



Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

October 25, 2009

A Volunteer Mutual Aid Fire Fighter Dies in a Floor Collapse in a Residential Basement Fire – Illinois

Revised on November 06, 2009 to update Investigator Information Section.

SUMMARY

On July 22, 2008, a 24 year-old male fire fighter responding from a volunteer mutual aid department was fatally injured during a floor collapse in a residential basement fire. Fire fighters were on scene approximately 30 minutes and had made several attempts to locate the fire by entering the basement via stairs at the B/C corner of the structure. While a crew was in the basement, a 4-member mutual aid interior crew entered the first floor of the structure to open windows to horizontally ventilate the structure without damaging the windows. The ventilation crew crawled across the first floor to egress; several members of the ventilation crew verbally reported to each other that the floor was spongy about halfway to the door. The floor collapsed just as the last crew member (the victim) approached the door, sending fire and heavy smoke throughout the house. The attack crew in the basement and crews just outside the door were blown down by the force of the fire and smoke. Due to heavy smoke, the victim could not be located. Fire fighters used several hoselines to put water on the area; a crew made entry into the basement by placing a ground ladder in the collapsed floor at the B-side french doors and found the victim. After moving a large sofa to gain access to the victim, the crew was able to remove the victim from the structure. The victim was nonresponsive to CPR and was pronounced dead at the hospital.

Key contributing factors identified in this incident included: a crew operating on the floor above a fire that had been burning for more than the 30 minutes that fire fighters were on scene, characteristics of the structure that inhibited early efforts to ventilate the structure, and subsequent ventilation efforts that were not coordinated with interior operations.

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

- *ensure that the incident commander (IC) conducts a 360 degree size-up which includes risk-versus-gain analysis prior to committing interior operations and continues risk assessments throughout the operations*
- *ensure that standard operating procedures are established for a basement fire*
- *ensure that proper ventilation is done to improve interior conditions and is coordinated with the interior attack*
- *ensure that interior crews are equipped with a thermal imaging camera*
- *ensure that Rapid Intervention Teams are staged and ready*

INTRODUCTION

On July 22, 2008, a 24 year-old male fire fighter responding from a mutual aid department was fatally injured during a floor collapse in a residential basement fire. On July 23, 2008, the U.S. Fire Administration notified NIOSH of the fatalities. On July 29-31, 2008, a General Engineer and an Occupational Safety and Health Specialist from the NIOSH, Division of Safety Research, Fire Fighter Fatality Investigation and Prevention Program traveled to Illinois to investigate the incident. Meetings were conducted with the fire chiefs from the initial responding and mutual aid departments and a representative from the State Fire Marshals Office. The NIOSH investigators conducted interviews with responding fire fighters and officers. The NIOSH investigators reviewed the fire department's Standard Operating Procedures (SOPs), the officers' and victim's training records, photographs of the incident scene, written witness statements, dispatch transcriptions, the coroner's report, and the Illinois State Fire Marshal report.¹ NIOSH investigators examined and took pictures of the victim's personal protective equipment (PPE) including self-contained breathing apparatus (SCBA) and protective clothing that were stored at the local sheriff department.

FIRE DEPARTMENT

The responding volunteer district department has 2 stations with a total of 40 members serving a population of approximately 2,500 in a geographic area of approximately 85 square miles. The department's SOPs define the duties and responsibilities of each position on a specific apparatus. However, SOPs for specific/technical operations such as basement fires did not exist.



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Volunteer mutual aid department #1 (the victim's fire department) has 1 station with a total of 27 members serving a population of approximately 4,800 in a geographic area of approximately 1.3 square miles.

Volunteer mutual aid department #2 has 1 station with a total of 26 volunteer fire fighters serving a population of more than 1,600 residents in a geographic area of approximately 1 square mile.

Volunteer mutual aid department #3 has 1 station with a total of 18 volunteer fire fighters serving a population of more than 420 residents in a geographic area of approximately 0.3 square mile.

The regional ambulance service has a staff of paid and volunteer emergency medical service (EMS) personnel operating out of one facility covering 425 square miles.

TRAINING/EXPERIENCE

The State of Illinois does not require Fire Fighter I certification or Fire Officer certification to serve on a volunteer fire department.

The victim was a volunteer fire fighter with 6 years experience; 1 year as a junior fire fighter. He had completed the Basic Fire Suppression training, Field Training, Developing Fireground Expertise, Fire Fighter Survival Training and various other administrative and technical courses offered by local departments.

The Incident Commander had 28 years of volunteer fire fighting experience and had completed the Fire Fighter I and II, Fire Service Instructor I, National Incident Management System training, Incident Scene, Construction Awareness, Risk Management, Developing Fireground Expertise, Leadership Skills and various other administrative and technical courses offered by state and local departments.

PERSONAL PROTECTIVE EQUIPMENT

At the time of the incident, the victim was wearing a full set of personal protective equipment consisting of turnout coat and pants, boots, gloves, a helmet, hood, and self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS) device. The victim carried a portable radio with a lapel microphone which had been in operation on the scene.

APPARATUS

On scene at 1948 hours:

From the District Fire Department



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Squad #283 [SQ283] – Three fire fighters

Engine #285 [E285] – 1st Assistant Chief (initial Incident Commander) and 3 fire fighters

On scene at 1952 hours:

Tender #281 [T281] – 2nd Assistant Chief (assumed command as Incident Commander) and a fire fighter

On scene at 1955 hours:

Personally Owned Vehicle – Fire Chief (took command as Incident Commander)

From the Regional Ambulance Service

Medic 21 [M21] – 2 Paramedics

On scene at 1957 hours:

From the Mutual Aid Department #1

Engine #246 [E246] – Four fire fighters (1 being the Victim)

Squad #245 [SQ245] – Four fire fighters

From the District Fire Department

Engine #288 [E288] – Fire Fighter

On scene at 1958 hours:

From the District Fire Department

Tanker #282 [T282] – Fire Fighter (Accountability Officer)

On scene at 1959 hours:

From the Mutual Aid Department #2

Engine #1511 [E1511] – Assistant Chief, lieutenant, and 4 fire fighters

Engine #1512 [E1512] – Four fire fighters

On scene at 2013 hours:



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From the Mutual Aid Department #3

Engine #1419 [E1419] – Four fire fighters

Note: Mutual aid agreements to further enhance manpower capabilities were in place. This is a significant enhancement for fire departments with limited first alarm staffing to insure that an adequate and calculable number of fire fighters are responding on a first alarm based upon the type of structure, water supply, and related considerations. Departments with limited resources should consider automatic first alarm.

BUILDING INFORMATION

The 1,824 square foot structure was a two-story, non-sprinklered residential home that was built in 1920. It was constructed of wood framing with a concrete block foundation, stucco exterior, plaster interior walls, carpet and hardwood floors, and asphalt shingled roof (see Photo 1). The structure had a 220 square feet closed-in porch on the A-side and a 325 square foot wood deck on the B-side. The basement had only one ingress/egress door at the B/C corner of the structure. The basement was finished and the concrete block walls were hidden by a wood framed wall with a 2 foot void space between the exterior and interior walls. This interior wall covered the D-side exterior basement window, but the C-side window was framed around creating a 2 feet window sill.

WEATHER

On the evening of July 22, 2008, the weather was clear with a temperature of 73 degrees F, and the winds were light at 4.6 mph.

INVESTIGATION

On July 22, 2008, a 24 year-old male fire fighter responding from a volunteer mutual aid department was fatally injured during a floor collapse in a residential basement fire. At 1945 hours, dispatch reported a residential structure fire in the basement with smoke showing. A minute later, mutual aid departments #1 and #2 were dispatched to assist in first alarm staffing. At 1948 hours, the responding district fire department's squad 283 (SQ283) and engine 285 (E285) arrived on scene. Upon arrival the crews saw smoke seeping from basement windows and eaves and drifting to the southeast (see Photo 2). E285 connected to the hydrant across the street on the D-side of the fire structure (see Diagram 1). SQ283's crew helped pull a 1 ¾" hoseline then set-up a rehab area. The E285 attack crew pulled the 1 ¾" hoseline across the A-side and around the B-side near the B/C corner to an entry door with stairs to the basement and stairs to the right to the first floor (see Diagram 1).



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The homeowner informed the fire department that everyone was out of the residence and he believed the fire was in the furnace room of the basement. A two man attack crew made entry into the basement without a thermal imaging camera (TIC) and went about five feet to the bottom of the stairs and turned right towards the furnace room (see Diagram 2). The crew encountered heavy brown/gray smoke banked down to the floor and felt some heat. The crew sprayed water but never saw any fire and felt debris falling so they backed out.

At 1952 hours, the responding fire department's 2nd assistant chief (acting as the incident commander (IC)) arrived on scene and saw moderate brown smoke coming from the B and C-side basement windows and requested mutual aid from two neighboring departments. The IC requested ventilation. A crew ventilated the C-side basement window and placed a negative pressure ventilation fan at the basement window.

At approximately 1955 hours, the responding department's fire chief arrived on scene and assumed command. The 2nd assistant chief was assigned as B-side Officer.

At 1957 hours, E246 (the victim's engine) and SQ245, both from the mutual aid department #1, arrived on scene followed by E288 from the district fire department. Minutes later, mutual aid department #2 arrived with 2 additional engines, eight fire fighters, and 2 officers.

At approximately 2000 hours, a second attack team consisting of 3 fire fighters, two from mutual aid department #2 and one from the responding district department with a thermal imaging camera (TIC), entered the basement and had no visibility and moderate heat and they backed out. The IC assigned an accountability officer on the B-side just as a four man crew from mutual aid #1 (including the victim) made entry on the first floor through the B-side french doors to open all available windows (see Diagram 3). They were instructed to lift the bottom window sashes to minimize property damage in the moderate light gray smoke conditions. After the ventilation crew opened a few windows, they re-grouped to look for more windows by crawling on their hands and knees across the D-side living room floor. One of the fire fighters was low on air and exited the fire structure by himself on the A-side. Two of the remaining three fire fighters reported that the carpeted hardwood floor became sticky and spongy about halfway across the floor. When the victim noticed this, he yelled something like lets get out of here.

While the ventilation crew was opening windows, a third attack crew (from E246) had pulled a 1 ¾" hoseline off E246 and went to the B-side entry door (near the B/C corner) and made entry to the basement. The four man attack crew encountered heavy dark smoke down to the floor with heat up high. After checking the bathroom, they made their way to the furnace room. Meanwhile, the interior ventilation crew on the first floor headed for the french doors on the B-side of the fire structure with the victim bringing up the rear. The responding district department fire fighter with the TIC had gone to the french doors and looked to the left and saw what looked to be flames licking at the base of the stairs. The fire fighter yelled to the nearby B-side officer that the crew in the basement needed to be pulled out and that the fire attack should be on the B-side deck. The E285 crew laddered the A-side porch to do roof ventilation. Two attack crews from mutual aid department #2 were on the deck at the



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B-side french doors with two 1 ¾” hoselines standing at the ready and reported no visibility looking into the fire structure. At approximately 2023 hours, the interior ventilation crew approached the french doors and the floor collapsed sending fire and heavy smoke throughout the house. A fireball blew out the french doors pushing the fire fighter ahead of the victim out the door; he yelled that the victim was still inside the structure. The roof ventilation crew was nearing the top of the ground ladder when they heard a loud noise, which they thought was an explosion and noticed the main floor of the fire structure light up with fire shooting out of the B-side french doors and D-side basement window. The attack crew in the basement had stepped into the basement hallway and everything lit up around them. They flowed water for a moment and backed out of the basement following the hoseline. The crews by the french doors were blown down by the force of the fire and smoke.

The IC radioed for accountability and to sound the evacuation horns. The mutual aid crew at the french doors was instructed to spray water into the fire structure. Initially a fog pattern was used then they were told to switch to a stream. Due to heavy smoke, the victim could not be located but a PASS device was heard. The E285 crew grabbed a 3” hoseline off E285 and sprayed water in the D-side basement window. A fire fighter from E285 took a crew into the basement to search and almost made it to the collapsed area, but the smoke got heavier and debris was in the way (see Diagram 2). Water was coming in from both the B and D-side of the fire structure. A fire fighter from E285 requested that the hoselines be shutdown to let the smoke clear and the crew backed out.

After chopping away a small one foot section of floor by the french doors, a ladder was put into the collapsed area at the french doors (see Photo 3). A team of 2 from mutual aid department #3 went down the ladder followed by another 2 man team from mutual aid department #2. The first team located the victim but could not move him due to debris (see Photo 4 and Diagram 3). The second team realized that the debris contained a large sofa that needed moved to access the victim. After moving the large water soaked sofa and untangling the victim’s SCBA from electrical wires, he was placed on a backboard and extricated by a rope onto the B-side deck of the fire structure. The victim was nonresponsive to CPR and was pronounced dead at the hospital.

FIRE BEHAVIOR

The Fire Marshal’s report stated that the cause of fire was undeterminable.¹ The report states that the origin of fire was located in the basement ceiling underneath the landing of the second floor staircase (see Photo 4) and near the circuit breaker panel box in the basement. The residents were out of the structure several hours and upon their return smelled and found visible smoke in the basement. When the fire department arrived smoke was showing at basement windows. Conditions at the time of the fire department’s first entry into the basement were smoke a foot off the basement floor and heat at 5 to 6 feet. Conditions deteriorated during the following two basement entries without the crews locating the seat of the fire. The location of the fire allowed it to go visibly undetected while smoke traveled the floor joists and the large perimeter void space between the exterior and interior walls. The victim was on the floor above and near the fire’s origin at the time of the collapse.



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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 the death of the victim:

- A crew operating on the floor above a fire that had been burning for more than the 30 minutes that fire fighters were on scene
- Characteristics of the structure that inhibited early efforts to ventilate the structure
- Subsequent ventilation efforts that were not coordinated with interior operations

CAUSE OF DEATH

The coroner listed the cause of death as compressional asphyxia. Thermal injuries (first and second degree burns) were present over approximately 50% of the body surface area.

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that the incident commander (IC) conducts a 360 degree size-up which includes risk-versus-gain analysis prior to committing interior operations and continues risk assessments throughout the operations.

Discussion: Size-up includes risk-versus-gain at the start and throughout the fire operations. Elements included in this analysis are characteristics of the structure (e.g., type of construction, age, type of roof system, etc.), time considerations (i.e., time of day, amount of time fire was burning prior to fireground operations), contents of the structure, conditions upon arrival and potential hazards. The level of risk to the fire fighters must be balanced against the potential to save lives or property.² If additional command officers arrive on the scene who may assume command, they should consider their own additional 360 degree size-up of the structure and compare it against radio reports, prior to assuming command.

In this incident, elements that may have prompted the use of alternative tactics were that the residents were out of the structure, smoke was showing at basement windows upon the fire department's arrival, smoke was a foot off the basement floor, heat at 5 to 6 feet, with conditions deteriorating during each basement entry, and the age of structure.



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Recommendation #2: Fire departments should ensure that standard operating procedures are established for a basement fire.

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. Properly ventilating the heat and smoke from buildings can reduce the possibilities of potentially hazardous situations for fire fighters. The fire fighters performing ventilation tasks should be in communication with the fire fighters attacking the fire or entering the structure to coordinate their efforts in communication and coordination with command.³ The SOPs should be in written form, trained on, and be included in the overall risk management plan for the fire department. If these procedures are changed, appropriate continuous training should be provided to all affected members.

In this incident, the basement stairway was the only ingress and egress point. Small casement windows were placed around the foundation. However, due to the interior wall being placed 2 feet from the exterior wall and the casement window closest to the stairway being covered over, the effect of ventilation was minimal. The fire department did not have an established basement fire SOP.

Recommendation #3: Fire departments should ensure that proper ventilation is done to improve interior conditions and is coordinated with the interior attack.

Discussion: Ventilation is performed to remove the products of combustion, allowing fire fighters to advance on the fire. When venting, the principle is to pull the fire, heat, smoke, and toxic gases away from victims, stairs, and other egress routes.^{3,4} Ventilation is necessary to improve a fire environment so that fire fighters can approach a fire with a hoseline for extinguishment. Only after a charged hoseline is in place ready for extinguishment is ventilation of windows and doors most effective. Command should determine if and where ventilation is needed. The type of ventilation should be determined, based on an evaluation of the structure and conditions on arrival. Decisions regarding ventilation should be communicated to all fire fighters on the scene. Chapter 11 of *Essentials of Fire Fighting*, 5th edition, states that, "ventilation must be closely coordinated with fire attack. When a ventilation opening is made in the upper portion of the building, a chimney effect (drawing air currents throughout the building in the direction of opening) occurs."⁴

In this incident, the IC called for horizontal ventilation, but the initial use of a negative pressure fan at a basement window had minimal impact, so ventilation of the first floor was attempted. To minimize property damage, the IC requested that the crew manually open the windows from the interior instead of knocking them completely and fully out. Crews were in the basement at the time ventilation was ongoing which can present a risk due to potential fire growth. Vertical ventilation was being established at the time of the collapse.



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Recommendation #4: Fire departments should ensure that interior crews are equipped with a thermal imaging camera.

Discussion: A thermal imaging camera (TIC) is a useful and proven tool for initial size up. TICs assist fire fighters in quickly getting crucial information about the location of the source (seat) of the fire, so they can plan an effective response with the entire incident team. Knowing the location of the most dangerous and hottest part of the fire may help fire fighters determine a safe and effective approach. Ceilings and floors that have become dangerously weakened by fire damage and are threatening to collapse may be spotted with a TIC. A fire fighter (from the exterior or interior of a fire structure) about to enter a room or structure can use a TIC to assist in judging if fire or hot gases are in the walls, floor, 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.⁴ For example, the insulating properties of different materials may hide or mask fires burning in concealed spaces.

In this incident, a TIC was not utilized in the initial exterior size-up or in the fire structure to locate the seat of the fire by the interior attack crew. The horizontal ventilation crew did not use a TIC upon entry or while in the fire structure. Potentially a TIC may have indicated that the seat of the fire was underneath the floor by the french doors prior to entry, or that the floor was getting too hot and possibly too weak to crawl across during egress to the B-side of the structure.

Recommendation #5: Fire departments should ensure that Rapid Intervention Teams are staged and ready.

Discussion: Fire departments should have a designated rapid intervention team (RIT) as a part of the first alarm assignment standing by on scene during any structure fire to rescue a trapped, injured, or missing fire fighter. NFPA 1500, section 8.5.7 states that: “In the initial stages of an incident where only one crew is operating in the hazardous area at a working structure fire, a minimum of four individuals shall be required, consisting of two individuals working as a crew in the hazardous area and two individuals present outside this hazardous area available for assistance or rescue at emergency operations where entry into the danger area is required.” Further, NFPA 1500, section 8.8.7 states that: “At least one dedicated RIT shall be standing by with equipment to provide for the rescue of members that are performing special operations or for members that are in positions that present an immediate danger of injury in the event of equipment failure or collapse.”⁵ A qualified RIT should always be a part of the initial first alarm. When the team is assigned as the RIT they must be at the ready to initiate rescue when called upon. When standing by the RIT should monitor designated radio traffic and size up the incident, but not assist in regular fire fighting activities.

Training is an important aspect of all fire fighter tactics. RIT tactics are unique and properly conducted RIT operations require conducting RIT specific training. Continual RIT training is necessary to have a successful rapid intervention team member. In this incident, a RIT had not been established at the time of the incident.



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REFERENCES

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4. International Fire Service Training Association [2008]. Essentials of fire fighting and fire department operations, 5th ed. Stillwater, OK: Fire Protection Publications, Oklahoma State University.
5. NFPA [2007]. NFPA 1500: Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

INVESTIGATOR INFORMATION

This incident was investigated by Matt Bowyer, General Engineer and Steve Berardinelli, Jr., Occupational Safety and Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Division of Safety Research at NIOSH. The report was written by Matt Bowyer. An expert technical review was conducted by Deputy Chief William Goldfeder, Loveland-Symmes Fire Department and editor of <http://www.FirefighterCloseCalls.com>.



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Photo 1. View of fire structure A-side and B-side deck.
(NIOSH Photo)



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Photo 2. View of fire structure upon fire department's arrival.
(Courtesy of fire department)



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Photo 3. View of fire structure from the B-side deck and approximate placement of ladder when the victim was recovered.
(NIOSH Photo)



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Photo 4. View of fire structure's floor collapse just inside the B-side french door. The fire originated underneath the step shown on the left.
(NIOSH Photo)



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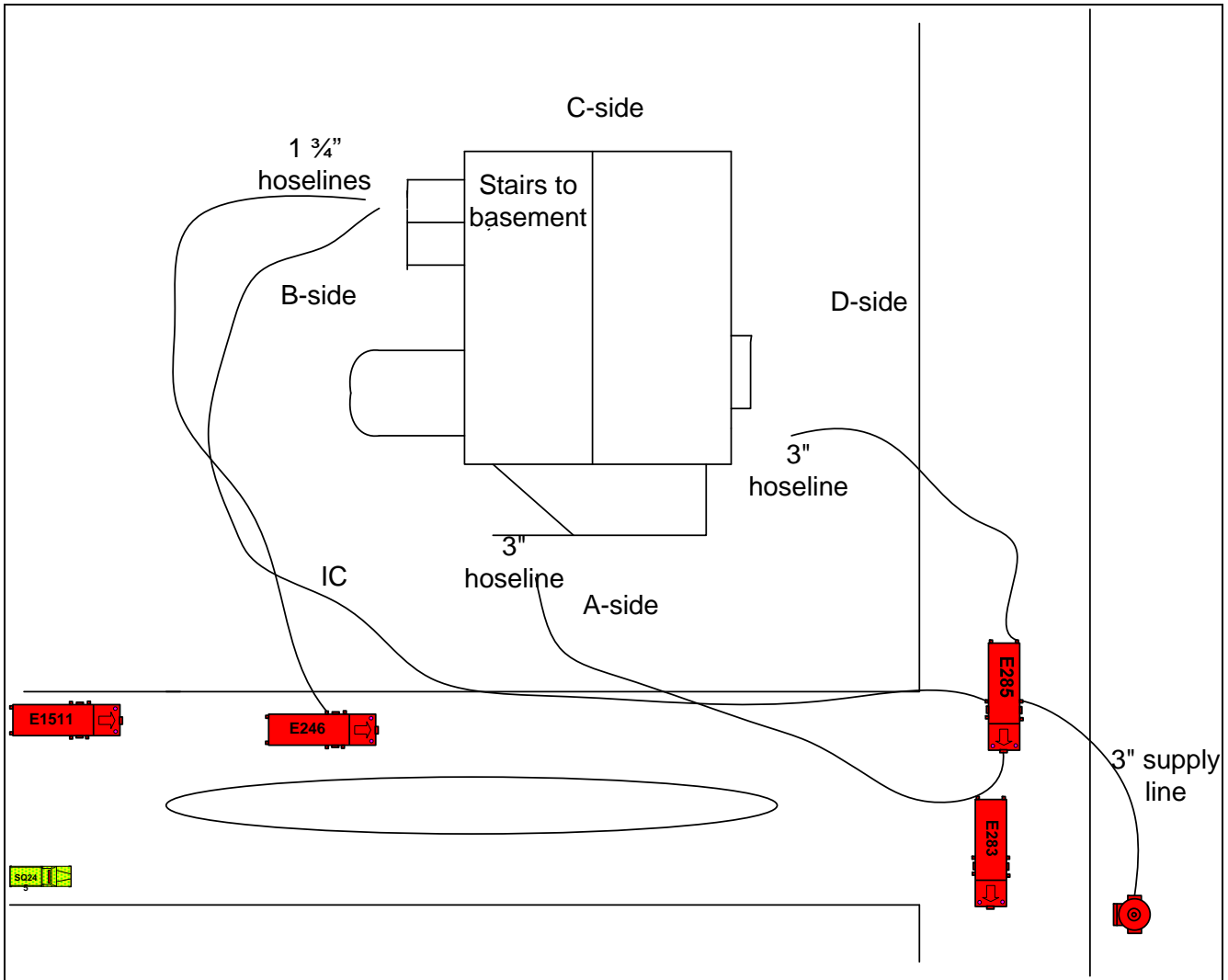


Diagram 1. Apparatus and hoseline placement prior to incident.



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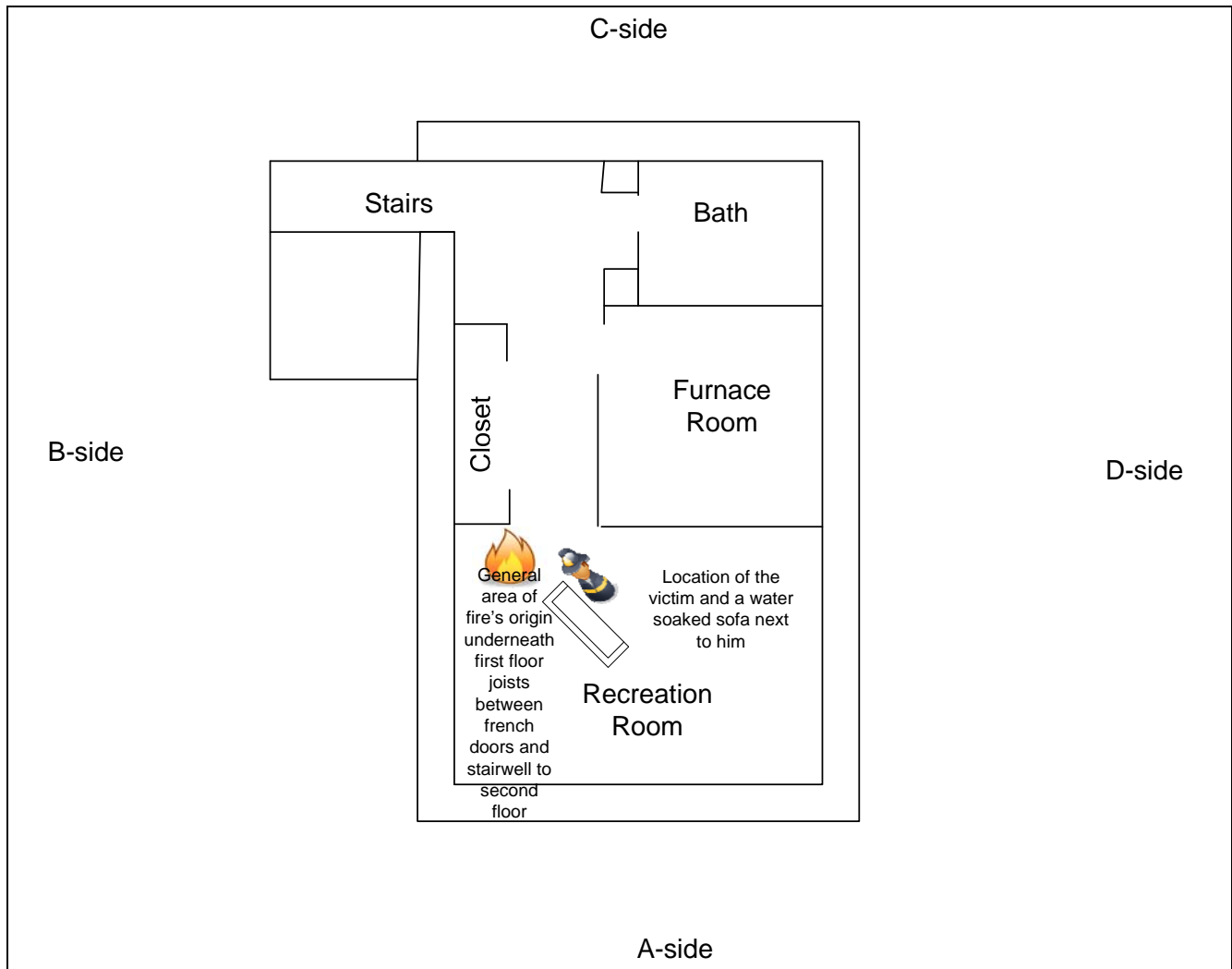


Diagram 2. Depicts the fire structure's basement layout and approximate location in which the victim was found.



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Diagram 3. Depicts the fire structure's first floor layout, collapsed area, and approximate location of the fire's origin.



NIOSH
Fire Fighter Fatality Investigation
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