F2008 09 NIOSH Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation July 29, 2009

A Career Captain and a Part-time Fire Fighter Die in a Residential Floor Collapse—Ohio

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SUMMARY

On April 04, 2008, a 37-year-old female career captain and a 29-year-old male part-time fire fighter were fatally injured when a section of floor collapsed and trapped them in the basement during a fire at a residential structure. At 0611 hours, an automatic alarm dispatched the fire department. Dispatch upgraded the alarm to a working structure fire 9 minutes later. At 0623 hours, the victims' engine was the first to arrive on scene. The homeowner met the engine crew and stated that the fire was in the basement and everyone was out. With moderate smoke showing, the captain and the fire fighter donned their self-contained breathing apparatus and entered the residence through the opened front door with a 1¾" hoseline. A second fire fighter joined the captain and fire fighter at the basement stairs doorway. After the captain called for water several times, the line was charged and both fire fighters took the hoseline to the bottom of the stairs but needed additional hoseline to advance. The second fire fighter went back up the stairs to pull more hose at the front door. As he returned to the basement stairway, he saw the captain at the top of the stairs, trying to use her radio and telling him to get out. A captain from the second arriving engine noticed the smoke getting black, heavy, and pushing out the front door and requested the incident commander (IC) to evacuate the interior crew. The second fire fighter exited the structure alone. The IC made several attempts to contact the interior crew with no response. At 0637 hours, the IC sent out a "Mayday." A rapid intervention team was activated and followed the hoseline through the front door and down to the basement. Returning to the first floor, they noticed a collapsed section of floor and went to investigate the debris in that area of the basement. At 0708 hours, the captain was found near a corner of the basement. At 0729 hours, after removing debris from around the captain, the other fire fighter was located underneath her and some additional debris. Both victims were pronounced dead at the scene.

Key contributing factors identified in this investigation included that the initial 360-degree size-up was incomplete, likely disorientation of victims effecting key survival skills, radio communication problems, well-involved basement fire before the department's arrival, and potential fire growth from natural gas utilities.

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

- ***ensure that standard operating procedures (SOPs) for a 360-degree size-up are followed***
- ***ensure that fire fighters are sufficiently trained in survival skills***
- ***develop SOPs and train on the specific hazards of fighting basement fires to include ingress/egress points, flashover, and structure collapse***
- ***ensure that radio operability guidelines follow best practices recommended by the International Association of Fire Chiefs***
- ***ensure that thermal imaging cameras (TICs) are used to help assess interior conditions and potential structural damage***
- ***ensure that SOPs for offensive operations are followed, such as, cutting utilities to the fire structure***

Although there is no evidence that the following recommendations would have prevented these deaths, they are being provided as a reminder of good safety practices.

- ***ensure that interior attack crews advance with a charged hoseline***
- ***consider dispatch information regarding the call, such as fire location and if the building's occupants have exited the structure***

Additionally, first responder radio manufacturers, research/design facilities and standard setting bodies should continue research and efforts to

- ***improve radio system capabilities***
- ***refine existing and develop new technology to track the movement of fire fighters inside structures***

INTRODUCTION

On April 04, 2008, a 37-year-old female career captain and a 29-year-old male part-time fire fighter were fatally injured when a catastrophic structure failure occurred and a section of floor collapsed and trapped them in the basement. On April 04, 2008, the fire department notified the National Institute for Occupational Safety and Health (NIOSH) of these fatalities. On April 7–9, 2008, a general engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated the incident scene and photographs were taken. A preliminary meeting was conducted with the department's assistant chief of administrative services (investigating team leader) and an International Association of Fire Fighter's union representative. On April 21–25, 2008, a general engineer and a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program conducted interviews with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's standard operating guidelines, training records of the incident commander and both victims, photographs of the incident scene, written witness statements, dispatch audio transcripts, the coroner's reports, and the fire department's preliminary report, and met with a county communication center support specialist. Photographs were taken of the self-contained breathing apparatus (SCBA) and turnout gear. The SCBAs and personal alert safety system (PASS) devices used by the victims were too damaged to be tested by NIOSH.

FIRE DEPARTMENT

The department has five stations with 60 full-time and 150 part-time career fire fighters serving a population of over 60,000 residents in a geographic area of approximately 45 square miles. The fire department has established standard operating procedures (SOPs) and protocols that are employed in establishing command and providing safety for personnel. An SOP specific to basement fires did not exist.

TRAINING/EXPERIENCE

The fire department supports and encourages fire fighter training. They provide periodic training on numerous technical areas of fire fighter safety and survival awareness. The fire department records and maintains all training records on each fire fighter.

The captain (Victim #1) had 17 years career fire fighting experience and had completed Fire Fighter 1 and 2, multiple levels of EMT training, HazMat Operations, Fire Safety Inspector, Fire Instructor, and numerous public safety courses.

The fire fighter (Victim #2) had 4 years reserve fire fighting experience and had completed Fire Fighter 1 and 2, Basic EMT, HazMat Operations, Incident Safety Officer, Leadership I, Introductory and Level 200 Incident Command System, Introduction to National Incident Management System (NIMS), and various other administrative and technical courses.

The incident commander (battalion chief) had over 19 years of career fire fighting experience and had completed Fire Fighter 1 and 2, Fire Instructor, Fire Safety Inspector, Paramedic, Introductory and Level 200 ICS, Introduction to NIMS, National Incident Management System training, various Fire Tactics training, various levels of Hazardous Materials training, Building Construction, and numerous other administrative and technical courses.

Note: Fire Fighter 1 and 2 training are equivalent to NFPA 1 and 2.

PERSONAL PROTECTIVE EQUIPMENT

At the time of the incident, the captain and the fire fighter were wearing a full array of personal protective equipment consisting of turnout coat and pants, gloves, helmet, hood, boots, and SCBA with an integrated PASS device (compliant with the 2002 edition of NFPA 1982) and each carried a portable digital radio with a lapel microphone. Note: No PASS devices were heard during the search but Victim #1's PASS was chirping when debris was cleared and the device was no longer covered.

APPARATUS, PERSONNEL, AND ON SCENE ARRIVAL TIMES

0623 hours
Engine #102 [E102]—captain (Victim #1), engineer, and two fire fighters (Victim #2 and FF#1)
0625 hours
Engine #109 [E109]—captain (C#1), engineer, and two fire fighters
0626 hours
Ladder #25 [L25]—captain (C#2), engineer, and 2 fire fighters
Car #25 [C25]—battalion chief (incident commander (IC))
0627 hours
Car #2508 [C2508]—division chief ((DC#1) assigned as rear sector officer)
0630 hours
Engine #25 [E25]—captain, engineer, and 2 fire fighters (assigned as first Rapid Intervention Team (RIT))

0632 hours
Rescue #26 [R26]—captain and a fire fighter
0634 hours
Squad #25 [S25]—two fire fighter/paramedics
0643 hours
Car #2506 [C2506]—division chief ((DC#2) assigned as accountability officer)
0644 hours
Car #2501 [C2501]—fire chief (assumed fireground suppression operations after RIT activation)
0645 hours
Engine #26 [E26]—captain (C#3), engineer, and 2 fire fighters (assigned as second RIT)
0650 hours
Car #2512 [C2512]—battalion chief (assisted with accountability)
Car #2514 [C2514]—division chief ((DC#3) assigned as front sector officer)
Car #4202 [C4202]—assistant chief (assigned to rear RIT operations)

BUILDING INFORMATION

The fire structure was a 1991, two-story, single-family home of approximately 2,050 square feet (see Photos 1 and 2). The home was of traditional wood framing with a brick veneer. Vinyl siding covered the second floor B-, C-, and D-side walls and the gables. The gable roof was covered with traditional asphalt shingles. The structure had a poured concrete foundation with a finished walkout basement in the rear (C-side) (see Diagram 1). The first floor area that sustained the structural failure was comprised of 2"x10" wood joists on 16" centers with ¾" oriented strand board as the subfloor and was covered with carpet (see Diagram 2).

The home had natural gas forced air heat. During the investigation, it was noticed that the gas line (standard black iron pipe) to the furnace was missing some type of short connector (see Photo 3). The upper section of the main gas line in the house was weighted down from the collapse. When the pipe was at its original height a connector (approximately 2") was missing. The pipe threads on both remaining ends of pipe were relatively clean. If the missing connector was made of a flammable material it would have been completely destroyed during the fire. Unfortunately, there was not enough information to speculate what type of connector was missing.

The home was near the bottom of the hill resulting in a 450-foot driveway to the main street where a fire hydrant was located (see Diagram 3).

Photo 1. Fire structure, a two-story single-family residence (A-side). The 1¾" hoseline is shown lying in the yard and going through the front door.
(NIOSH photo)

Photo 2. Fire structure showing rear (C-side) ingress and egress points on two decks.
(NIOSH photo)

WEATHER

The weather the morning of April 4th was overcast with light rain and a temperature of approximately 58 degrees F. The winds were out of the south-southwest at 9 miles per hour (mph) with gusts up to 17 mph. The winds did not seem to significantly impact fire growth.

INVESTIGATION

On April 04, 2008, a 37-year-old female career captain and a 29-year-old male part-time career fire fighter were fatally injured when a catastrophic structure failure occurred and a section of floor collapsed and trapped them in the basement. At 0611 hours, an automatic alarm dispatched the fire department. While en route, 9 minutes later, dispatch upgraded the alarm to a working structure fire. At 0623 hours, Engine #102 (E102) was the first to arrive on scene with a captain (Victim #1), engine operator, and two fire fighters (Victim #2 and FF#1). After some confusion and driving past the driveway, the E102 crew then laid a 5" supply line down the 450-foot driveway. E102's engine operator was met by the homeowner stating that the fire was in the basement and everyone was out. Additionally, the excited homeowner directed the captain to the front door and indicated where the basement stairway was located. (*Note: The actions of the homeowner may have distracted the first arriving crew from doing a proper size-up.*) The engine operator relayed that information to the captain. A 1¾" hoseline was stretched to the front door with moderate smoke in the doorway.

At 0625 hours, Engine #109 (E109) arrived on scene and established E102's water supply at the hydrant on the main road. At 0626 hours, Ladder #25 (L25) and a battalion chief in District Car #25 (D25) arrived on scene and staged in the driveway (see Diagram 3). D25 assumed incident command. E109's captain (C#1) informed command that he could not assume taking accountability because he was busy with establishing the water supply. L25 was assigned a search sector and prepared their crew to enter the structure behind E102's interior crew.

Donning their SCBA, Victims #1 and #2 entered the residence through the opened front door. After kicking out kinks in the 5" supply, FF#1 joined the victims at the basement stairs doorway (see Diagram 2). Victim #1 made several attempts calling for water but was not heard by the pump operator; FF#1 radioed for water and was heard. Once the line was charged both Victim #2 and FF#1 took the hoseline to the bottom of the stairs. Reaching the bottom of the stairs, they both felt heat and saw a glow to their left. Needing additional hoseline to advance, FF#1 went back up the stairs passing Victim #1 near the bottom of the stairs. FF#1 pulled about 3 feet of hoseline at the basement door then went to the front door to pull more hoseline.

L25's captain (C#2) and crew member, with a thermal imaging camera (TIC) in hand, went to the front door and pointed it down the hallway. The TIC registered a white screen indicating very hot temperatures. C#2 stepped inside the fire structure about 5 feet and could hear Victim #1 giving orders. C#2 backed out and went over to C#1 at the A/D corner. Both captains agreed that things were getting bad and E102's crew needed to get out and go to the rear to make entry. C#2 went to the front door and yelled through his mask, and C#1 radioed E102 to get out and go to the rear, but received no response.

At 0627 hours, a division chief (DC#1) in Car #2508 arrived on scene. DC#1 reported to command and was assigned rear sector officer and proceeded down the D-side of the fire structure. DC#1 met up with E109 and L25 crew members who were stretching a 1¾" hoseline down the D-side of the house to the rear. At the rear (C-side), DC#1 reported fire through the basement and first floor windows melting the vinyl siding and traveling in a v-shape to the top floor. The E109 crew knocked down the exterior fire in an attempt to keep the fire out of the top floor and attic. At this time, fire in the basement was heavy and command asked DC#1 if they had verbal or visual contact with the interior crew. DC#1 replied that they had neither form of contact.

At 0630 hours, Engine #25 (E25) arrived on scene and was assigned as a rapid intervention team (RIT). The E25 crew gathered their gear and tools and staged at the A/D corner of the fire structure. After pulling about 10 feet more of hoseline, FF#1 re-approached the basement stairway and saw the captain (Victim #1) at the stairway door trying to use her radio. FF#1 heard Victim #1 calling Mayday, 3 times, but getting a busy tone, then she told him to get out. FF#1 noticed a glow in the kitchen area as he turned to leave and assumed Victim #1 and Victim #2 were following behind him. The captain (C#1) from E109 noticed the smoke getting black, heavy, and pushing out the front door and

requested the incident commander (IC) evacuate the interior crew. FF#1 exited the structure as ordered, but once outside, he realized his crew was not behind him. FF#1 re-entered the fire structure to look for his crew. Feeling the heat and seeing fire in the kitchen, he slid down the basement stairs on his bottle, but did not find his crew. Realizing he was alone, he followed the hoseline back out. FF#1 felt a wave of heat hit him in the back before exiting the fire structure. As he entered the front yard through heavy smoke, he reported to the IC that he lost his crew and that Victim #1 was trying to send a Mayday. The IC made several attempts to contact the interior crew with no response.

At 0637 hours, the IC sent out a Mayday and told FF#1 to report to rehab. After the E109 crew knocked down the fire at the basement sliding glass door, a RIT entered the basement with tools and a search line to search for the missing crew toward the A-side of the structure. Other crews brought a 1¾" and 2½" hoseline to the rear to assist in fire control. The RIT reported finding the hoseline at the bottom of the stairs but no crew. DC#1 thought he could see a sagging structural beam and ordered the RIT to evacuate. After determining it was ductwork and not a beam, the RIT went back in.

At 0643 hours, Car #2506 arrived on scene, and DC#2 was assigned the accountability officer and staged in the front yard. At 0644 hours, Car #2501, with the fire chief, arrived on scene and took over fireground operations on radio channel 11 while the IC handled the RIT operations on radio channel 2. At 0645 hours, Engine #26 arrived on scene and was made a second RIT. DC#2 met the E26 crew and told them to search for the victims. As they followed the hoseline to the basement, C#3 noticed an 18" burn in the right-side of the hoseline, 2 feet from the nozzle. At 0650 hours, Car #2512 with a battalion chief, Car #2514 with a division chief, and Car #4202 with an assistant chief arrived on scene and were assigned accountability, front sector officer, and rear RIT operations, respectively.

As the second RIT returned to the first floor, they encountered the first RIT, and after a brief face-to-face discussion, the C#3 noticed a collapsed section of the B/C section of floor. Also, they noticed a blue flame in the kitchen area of the collapse zone. At 0654 hours, the RIT crew radioed a possible gas-fed fire to the IC. *Note: The fire structure's utilities, both gas and electric, were not shut off or cut until approximately an hour after the fire department's arrival.* The RIT crews went to investigate the debris in that area of the basement.

At 0708 hours, after moving some debris, Victim #1's SCBA was exposed near the B/C corner of the basement. It was determined that the victim was dead on the scene and C#3 told the crew not to move the body. The IC was informed of the location of the body and after some discussion Victim #1 was placed in a stokes basket. At 0729 hours, upon moving Victim #1 and some debris, Victim #2 was located underneath Victim #1 (see Photo 4 and Diagram 1). Victim #2 was also dead at the scene.

FIRE BEHAVIOR

The fire department's report stated that the fire was caused by an electrical short in a fan located in a small cedar closet used to cultivate orchids located in the basement (see Photos 5 and 6 and Diagram 1).[1]

Significant fire behavior events/factors were as follows:

- Automatic fire alarm activated at 0611 hours.
- Basement fire reported by homeowner 2 minutes later.
- Twelve minutes from automatic alarm, first engine arrived on scene and reported moderate smoke showing.
- Sixteen minutes from automatic alarm, initial attack crew made entry into basement and encountered heavy smoke.
- Twenty-three minutes from automatic alarm, contact was lost with the victims. *Note: no water on seat of the fire at this time.*
- Forty-three minutes from automatic alarm, RIT reported possible gas fed fire.

According to the fire department's report, an electric fan shorted, causing the fire. The fan was located in a small cedar closet, along the C-side wall about 14 feet from the B/C corner (see Photo 5). As the fire extended up the C-side basement wall, the first floor 2"x10" wood floor joists were directly impacted by the fire and heat (see Photo 6).

The victims exited the basement from the heavy smoke and heat by way of the basement stairs to the first floor. On the first floor, the captain (Victim #1) tried to transmit on the radio and informed FF#1 to get out. FF#1 exited the structure alone following the hoseline. It can only be assumed that the captain (Victim #1) and the fire fighter (Victim #2) became disoriented or felt that the quickest escape from the heat was diagonally across the room to the atrium door (see Diagram 2). This path was above the seat of the fire which had severely damaged the structural integrity of the floor and collapsed.

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:

- Initial 360-degree size-up was incomplete.
- Likely disorientation of victims effecting key survival skills.
- Radio communication problems.
- Well-involved fire before fire department arrival
- Potential fire growth from natural gas

CAUSE OF DEATH

According to the coroner's reports, the cause of death for both victims were burns and inhalation of smoke and superheated and noxious gases. Second-, third- and fourth-degree burns covered 100% of the bodies and the tracheal lining.

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that standard operating procedures (SOPs) for a 360-degree size-up are followed.

Discussion: The process of conducting a size-up includes the consideration of many factors, which include a 360-degree walk-around and assessment of the type of building construction, location of doors and access to the structure, occupancy and contents of the structure, location of the fire in the structure, time of day and weather conditions, time of the alarm, and day of the week.[2] A complete size-up of a fire incident assists the IC in determining needed and available resources and developing a sound strategy prior to making an offensive, interior attack which increases safety risks for fire fighters.[3]

In this incident, the first arriving engine crew was met by an excited homeowner who informed them that the fire was in the basement and directed them to the front door and down the stairs. Acting quickly, the engine crew prepared to enter the fire structure without conducting an initial size-up. An initial size-up may have identified a better access (the walk-out sliding door) to the basement and reduced the possibility of fire underneath the fire fighters. A basement fire is one of the most dangerous situations fire fighters can face. Alternate egress routes should be considered before committing to an offensive basement attack.

Recommendation #2: Fire departments should ensure that fire fighters are sufficiently trained in survival skills.

Discussion: Fire fighters must act promptly when they become lost, disoriented, injured, low on air, or trapped.[4-8] First, they must transmit a distress signal while they still have the capability and sufficient air. The fire fighter should provide as much information about their location as possible to aid the RIT in locating them. The next step is to manually activate their PASS devices. To conserve air while waiting to be rescued, fire fighters should try to stay calm

and avoid unnecessary physical activity. They should survey their surroundings to get their bearings, determine potential escape routes and stay in radio contact with incident command and rescuers. Additionally, fire fighters can attract attention by maximizing the sound of their PASS device (e.g., by pointing it up in an open direction), pointing their flashlight toward the ceiling or moving it around, or using a tool to make tapping noises.

A crew member or other fire fighter who recognizes a fellow fire fighter is missing or in trouble should quickly try to communicate with the fire fighter via radio and, if unsuccessful, initiate a Mayday for that fire fighter, providing relevant information as described above.

Hoselines can be the last line of defense and the last chance for a lost firefighter to find egress from a burning building. According to the *USFA Special Report: Rapid Intervention Teams and How to Avoid Needing Them*, the basic techniques taught during entry level fire fighting programs describe how to escape a zero-visibility environment using only a hoseline.[9] However, as years elapse from the time of basic training, fire fighters may overlook this technique. Exiting a structure in zero visibility utilizing a hoseline should become second nature for a fire fighter. A fire fighter operating on a hoseline should search along the hose until a coupling is found. Once found, the fire fighter can "read" the coupling and determine the male and female ends. The IFSTA manual *Essentials of Fire Fighting* teaches that the female coupling is on the nozzle side of the set and the male is on the water side of the set. In most cases, the male coupling has lugs on its shank while the female does not (see Diagram 4). Once oriented on the hose, fire fighters can follow the hoseline which will take them toward the exit.[10]

There are a number of ways that a hoseline can be marked to indicate the direction to the exit, including the use of raised arrows and chevrons that provide both visual and tactile indicators. Fire departments may use a variety of techniques to train fire fighters on how to identify hoseline couplings and the direction to the exit, based on the model of hose used by the department. The key point is that **this training needs to be conducted and repeated often** so that fire fighters are proficient in identifying the direction to the exit in zero visibility conditions while wearing gloves, with the hose entangled, and with various obstructions present. This procedure should be incorporated into SOPs, trained upon, and enforced on the fireground.

It is critical for fire fighters to understand when to self-rescue and when to stay in a location to be rescued. Fire departments should provide periodic refresher training to ensure fire fighters can effectively apply this training in different scenarios. In this incident, the victims left the hoseline and unknowingly traveled across a fire-damaged floor.

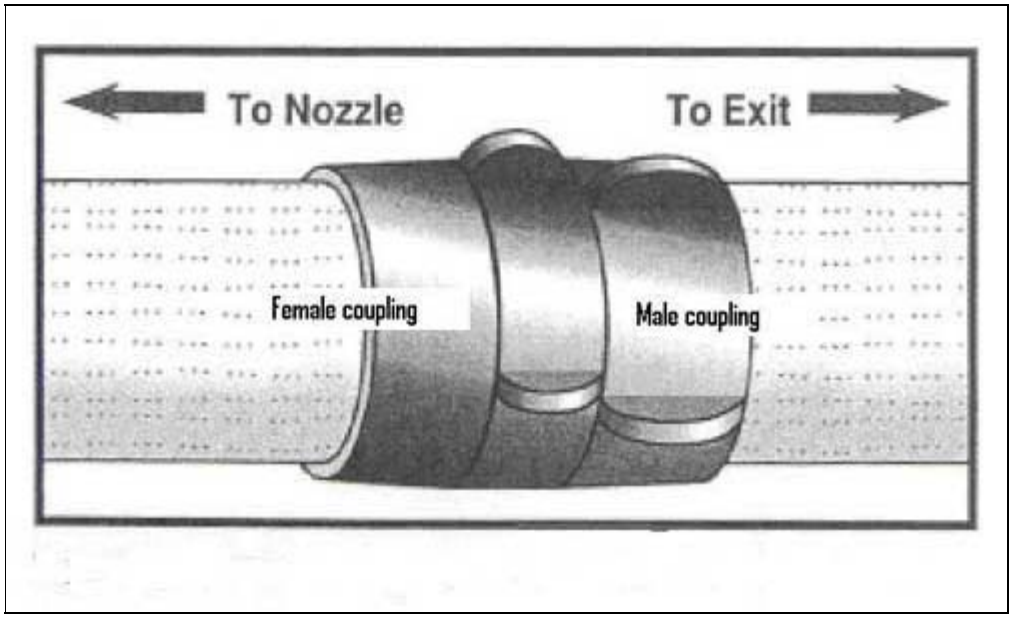

Diagram 4. Hose couplings will indicate the direction toward the exit. Adapted from IFSTA Essentials of Fire Fighting, 5th Edition

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Recommendation #3: Fire departments should develop SOPs and train on the specific hazards of fighting basement fires to include ingress/egress points, flashover, and structure collapse.

Discussion: Standard operating procedures (SOPs) should be developed addressing structural fire fighting operations specific to basement fires. Basement fires present a complex set of circumstances, and it is important that SOPs are developed and followed to minimize the risk of serious injury to fire fighters. Fire can quickly spread upward into the structure causing potential problems such as a flashover, backdraft, or weakening of the structure. The basement stairway may act as a chimney, drawing fire and hot gases upward. Fire fighters using the stairway as their main egress may be endangered by this chimney effect. Basements that have a ground-level or walk-out ingress/egress make it considerably safer than working above the fire floor and should be utilized to reduce risks to the fire fighter. Properly ventilating the heat and smoke from buildings can reduce the possibilities of potentially hazardous situations for fire fighters. To coordinate their efforts, fire fighters performing ventilation tasks should be in communication with the fire fighters attacking the fire or entering the structure. SOPs for fighting basement fires should be included in the overall risk management plan for the fire department. If these procedures are changed, appropriate training should be provided to all affected members.

Recommendation #4: Fire departments should ensure that radio operability guidelines follow best practices recommended by the International Association of Fire Chiefs.

Discussion: The fireground communications process combines electronic communication equipment, a set of standard operating procedures, and the fire personnel who will use the equipment. To be effective, the communications network must integrate the equipment and procedures with the dynamics of the incident site, especially in terms of the environment and the human factors affecting its use. The ease of use and operation of established communication procedures may well determine how consistently fire fighters monitor and report conditions and activities over the radio while fighting fires. Fire departments should review both operating procedures and human factors issues to determine the ease of use of radio equipment on the fireground which is essential to ensuring that fire fighters consistently monitor radio transmissions from the IC and respond to radio calls.[11] The need to have equipment operate properly during fire operations is critical.

In this incident, the engine operator could not initially hear the call for water over the ambient noise of the apparatus. Also, when Victim #1 tried to transmit (at least three times) what is believed to have been a Mayday, it was not heard or understood. The incorporation of radio headsets may have improved communications. The International Association of Fire Chiefs has released an interim report concerning possible communications problems involving digital two-way portable radios in close proximity to common fireground noise.[11] This report includes recommendations and best practices, such as the IC should assign an aide to assist in communication capabilities in a high noise environment, consider location of radios and microphones in relationship to noisy equipment, and shield microphones from noise to improve intelligibility.

Recommendation #5: Fire departments should ensure that thermal imaging cameras (TICs) are used to locate the seat of the fire.

Discussion: A thermal imaging camera (TIC) can be a useful tool in detecting if ceilings and floors have become dangerously weakened by fire damage and are threatening to collapse. A fire fighter about to enter a room or structure can use a TIC to assist in judging if fire or hot gases are in the walls, attic, or void spaces. The use of a TIC may also provide additional information the incident commander can use during the initial size-up. TICs should be used in a timely manner, and fire fighters should be properly trained in their use and be aware of their limitations.[10]

In this incident, a TIC was not utilized in the fire structure to locate the seat of the fire by the interior attack crew. E102 was the reserve engine and was not equipped with a TIC; however, L25 had a TIC on board. The L25 crew used

a TIC at the front door and determined it was not safe to make entry after the initial attack crew had entered.

Recommendation #6: Fire departments should ensure that SOPs for offensive operations are followed, such as cutting utilities to the fire structure.

Discussion: During an offensive attack, fire fighters are responsible for a wide range of important tasks, such as primary search, rescue, and forcible entry; checking for fire extension; ventilating; accessing concealed/void spaces; control of utilities; and laddering the building. To conduct these tasks, fire fighters need to carry the proper tools, e.g., TIC, utility bar, pike pole, axe. It is critically important to properly staff companies that are charged with these duties. Safety and control dictate that operating units work as groups. Given the variety of tasks, and that many of these tasks can be performed by two-member teams, it may be necessary to split into separate crews.[3] At a working structure fire, two members may be required to conduct primary search, while a second two-member crew may locate and cut utilities. SOPs should clearly identify which crews are responsible for each critical task.

In this incident, the fire structure's utilities, both gas and electric, were not shut off or cut until approximately an hour after the fire department's arrival. At 0630 hours, the utility company was contacted, but they did not have an estimated time of arrival. During RIT operations a blue flame was noticed near the D-side of the collapsed area indicating a possible gas-fed fire. At 0654 hours, the RIT crew radioed a possible natural gas-fed fire.

Although there is no evidence that recommendations #7 and #8 would have prevented these deaths, they are being provided as a reminder of good safety practices.

Recommendation #7: Fire departments should ensure that interior attack crews advance with a charged hoseline.

Discussion: Successful fire suppression and fire fighter safety depends upon discharging a sufficient quantity of water to remove the heat being generated and provide safety for the interior attack crews. When advancing a hoseline into a fire structure, air should be bled from the line once it is charged and before entering the structure.[10] To ensure successful interior attacks, fire fighters should continually train in establishing a water supply, proper hose deployment, and advancing and operating hoselines.

In this incident, the victims made entry and did not call for water until they were at the basement door. The captain (a victim) made several radio calls for water but wasn't heard by the engine operator because of the engine noise. FF#1 made a radio transmission that was received and the hoseline was charged. When the RIT was activated charged back-up lines were in place.

Recommendation #8: Fire departments should consider dispatch information regarding the call, such as fire location and if the building's occupants have exited the structure.

Discussion: Often a homeowner may divulge or a dispatcher may ask for information that can be passed on to the responding fire department so that they can better plan their attack strategy. Information given by the caller or asked by the dispatcher, such as anything unique about the location of the fire structure, if the structure is occupied, and possible location of the seat of the fire can be passed on to the arriving units and speed up the response time and influence the tactics to be employed.

In this incident, the fire structure was located at the end of a long 450-foot driveway and was hidden by structures and trees closer to the main road. The arriving apparatus initially passed the driveway and they were not expecting to have a long hose lay. The structure was unoccupied and the fire originated in the basement which adds inherent danger to fire fighters. Often basements are used for storage resulting in a high fuel load and/or are altered for additional living space making it a maze. Committing an attack crew above the fire floor or into a basement requires tactics to be well thought out.

Recommendation #9: First responder radio manufacturers, research/design facilities and standard setting bodies should continue research and efforts to improve radio system capabilities.

Discussion: The use of personal protective equipment and an SCBA make it difficult to communicate, with or without a radio.[12,13] Several NIOSH Fire Fighter Fatality Investigation Reports have cited issues with portable radio communication, and the International Association of Fire Chiefs has released an interim report concerning possible communications problems involving digital two-way portable radios in close proximity to common fireground noise.[11]

To facilitate communication, equipment manufacturers have designed facepiece-integrated microphones, intercom systems, throat mikes, and bone mikes worn in the ear or on the forehead.[13,14] The National Institute for Standards and Technology (NIST) has recently tested portable radios in simulated fire fighting environments and has identified that radios are vulnerable to exposures to elevated temperatures. Some degradation of radio performance was measured at elevated temperatures ranging from 100 to 260 degree C, with the radios returning to normal function after cooling down. Additional research is needed in this area.[15]

During this incident, the victim experienced intermittent radio communication problems and interruptions. Audio transcripts of the fireground channel recorded multiple instances where the victim inside the structure transmitted over the radio, but the transmissions were not heard or could not be understood. Effective radio communication is an important part of safe fireground operations.

Recommendation #10: First responder radio manufacturers, research/design facilities and standard setting bodies should continue research and efforts to refine existing and develop new technology to track the movement of fire fighters inside structures.

Discussion: Fire fighter fatalities often are the result of fire fighters becoming lost or disoriented on the fireground. The use of systems for locating lost or disoriented fire fighters could be instrumental in reducing the number of fire fighter deaths on the fireground. The National Institute for Standards and Technology (NIST) has been evaluating the feasibility of real-time fire fighter tracking and locator systems.[12,16] Research should continue into refining existing systems and developing new technologies for tracking the movement of fire fighters on the fireground.

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INVESTIGATOR INFORMATION

This incident was investigated by Matt Bowyer, General Engineer, and Tommy Baldwin, Safety and Occupational Health Specialist, with the NIOSH Fire Fighter Fatality Investigation and Prevention Program. Mr. Bowyer works in the Division of Safety Research and Mr. Baldwin works in the Division of Surveillance, Hazard Evaluations and Field Studies. An expert technical review was conducted by Division Chief Edward Buchanan, Hanover, Virginia Fire/EMS and President, International Society of Fire Service Instructors.

PHOTOS AND DIAGRAMS

Photo 3. Gas line to furnace. Part connecting top line (end near floor) and line into furnace is missing.
(NIOSH photo)

Photo 4. Collapsed section of floor the victims crawled across and the approximate location of their bodies in the basement.
(NIOSH photo)

Photo 5. Origin of the fire: small cedar closet used for growing orchids.
(NIOSH photo)

Photo 6. Burned away floor joists above the small cedar closet along the C-side wall.
(NIOSH photo)

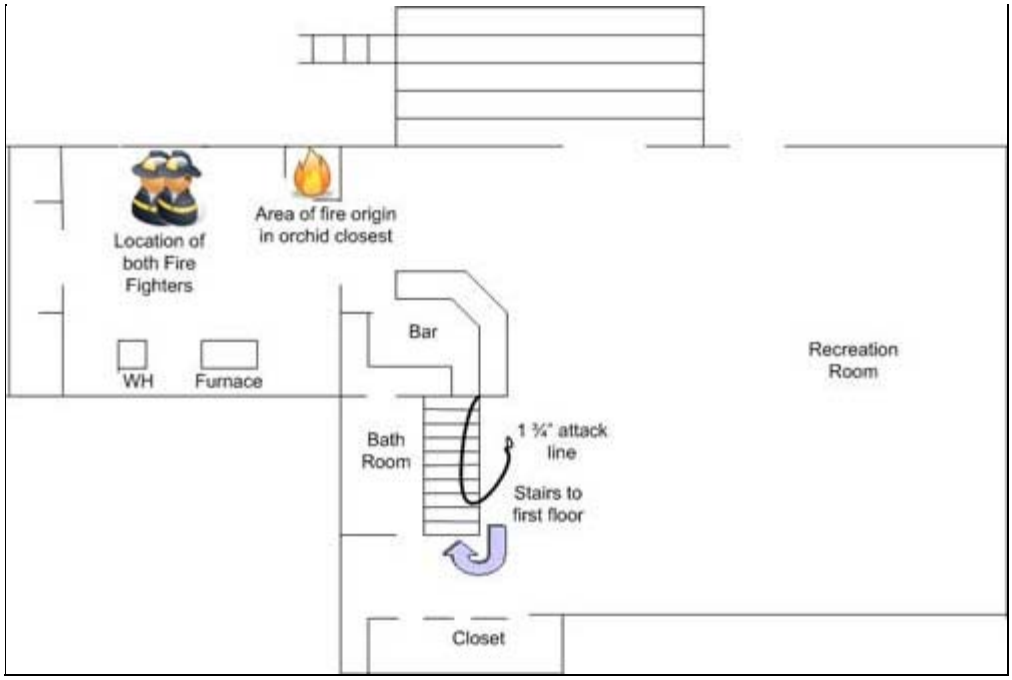

Diagram 1. Layout of the basement with approximate location where the victims were found and seat of the fire.

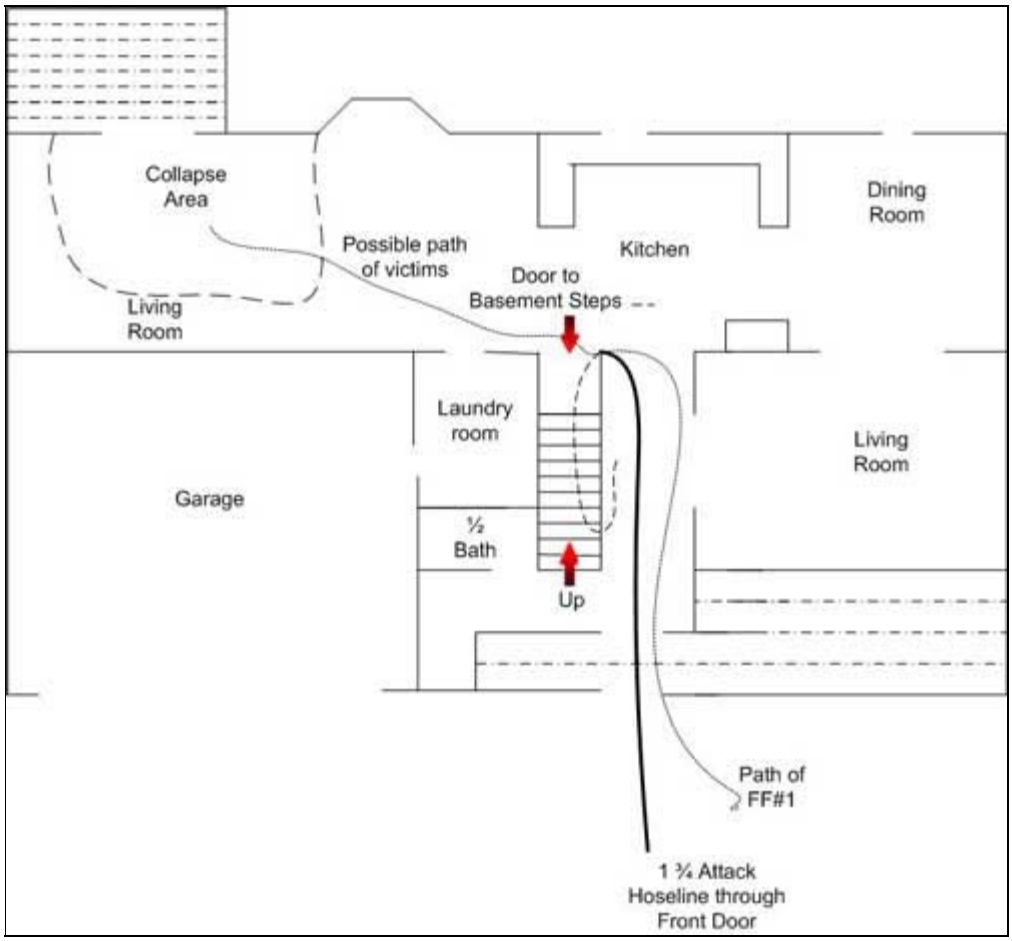

Diagram 2. Fire structure's first floor layout:

Possible path of interior crew when the captain (Victim #1) told FF#1 to get out at basement stairs door.

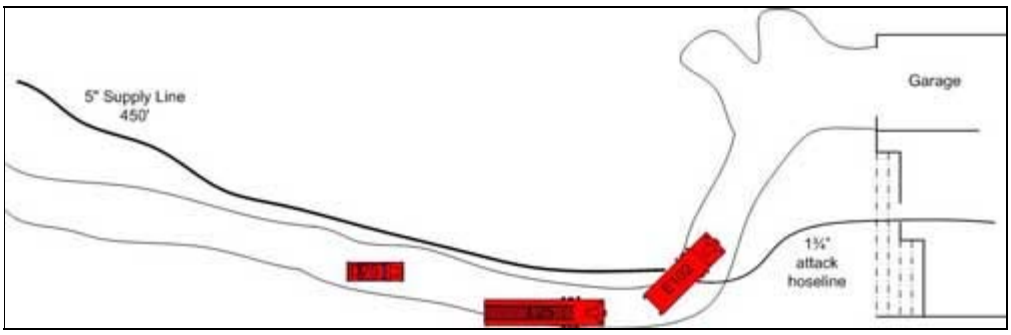

Diagram 3. Location of key fire apparatus and 1¾" attack hoseline from E102 into front door.

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 fiscal year 1998, the Congress appropriated funds to NIOSH to conduct a fire fighter initiative. NIOSH initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. For further information, visit the program website at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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This page was last updated on 07/27/09.