2011
15

Death in the line of duty...

NIOSH Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

December 6, 2011

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Executive Summary

On June 17, 2011, a 22-year-old male paid-on-call fire fighter received fatal injuries when he was struck by bricks and falling debris during an exterior wall collapse at a commercial structure fire. Crews worked using defensive operations for about 45 minutes attempting to extinguish the fire in the 96 year-old brick and masonry structure that housed an antique store with living quarters located in a rear addition. The victim and another fire fighter were moving a 35-foot aluminum ground ladder away from the Side D (east) wall of the structure when the top part of the exterior wall collapsed. No other fire fighters were injured in the collapse.

Defensive operations at commercial structure fire just after the collapse.
(Photo courtesy of local newspaper)

Contributing Factors

- *96 year-old brick masonry structure degraded by fire burning for over 45 minutes*
- *Fire fighters with limited experience entered collapse zone to move ground ladder*
- *Entering collapse zone in close proximity to master stream directed onto roof*
- *Limited visibility at side and rear of structure may have obscured signs of pending collapse*
- *Limited training on structure collapse hazards.*

Key Recommendations

- *Establish and monitor a collapse zone when conditions indicate the potential for structural collapse*
- *Train all fire fighting personnel on the risks and hazards related to structural collapse*
- *Train on and understand the effects of master streams on structural degradation*
- *Conduct regular mutual aid training with neighboring departments*

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

- *Designate a staging area for all unassigned fire fighters and apparatus*
- *Implement national fire fighter and fire officer training standards and requirements.*

Collapsed portion of D-side wall can be seen in center of photo.
(Photo courtesy of local newspaper)

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

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

2011
15

Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

December 6, 2011

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Introduction

On June 17, 2011, a 22-year-old male paid-on-call fire fighter received fatal injuries when he was struck by bricks and falling debris during an exterior wall collapse at a commercial structure fire. On June 20, 2011, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. That same day, NIOSH investigators with the Fire Fighter Fatality Investigation and Prevention Program contacted both fire departments involved in this incident to arrange an investigation. On July 12, 2011, a safety engineer and an investigator with the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Illinois to investigate this incident. The NIOSH investigators met with the Fire Chief and the city's Commissioner of Public Safety and Health at the fire department in the city where the incident occurred. The NIOSH investigators then traveled to a neighboring city to meet with the Fire Chief, officers and fire fighters from the mutual aid fire department where the victim worked as a paid-on-call fire fighter. The NIOSH investigators reviewed training records and standard operating procedures at both fire departments and interviewed the fire fighters from both departments who were involved in the incident. The NIOSH investigators visited the county dispatch center and obtained a copy of the fireground audio. The NIOSH investigators met with the State Fire Marshal investigating the incident and with the Southern Regional Coordinator with the Illinois Fire Service Institute. The NIOSH investigators visited the local newspaper office and obtained copies of photographs and a video taken by the newspaper's reporters.

Fire Departments

This report covers the demographics and actions of two fire departments. The fire department in the city where the incident occurred (Department A) has a paid Fire Chief and 27 paid-on-call fire fighters who serve a population of approximately 5,600 within an area of about 5 square miles. The fire department has 1 station that houses 2 engines, and a utility vehicle. At the time of the incident, the fire department was in the process of equipping a new (third) engine for service. The fire department had a limited number of standard operating procedures (SOPs) that covered areas such as chain of command, accountability, emergency response, vehicle safety, seat belt use, required use of personal protective equipment and clothing, hazardous materials response, technical rescue response and code of ethics. The Fire Chief is also the Chief of the local rural fire protection district that provides service to the rural areas surrounding the city. The fire protection district maintains its own equipment, some of which is housed at the city fire station. Many fire fighters are members of both the city fire department and the rural fire protection district. The fire department is dispatched by the county sheriff's office. The fire department responds to approximately 40 calls per year, including 5-6

working structure fires per year. The fire department is rated as a Class 5 department by ISO.[a] In the ISO rating system, Class 1 represents exemplary fire protection, and Class 10 indicates that the area's fire-suppression program does not meet ISO's minimum criteria.

The fire department where the victim worked as a paid-on-call fire fighter (Department B) has a paid Fire Chief and 6 full time career fire fighters. The fire fighters work 24 hour shifts with 2 fire fighters working per shift. The fire department also has 15 active members who serve as paid-on-call fire fighters. The fire department serves a population of approximately 11,000 in an area of approximately 85 square miles that extends outside the corporate city limits. The fire department has two engines, one ladder truck and one brush truck. A major east-west railroad splits the city so the fire department keeps one engine at an un-staffed station on the south side of the city. Members who are paid-on-call carry their turnout gear in their personally owned vehicles and can respond directly to an incident scene. Every fire fighter is assigned a radio. The fire department is dispatched by the city's police 911 dispatch system. The fire department is rated as a Class 4 department by ISO. The fire department responded to 227 incidents during 2010 and had responded to 120 at the time of this incident. The fire department responds to approximately 15 structure fires per year. The current chief has worked to bring existing standard operating procedures (SOPs) up to date and to add new standard operating guidelines (SOGs). Newly adopted SOGs covered operations such as personal protective clothing and equipment use, SCBA use, lost/trapped fire fighter self-survival actions, Mayday procedures, hydraulic and pneumatic rescue tool use, fire ground command, apparatus staging, Rapid Intervention Team (RIT), accountability, emergency responder rehabilitation and several others. *Note: SOPs are typically defined as procedures that must almost always be followed with very rare variance – for example; size-up reports, 360-degree size up as applicable, water supply establishment, self-contained breathing apparatus use in immediately-dangerous-to-life-or-health atmospheres, stopping at red lights, seat belt use, etc.). SOGs are typically guidelines providing suggestions on how to operate based upon current circumstances and officer discretion – for example; stretching hoselines, hoseline placement, ventilation, etc.).*

Mutual Aid Box Alarm System (MABAS)

Both fire departments recently became members of the organization known as the Mutual Aid Box Alarm System (MABAS). MABAS is a mutual aid system designated to assist with mutual aid response of fire, emergency medical services (EMS), specialized response teams, and station coverage during a state declared disaster or when an incident overwhelms the available resources of a participating community. Primarily in the state of Illinois, MABAS has also branched out to additional states such as Wisconsin, Indiana, Iowa, Michigan, and Missouri. Approximately 1,000 fire

[a] ISO is an independent commercial enterprise which helps customers identify and mitigate risk. ISO can provide communities with information on fire protection, water systems, other critical infrastructure, building codes, and natural and man-made catastrophes. ISO's Public Protection Criteria program evaluates communities according to a uniform set of criteria known as the Fire Suppression Rating Schedule (FSRS). More information about ISO and their Fire Suppression Rating Schedule can be found at the website http://www.isogov.com/about/.

departments from the state of Illinois have joined this organization. The MABAS requires that all its members agree to and sign an identical contract that includes standards of operation, incident command procedures, minimum equipment staffing requirements, and safety and on-scene terminology. This agreement also aids departments and agencies by having predetermined resources that will be sent from one's community to assist other communities when in need. This allows the fire chief and incident commanders to focus on operational needs during a serious incident, knowing that a predetermined set of resources is responding upon issuance of a single order by command. Having members agree to the same contract allows departments or agencies from around the state to work together seamlessly. This incident did not escalate to the size and scope of a MABAS response.

Training and Experience

The State of Illinois does not have any mandatory state training requirements for volunteer fire fighters or fire officers. It is up to each fire department or authority having jurisdiction to implement training requirements to meet their own needs. The Illinois Fire Service Institute (IFSI) coordinates a statewide training program for individuals interested in becoming a fire fighter. This program offers a 24-hour Basic Fire Fighter course as well as Fire Fighter II and Fire Fighter III certification. At the time of this investigation, the IFSI Fire Fighter II certification was roughly equivalent to the National Fire Protection Association (NFPA) Fire Fighter I and IFSI Fire Fighter III was roughly equivalent to NFPA Fire Fighter II as specified in NFPA 1001 *Standard for Fire Fighter Professional Qualifications*.[1] *Note: NFPA FF I reflects minimum training standards for a fire fighter who is always working under supervision. NFPA FF II addresses the assumption of command and transfer of command but does not contain specific job performance requirements (JPRs) to illustrate the required skills.* IFSI is currently enhancing their training requirements.

Fire Department A does not require a person wanting to join the department to have any prior fire fighting training or experience. Persons interested in joining the fire department submit a written application. The Fire Chief selects potential candidates from the applicant list and requests that the city conduct a background check on the individual. After clearing the background check, the candidate fire fighter is placed on a 12-month probation period. Probationary fire fighters are expected to complete the 24-hour Basic Fire Fighter program offered through the Illinois Fire Service Institute at a local community college. This entry level program covers self-contained breathing apparatus (SCBA) and personal protective equipment and clothing (PPE) use, hoseline operations, ground ladders, ropes and knots, forcible entry, ventilation, and overhaul and salvage. The fire department provides basic first aid, cardio-pulmonary resuscitation (CPR) and bloodborne pathogen training in-house. Probationary fire fighters are restricted from responding on the first apparatus, unless approved by an officer, based upon training and experience. Thus, probationary fire fighters should not be part of an interior attack crew. Probationary fire fighters cannot drive an apparatus unless for training or returning from an incident. The probationary period can exceed 12 months based upon their skill level, knowledge and their demonstrated ability to perform tasks such as fire fighting skills, pump operations, and overall apparatus functions. The fire department does not have a mandatory training attendance policy but has recently implemented an incentive program for fire fighters who attend 75 percent or more of the monthly training sessions (a gift certificate to a local merchant). Officers are required to have at least 5 years of experience and have Fire Fighter II certification to hold the rank of lieutenant.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Three-hour long monthly training sessions are held covering topics such as SCBA familiarization and use, fire apparatus driver training, fire apparatus operation, hoseline operations, blood born pathogen training, search and rescue, rapid intervention team (RIT) training and other topics. Training records documented that a limited number of training sessions with mutual aid departments have been conducted.

Fire Department B requires that newly selected members obtain IFSI Fire Fighter I training and certification before responding to an emergency incident. Individuals can join the department by submitting an application. The Fire Chief reviews all applications and requests that the city conduct background checks on likely candidates. The fire department is working toward having all active members receive Fire Fighter II training and certification. All fire fighters are cross-trained to perform all expected job functions. The fire department has an assigned training officer and all full time fire fighters work on updating the existing SOPs. One full time fire fighter maintains a pre-incident planning program within the city. Fire fighters are trained to the hazardous materials (Hazmat) operations level. Two full time fire fighters are currently attending classes for additional training to receive certification as Hazmat Technicians. Two other fire fighters are working on obtaining MABAS Technical Rescue certification. Monthly training sessions at Fire Department B covered subjects such as ice rescue, SCBA use, ladder operations, confined space hazards, apparatus driver training, auto extrication, bloodborne pathogens, fireground tactics, Hazmat operations and other subjects.

The victim joined the fire department in July 2010. He had received training on bloodborne pathogens and Heartsaver AED operations. He had completed Module A of the IFSI basic fire fighter training and was working toward IFSI Fire Fighter I certification.

The initial incident commander (2nd lieutenant with Department A) had 11 years of fire fighting experience and had been an officer with the fire department for approximately 2 years. He had received Illinois Office of the State Fire Marshal Firefighter II certification and had received training on blood borne pathogens; Heartsaver AED operation; Statewide WMD Response and Hazardous Materials Awareness; Introduction to the Incident Command System (ICS), IS-100; IS-200; IS-300; IS-800.B (National Response Plan) and several others.

Incident command was transferred to the 1st lieutenant with Department A when he arrived on-scene. He had 29 years of fire fighting experience and was a certified Emergency Medical Technician (EMT –Basic). He had been an officer with Department A since 1993. He had received Illinois Office of the State Fire Marshal Firefighter II certification and had received training in blood borne pathogens; Heartsaver AED; Natural Gas Emergency Training; Introduction to the Incident Command System (ICS), IS-100; IS-200; IS-300; basic auto extrication, tanker operations; National Weather Service Basic and Advanced Skywarn Spotter; and several others.

Incident command was then transferred to the Fire Chief of Department A when he arrived on scene. He joined the fire department in 1985. He became Fire Chief in 2009 and served as the Acting Chief for two years prior to becoming Fire Chief. The Fire Chief had received certification from the IFSI in

Essentials of Fire Fighting, Level I through IV; blood borne pathogens; Heartsaver AED operation; chemical safety; rural water supply; Statewide WMD Response and Hazardous Materials Awareness; aircraft crash response; Introduction to the Incident Command System (ICS), IS-100; IS-200; IS-700; IS-800.A (National Response Plan); Natural Gas Emergency Training; Fire Communications; Ground Search and Rescue; National Weather Service Skywarn Spotter Training; Fire Investigation – Origin and Cause; and several others.

Equipment and Personnel

Fire Department A responded with the following 15 personnel and 4 apparatus to the initial dispatch. Six other members of Fire Department A responded later in the incident, after the collapse had occurred.

Engine 43 – 2nd lieutenant and 4 fire fighters
Engine 45 – 2 fire fighters
Chief's vehicle – Fire Chief A and 1 fire fighter
Engine 49 – 2 fire fighters
4 fire fighters arrived on-scene via personally owned vehicle (POV) or by driving to the station and walking approximately 4 blocks to the incident scene.

Fire Department B responded with the following apparatus and personnel:

Aerial Ladder 110 – Fire Chief B and 3 fire fighters
2 fire fighters drove their POV to the incident scene including the Victim

Three other fire departments responded for mutual aid support but were not directly involved in the collapse or the rescue operation.

Timeline

The timeline for this incident is limited to the initial response of Fire Departments A and B with fire apparatus to a structure fire on June 17, 2011.

- **1515 Hours**
  Local fire department (Fire Department A) dispatched for a report of a fire in the building behind the antique store.

- **1519 Hours**
  Engine 43 enroute to fire scene.

- **1521 Hours**
  Engine 45 enroute to fire scene.

- **1525 Hours**
  Fire Chief A requests mutual aid including Fire Department B which has the only aerial ladder truck in the county.

- **1531 Hours**
  Fire Department B enroute with crew of 4 onboard.

- **1548 Hours**
  Overhead powerlines on ground at the rear of structure (C/D corner).

- **1554 Hours**
  Partial collapse of D-side exterior wall. Fire Chief A radios for ambulance.

- **1602 Hours**
  Victim transported to local hospital.

Personal Protective Equipment

At the time of the incident, the victim was wearing turnout pants, coat, hood, helmet, boots and a self-contained breathing apparatus with integrated personal alert safety system (PASS) meeting current NFPA requirements. The victim was not on air at the time of the wall collapse. The NIOSH investigators inspected the victim's personal protective equipment at the police station in the city where Fire Department B was located. While the SCBA and protective equipment suffered some damage as the result of the wall collapse, the personal protective equipment was not considered to be a contributing factor in this incident. The equipment was not tested by NIOSH.

Structure

The structure involved in this incident was one of three structures that occupied a city block near the center of town. The fire building occupied approximately half of the block on the eastern side. This Type III, ordinary construction structure was believed to have been built in 1915 with multiple additions and renovations extending the structure to the rear (north and west). The original building was a two-story structure approximately 22 feet high with a flat roof. The exterior walls consisted of three course brick and masonry construction. The front of the structure faced a city side walk that was covered by an overhead awning made of wood and metal. Four large glass showroom windows were located across the front wall, one to the left of the double glass doors, and three to the right. The roof and second floor were supported by wooden joists embedded into the west and east (B and D-side) walls. A steel beam running from front to back also supported the second floor joists. A one-story addition had been added in multiple stages using brick and concrete blocks for the exterior walls. The one-story addition also included a flat roof. The structure enclosed approximately 14,600 square feet and measured approximately 50 feet wide by 148 feet deep with a 48-foot by 48-foot addition extending to the west at the rear (see Diagram 1). At the time of the fire, the front portion of the structure, (the original section) contained an antique store. The rear addition contained living quarters and storage. A wood and metal awning covered the sidewalk at the front. The fire is believed to have originated in the rear of the structure due to an undetermined cause. A thunderstorm had passed through the immediate area approximately 2 hours before the fire was reported.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

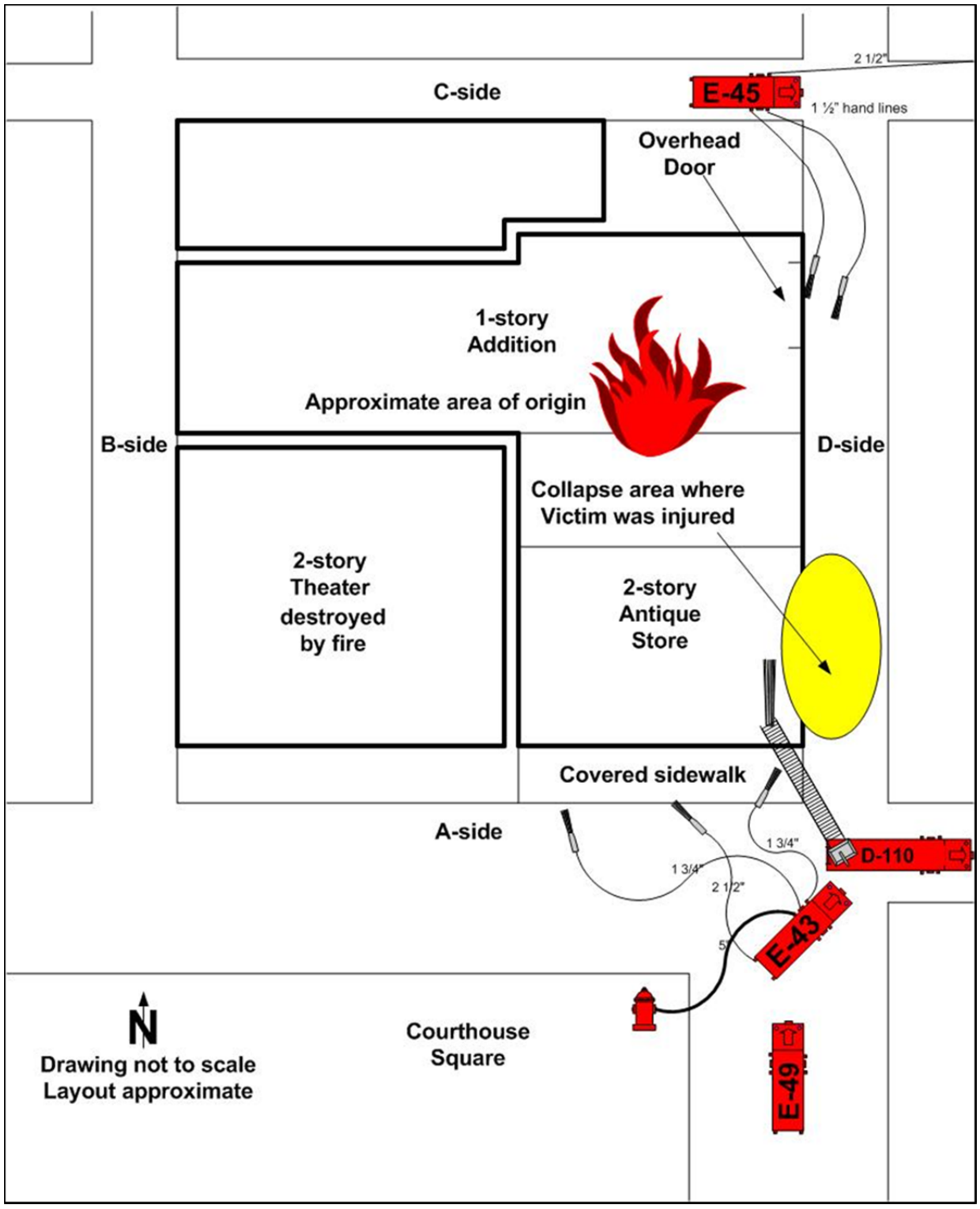

Diagram 1 – Approximate layout of fire building and exposure structures.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

The structure did not contain a sprinkler system or other type of automatic fire suppression. The adjacent structure (a theater) located to the west was not in use at the time of the fire.

The exterior walls on both the fire structure and the adjacent theater contained star-shaped anchor plates (see Photo 1 and Photo 2). Anchor plates were used for structural reinforcement on buildings in the 18th, 19th and early 20th centuries. These anchor plates were typically made of cast iron and were used as tie plates serving as the washers for tie-rods on brick or other masonry-based buildings. The

Photo 1. Arrows mark locations where star-shaped anchor plates were located on the west-side of the theater building that was adjacent to the fire building. The anchor plates appear to have been attached to the ends of the heavy timber roof trusses supporting the roof and also to some of the second-floor joists. See Photo 4 and Photo 5 for more details.
(Photos courtesy of the local newspaper)

tie-rod and plate assembly serves to brace the masonry wall against lateral bowing.[2] Photo 2 and Photo 3 show the presence of these star-shaped anchor plates on the antique store's D-side wall which collapsed. The tie-rod assemblies used in the adjacent theater were connected directly to the ends of the floor joists and heavy timber roof trusses (see Photo 4 and Photo 5). NIOSH investigators did not

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

observe anchor plates in the remains of the fire building but did observe them in the remains of the adjacent theater. The anchor plates used on the D-side of the fire structure were likely attached in a similar manner as those that were observed in the remains of the theater. While the presence of anchor plates may not necessarily be an indicator of structural instability, fire fighters need to be aware that these anchor plates are used to provide lateral support to help prevent bowing of exterior walls. Collapsing roofs typically exert outward pressure at the top of exterior walls supporting the roof. When weakened by fire degradation, the possibility of exterior wall collapse should be considered. As seen in the following photos, star-shaped anchor plates were present in the area of the D-side wall that collapsed during this incident.

Photo 2 (left) and Photo 3 (enlarged – on right). Photos show star-shaped anchor plates located on the D-side wall in the area that collapsed, injuring the Victim.
(Photo 2 courtesy of the local newspaper. Photo 3 edited by NIOSH)

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 4 (left) and Photo 5 (right). Photo 4 shows star-shaped anchor plate attached to end of floor joist. Photo 5 shows star-shaped anchor plate attached to end of heavy timber roof truss. Both photos are of the theater adjacent to the fire structure.
(Photos courtesy of the local newspaper)

Weather

At approximately 1555 hours, the weather in the immediate area was reported to be 69.8 degrees Fahrenheit with a dew point of 66.2 degrees F. and relative humidity of 88 percent. Winds were from the East at 6.9 miles per hour.[3] A thunderstorm had passed through the area approximately 2 hours prior to the time of the dispatch. Lightning strikes were reported in the immediate area. Winds from the southeast were recorded gusting from 12.7 to 17.3 miles per hour. Wind conditions during the fire contributed to reduced visibility on the C and D-sides of the structure as the winds pushed thick heavy smoke from the south to the north (front to rear). Visibility in the alley located on the D-side of the structure was limited at times.

Investigation

At approximately 1515 hours on Friday afternoon, June 17, 2011, the city fire department (Fire Department A) was dispatched for a report of a fire in a building behind an antique store located near the courthouse square at the center of town. Paid-on-call members of the fire department responded to the station or directly to the fire scene. Engine 43 (E-43) responded to the scene at approximately 1519 hours with a 2nd lieutenant and 4 fire fighters onboard. A light haze of smoke could be seen in the air as the crews left the fire station. E-43 staged in the street near the A-D corner in front of the antique store. A large column of smoke rose over the rear of the building and smoke could be seen pushing out of cracks around the windows on the A and D sides. No fire was visible to the arriving crews (see Photo 2 and Photo 6). As the fire fighters arrived on scene, it was apparent the fire was located in the antique store and not the building behind the store

The 2nd lieutenant assumed command and directed fire fighters to pull a 1¾-inch pre-connected crosslay to the front door. Two fire fighters who had responded on E-43 pulled the 1¾-inch hand line

to the front door while two other fire fighters who had responded on E-43 pulled a section of 5-inch supply line to a nearby hydrant across the street. The store owner asked the 2nd lieutenant to retrieve two boxes that were located just inside the store near the A-B corner. The lieutenant was able to retrieve one box but could not re-enter the store due to the high heat and smoke conditions. *Note: At this point, the lieutenant had not yet donned his SCBA.* A vehicle that was parked in front of the entrance had to be moved. The 2nd lieutenant charged the hand line using tank water for the initial fire attack. At this point, the front of the store was full of dark brown smoke but little fire was visible. When the hand line was put into operation, thick dark smoke was pushed out the front door, further decreasing visibility at the front of the structure and forcing the fire fighters to move back from the doorway . Fire fighters discussed venting the store front windows with the 2nd lieutenant and the 2nd lieutenant advised the fire fighters to knock out the glass windows. One of the fire fighters who had responded on E-43 used an axe to vent the front windows. The 2nd lieutenant told the E-43 crew that no one was to enter the structure and that they would use defensive operations from the sidewalk. After the two E-43 fire fighters established the water supply to E-43, they went down the alley on the D-side of the structure to the rear to assist the two fire fighters arriving on E-45. The Fire Chief was located a few miles out of town when he heard the fire dispatched over the radio. The Fire Chief immediately responded to the station. He stayed in contact with dispatch and the first arriving crews as they responded to the fire.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 6. Conditions seen by first arriving fire fighters. Note that no fire is visible but smoke can be seen pushing out cracks near the windows and vertical cracks in the brick masonry walls. ***(Photo courtesy of the local newspaper)***

Engine 45 (E-45) responded at approximately 1521 hours with 2 fire fighters onboard. They were assigned to stage at the north-east corner (C-D corner). Additional fire fighters arrived on scene via personally owned vehicles (POV) and by walking the short distance from the fire station after getting their turnout gear from the station. Other fire fighters arriving on-scene came to the rear of the structure to assist with laying a 2½-inch supply line to a hydrant located about one block east of the structure.

A 2½ inch hose line was pulled from E-43 to the front of the structure and put into operation. Initially, the hose lines were operated from the sidewalk directly in front of the structure. An overhead awning covered the front of the structure. Due to the collapse hazard, the fire fighters operating the hose lines under the awning were directed to move back into the street (see Photo 7 and Photo 8).

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 7. Early fire attack at Side A (front) of structure. Note the overhead awning.
(Photo courtesy of the local newspaper)

Photo 8. Three hose lines from Engine 43 in operation at front of structure. Note the smoke pushing out cracks near the windows and vertically along the A/D corner.
(Photo courtesy of the local newspaper)

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

The fire department's 1st Lieutenant responded to the scene in his POV. He met with the 2nd lieutenant in front of the structure and assumed Command. They discussed the condition of the structure and agreed that nobody should enter the structure.

Two fire fighters who had just arrived on-scene were instructed to raise a ground ladder to the second floor windows along Side D of the structure and to vent the windows. A 35-foot aluminum ground ladder was taken from E-43 and raised to the first window on Side D (closest to the south east corner of Side A). A fire fighter climbed the ladder to knock out the window with an axe.

The Fire Chief responded to the station in his personal vehicle where he picked up a fire fighter and drove the department's chief's vehicle to the scene. The Fire Chief drove to the rear of the structure and parked near E-45 to assist with establishing water supply to E-45. After water supply was established, the Chief walked along Side D to the front of the structure where he met with the two lieutenants and assumed Command. They discussed the operations and agreed that they should continue with a defensive strategy. *Note: Fire fighters reported to NIOSH investigators that the fire department had an unwritten policy that any fires in the older commercial structures within the city would be fought defensively.* The Fire Chief and the two lieutenants discussed that four mutual aid fire departments had been dispatched including Fire Department B that had the county's only aerial ladder truck. The Fire Chief (Incident Commander) also served as the incident safety officer.

One of the 1¾ inch hose lines was pulled from Side A to Side D and water was directed through one of the second story windows on Side D. The second window on Side D was boarded over. Fire fighters used the hose line water stream to try to break the glass in the third window but were unsuccessful so they moved the ladder to the third window and a fire fighter climbed the ladder to knock out the third window. The fire fighter returned to the sidewalk and assisted with the hose line as water was directed through the window opening to the second floor. The ground ladder was left standing against the building.

The building owner advised fire fighters that they could open an overhead roll-up garage door located on Side D near the C/D corner. The overhead door was opened and fire fighters pulled two 1 ½-inch preconnected crosslays from E-45 to the garage door. Fire fighters began applying water to the large volume of fire that was rolling out the doorway (see Photo 9). Another lieutenant arrived in his POV and the Fire Chief assigned him to oversee the operations at the rear of the building.

The fire continued to intensify at the rear causing overhead power lines and a utility pole to catch fire. The lieutenant radioed that the utility company was needed to cut the power to the electric lines.

After the windows were vented at the front and Side D, the fire rapidly intensified and moved toward the front of the structure. The Fire Chief directed the 1st lieutenant to put the E-43 deck gun into operation. The deck gun, equipped with a 1 3/8-inch solid-bore tip was quickly put into operation applying water onto the roof of the antique store.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 9. Fire fighters attack the fire through the open overhead roll-up door located on Side D at the C/D corner (rear of structure). Note that the flames are impinging on the overhead wires and the wire insulation has started to burn. The utility pole seen in the background later caught on fire. Also note how smoke obscured visibility toward the front of structure.
(Photo courtesy of the local newspaper)

Fire Department B arrived on-scene with a crew of four (Fire Chief B and three fire fighters) on their ladder truck. Two other fire fighters from Fire Department B drove their (POVs) to the scene, including the Victim, who arrived just before the ladder truck arrived. *Note: Fire Department B follows a procedure that for all mutual aid responses, an apparatus does not leave the station until a crew of at least 3 fire fighters are on-board. For mutual aid responses that involve a request for the ladder truck, the apparatus does not leave the station until a crew of at least 4 fire fighters are on-board.* While enroute, Fire Chief B radioed for staging information and received the assignment to approach the court house square (center of town) and set up at the A/D (south-east) corner. The aerial ladder crew conducted a forward lay from a nearby hydrant east of the structure, dropping supply line to the first cross street. The crew pulled additional supply line off the ladder truck, turned onto the cross street and then backed up to the final position located in the street near the A/D corner. After chocking the wheels and setting the outriggers, the crew worked to set up the aerial ladder for master stream operations.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

The Fire Chiefs from Fire Department A and Fire Department B met near the A-D corner of the structure and discussed the fireground operations. A large vertical crack was noted on the D-side wall near the A-D corner and smoke could be seen pushing out through the crack. Both Chiefs concurred that the fire suppression operation was a defensive operation.

The fire continued to grow and self-vented through the roof at the rear of the structure. As the fire intensified, flames could be seen extending several feet above the two-story roof line. The fire impinged upon overhead power lines causing them to fall to the ground in the alley near the C/D (north east) corner. A utility pole located in the alley near the center of the building caught fire. The intense heat caused vinyl siding on an exposure across the alley to melt so fire fighters turned their attention to protecting the exposure structure using the 1¾-inch hose line in the alley. The lieutenant directing operations at the rear of the structure radioed for the E-43 deck gun to help protect the exposure.

Shortly after the E-43 deck gun was directed onto the exposure building, Fire Department B put their elevated master stream into operation directing water onto the roof of the antique store. The operator reported that there was insufficient water supply from the hydrant to fully operate the master stream.

One of the Chiefs noticed the ground ladder positioned against the Side D wall and stated that the ladder was in a bad position and should be moved away from the burning building (see Photo 10). The Victim and a fire fighter from Fire Department A standing nearby overheard the comment and quickly moved to retrieve the ladder. The Victim positioned himself between the ladder and building with his back to the building while the other fire fighter stood on the other side of the ladder to brace it. They raised the ladder vertically and the Victim was using the ladder's rope to lower the ladder's upper section when the top portion of the exterior wall collapsed outward. Several fire fighters working in the immediate area near the A/D corner witnessed the collapse. Other fire fighters reported that they felt a shaking or vibration and heard the sound of the collapse. Someone yelled that the wall was coming down. Bricks and falling debris struck the Victim from behind as the other fire fighter grabbed for the Victim and simultaneously spun around and moved across the alley to get clear of the collapse. Witnesses reported that the Victim attempted to run toward the front of the building (parallel to the wall) while the Department A fire fighter moved perpendicularly away from the wall. The Victim was knocked down and partially buried by the falling debris. The other fire fighter moving the ladder was not struck.

Several fire fighters immediately rushed to aid the Victim. They quickly uncovered the Victim and pulled him to the corner of the alley where they immediately began to assess his condition. They were concerned about a secondary collapse of the rest of the wall so they moved the Victim east along the sidewalk to get out of the collapse zone. After the Victim was moved to a safe location, fire fighters who were also paramedics stabilized the Victim with a cervical collar and worked to control bleeding. Fire Chief A radioed dispatch for an ambulance. The Victim was transported to the local hospital emergency room and then transported via air ambulance helicopter to a trauma hospital in Missouri where he died.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 10. Ladder can be seen positioned against the Side D wall before the collapse occurred. Note how smoke is pushing out through the masonry joint at the A/D corner. The smoke obscures a clear view of the exterior wall, possibly hiding cracks and other signs of structural deterioration.
(Photo courtesy of the local newspaper)

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

At the time of the collapse, the aerial ladder was flowing approximately 500 gallons of water per minute. It is believed the master stream was in operation no more than 5-10 minutes at the time of the collapse. Water weights approximately 8.33 to 8.35 pounds per gallon. A master stream flowing 500 gallons of water per minute could potentially add 21,100 pounds or more than 10½ tons of excess weight in just 5 minutes to a structure not designed to support this additional weight at the same time the structure is being degraded by fire.

Fire Behavior

According to the investigating State Fire Marshal, the fire originated in the rear of structure due to undetermined causes. A thunderstorm had passed through the area approximately two hours before the fire was reported and lightning strikes were reported in the immediate area. The dispatch center received multiple phone calls reporting a fire behind the antique store near the courthouse square.

Indicators of significant fire behavior

- Smoke filled store front when first crews arrived
- Smoke pushing out cracks in the Side A and D walls and around windows on Side D
- Thickening dark brown smoke upon arrival
- No visible fire
- Windows at front broken to vent structure
- Windows on Side D broken to vent 2nd floor
- Roll up overhead door opened at C/D corner
- Fire rapidly grew and moved toward front of store, becoming visible through windows
- Smoke diminished and visibility improved at front
- Smoke continued to push out under pressure through cracks in Side A and D walls
- Fire vented through roof at rear of structure
- Thick column of turbulent dark grey-black smoke rose above structure
- Smoke increased in front and Side D of structure as fire intensified
- Smoke continued to push out cracks on Side A and D walls
- E-43 deck gun put into operation applying water to roof with 13/8-inch solid bore tip
- Elevated master stream put into operation from D-110 aerial ladder (insufficient water supply resulted in insufficient fire flow)
- E-43 deck gun re-directed hose stream to protect exposure buildings opposite Side D
- Initial collapse of roof and walls at C/D corner
- Partial wall collapse of Side D wall strikes fire fighter moving ground ladder.

Contributing Factors

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

- 96 year-old brick masonry structure degraded by fire burning for over 45 minutes
- Fire fighters with limited experience entered collapse zone to move ground ladder
- Entering collapse zone in close proximity to master stream directed onto roof
- Limited visibility at side and rear of structure may have obscured signs of pending collapse
- Limited training on structure collapse hazards.

Cause of Death

According to the death certificate, the medical examiner listed the manner of death as accidental during a structure fire and collapse. The immediate cause of death was listed as blunt cranio-cerebral injury.

Recommendations

Recommendation #1: Fire departments should establish and monitor a collapse zone when conditions indicate the potential for structural collapse.

Discussion: During fire operations, two rules exist about structural collapse: (1) the potential for structural failure always exists during and after a fire, and (2) a collapse danger zone must be established.[4-9] A collapse zone is an area around and away from a structure in which debris might land if a structure fails. The collapse zone area should be equal to the height of the building plus an additional allowance for debris scatter and at a minimum should be at least 1½ times the height of the building.

Buildings can collapse due to the structural damage directly caused by a fire, or the activities of fire fighting operations. A fire department's familiarity with types of construction in their community is an important tool in safely fighting fires. Once a collapse zone is established, fire departments should enforce a "no re-entry" policy unless approved by the Incident Commander.

Fire fighters need to recognize the dangers of operating near parapet walls or underneath overhanging awnings, porches, and other areas susceptible to collapse. Immediate safety precautions must be taken if factors indicate the potential for a building collapse. An external load, such as a parapet wall, steeple, overhanging porch, awning, sign, or large electrical service connections reacting on a wall weakened by fire conditions may cause a wall to collapse. Other factors include fuel loads, damage, renovation work, deterioration caused by the fire as well as pre-existing deterioration, support systems and truss construction.[10 - 12] A collapse is a possibility after fire involvement of more than 10 minutes but fire departments should not rely solely on time as a collapse predictor.[11]

In this incident, the structure was estimated to be 22 feet high at the top of the D-side wall parapet wall so the collapse zone should have extended at least 33 feet from the structure, covering the entire width of the side-street adjacent to the structure. It is noted that fire fighters were instructed to stay away from the structure and a defensive strategy was used throughout the fire suppression operations. However, a collapse zone was never established or physically identified. Collapse zones can be

physically marked by cones, caution tape and other types of physical barriers. Photo 10 taken at the incident scene showed fire fighters standing on the sidewalk as instructed opposite the wall that collapsed.

Recommendation #2: Fire departments should train all fire fighting personnel in the risks and hazards related to structural collapse.

Discussion: Proper training is an important aspect of safe fire ground operation. Both officers and fire fighters need to be aware of different types of building construction and their associated hazards.[7, 9-10] For example, collapsing roof systems can exert pressure on supporting exterior walls, increasing the potential for wall collapse. Different roof systems may collapse at different rates.[11] While heavy timber roof systems will withstand more degradation by fire than lightweight engineered roof trusses, both types are subject to failure.[12] Different phases of the fire suppression activities, such as the initial attack, offensive, defensive, and overhaul phases will have different hazards. However, the potential for collapse exists in any fire-damaged structure.[11] One source of information related to structural collapse hazards is the National Institute of Standards and Technology, Building and Fire Research Laboratory (NIST / BFRL). A DVD containing videos and reports related to structural collapse can be obtained from the NIST website http://www.bfrl.nist.gov/. [13]

Establishing priorities is another primary factor in safe fire ground operation that should be included in fire fighter training programs. The protection of life should be the highest goal of the fire service. According to retired Chief Vince Dunn, "When there is no clear danger to civilians, the first priority of firefighting should be the protection of fire fighters' lives and when no other person's life is in danger, the life of the fire fighter has a higher priority than fire containment or property consideration."[12] In this incident, there were no indications of civilians in danger inside the structure. It is noted that defensive operations were used throughout the incident.

The Illinois Fire Service Institute (IFSI) coordinates a statewide training program for individuals interested in becoming a fire fighter. This program offers a 24-hour Basic Fire Fighter course as well as Fire Fighter II and Fire Fighter III certification. The IFSI Fire Fighter II certification is roughly equivalent to the National Fire Protection Association (NFPA) Fire Fighter I and IFSI Fire Fighter III is roughly equivalent to NFPA Fire Fighter II as specified in NFPA 1001 Standard for Fire Fighter Professional Qualifications.[1] NFPA FF I reflects minimum training standards for a fire fighter who is always working under supervision. NFPA FF II addresses the assumption of command and transfer of command but does not contain specific job performance requirements (JPRs) to illustrate the required skills. The IFSI 24-hour Basic Fire Fighter course may not properly prepare new fire fighters for the hazards associated with structural fire fighting. Many fire fighters, especially in the volunteer ranks, may be called upon to fill company officer and incident commander roles when they may not have received adequate training to prepare them for the additional responsibilities that are required of fireground officers. At a minimum, fire fighters who serve as company officers and who may be expected to serve as the initial incident commander should receive training equivalent to NFPA Fire Fighter II, as defined by NFPA 1001. In this incident, the victim had not completed the minimum IFSI or NFPA training requirements for individuals operating at a structure fire. Also, the two lieutenants

who served as incident commanders had not completed training meeting the requirements of NFPA Fire Fighter II as defined by NFPA 1001, which should be the minimum training requirements for a fire fighter operating as a fireground officer.

Recommendation #3: Fire departments should train on and understand the effects of master streams on structural degradation.

Discussion: Master streams are an effective tool for fire suppression operations. Master streams can deliver a large volume of water over a distance while reducing the direct exposure of fire fighters to the fire. Master stream operations can also accelerate structural degradation and can increase the risk of a building collapse.[14-16] When multiple master streams are flowing water into a building, the additional weight of the water can rapidly increase the potential for structural collapse. Water weighs 8.33 pounds per gallon. A master stream flowing 1,000 gallons per minute can add an additional 8,330 pounds per minute that the structure, already deteriorated by fire, must support. In 30 minutes, the additional weight contributed by this master stream could add 249,900 pounds or 125 tons of additional weight to the structure.[17] Direct impingement of the master stream at close range can also directly contribute to structural degradation by dislodging bricks, breaking windows and other building components. Master streams can also push fire throughout the interior of a structure, leading to fire spread.

Another important indicator that fire fighters and officers should look for is the presence or lack of runoff during master stream operations. If multiple outside streams are being applied to a structure and there is little or no water runoff, the water must be accumulating somewhere.[15] As noted above, the additional weight added by standing water on roofs or floors can significantly contribute to the risk of structural collapse. Fire fighters and fire officers need to understand this fact and take this into consideration as part of the Incident Action Plan. If a collapse zone has not already been established, one should be established now. Fire fighters should not be allowed to enter the collapse zone without the direct permission of the Incident Commander.[18]

Recommendation #4: Fire departments should use risk management principles at all structure fires.

Discussion: 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.[19] More importantly, the fire department must establish a standardized method or approach to assess the risks encountered at each incident especially structure fires. Structure fires are very dynamic and fast paced operations with little room for error, mistakes, or miscalculations of the significance of the risk encountered.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

The Incident Commander is specifically responsible for managing risk at the incident; however, one person cannot be expected to apply these principles to an incident if the organization has not integrated a standard approach to risk management into its standard operating procedures and its organizational culture. To be effective, risk management principles must be integrated into the entire operational approach of the fire department organization. They must be incorporated within the duties and responsibilities of every officer and member. The single most important reason to establish an effective incident management system is to ensure that operations are conducted safely. Every individual assigned to the incident is responsible for monitoring and evaluating risks and for keeping the Incident Commander informed of any factor that causes the system to become unbalanced. Continuous risk assessment should be reprocessed with every benchmark or task completed until the incident is ended.[20]

A standardized evaluation of the situation must occur at each incident starting with the first arriving officer or member of the department arriving on scene of the incident. This process starts with the scene size-up. This responsibility starts with the first arriving unit that must look at the entire incident scene versus focusing on a small part of the situation. During the size-up, the Incident Commander must remember the incident prioritizes which are:

- Life Safety
- Incident Stabilization
- Property Conservation
- Continuous – fire fighter safety

Situations where there is clear evidence or indication that there is a life safety (imminent rescue or trapped occupants) changes the focus of the strategy and incident action plan. Established risk management principles dictate that more caution is exercised in abandoned, vacant, and unoccupied structures.

Scene size-up should include the following information. Scene size-up should begin at the beginning of the alarm, continue upon arrival on scene, and continue throughout the incident. Some considerations should include:

- Life safety/occupied structure and realistic evaluation of occupant survivability and rescue potential
- Type of Occupancy and consideration of fire load and fire behavior
- Access
- Building Construction
- Environmental Conditions
- Location and extent of the fire within the building
- Resources Responding
- Water Supply
- Special Hazards/Risks
- Time of Day

- Color of Smoke
- Utilities
- Exposures affected or potential affected
- A realistic evaluation of the ability to conduct an offensive attack with available resources.[19,21]

The Incident Commander should use the scene size-up to formulate a strategy and the Incident Action Plan. Incident factors and their possible consequences offer the basis for a standard incident management approach. Decisions and the action they produce can be no better than the information on which they are based. A standard information management approach is the launching pad for effective incident decision making and successful operational performance. The IC must develop the habit of using the critical factors in their order of importance as the basis for making the specific assignments that make up the Incident Action Plan (IAP). This standard approach becomes a huge help when it is hard to decide where to start.

The incident scene size-up must be viewed as a 2-part process: 1) determining the conditions of the incident scene, and 2) determining whether the fire department has on scene, has in route, or is in need of additional resources to address the challenge presented by what has been identified during the first part of the size-up process.

The IC must create a standard information system and use effective techniques to keep informed at the incident. Information is continually received and processed so that new decisions can be made and old decisions revised based on increased data and improved information. The IC can never assume action-oriented responders engaged in operational activities will just naturally stop what they are doing so they can feed the IC a continuous supply of top-grade objective information. It is the IC's responsibility to do whatever is required to stay effectively informed.[22]

During most critical incident situations, Command many times must develop an IAP, based only on the critical factor evaluation information available at the beginning stage of operations. Many times, that information is incomplete. Even though the IC will continue to improve its quality, the IC will seldom function during the fast, active periods of the event with complete or totally accurate information on all factors.[22]

This is most evident during confused, compressed-time initial operations. This continual improvement in the accuracy and timeliness of incident information becomes a major IC function. The ability of the IC and the tactical and task level officers to quickly be informed and perform an analysis of the critical factors that can cause major physical and emotional setbacks to the responders and the customers will have a great impact on the health and longevity of the fire fighters, other first responders, the customers and their property.[22]

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.[19,23,24] NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program*, Chapter 8.3 addresses the use of risk management principles at emergency operations. Chapter 8.3.4 states that risk management principles shall be routinely employed by supervisory personnel at all levels of the incident management system to define the limits of acceptable and unacceptable positions and functions for all members at the incident scene. Chapter 8.3.5 states that at significant incidents and special operations incidents, the Incident Commander shall assign an incident safety officer who has the expertise to evaluate hazards and provide direction with respect to the overall safety of personnel. The annex to Chapter 8.3.5 contains additional information.[25]

This incident occurred in a structure of mixed occupancy of both commercial and residential use. First arriving crews talked to the building owner and verified that no one was inside the structure. The Incident Commander quickly adopted a defensive strategy and told fire fighters at the front door not to enter the structure. As additional resources arrived on-scene, and Command was passed to higher ranking officers, a defensive operation was maintained. A ground ladder used to ventilate the second story windows on the Side D was left in place where it was last used. Approximately 45 minutes after the first crews arrived on-scene, two fire fighters overheard discussions about the ladder being in a bad location and approached the structure to retrieve the ladder. Given the length of time the fire had been burning, the visual indicators of structural instability (smoke pushing out through cracks in the masonry walls and the sound of bricks popping), the presence of star-shaped anchor plates on the exterior wall and other factors, the best scenario would have been to leave the ladder in place until the area was deemed safe or just write the ladder off. A safer strategy for retrieving the ladder would have been to use a pike pole or other long tool to reach the ladder from a safe distance under the direct observation of other fire fighters monitoring the conditions of the exterior walls. Using a pike pole or other tool to pull the ladder down while standing as far as possible from the exterior wall, may have resulted in a different outcome.

Recommendation #5: Fire Departments should utilize the Incident Command System at all emergency incidents.

Discussion: National Fire Protection Association (NFPA) 1500 *Standard on Fire Department Occupational Safety and Health Program*, 2007 Edition[25] and NFPA 1561 *Standard on Emergency Services Incident Management System*, 2008 Edition[26], both state an incident management system should be utilized at all emergency incidents. Most often, this system is commonly known as or referred to as the Incident Command System (ICS).

The Incident Command System is intended to provide a standard approach to the management of emergency incidents. The many different and complex situations encountered by fire fighters require a considerable amount of judgment in the application of the Incident Command System. The primary objective is always to manage the incident, not to fully implement and utilize the Incident Command System. The Incident Commander should be able to apply the Incident Command System in a manner that supports effective and efficient management of the incident. The use of the Incident Command System should not create additional challenges for the Incident Commander, but rather provide a systems approach to ensuring for a successful outcome of the incident.[26]

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Most incidents are considered routine and involve a small commitment of resources, while few incidents involve large commitments of resources, complex situations, and are low frequency/high risk events. It is imperative that the Incident Command System be able to accommodate all types and sizes of incidents and to provide for a regular process of escalation from the arrival of the first responding resources at a routine incident to the appropriate response for the largest and most complex incidents. The Incident Command System should be applied, even to routine incidents, to allow fire fighters and other first responders to be familiar with the system, prepared for escalation, and aware of the risks that exist at all incidents.[26]

NFPA 1561, Chapter 3.3.29 defines an incident management system as "A system that defines the roles and responsibilities to be assumed by responders and the standard operating procedures to be used in the management and direction of emergency incidents and other functions."[26] Chapter 4.1 states "The incident management system shall provide structure and coordination to the management of emergency incident operations to provide for the safety and health of emergency services organization (ESO) responders and other persons involved in those activities."[26] Chapter 4.2 states "The incident management system shall integrate risk management into the regular functions of incident command." [26]

The incident management system covers more than just fireground operations. The incident management system must ensure for command and fire fighter safety which includes situational evaluation, strategy and the incident action plan, personnel accountability, risk assessment and continuous evaluation, communications, rapid intervention crews (RIC), roles and responsibilities of the Incident Safety Officer (ISO), and interoperability with multiple agencies (law enforcement, emergency medical services, state and federal government agencies and officials, etc.) and surrounding jurisdictions (automatic aid or mutual aid responders).

One of the most critical components of this system is the development and implementation of an Incident Action Plan (IAP). For the fire service, the majority of times the Incident Action Plan is communicated verbally. The IAP is based on the resources immediately available and those responding. The goal is determined in accordance with the incident priority from which a strategy must emerge; tactical objectives, aimed at meeting the strategy, are determined and specific assignments made. A personnel accountability system should be established as assignments are made. The important point is that the Incident Commander communicates the IAP to tactical and task level supervisors.

Recommendation #6: Fire departments should designate a staging area for all unassigned fire fighters and apparatus.

Discussion: NFPA 1561 *Standard on Emergency Services Incident Management System* defines staging as a specific emergency management function where resources are assembled in an area at or near the incident scene to await instructions or assignments.[26] Staging provides a standard controlled method to keep reserves of responders, apparatus, and other resources ready for action at the scene of

the incident or close to the scene of the incident (within two – three minute response times). Staging also provides a standard method to control and record the arrival of apparatus and resources.

When the Incident Commander requests additional resources for an incident, the IC is responsible for designating a staging area. Depending on the size and complexity of an incident, multiple staging areas may be used. This is based on the response route of the resources, to stage resources by typing (e.g. engines, brush trucks, medic units, law enforcement, etc.), or due to location near the incident. The staging area manager documents the available resources. This helps the Incident Commander to keep track of the resources that are on the scene and available for assignment, and to know where they are located and where specific units have been assigned. The Staging Area Manager reports to the IC unless an Operations Section Chief has been assigned, then the Staging Area Manager would report to the Operations Section Chief.

When companies or resources arrive in staging, they report to the Staging Area Manager and stand by for assignment. The Staging Area Manager records and keeps an inventory of all resources and equipment assigned to Staging. A system needs to be in place that details what needs to occur when Staging starts to run low on resources. Staging lets "Command" know when resources are low, and Command orders more resources through Dispatch.

Staging provides an avenue for reducing overall incident communications, and maintaining control of resources throughout the incident operations.

Recommendation #7: Fire departments should conduct pre-incident planning inspections of buildings within their jurisdictions to facilitate development of safe fireground strategies and tactics.

Discussion: National Fire Protection Association (NFPA) 1620 *Standard for Pre-Incident Planning*, 2010 Edition, states "the pre-incident plan shall provide critical information for responding personnel at the time of dispatch and shall include initial actions based on the priorities of life safety, scene stabilization, and incident mitigation." This standard also states that "the primary purpose of a pre-incident plan is to help responding personnel effectively manage emergencies with available resources. Pre-incident planning involves evaluating the protection systems, building construction, contents, and operating procedures that can impact emergency operations."[27] A pre-incident plan identifies deviations from normal operations and can be complex and formal, or simply a notation about a particular problem such as the presence of flammable liquids, explosive hazards, modifications to structural building components, or structural damage from a previous fire.[7, 27-28]

In addition, NFPA 1620 outlines the steps involved in developing, maintaining, and using a preincident plan by breaking the incident down into pre-, during- and post-incident phases. In the preincident phase, for example, it covers factors such as physical elements and site considerations, occupant considerations, protection systems and water supplies, hydrant locations, and special hazard considerations. Building characteristics including type of construction, materials used, occupancy, fuel load, roof and floor design, and unusual or distinguishing characteristics should be recorded, shared with other departments who provide mutual aid, and if possible, entered into the dispatcher's computer

so that the information is readily available if an incident is reported at the noted address. Since many fire departments have tens and hundreds of thousands of structures within their jurisdiction, making it impossible to pre-plan them all, priority should be given to those having elevated or unusual fire hazards and life safety considerations.

Pre-plan information should include predicted alarm assignments based upon the fire potential. This will help to ensure that needed resources are dispatched immediately, even if they are some distance away or will provided through mutual aid. If the expected fire potential dictates that 30 fire fighters are needed and the authority having jurisdiction only has 15 fire fighters, the pre-plan should identify the mutual aid resources available to safely and effectively mitigate the expected fire scenario. The pre-plan information should take into consideration the need for incident command and command level officers to fill roles such as safety officer, accountability, tactical level management (i.e. division or group supervisor), RIT / RIC supervision, staging, rehabilitation, IC support (chief's aide or staff assistant to monitor radio communications, track crew assignments, resources availability, etc.) and other functions as necessary. When the need for these positions are considered in the pre-planning process, these positions can be rapidly filled throughout the initial alarm assignments, allowing for crew and supervisory integrity while placing more experienced command level support officers in the roles needed to ensure effective supervision and support in the hazard zone. In this incident, pre-planning the structure could have identified the potential collapse hazards associated with the structure due to the age and type of construction, the presence of the star-shaped anchor plates on the exterior walls, and the high fuel load present. It is noted that the Fire Department A had an unwritten policy that any fires in the older commercial structures within the city would be fought defensively.

Recommendation #8: Fire departments should conduct regular mutual aid training with neighboring departments.

Discussion: Although there is no evidence that the following recommendation would have prevented this fatality, it is being provided as a reminder of a good safety practice. Mutual aid companies should train together and not wait until an incident occurs to attempt to integrate the participating departments into a functional team. Differences in equipment and procedures need to be identified and resolved before an emergency occurs when lives may be at stake. Procedures and protocols that are jointly developed, and have the support of the majority of participating departments, will greatly enhance overall safety and efficiency on the fireground. Once methods and procedures are agreed upon, training protocols must be developed and joint-training sessions conducted to relay appropriate information to all affected department members.

Fire departments should develop and establish good working relationships with surrounding departments so that reciprocal assistance and mutual aid is readily available when emergency situations escalate beyond response capabilities. Both fire departments involved in this incident were participating members in the Mutual Aid Box Alarm System (MABAS), a mutual aid system designated to assist with mutual aid response of fire, emergency medical services (EMS), specialized response teams, and station coverage during a state declared disaster or when an incident overwhelms the available resources of a participating community. This incident did not escalate to the size of a

MABAS event. Both departments reported that they planned to implement mutual aid training with neighboring departments but had done so on a limited basis up to the time that this incident occurred.

Recommendation # 9: Fire departments should ensure that fire fighters wear a full array of turnout clothing and personal protective equipment (i.e. SCBA and PASS device) appropriate for the assigned task while participating in fire suppression and overhaul activities.

Discussion: Although there is no evidence that the following recommendation would have prevented this fatality, it is being provided as a reminder of a good safety practice. The proper selection and use of personal protective equipment (PPE) is required by OSHA regulations, recommended in NFPA standards, and is good safety practice. Chapter 7.1.1 of NFPA 1500, Fire Department Safety and Health Program, 2007 Edition, states "the fire department shall provide each member with protective clothing and protective equipment that is designed to provide protection from the hazards to which the member is likely to be exposed and is suitable for the tasks that the member is expected to perform." Chapter 7.1.2. states "protective clothing and protective equipment shall be used whenever a member is exposed or potentially exposed to the hazards for which the protective clothing (and equipment) is provided."[25] The incident commander should establish the level of protective clothing necessary to enter the fire zones (hot, warm, and cold). The OSHA Respirator Standard Title 29, Code of Federal Regulations (CFR) 1910.134 lists requirements for SCBA use in immediately dangerous to life or health (IDLH) atmospheres.[29] While the lack of personal protective equipment (PPE) and clothing did not contribute to the fatality that occurred at this incident, it is generally recognized that SCBA should be worn and used at all times when fire fighters may be exposed to smoke and other hazardous atmospheres. Photos taken during the incident show fire fighters working in close proximity to the burning structure who were not wearing proper respiratory protection (see Photo 7, Photo 8 and Photo 11).

In addition, standard setting organizations, national fire service organizations and other interested parties should:

Recommendation #10: Implement national fire fighter and fire officer training standards and requirements.

Discussion: In 2008, the National Volunteer Fire Council (NVFC) adopted a policy position that all volunteer fire departments should establish a goal to train all personnel to a level consistent with the mission of the fire department, based on the job performance requirements outlined in *NFPA 1001: Standard for Fire Fighter Professional Qualifications*. The NVFC is committed to ensuring that volunteer firefighters have an appropriate level of training to safely and effectively carry out the functions of the department(s) that they belong to. [30]

"The roles and responsibilities of the fire service have evolved over the years. As the breadth and scope of what it means to be a firefighter has expanded, to varying degrees depending on the jurisdiction, the necessity for training within the fire service has grown. Unfortunately, a large number

of volunteer fire departments are still operating with personnel who are not trained to a level consistent with national consensus standards for basic firefighter preparedness. This can lead to ineffective and unsafe responses that put lives and property at risk." [30] This issue actually encompasses the entire fire service and not just the volunteer ranks.

"As the need for proper training has become more urgent, many volunteer fire departments are finding it increasingly difficult to attract new members. The average age of volunteer firefighters has risen steadily over the past two decades, as many young people move out of rural areas and the ones who stay find themselves with less free time to devote to training."[30]

Standard setting organizations, states and authorities having jurisdiction should move to develop national standards so that fire fighters across the United States are trained to the same minimum levels. The Illinois Fire Service Institute (IFSI) coordinates a statewide training program for individuals interested in becoming a fire fighter. This program offers a 24-hour Basic Fire Fighter course as well as Fire Fighter II and Fire Fighter III certification. The IFSI Fire Fighter II certification is roughly equivalent to the National Fire Protection Association (NFPA) Fire Fighter I and IFSI Fire Fighter III is roughly equivalent to NFPA Fire Fighter II as specified in NFPA 1001 Standard for Fire Fighter Professional Qualifications.[1] NFPA FF I reflects minimum training standards for a fire fighter who is always working under supervision. NFPA FF II addresses the assumption of command and transfer of command but does not contain specific job performance requirements (JPRs) to illustrate the required skills. The IFSI 24-hour Basic Fire Fighter course may not properly prepare new fire fighters for the hazards associated with structural fire fighting. Many fire fighters, especially in the volunteer ranks, may be called upon to fill company officer and incident commander roles when they may not have received adequate training to prepare them for the additional responsibilities that are required of fireground officers. At a minimum, fire fighters who serve as company officers and who may be expected to serve as the initial incident commander should receive training equivalent to NFPA Fire Fighter II, as defined by NFPA 1001.

Fire department members that are assigned to or assume supervisory positions at an incident scene must have an additional level of competencies that are necessary to ensure for the safety of themselves and the members they supervise while mitigating the hazard encountered. A company officer must have the correct combination of practical experience, training and skill sets that correspond with their job requirements and expected functions in order to execute the expected duties in a safe, effective, efficient and competent manner. The company officer fulfills a mission critical role within the fire service that directly affects department personnel, public safety and community accord. The title carries with it the opportunity to ride the "front seat" and be in charge of directing a company to address incident operations and demands dictated by the company's function, responsibility, and task assignment. NFPA 1021, *Standard on Fire Officer Professional Qualifications* provides clear and concise job performance requirements (JPR) that can be used to determine if an individual, when measured to the standard, possess the skills and knowledge to perform as a fire officer.[31] Fire departments should ensure that all fire fighters who are expected to perform the duties of a company officer or greater responsibility have the necessary knowledge, experience and receive adequate

training equivalent to NFPA Fire Fighter II, as defined by NFPA 1001 and Fire Officer as defined by NFPA 1021.

References

1. NFPA [2008]. NFPA 1001 Standard for Fire Fighter Professional Qualifications, 2008 ed. Quincy, MA: National Fire Protection Association.

2. Wikipedia [2011]. Anchor Plates. http://en.wikipedia.org/wiki/Anchor_plate. Date accessed: September 20, 2011.

3. Weather Underground [2011]. Weather conditions for June 17, 2011. http://www.wunderground.com/history/airport/KSAR/2011/6/17/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA. Date accessed: August 12, 2011.

4. Dunn V [1988]. Collapse of burning buildings, a guide to fireground safety. Saddle Brook, NJ: PennWell.

5. Klaene BJ and Sanders RE [2000]. Structural fire fighting. Quincy, MA: National Fire Protection Association, pp 101-117.

6. Dodson D [1999]. Fire department incident safety officer. New York: Delmar Publishers.

7. NIOSH [1999]. NIOSH Alert: Preventing injuries and deaths of fire fighters due to structural collapse. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99-146. http://www.cdc.gov/niosh/docs/99-146/.

8. Delmar Publishers [2000]. Fire fighter's Handbook: Essentials of fire fighting and emergency response. New York: Delmar Thomson Learning.

9. NIOSH [2005]. NIOSH Alert: Preventing injuries and deaths of fire fighters due to truss system failures. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-132. http://www.cdc.gov/niosh/docs/2005-132/.

10. NIOSH [2007]. Career fire fighter dies and chief is injured when struck by 130-foot awning that collapses during a commercial building fire – Texas. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. FACE Report F2007-01.

11. Brannigan FL [1999]. Building construction for the fire service, 3rd ed. Quincy, MA: National Fire Protection Association, pp 517-563.

12. Dunn V [1992]. Safety and survival on the fireground. Saddle Brook, NJ: Fire Engineering Books and Videos. pp285-292.

13. NIST [2011]. Structural Collapse. Gaithersburg, MD. National Institute of Standards and Technology, Fire Research Division. http://nist.gov/fire/collapse.cfm. Date accessed: September 14, 2011.

14. IFSTA [2008]. Essentials of fire fighting, 5th ed. Oklahoma State University. Stillwater, OK: Fire Protection Publications. International Fire Service Training Association.

15. IFSTA [2010]. Building Construction Related to the Fire Service, 3rd ed. Oklahoma State University. Stillwater, OK: Fire Protection Publications. International Fire Service Training Association.

16. Norman J [2005]. Fire Officer's Handbook, 3rd ed. Tulsa, OK. Penn Well Corporation: Fire Engineering.

17. Klaene B and Sanders R [2000]. *Structural fire fighting*. Quincy, MA: National Fire Protection Association.

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

19. NIOSH [2010]. *NIOSH ALERT: Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires*. July 2010. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH), Publication No. 2010-153. http://www.cdc.gov/niosh/docs/2010-153/.

20. FEMA [1996]. Risk Management Practices in the Fire Service, 1996. Washington, DC: Federal Emergency Management Agency; U.S. Fire Administration.

21. Phoenix Fire Department [2009]. Written comment to NIOSH Docket # 141. March 9, 2009.

22. Brunacini A and Brunacini N [2004]. Command Safety. Across the Street Publications.

23. Dunn V. [1992]. Safety and survival on the fireground. Saddle Brook, NJ: Fire Engineering Books and Videos.

24. IAFC [2009]. Rules of engagement for structural firefighting, increasing firefighter survival. Draft manuscript developed by the Safety, Health and Survival Section, International Association of Fire Chiefs. Fairfax Va. March 2009.

25. NFPA [2007]. *NFPA 1500 Standard on fire department occupational safety and health program*, 2007 ed. Quincy, MA: National Fire Protection Association.

26. NFPA [2008]. *NFPA 1561 Standard on emergency services incident management system*, 2008 ed. Quincy, MA: National Fire Protection Association.

27. NFPA [2010]. NFPA 1620: *Recommended practice for pre-incident planning*, 2010 ed. Quincy, MA: National Fire Protection Association.

28. Dunn, V. [2007]. Strategy of Firefighting. Saddlebrook NJ: Penn Well Publishing Co. p- 162.

29. OSHA [1998]. 29 CFR Parts 1910 and 1926 Respiratory Protection; Final Rule. Federal Register Notice 1218-AA05. Vol. 63, No. 5. January 8, 1998. U.S. Department of Labor, Occupational Safety and Health Administration. Washington DC.

30. NVFC [2010]. White Paper on Volunteer Firefighter Training. Greenbelt, MD. National Volunteer Fire Council. January 2010. http://www.nvfc.org/files/documents/Volunteer_Training_White_Paper.pdf. Date accessed: September 21, 2011.

31. NFPA [2008]. NFPA 1021 *Standard on Fire Officer Professional Qualifications*, 2009 ed. Quincy, MA: National Fire Protection Association.

Investigator Information

This incident was investigated by Tim Merinar, Safety Engineer, and Murrey Loflin, Investigator, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. An expert technical review was provided by Deputy Chief Billy Goldfeder, EFO, Loveland-Symmes Ohio Fire Department and co-host of the website www.firefighterclosecalls.com. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division. This report was authored by Tim Merinar and Murrey Loflin.

Additional Information

IAFC Rules of Engagement for Firefighter Survival. The International Association of Fire Chiefs (IAFC) is committed to reducing firefighter fatalities and injuries. As part of that effort the nearly 1,000 member Safety, Health and Survival Section of the IAFC has developed DRAFT "Rules of Engagement for Structural Firefighting" to provide guidance to individual firefighters, and incident

commanders, regarding risk and safety issues when operating on the fireground. The intent is to provide a set of "model procedures" for Rules of Engagement for Structural Firefighting to be made available by the IAFC to fire departments as a guide for their own standard operating procedure development. http://www.iafcsafety.org/downloads/Rules_of_Engagement.pdf.

IAFF Fireground Survival Program. The purpose of the Fire Ground Survival program is to ensure that training for Mayday prevention and Mayday operations are consistent between all fire fighters, company officers and chief officers. Fire fighters must be trained to perform potentially life-saving actions if they become lost, disoriented, injured, low on air or trapped. Funded by the IAFF and assisted by a grant from the U.S. Department of Homeland Security (DHS) through the Assistance to Firefighters (FIRE Act) grant program, this comprehensive Fire Ground Survival training program applies the lessons learned from fire fighter fatality investigations conducted by the National Institute for Occupational Safety and Health (NIOSH) and has been developed by a committee of subject matter experts from the IAFF, the International Association of Fire Chiefs (IAFC) and NIOSH. http://www.iaff.org/HS/FGS/FGSIndex.htm.

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.

Acknowledgement

NIOSH would like to thank the local newspaper for providing photographs taken during the incident. These photographs were extremely helpful in conducting this investigation. Some photos used in this report have been edited by NIOSH to remove names and identifiers.

Paid-on-call Fire Fighter Killed by Exterior Wall Collapse during Defensive Operations at a Commercial Structure Fire – Illinois

Photo 11. Hose lines in operation at front of structure prior to the collapse. Photo shows awning at front of the structure and also how smoke conditions changed shortly after storefront windows were taken out for ventilation (in contrast to Photo 7) .
(Photo courtesy of the local newspaper)