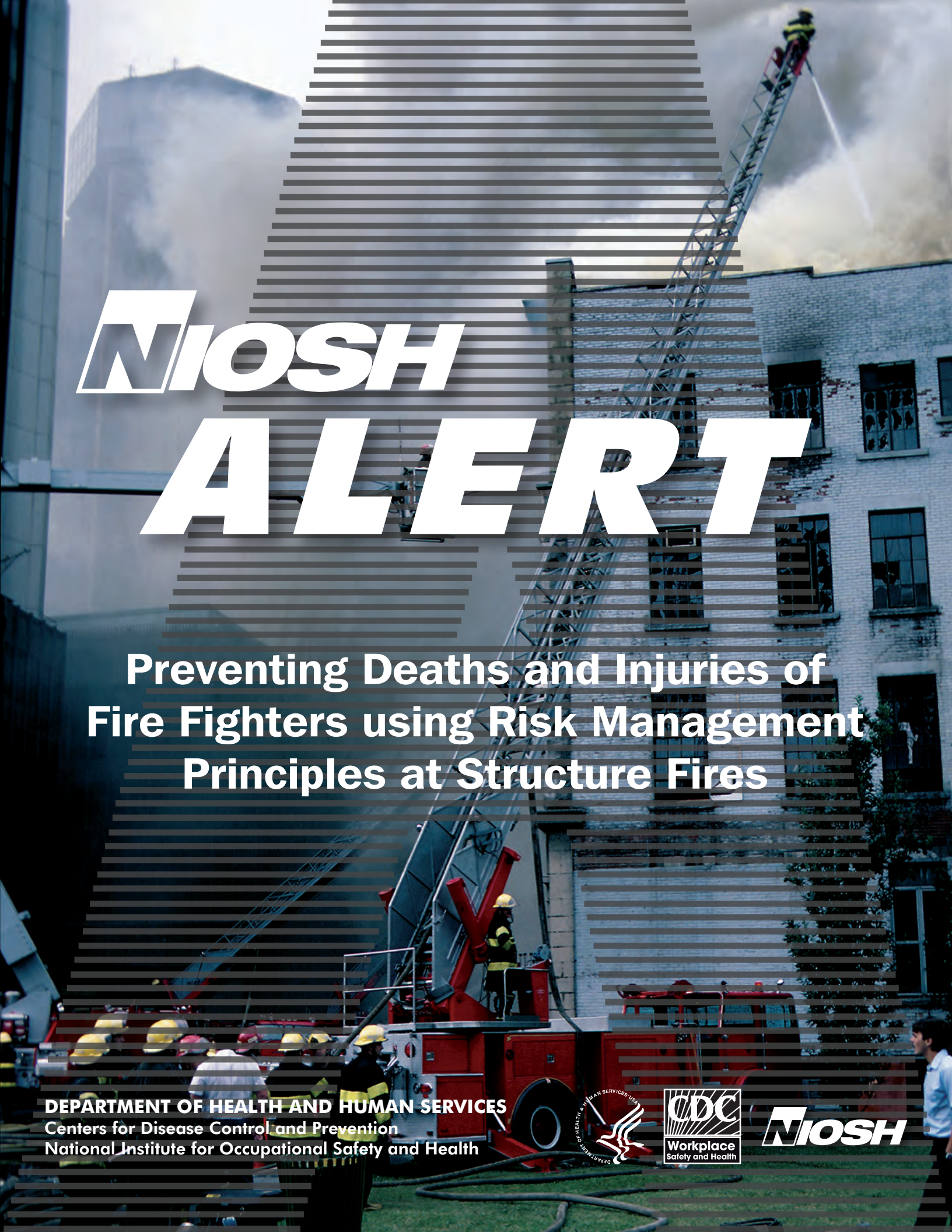

NIOSH ALERT

Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires

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

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NIOSH ALERT

Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires

WARNING!

Fire fighters are often killed or injured when fighting fires in abandoned, vacant, and unoccupied structures. These structures pose additional and sometimes unique risks due to the potential for fire fighters to encounter unexpected and unsafe building conditions such as dilapidation, decay, damage from previous fires and vandals, and other factors such as uncertain occupancy status. Risk management principles must be applied at all structure fires to ensure the appropriate strategy and tactics are used based on the fireground conditions encountered.

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

- 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 standard operating procedures (SOPs) / standard operating guidelines (SOGs) and safety rules.
- Be constantly aware of your surroundings and changing conditions.

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 abandoned, vacant, or unoccupied structures.
  - A thorough size-up and risk analysis should be performed before conducting operations in any burning structure.

- Fire-fighting operations should be limited to defensive (exterior) strategy if the structure is judged to be unsafe and in any situation where the risks to fire fighter safety are excessive.
- Offensive (interior attack) operations should only be considered when sufficient resources are on scene to conduct offensive operations with a reasonable degree of safety, including the ability to perform essential support functions (i.e., water supply, ventilation, lighting, utility control, accountability, rapid intervention teams).
- Additional size-ups and risk analyses should be performed before changing strategies, including any decision to conduct interior overhaul operations following a defensive fire attack.

- Have adequate resources available on scene to perform rapid intervention team (RIT) duties 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/or lightweight construction in the roof and floor, type of occupancy, fuel load, exit routes, and other distinguishing characteristics.
- Enter preplan information into the dispatch computer so that when a fire is reported at a preplanned location, the critical information is provided to all responding units.
- Adopt and enforce a standard system of marking dangerous abandoned, derelict, and vacant buildings, based on a prefire assessment of their structural conditions and other risk factors, in cooperation with municipal agencies and local authorities such as local housing authorities.
- Train fire fighters and officers to recognize the marking system and incorporate the information into their size-up considerations. Additionally, local authorities should ensure programs are in place that provide for the demolition and removal of structures deemed unsafe by code enforcement.
- Make sure that the incident commander conducts an initial size-up of critical fireground factors before beginning fire-fighting efforts and continuously reviews and reevaluates these factors during all fireground operations. A 360-degree size-up should be conducted for all abandoned, vacant, or unoccupied structures.
- Ensure those in charge of fire incidents (e.g., incident commanders, chief officers, safety officers) are fully trained to fulfill their responsibilities and obligations in the execution of their duties.
- Educate the public on the need to have home fire drills and designated meeting places in the event of an emergency. The location of designated meeting

places should be communicated to the fire department as a way to help confirm and verify building occupancy status.

Incident commanders (IC) and incident safety officers (ISO) should do the following:

- The IC should conduct an initial size-up of each incident weighing critical fireground factors (i.e., occupancy status; occupant survivability and rescue potential; vacant building markings or indicators; size, construction and use of the building; age and condition of the building; and the location, size, and extent of the fire in the building) against the department's risk management profile to determine the initial incident strategy (offensive or defensive). The IC should develop an incident action plan before beginning firefighting efforts and continually review and reevaluate the factors and the risk management plan throughout the operation.
- The IC should use appropriate risk management criteria to decide whether an offensive or defensive strategy should be employed to attack a fire. The IC should attempt to determine whether the building is occupied or not. Signs to look for include vehicles in garage, driveway, or parked nearby; people at windows of apartment or office buildings calling for help indicates the possibility of other occupants as well; time of day; type of occupancy; and reports from occupants who have escaped the burning structure. Reports from neighbors and bystanders may also provide valuable information.
- The IC should consider the number of fire fighters, the amount and type of apparatus and 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.
- Establish, clearly mark, and monitor an exterior collapse zone at structure fires where there is a risk of collapse.
- Use effective and universal evacuation signals when command personnel determine that all fire fighters should be evacuated from a burning building, as well as during the initiation of defensive operations and during overhaul and salvage operations.

For additional information, see ***NIOSH Alert: Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires*** [DHHS (NIOSH) Publication No. 2010–153]. To request single copies of the Alert, contact NIOSH at

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

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ALERTA DE NIOSH

Prevención de muertes y lesiones de bomberos mediante el uso de principios de gestión de riesgos en incendios de estructuras

¡ADVERTENCIA!

Es frecuente que los bomberos se lesionen o mueran al combatir los incendios en construcciones vacías, deshabitadas o abandonadas. Estas estructuras constituyen riesgos adicionales y a veces únicos debido a la posibilidad de que los bomberos se encuentren con edificios bajo condiciones inseguras e inesperadas como construcciones en ruinas, deterioradas, dañadas por incendios anteriores o vandalismo y otros factores, como la incertidumbre de no saber si están habitadas. Los principios de gestión de riesgos se deben aplicar para todos los incendios de estructuras con el fin de garantizar el uso de tácticas y estrategias adecuadas de acuerdo a las condiciones encontradas en el lugar del incendio.

Los bomberos deben tomar los siguientes pasos para disminuir el riesgo de muerte y lesiones al combatir incendios de estructuras:

- Infórmele a su supervisor, al comandante encargado de la operación o al oficial encargado de la seguridad durante las operaciones, cuál es la situación y si existe algún peligro.
- Recuerde que mantenerse seguro es una responsabilidad compartida. Cumpla con los procedimientos y lineamientos operativos estándar y las normas de seguridad.
- Manténgase todo el tiempo alerta de sus alrededores y de las condiciones que manifiestan cambios.

Los departamentos de bomberos (supervisor principal, jefe del cuartel y responsables de formular reglamentos) deben tomar los siguientes pasos para proteger a los bomberos:

- Establecer planes de gestión de riesgos y hacer que se cumplan, al igual que con los reglamentos y los procedimientos y lineamientos operativos estándar establecidos para la gestión de riesgos.
- Capacitar a los comandantes encargados de la operación, los oficiales encargados de la seguridad y los bomberos sobre los planes de gestión de riesgos y los procedimientos y lineamientos operativos estándar establecidos para la gestión de riesgos.

- Crear e implementar los reglamentos del departamento de bomberos y los procedimientos y lineamientos operativos estándar que serán utilizados durante una emergencia y durante las actividades de extinción de incendios en estructuras vacías, deshabitadas o abandonadas. Se debe realizar detenidamente una evaluación y un análisis del riesgo antes de llevar a cabo operaciones en cualquier incedio de estructura. Las operaciones de los bomberos se deben limitar a las estrategias defensivas (exterior) si la estructura se considera poco segura y en cualquier situación donde los riesgos para la seguridad del bombero sean excesivamente altos. Las operaciones ofensivas (en el interior) solo se deben considerar cuando se cuente en el lugar con los recursos suficientes para llevarlas a cabo con un grado de seguridad razonable y se puedan realizar funciones esenciales de apoyo (es decir, suministro de agua, ventilación, iluminación, control de los servicios públicos, control del número de personas en el lugar, equipos de intervención rápida). Se deben realizar evaluaciones y análisis del riesgo adicionales antes de cambiar de estrategias, incluso antes de cualquier decisión de llevar a cabo operaciones de inspección en el interior después de una estrategia defensiva para extinguir el fuego.
- Contar con recursos adecuados en el lugar del incendio para que el equipo de intervención rápida pueda realizar sus tareas siempre que el personal esté operando en un incendio de estructuras.
- Inspeccionar las edificaciones que se encuentren dentro de su jurisdicción y elaborar en forma anticipada un plan. Determinar el tipo de construcción, los materiales usados, la presencia de vigas o estructuras livianas en techos y pisos, si está o no habitada, si hay combustible almacenado, las salidas y otras características particulares.
- Ingresar la información del plan que se trazó por anticipado en la computadora del coordinador de la estación de bomberos, para que cuando se notifique un incendio en un sitio inspeccionado, que cuenta con un plan, se le pueda proporcionar a todas las unidades de respuesta la información crítica.
- Adoptar e imponer un sistema estándar para identificar los edificios desocupados, abandonados o en ruinas que esté basado en un diagnóstico previo de las condiciones de la estructura y de otros factores de riesgo. Esto se debe realizar en conjunto con las agencias municipales y autoridades locales tales como las autoridades locales de vivienda.
- Capacitar a los bomberos y a los oficiales en la identificación de los sistemas de señales y en las formas de incorporar la información a sus evaluaciones realizadas. Además, las autoridades locales deben asegurarse de que se estén implementando los programas que prevén la demolición y remoción de estructuras consideradas inseguras bajo los reglamentos de construcción.
- Asegurarse de que el comandante encargado de la operación lleve a cabo una evaluación inicial de los factores críticos del sitio del incendio, antes de comenzar con los esfuerzos de extinción del fuego, y de que revise y revalúe constantemente estos factores durante todas las operaciones en el lugar del incendio. Se debe realizar una evaluación completa de todas las estructuras vacías, deshabitadas o abandonadas.
- Garantizar que las personas encargadas de los incendios (es decir comandantes encargados de la operación, supervisores principales, oficiales encargados de la seguridad, etc.) hayan recibido toda la capacitación necesaria para cumplir con sus responsabilidades y obligaciones en la ejecución de sus tareas.
- Educar al público sobre la necesidad de hacer simulacros de incendio en las casas y de designar lugares de encuentro en caso de una emergencia. Se le debe mostrar al departamento

de bomberos el lugar designado de encuentro para ayudarle a verificar si hay ocupantes en el edificio.

Los comandantes encargados de la operación y los oficiales encargados de la seguridad deben tomar los siguientes pasos:

- Los comandantes encargados de la operación deben llevar a cabo una evaluación inicial de cada incidente considerando los factores críticos del lugar del incendio (como por ejemplo, saber si el edificio está ocupado o no; las posibilidades de rescatar con vida a los ocupantes; indicativos o señales de que el edificio está vacío; dimensiones; tipo de construcción, uso, edad y condiciones del edificio; sitio y extensión del fuego). La estrategia inicial (ofensiva o defensiva) que se determinará de la observación de estos factores se basará en los procedimientos del departamento de gestión de riesgos. Los comandantes encargados de la operación deben elaborar un plan de acción para el incidente antes de comenzar sus esfuerzos de extinción del fuego y revisar y revaluar constantemente, durante toda la operación, los factores y el plan de gestión de riesgos.
- Los comandantes encargados de la operación deben usar criterios adecuados de gestión de riesgos para decidir si emplearán una estrategia ofensiva o defensiva para combatir el fuego. También deben intentar determinar si el edificio está ocupado o desocupado. Algunos de los indicios que se deben buscar son coches en el garaje, en la entrada para coches o estacionados cerca del edificio; personas en las ventanas del departamento o edificio que estén pidiendo ayuda, hora del día, si está ocupado e informes de los ocupantes que hayan escapado la estructura en llamas. Los informes de los vecinos y de los testigos en el lugar también pueden proporcionar información valiosa.
- Los comandantes encargados de la operación deben tener en cuenta la cantidad de bomberos, la cantidad y tipo de aparatos y equipos disponibles y la etapa del incendio cuando se determine el tipo de combate.
- Seguir las políticas del departamento (planes de gestión de riesgos, procedimientos operativos y lineamientos de operación estándares) sobre gestión de riesgos.
- Determinar, señalar claramente y vigilar la zona de derrumbe exterior de las estructuras incendiadas que puedan desplomarse.
- Usar señales de evacuación universales y eficaces cuando el personal de comando determine que todos los bomberos deben evacuar el edificio en llamas, así como también durante el comienzo de las operaciones defensivas y durante las operaciones de evaluación y rescate.

Para más información, consulte la ***Alerta de NIOSH: Prevención de muertes y lesiones de bomberos mediante el uso de principios de gestión de riesgos en incendios de estructuras*** (en inglés). [Publicación de No. 2010–153 de DHHS (NIOSH)]. Solicite copias gratuitas de esta Alerta escribiendo a:

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ABBREVIATIONS

The following abbreviations, listed in the order that they appear in the document are used:

SOPs/SOGs	standard operating procedures / standard operating guidelines
RIT	rapid intervention team
IC	incident commander
ISO	incident safety officer
NIOSH	National Institute for Occupational Safety and Health
NFPA	National Fire Protection Association
NFIRS	National fire incident reporting system
IAFC	International Association of Fire Chiefs
HVAC	heating, ventilation and air conditioning
FDNY	Fire Department of New York
USFA	United States Fire Administration
IAAI	International Association of Arson Investigators
ICC	International Codes Council
BOCA	Building Officals and Code Administration
ICBO	International Conference of Building Officials
SBCCI	Southern Building Code Congress International
IBC	International Building Code
EMT	Emergency Medical Technician
CPR	cardio-pulmonary resuscitation
PARs	personnel accountability reports
PASS	personal alert safety system

NIOSH ALERT

Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires

WARNING!

Fire fighters are often killed or injured when fighting fires in abandoned, vacant, and unoccupied structures. These structures pose additional and sometimes unique risks due to the potential for fire fighters to encounter unexpected and unsafe building conditions such as dilapidation, decay, damage from previous fires and vandals, and other factors such as uncertain occupancy status. Risk management principles must be applied at all structure fires to ensure the appropriate strategy and tactics are used based on the fireground conditions encountered.

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 burning structures. The mission of the U.S. fire service is to save lives and property. While it is recognized that fire fighting 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. Interior (inside a structure) offensive fire-fighting operations can increase the risk of traumatic injury and death to fire fighters from structural collapse, burns, and asphyxiation. Established risk management principles suggest that more caution should be exercised in abandoned, vacant, and unoccupied structures and in situations where there is no clear evidence indicating that people are trapped inside a structure and can be saved. When the incident commander (IC) has determined that there are no lives to save and the property can no longer be preserved through offensive operations, defensive tactics should be initiated in order to decrease the risk to fire fighters.

This Alert describes 4 incidents that resulted in the deaths of 5 fire fighters and injuries to 10 others during operations in and around structures with considerable fire involvement where there were indications that the buildings were unoccupied. NIOSH recommends that fire departments review their occupational safety and health programs, risk management plans, training programs, 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

Statistics

The National Fire Protection Association (NFPA) reported more than 500,000 structure fires each year between 1999 and 2007 with the direct dollar losses in 2007 alone totaling more than 10 billion dollars [Karter 2008]. The NFPA* also reported approximately 30,000 fires each year from 2002 through 2005 in vacant buildings, defined as any building that was unoccupied and without a tenant, including but not limited to abandoned buildings [Ahrens 2009].

*The NFPA report *Vacant Building Fires* utilized data collected by the U.S. Fire Administration National Fire Incident Reporting System (NFIRS). NFIRS defines a vacant building as any building that is unoccupied and without a tenant. NFIRS does not distinguish between abandoned and vacant buildings. For additional information see: http://www.usfa.dhs.gov/fireservice/nfirs/about.shtm.

Based on statistics compiled by the NFPA, 269 fire fighters died on the fireground at structure fires during the years 1998 through 2008 [Fahy 2009]. Of these 269 fire fighters, 171 were killed inside the fire structure: 92 died from asphyxiation, 34 from burns, 25 from sudden cardiac death, 15 from crushing injuries, and 5 from internal trauma [Fahy 2009].

NIOSH Investigation of Structure Fires

The NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated 84 trauma-related incidents at structure fires between January 1998 and December 2008. In these incidents, 118 fire fighters died and 126 were injured.

Sixty-two of the 84 incidents occurred at structures that were known or suspected to be unoccupied at the time fire fighters arrived (unoccupied is defined as any structure in which nobody was present at the time of the fire). In some instances, incident commanders and chief officers may not have had definitive evidence regarding occupancy status. These 62 incidents accounted for 75% of the deaths (89 of 118) and 86% of the injuries (108 of 126) sustained during the 84 incidents investigated by NIOSH. Ten (11%) of the 89 fire fighters killed at unoccupied structures were operating within the collapse zones and were struck by falling debris. Of the 84 total incidents, 65 involved offensive fire-fighting tactics.

Fire Fighting Principles and Building Occupancy

The mission of the fire service is to save lives and property from the threat of fire. In carrying out this mission, fire fighters are

routinely exposed to certain known and predictable risks while conducting operations that are directed toward saving lives and property. Building occupancy status is just one variable that can impact incident management decisions at a structure fire.

The International Association of Fire Chiefs (IAFC) suggests the following definitions to describe the occupancy status of buildings [Grorud 2009]:

- **Abandoned** (or derelict) refers to a structure that is not being used for any purpose and is not being maintained or preserved for some future use or occupancy. In many cases the building could be classified as a public nuisance awaiting demolition. A building in this condition typically has no value or negligible value.
- **Vacant** refers to a building that is not currently in use, but which could be used in the future. The term "vacant" could apply to a property that is for sale or rent, undergoing renovations, or empty of contents in the period between the departure of one tenant and the arrival of another tenant. A vacant structure has inherent property value, even though it may not contain valuable contents or human occupants.
- **Unoccupied** generally refers to a structure that is not occupied by any persons at the time an incident occurs. An unoccupied building could be used by a business that is temporarily closed (i.e., overnight or for a weekend). The term unoccupied could also apply to a building that is routinely or periodically occupied, but the occupants are not present at the time an incident occurs. A residential structure could be temporarily unoccupied because the residents are at work or on vacation. A building that is temporarily unoccupied has inherent property value as well as valuable contents.
- **Evacuated** refers to a building that was occupied (or could have been occupied) at the time an incident occurred; however, all the occupants have self-evacuated, have been assisted in evacuating, or have been rescued by fire fighters. At this point there is no possibility of saving the lives of any remaining occupants. A building that has been evacuated generally has inherent property value as well as valuable contents.

Only the category "abandoned (or derelict)" refers to a structure that is considered to have negligible property value. Structures that are described as "vacant," "unoccupied," or "evacuated" are all assumed to have property value. Accepted fire service risk management principles recognize that an offensive strategy (such as a fast attack on a room and contents fire) is often justified (e.g., to stop the spread of the fire in a structure or to protect adjacent structures) and may be employed after conducting a thorough risk management assessment in an attempt to save property where there are no human occupants to be saved [Grorud 2009].

Addressing Unsafe and Abandoned Structures

Abandoned buildings can and do pose numerous hazards to fire fighters' health and safety. Hazards should be identified and warning placards affixed to entrance doorways or other openings to warn fire fighters of the potential dangers. Such hazards can be structural as the result of building deterioration or damage from previous fires. Gutted interiors also increase the amount of exposed flammable materials and contain open pathways for rapid flame spread.

Structural hazards can occur when building owners or salvage workers remove components of the building such as supporting walls, doors, railings, windows, electric wiring, utility pipes, etc. Abandoned materials such as wood, paper, and flammable or hazardous substances, as well as collapse hazards, constitute additional dangers fire fighters may encounter. Collapse hazards can be chimney tops, parapet walls, slate and tile roof shingles, metal and wood fire escapes, HVAC or other mechanical equipment, solar electrical collectors and cells, advertising signs, and entrance canopies. A warning placard may be a 12-inch-square piece of metal painted reflective yellow so that it reflects light in the dark and indicates to fire fighters that hazards exist inside the building. Figure 1 illustrates symbols used on warning placards developed and used by the New York City Fire Department [NIOSH 1999, FDNY 2009]. *Note: The checkbox with one slash indicates the building is vacant and there are interior hazards that fire fighters need to be aware of. The checkbox with an X in it indicates the building is seriously compromised and fire fighters should not enter, but rather initiate an exterior attack.*

Fire departments should work with Federal, State, and local authorities to develop and implement a strategy to identify, mark, secure, and where possible demolish unsafe structures within their jurisdictions. The IAAI / USFA Abandoned Building Project, conducted by the International Association of Arson Investigators and the US Fire Administration [IAAI / USFA 2006] is one example of a program that can be utilized to aid fire fighter safety and health by identifying, marking, and removing unsafe structures. The Abandoned Building Project Toolbox can be found at the Web site http://www.interfire.org/features/AbandonedBuildingProjectToolBox.asp. The toolbox contains the Abandoned Building

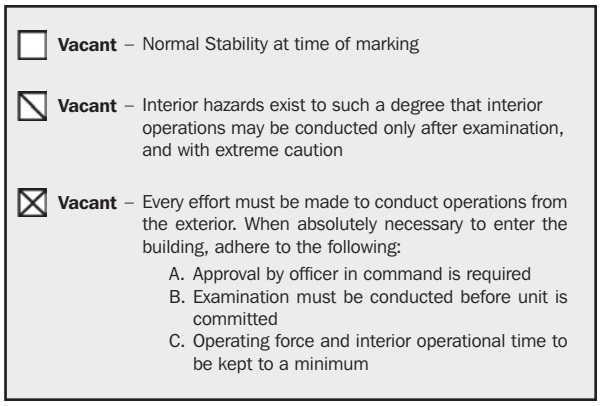

Figure 1. Warning placard used to identify hazards in vacant buildings.

Project report *Managing Vacant and Abandoned Properties in Your Community* and other reference materials. This report includes recommendations on how fire departments can work with governmental authorities to reduce the public safety hazard created by unsafe and abandoned buildings. A number of locations across the country have developed laws and regulations that address the public safety hazards created by vacant and abandoned buildings. Examples are the *Commonwealth of Massachusetts, Abandoned or Dangerous Building Regulations 780 CMR and 527 CMR* [Commonwealth of Massachusetts 2008] and the City of Cincinnati Vacated Building Maintenance License [Cincinnati Municipal Code 1101–77].

Determining Safer Tactics for Fire Fighting

The incident commander, with input from the assigned incident safety officer, is responsible for evaluating conditions at a structure fire and determining safe tactics for fighting the fire. To accomplish this, the incident commander should use a standardized strategic decision-making model. First, the incident commander should size up the critical fireground factors [Phoenix Fire Department 2009]. The incident commander must make

a determination that offensive (interior) operations may be conducted without exceeding a reasonable degree of risk to fire fighters before ordering an offensive attack and must be prepared to discontinue the offensive attack if the risk evaluation changes during the fire fighting operation. A full range of factors must be considered in making the risk evaluation, including (but not limited to):

- Presence of occupants in the building
- A realistic evaluation of occupant survivability and rescue potential
- Size, construction, and use of the building
- Age and condition of the building
- Nature and value of building contents
- Location and extent of the fire within the building
- Adjacent exposures (structures)
- Fire involvement or compromise of the building's structural components
- A realistic evaluation of the ability to execute a successful offensive fire attack with the resources that are available [Phoenix Fire Department 2009].

These fireground factors must be weighed against the risk management plan. There is absolute recognition of the fact that fire fighters are routinely exposed to certain known and predictable risks while conducting operations that are directed toward saving property. The incident commander is responsible for recognizing and evaluating those risks and determining whether the level of risk is acceptable or unacceptable. However, risks taken to save property should always be lesser than those to save lives [Grorud 2009]. Risks 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 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 reevaluate conditions and radio progress reports in reaching objectives to dispatch and on-scene fire fighters. 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]. All offensive strategy incident action plans should be based on adequate support work (water supply, ventilation, lighting, utility control, accountability, RIT, etc.) to insure safe operating conditions on the interior.

Offensive operations should not commence or be performed unless they can be safely performed by the personnel available at the scene and within the fire department's established safety procedures and SOPs. Incident command should be established by the deployed supervisory chief officer outside of the hazard area for the overall coordination and direction of the interior operation. An incident safety officer should be present to assist the IC and to ensure that the health and safety system is established before the

[†] 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 [NIOSH 1999a; NIOSH 2005b; Fire Fighter's Handbook 2000; IFSTA 2008].

interior attack. Interior operations require the establishment of an uninterrupted water supply to provide an effective water flow for at least one attack line and one backup line. For interior operations, adequate ventilation (either horizontal or vertical) is required to minimize the risk of thermal insult to interior forces as well as to improve interior tenability, survivability, and visibility [Phoenix Fire Department 2009]. And for the safety of all personnel on the scene, interior operations should not commence or continue to be performed without personnel accountability in place or without the availability of an on-scene Rapid Intervention Team. The above tasks are key components of an offensive strategy in any building whether occupied or not [Klaene and Sanders 2000, Duffy 2009].

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]. Chief Dunn also states "The protection of life is the highest goal of the fire service…When a life is clearly threatened, there is no risk too great. At most fires, however, lives are not clearly endangered. At most fires, then, the priority of firefighting is the protection of the fire fighters' lives." In general terms, the risk management plan must consider the following: (1) risk nothing for what is already lost—choose defensive operations; (2) extend limited risk in a calculated way to protect savable property—consider offensive operations; (3) and extend very calculated risk to protect savable lives—consider offensive operations [IAFC 2009].

CURRENT STANDARDS

National Fire Protection Association (NFPA)

The NFPA is a standards development organization that develops and publishes consensus codes, standards, recommended practices, and guides for protecting fire fighters and civilians from fire-related injuries and deaths. The following NFPA standards address building construction and fire fighter safety related to performing offensive and 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 2008a].
- NFPA 1561, *Standard on Fire Department Incident Management System,* defines the essential elements of an incident management system [NFPA 2008b].
- NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments,* defines the minimum criteria addressing the effectiveness and efficiency of the career public fire suppression operations, emergency medical service, and special operations delivery in protecting the citizens of the jurisdiction and the occupational safety and health of fire department employees [NFPA 2010a].
- NFPA 1720, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Volunteer Fire Departments,* defines the minimum level of service, deployment capabilities, and staffing levels for substantially volunteer fire departments [NFPA 2010b].
- NFPA 5000, *Building Construction and Safety Code,* provides code criteria for new construction, building rehabilitation, and safety enforcement [NFPA 2009].

International Code Council (ICC)

The ICC is a standard development organization that develops and publishes consensus building safety and fire prevention codes. The ICC was established in 1994 as a nonprofit 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. The following ICC standards address building construction:

International Building Code covers all buildings except detached one- and two-family dwellings and townhouses not more than 3 stories in height [ICC 2009a].

International Residential Code establishes minimum regulations for one- and two-family dwellings and townhouses up to three stories [ICC 2009b].

International Fire Code includes regulations governing the safeguarding of life and property from all types of fire and explosion hazards [ICC 2009c].

CASE REPORTS

The following case reports describe incidents involving fire fighter injuries and deaths that occurred during offensive attacks at fires in structures known or suspected to be unoccupied at the time of the incident (in some instances, incident commanders and chief officers may not have had definitive evidence regarding occupancy status). These cases represent situations in which the fire involvement suggested considerable risk to fire fighters. 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, in a dilapidated condition, 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, with some fire fighters reporting that flames were well above the roofline. The victim was the captain on the first-arriving engine crew, which was assigned to perform a "fast attack": They were to take a hoseline into the house, locate the seat of the fire, and begin to extinguish it. Thermal imaging cameras were available on scene but not used to locate the seat of the fire. The incident commander walked to the C-D corner of the burning house to size up the situation and determined that roof ventilation was not feasible because of the fire venting through the roof.

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]. The dilapidated condition of the abandoned structure, fire venting through the roof upon arrival, and deteriorating conditions encountered by the advancing interior crews as the fire escalated were all factors suggesting a more defensive strategy was in order.

Case 2

On September 30, 2002, a 50-year-old male career captain (the victim) died when

a parapet wall collapsed on him at an auto body shop fire. At 0204 hours, the fire department was dispatched to a garage fire. At 0207 hours, an engine arrived on the scene and the captain (initial incident commander) advised the other responding units and Central Dispatch that the structure was "a strand steel building" that was "fully involved." Two of the windows on the B-side had self-vented and heavy fire was showing. Flames were emitting from underneath the eaves with heavy smoke above the building.

A gate to the motor vehicle storage area was forced open and the first-arriving crew advanced a 1¾-inch hand line to allow the crews to attack the fire from the B-side of the building. As additional crews arrived, they worked to knock out windows for ventilation and forced open the front door. At 0210 hours, a battalion chief arrived on scene, did a 360-degree drive-around and assumed incident command. The original incident commander ordered the victim and another fire fighter to begin an attack on the building's A-side. The fire fighter advanced a hand line through the front door and down the hallway approximately 5 feet while the victim stayed at the door. The incident commander announced on the radio that the operation was going to be defensive, and for all fire fighters to get out of the building. At approximately 0212 hours, the fire fighter, who was on the line inside the building, exited and began pulling the line toward the B-side of the building. The victim and a lieutenant were standing in front of the building when the roof, parapet wall, and overhanging façade collapsed. The parapet wall and façade fell forward, landing on top of the victim. Fire fighters told NIOSH investigators that they had little to no warning of the impending collapse. The lieutenant was knocked to the ground and suffered a broken leg and an emergency medical technician (EMT) suffered a fractured wrist. The incident commander was also knocked to the ground and received minor injuries.

Rescuers removed the victim from the debris, initiated cardiopulmonary resuscitation (CPR) and transported the victim to an area hospital where he was later pronounced dead at 0300 hours [NIOSH 2002]. The date and time of dispatch (early Monday morning, 0204 hours), type of occupancy (auto body shop), fully involved structure with fire rolling up the eaves, and locked doors were all factors indicating the structure was likely to be unoccupied and that a defensive operation was in order. While the incident commander radioed that the operation was going to be defensive, a collapse zone was not identified, and some fire fighters including the victim and injured fire fighters remained within the collapse zone.

Case 3

On May 3, 2002, two male, 38-year-old career fire fighters died while performing offensive operations at a two-story commercial structure fire. The structure was vacant, and all businesses in the building had previously been closed. Burglar bars and gates were installed and locked on all windows and doors of this structure. Many windows were boarded over. The initial responding crews had to force entry to the ground floor, where

they encountered light gray smoke. Incident command sized-up the structure and determined the fire was located on the ground level. During the initial fire attack, several fire fighters noted that there were holes in the ceiling of the first floor, and they noted embers and fire when ceiling tile was pulled. As crews battled the fire, it spread to the second story, with smoke, fire and heat significantly increasing approximately 10–12 minutes after the fire dispatch.

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, another 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]. The boarded-over windows, secured burglar bars, and locked doors were indicators that the building was likely to be vacant. Because evidence suggested that the fire fighting operations were to save property rather than civilian lives, and because the fire was deep-seated and efforts to extinguish the fire were not effective, a more defensive strategy was prudent.

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. 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 façade. 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]. The day of the week and the time (Thursday, 1030 hours) and locked doors were indicators that the church was likely to be unoccupied. While

the incident commander (victim) made the decision to switch to defensive operations, the fire had compromised the church's structural integrity before the order to begin evacuating was given.

CONCLUSIONS

Results of these NIOSH investigations suggest that fire departments, incident commanders, incident safety officers, and fire fighters may not fully consider information related to building occupancy, structural integrity, and fire involvement before entering structures to initiate interior operations and while performing offensive operations. NIOSH investigators have investigated other cases in which fire crews entered and remained in high-risk fire situations when it was known or there were clear indications that no occupants needed to be rescued and deteriorating conditions warranted a change to more defensive strategies.

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 unsafe or 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.

The incident commander, with input from 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. When no lives are at risk, the incident commander must carefully evaluate and limit the exposure of the fire fighters to the risk of death or injury at all types of occupancy status, including abandoned, vacant, unoccupied, and evacuated. The challenge for the incident commander is to recognize when the level of risk becomes excessive and to call for a defensive strategy in situations where no lives are at risk.

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 firefighting operations in abandoned or vacant structures and structures that are known or suspected to be unoccupied or evacuated.

Fire fighters should do the following:

- **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.

- — 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 and changing fire conditions.**
  - — When operating in an unoccupied building, NO RISK is worth your life or injury. Risk nothing for what is already lost; extend limited risk in a calculated way to protect savable property; and extend very calculated risk to protect savable lives [NFPA 2007; IAFC 2009].

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.
  - — 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].**
  - — Train incident commanders, incident safety officers, and fire fighters on how to size up all types of structures including abandoned, vacant, and unsafe structures. Training should include how to integrate the size-up into risk management decisions.

- **Develop and implement fire department policies and SOPs/SOGs for emergency response and fire-fighting activities in and around abandoned, vacant, or unoccupied structures.**
  - — No offensive interior attacks should be made in any structure without a thorough size-up and adequate staffing, resources, and support capability (i.e., water supply, ventilation, lighting, utility control, accountability, rapid intervention team). A defensive strategy should be employed in unsafe structures and at any structure fire when on-scene staffing, resources, and support capability are insufficient for a safe offensive response [Phoenix 2009]. Additional size-ups and risk analyses should be performed whenever changing strategies, including moving to interior overhaul operations.
  - — Abandoned and vacant buildings should be known in advance, based on preplanning and knowledge of local jurisdictions.

- **Maintain up-to-date preplan information and enter it into the dispatcher's computer so that when a fire is reported at preplanned locations, the dispatcher can provide responding crews with critical information [Dunn 1992; NIOSH 1999b].**
  - — Include the age of the structure, structural integrity, the type of roof

structure and supports (i.e., lightweight trusses, bowstring trusses, and heavy timber construction), the type of interior support structures (i.e., floor trusses, wooden I-joists, and support columns), the type of materials used in the structure (i.e., 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 (e.g., heavy heating and cooling units), water supply, and the presence of automatic sprinkler systems.

- **Have adequate resources available on scene to perform rapid intervention team (RIT) duties anytime personnel are operating at any structure fire.**
- **Conduct personnel accountability reports (PARs) on a regular basis [Fannon 2009].**
- **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].**
  - Check the structural integrity of walls, roofs, and floors.
  - Share this information with other departments who provide mutual-aid response in the same area.
- **Adopt and enforce a standard system of marking dangerous abandoned, derelict, and vacant buildings, based on a prefire assessment of their structural conditions and other risk factors, in cooperation with municipal agencies and local authorities such as local housing authorities [NIOSH 2005; IAAI/USFA 2006; Commonwealth of Massachusetts 2008; FDNY 2009].**
  - Fire departments should train fire fighters and officers to recognize the marking system and incorporate it into their size-up considerations. In addition, local authorities should ensure programs are in place that provide for the demolition and removal of structures deemed unsafe by code enforcement.
- **Make sure that the incident commander conducts an initial size-up of critical fireground factors before beginning fire-fighting efforts and continuously reviews and reevaluates these factors during all fireground operations.**
  - A 360-degree size-up should be conducted for all abandoned, vacant, or unoccupied structures.
  - Determine whether the building is likely to be occupied. People at windows of apartment or office buildings calling for help indicates the possibility of other occupants as well; windows and doors boarded up indicate a structure is not in normal use; vehicles in garage, driveway or parked nearby may indicate the presence of persons inside; time of day and type of occupancy (many businesses are closed during evening and nighttime hours); and reports from neighbors, by-standers and occupants who have escaped the burning structure may also provide reliable information [Richman, 1986].

- Get clear reports from occupants, neighbors and by-standers.
- Consider using a thermal imaging camera as part of the size-up operation to help locate fires from the exterior and 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 1999a].
- 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.) are fully trained to fulfill their responsibilities and obligations in the execution of their duties [Klaene and Sanders 2000].**
- **Educate the public on the need to have home fire drills and designated meeting places in the event of an emergency. The location of designated meeting places should be communicated to the fire department as a way to help confirm and verify building occupancy status [Carey 2009].**

Incident commanders (IC) and incident safety officers (ISO) should do the following:

- **The IC should conduct an initial size-up of each incident weighing critical fireground factors (i.e., occupancy status; occupant survivability and rescue potential; vacant building markings or indicators; size, construction, and use of the building; age and condition of the building; and the location, size, and extent of the fire in the building [Smith 2002]) against the department's risk management profile to determine the initial incident strategy (offensive or defensive). The IC should develop an incident action plan before beginning firefighting efforts, and continually review and reevaluate the factors and the risk management plan throughout the operation.**
- **The IC should use appropriate risk management criteria to decide whether an offensive or defensive strategy should be employed to attack a fire [Klaene and Sanders 2000]. The IC should attempt to determine whether the building is occupied or not. Signs to look for include 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 occupants who have escaped the burning structure. Reports from neighbors and bystanders may also provide valuable information.

- **Use a defensive operation when the fireground conditions suggest the following:**
  - 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 and the property is lost [Brannigan 1999; Dunn 2001].
- **The IC should consider the number of fire fighters, the amount and type of apparatus and equipment available, and the stage of the fire when determining the type of fire attack.**
  - Ensure that sufficient staff are available for the type and extent of the selected fire attack.
  - Ensure the availability of adequate resources, such as a rapid intervention team (RIT), backup hose lines, and emergency medical services (EMS) personnel.
- **Follow departmental policies (risk management plans, SOPs/SOGs) for risk management [Cook 1998].**
- **Establish, clearly mark, and monitor an exterior collapse zone at structure fires where there is a risk of collapse [Fire Fighter's Handbook 2000; NIOSH 2006]:**
  - 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 the collapse zone 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. [Note: this is not always practical in urban areas with high-rise structures, but the collapse zone should be considered.]
  - 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 placement of master streams, portable deluge nozzles, and aerial platforms at building corners and operate from a flanking position to reduce fire fighter exposure to the collapse zone [Dunn 1998; 1992; 1999]. Also consider using unstaffed ground monitors to reduce the risk of placing personnel in exposed positions [Klaene and Sanders 2000].
  - Consider all manual fire-suppression activities within the collapse zone to be an offensive attack. No personnel should operate in offensive positions during a defensive attack.
  - When explosion hazards are present, collapse zones should be expanded.
- **Use effective and universal evacuation signals when command personnel determine that all fire fighters should be evacuated from a burning building, as well as during the initiation of defensive operations and during overhaul and salvage operations [Smith 2002; NIOSH 1999a].**

— Examples include air-horn blasts, radio evacuation tones, and emergency signaling functions incorporated into personal alert safety systems or PASS systems.

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

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

John Howard, M.D.
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