbors, by-standers and occupants who have escaped the burning structure [Richman, 1986].
 - Get clear reports from occupants, neighbors and by-standers. Does “save my baby” mean a child or a pet?
 - Consider using a thermal imaging camera as part of the size-up operation to help locate fires in concealed spaces [NIOSH 2005b].
- Consider the type of building when determining (1) the number of fire fighters, support officers, and the amount of apparatus and equipment needed to control the blaze, (2) the most effective point of attack for extinguishing the fire, (3) the most effective method of venting heat and smoke, and (4) the nature of the attack (offensive or defensive) [NIOSH 2005b].
- Evaluate the type of structure (residential, commercial, institutional), time of day, type of occupancy, contents of the structure, hazards, and exposures [NIOSH 2005b].
- Pay close attention to the conditions outside the structure, monitor the roof, and check on interior conditions [Dunn 1996; NIOSH 1999].
- If preplan information is not available, try to determine the type of construction, age of the building, and modifications or additions to help assess structural stability [Dunn 1996].
- Plan for search and rescue operations before an emergency occurs in case a fire fighter becomes trapped [NIOSH 2005b].
- **Ensure those in charge of fire incidents (i.e. incident commanders, chief officers, safety officers, etc.) fulfill their responsibilities and obligations in the execution of their duties [Klaene and Sanders 2000]:**
 - Use a defensive operation whenever the following is apparent.
 - The risk to fire fighters’ lives and safety outweighs the possible benefit of an offensive attack.
 - A building is structurally unsound.

- No lives need to be saved [Brannigan 1999; Dunn 2001].

Incident commanders and incident safety officers should do the following:

■ Establish, clearly mark, and monitor a collapse zone at structure fires where there is a risk of collapse [Fire Fighter's Handbook 2000; NIOSH 2006b]:

- If a size-up determines that structural integrity is questionable, establish a collapse zone (an area around and away from a structure where debris might land if the structure fails).
- Make this area equal to the height of the building plus an additional allowance for debris scatter. At a minimum, it should equal 1½ times the height of the building.
- Take into consideration the fact that the collapse zone may move as the fire spreads.
- Consider the collapse zone when placing apparatus close to the burning structure and when locating staging and rehab areas.

■ Consider all manual fire-suppression activities within the collapse zone to be an offensive attack:

- Consider any operation within the collapse zone of the structure to be an offensive operation.
- Ensure the availability of adequate resources—such as a rapid intervention team (RIT), backup hose lines, and emergency medical services (EMS) personnel.

■ Use effective and universal evacuation signals when command personnel

decide that all fire fighters should be evacuated from a burning building [Smith 2002; NIOSH 1999].

- Examples include air-horn blasts, radio evacuation tones, emergency signaling functions incorporated into PASS systems, etc.

■ Consider the number of fire fighters and amount of apparatus and equipment available when determining the type of fire attack.

- Ensure that sufficient staff are available for the type of attack selected.

■ Follow departmental policies (risk management plans, SOPs/SOGs) for risk management [Cook 1998].

■ Conduct an initial size-up of the incident before beginning fire-fighting efforts and continually throughout the operation [Smith 2002].

■ Use proper criteria for deciding on an offensive or defensive strategy for fire attack during operations at an incident [Klaene and Sanders 2000].

Use a defensive operation when the following is apparent.

- The risk to fire fighters' lives and safety outweighs the possible benefit of an offensive attack,
- A building is structurally unsound.
- No lives need to be saved [Brannigan 1999; Dunn 2001].

ACKNOWLEDGMENTS

The principal contributors to this Alert were Robert E. Koedam, M.S.; and Timothy R. Merinar, M.S., Division of Safety Research. Steven Proudfoot provided statistical support. Anne Hamilton and Susan Afanuh

edited the document. Gino Fazio performed desktop design and publishing. The authors thank the following individuals for providing expert technical reviews of the draft document: Matt Chibarro, Occupational Safety and Health Administration (OSHA); Deputy Chief William Goldfeder, Loveland-Symmes Fire Department and editor of <http://www.FireFighterCloseCalls.com>; Robert Solomon and Rita Fahy, National Fire Protection Association (NFPA); Ken Farmer and Robert Neale, U.S. Fire Administration (USFA).

Please direct any comments, questions, or requests for additional information to the following:

Dr. Nancy A. Stout
Director, Division of Safety Research
National Institute for Occupational Safety
and Health
1095 Willowdale Road
Morgantown, WV 26505-2888

Telephone: 304-285-5894; or call
1-800-CDC-INFO (1-800-232-4636)
TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov

We greatly appreciate your assistance in protecting the health of U.S. fire fighters.

Christine M. Branche, Ph.D.
Acting Director,
National Institute for Occupational
Safety and Health
Centers for Disease Control and
Prevention

REFERENCES

- Brannigan FL [1999]. Building construction for the fire service. 3rd ed. Quincy, MA: National Fire Protection Association.
- Cook J [1998]. Standard operating procedures and guidelines. Saddle Brook, NJ: Fire Engineering Books and Videos.
- Dunn V [1992]. Safety and survival on the fireground. Saddle Brook, NJ: Fire Engineering Books and Videos.
- Dunn V [1996]. Systems analysis size-up: Part 1. *Firehouse Oct*:18-21.
- Dunn V [2001]. The deadly lightweight truss. *Firehouse Jan*:16-20.
- Fahy R [2008]. Email of February 28 from Rita Fahy, Fire Analysis and Research Division, National Fire Protection Association, to Timothy Merinar, Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.
- Fire Fighter's Handbook [2000]. Essentials of fire fighting and emergency response. New York: Delmar Publishers.
- Klaene B, Sanders R [2000]. Structural fire-fighting. Quincy, MA: National Fire Protection Association.
- NFPA [2006]. NFPA 220: standard on types of building construction. Quincy, MA: National Fire Protection Association.
- NFPA [2007] NFPA 1500: standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

NFPA [2008a]. NFPA 1521: standard for fire department safety officer. Quincy, MA: National Fire Protection Association.

NFPA [2008b]. NFPA 1561: standard on fire department incident management system. Quincy, MA: National Fire Protection Association.

NIOSH [1999]. NIOSH Alert: request for assistance in preventing injuries and deaths of fire fighters due to structural collapse. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99-146.

NIOSH [2003]. Two career fire fighters die in four-alarm fire at two-story brick structure—Missouri. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation (FACE) Report No. 2002-20.

NIOSH [2005a]. Career fire captain dies when trapped by partial roof collapse in a vacant house fire—Texas. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation (FACE) Report No. 2005-09.

NIOSH [2005b]. NIOSH Alert: preventing injuries and deaths of fire fighters due to truss

system failures. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-132.

NIOSH [2006]. Volunteer chief dies and two fire fighters are injured by a collapsing church facade—Tennessee. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation (FACE) Report No. 2004-37.

NIOSH [2007]. Volunteer deputy fire chief dies after falling through floor hole in residential structure during fire attack—Indiana. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation (FACE) Report No. 2006-24.

Richman H [1986]. Truck Company Fireground Operations, 2nd Edition. National Fire Protection Association, Quincy, Massachusetts.

Smith J [2002]. Strategic and tactical considerations on the fireground. Upper Saddle River, NJ: Prentice Hall.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45225-1998



Delivering on the Nation's promise:
Safety and health at work for all people
through research and prevention.

To receive NIOSH documents or for
more information about occupational safety and
health topics, contact NIOSH at

1-800-CDC-INFO (1-800-232-4636)

TTY: 1-888-232-6348

E-mail: cdcinfo@cdc.gov

or visit the NIOSH Web site at www.cdc.gov/niosh

For a monthly update on news at NIOSH, subscribe
to NIOSH eNews by visiting www.cdc.gov/niosh/eNews

DHHS (NIOSH) Publication No. 2009-XXX

SAFER • HEALTHIER • PEOPLE™

