1000 FREDERICK LANE, MORGANTOWN, WV 26508 · 304.285.5916

Captain Falls into the Basement and Dies While Fighting a Fire in a Large Residential Structure - Maryland

Executive Summary

On August 11, 2021, a 46-year-old career captain died after falling into a basement while fighting a large area residential structure fire.

Engine 251 had just cleared from an incident and responded as the first due company. After locating the driveway, Engine 251 dropped 500 feet of 4-inch supply line where the driveway split. Engine 251 drove up the driveway to the house arriving on-scene at 16:51 hours. Engine 251A (E251A) provided the scene size-up. E251A stated, "Engine 251 is on-scene, large 3½, 2 ½-story single family. We do have a working fire. Go ahead and start rapid intervention team (RIT) and tanker task force." Engine 251 parked on the Side Alpha/Side Bravo corner of the house in the driveway.

The working fire at Box 23-11 in the large area residential structure looking at Side Alpha of the structure. (*Courtesy of the Division of Fire and Rescue Services*)

At 16:52 hours, the Emergency Communication Center (ECC) transmitted the RIT dispatch. Truck 23 arrived on-scene at 16:52 hours. At 16:53 hours, a tanker task force was dispatched for Box 23-11. At 16:55 hours, Chief 23 responded to Box 23-11, arrived on scene, and assumed command. At the same time, OPSAC900 (division's Operations Division Assistant Chief) arrived on-scene and went to Side Charlie. A minute later, Truck 23A told Command, "360 of the residence showing single floor in the back, heavy fire on Side Charlie." Immediately after, E251A told Command, that he was unable to complete the 360. From 16:56 hours to 16:59 hours, Command dealt with arrival assignments and water supply. At 17:00 hours,

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OPSAC900 and Engine 251B (driver/operator) had two lines in service. Engine 251B told Command that Engine 251 was almost out of water.

At 17:00 hours, E251A (deceased firefighter) transmitted a Mayday stating “Mayday, Mayday, Mayday, Engine 251A has fallen through the floor in the fire room.” E231, E152, and TR23 were immediately deployed to find the downed captain. At 17:08 hours, E251A transmitted, I think I'm in the Side Charlie corner. I had to retreat from the fire, now I'm stuck and I'm burning up.” At 17:08 hours, a rapid intervention group entered the basement by the basement steps on the Side Charlie/Side Delta corner. At 17:09 hours, E251A transmitted, “Tell my family I love them.” At 17:12 hours, Engine 231A, with the RIT, told Command they found E251A unconscious and were removing him from the basement. At 17:14 hours, E251A was out of the basement and in the backyard. Basic and advanced life support treatment was initiated. E251A was taken to a trauma hospital in Washington, D.C. via air ambulance where he was pronounced deceased. The fire at Box 23-11 was marked under control around 22:00 hours. The fire was declared out at 07:00 hours the next day.

Contributing Factors

- *Low frequency/high risk incident*
- *Incident management system*
- *Crew integrity*
- *Initial rapid intervention crew (IRIC)*
- *Professional development*
- *Corrugated stainless-steel tubing (CSST) system*

Key Recommendations

For low-frequency, high-risk incidents, fire departments should ensure incident commanders (ICs) implement an incident management system that prioritizes personnel accountability and maintains effective incident communications. As a part of incident management system (IMS) oversight, the IC can:

- *Conduct a thorough scene size-up and risk assessment*
- *Develop a strategy and incident action plan specific to large-area residential structures that includes the eight functions of command*
- *Anticipate and forecast incident progression*
- *Implement a functional personnel accountability system*
- *Establish and maintain effective incident communications*
- *Assign a staff aide or incident command technician (ICT) to support the IC*

For low-frequency, high-risk incidents, fire departments should ensure all companies operating on the fireground maintain crew integrity throughout the incident. Companies can:

- *Operate based on the assignment given by the IC*

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- *Communicate critical incident benchmarks to the IC*
- *Deploy to rescue members during the initial stages of an incident*
- *Use a thermal imager during the scene size-up and while operating in the hazard zone*

Fire department standard operating procedures (SOPs)/standard operating guidelines (SOGs) are consistently updated to ensure adequate staffing and professional development opportunities to support skills and competencies to manage Type V and Type IV incidents. Possible opportunities and activities:

- *Train all firefighters and fire officers in fireground survival procedures*
- *Conduct training on rural water supply operations*
- *Provide annual proficiency training and evaluation on fireground operations, including live fire training, to all members involved in emergency operations*
- *Train all members and dispatchers on the safety features of portable radios including the emergency alert button (EAB)*
- *Train on awareness of Corrugated Stainless Steel Tubing (CSST) and the hazards associated with it*

Governing municipalities (federal, state, regional, and local) should develop and implement legislation which prohibits the use of corrugated stainless-steel tubing in residential, commercial, and industrial structures.

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Introduction

On August 11, 2021, a 46-year-old career captain from Engine 251 (i.e., E251A) died after falling into a basement during a large area residential structure fire. The United States Fire Administration (USFA) notified the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) on August 12, 2021, of the line of duty death. On August 26, 2021, two investigators with the NIOSH FFFIPP traveled to Maryland to investigate this incident. The NIOSH investigators met with fire division officials including the Fire Chief, Deputy Chief of Emergency Services, Deputy Chief of Administrative Services, Deputy Chief of Volunteer Services, Chief of Safety, Chief of Training, and members of the division's Fire Investigation Unit. The NIOSH investigators also met with representatives at the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), the director of emergency management, and the president of the International Association of Fire Fighters (IAFF) local. NIOSH investigators went to the county's ECC and obtained a copy of the fireground audio, visited the incident site, and conducted interviews with fire division officers and firefighters directly involved in this fatal incident. The NIOSH investigators inspected and photographed the victim's personal protective equipment (PPE) including the clothing and self-contained breathing apparatus (SCBA), and reviewed division training records and SOPs.

Fire Department

The Division of Fire and Rescue Services (DFRS) operates out of 30 fire stations throughout the county. DFRS employs 516 uniformed personnel, 16 civilian personnel, and partners with hundreds of volunteer responders. They serve nearly 260,000 citizens residing in the 644 square mile county. The DFRS is broken down into three sections, each led by a Deputy Chief that functions under the Office of the Director:

- The Emergency Services Section (ESS) includes field operations, emergency medical services, training, safety, and special operations offices.
- The Administrative Services Section includes finance, logistics, fire marshal, and EMS billing offices.
- The Volunteer Services Section coordinates with 25 independent volunteer Fire, Rescue and EMS corporations and manages a countywide volunteer recruitment and retention program.

The DFRS operates daily with both the county Volunteer Fire and Rescue Association and the county Career Fire Fighters and Paramedics Association (IAFF local). Working with both associations ensures

that the combination fire/rescue system of career and volunteer responders provides competent and coordinated service.

The ESS is the largest section within the DFRS, consisting of:

- 1 Deputy Chief
- 1 Assistant Chief
- 13 Battalion Chiefs
- 27 Captains
- 61 Lieutenants
- 351 Firefighters
- 54 Paramedic/Firefighters
- 1 Training Coordinator
- 1 Outreach Coordinator

Of the 30 DFRS fire stations, 25 are staffed with career firefighters. Career personnel are currently assigned to one of two work schedules, based on the staffing needs of the volunteer corporation. Currently, two stations are career staffed on the 12-hour work schedule and 23 stations are career staffed on the 24-hour schedule.

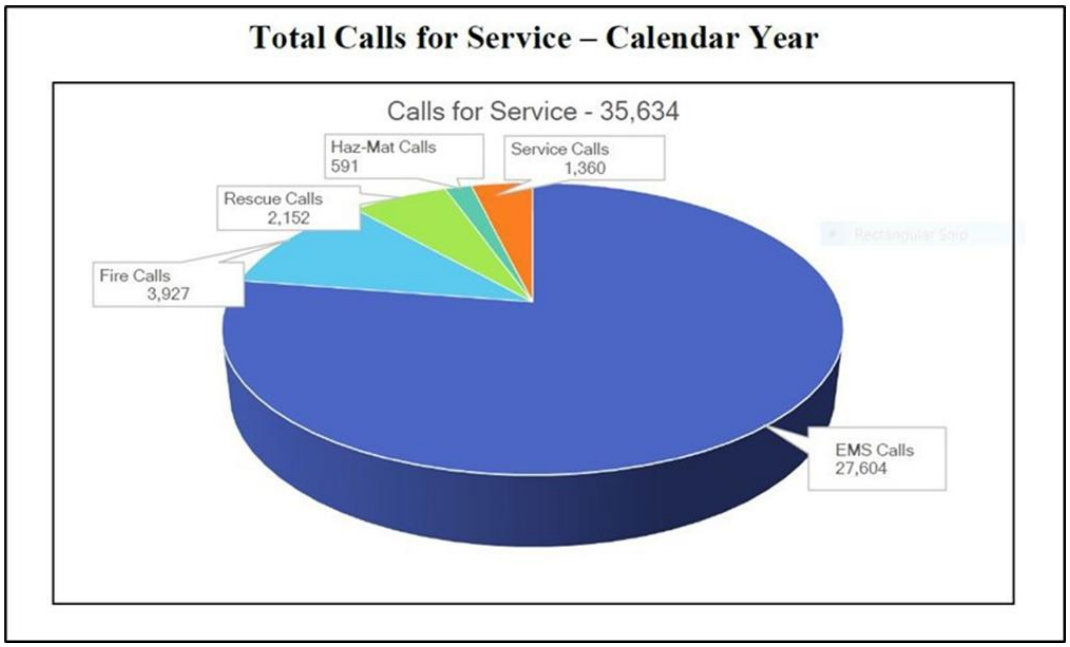

Diagram 1. The number of responses to types of emergency and non-emergency incidents in 2021.
(*Courtesy of the Division of Fire and Rescue Services*)

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Training, Education, and Professional Development

The state of Maryland requires training for career and volunteer firefighters that meets or exceeds the requirements of National Fire Protection Association (NFPA) 1001, Standard for Fire Fighter Professional Qualifications [NFPA 1001 2019] for the topic areas of Fire Fighter I, Hazardous Materials Awareness, Hazardous Materials Operations, and First Responder. Annual recertification is needed after initial training. All division training is provided by Maryland Fire and Rescue Institute and the County Division of Fire and Rescue Services' Office of Training.

Career Members

The training requirements for recruits are NFPA 1001, Fire Fighter I and Fire Fighter II (ProBoard®), Rope I, Vehicle Extrication (Technician level), HazMat Awareness and Technician (ProBoard®), Arson Investigation for First Responders, EMT/B, and physical training. Captains must also complete three years as a DFRS lieutenant. In addition, they must possess current State of Maryland EMT-B, EMT-I, or EMT-P and current CPR for the Professional Rescuer Certification, complete DFRS annual Compliance Training, possess a valid Class B driver's license or equivalent and a county employee driving permit, complete the National Incident Management System (NIMS), Incident Command System (ICS) 300, and hold certifications as Fire Officer II and Instructor II.

E251A completed more than 2,290 hours of training which included the recruit school curriculum and training certifications. Chief 23 (IC) completed more than 690 hours of training, including advanced courses.

Apparatus, Staffing, and Communications

At 16:49 hours, the county's ECC dispatched Box 23-11 for a reported house fire and directed units to respond and operate on Channel 9-Delta. The Box assignment in dispatch order is shown below in Table 1:

Table 1. The first Alarm assignment and staffing for Box 23-11.

Company or Resource	Staffing
Engine 231 (E231)	1 officer and 2 firefighters
Engine 251 (E251)	1 officer and 2 firefighters
Engine 152 (E152)	1 officer and 3 firefighters
Engine 153 (E153)	1 officer and 3 firefighters
Engine 331 (E331)	1 officer and 2 firefighters
Rescue Squad 3 (RS3)	1 officer and 3 firefighters
Truck 23 (TR23)	1 officer and 2 firefighters
Truck 41 (TR41)	1 officer and 2 firefighters
Tanker 23 (T23)	1 driver and 1 firefighter
Tanker 33 (T33)	1 chauffeur
Tanker 1 (T1)	1 chauffeur and 1firefighter
Ambulance 239 (A239)	2 EMTs and 1 paramedic

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Battalion 901 (BC901)	1 Battalion Chief
Safety 900 (SFT901)	1 Captain

The ECC serves as the public safety answering point (PSAP) for all 9-1-1 emergency and non-emergency requests for assistance in the county. The ECC dispatches fire, rescue and ambulance services, county animal control and law enforcement, including the county Sheriff's Office and two municipal police departments. The ECC operates a total of six shifts which alternate on a rotating schedule. Dispatchers work two shifts, from 06:00 hours to 18:00 hours. Or, dispatchers may also work two night shifts from 18:00 hours to 06:00 hours. There are two power shifts, during high volume call times, staffed daily from 10:00 hours to 22:00 hours and from 14:00 hours to 02:00 hours. At a minimum, there are two fire and two police dispatchers per radio console during the power shift periods. There are also dedicated tactical talkgroup (tactical channel) dispatchers assigned. There are a minimum of four call takers per shift and during power shifts there are up to six dispatchers. Each shift has a minimum of two supervisors.

Building Construction

The structure was a 5,375 square foot, two-story, colonial-style home with an unfinished basement. The structure was built in 2003 on an 11.86-acre lot in a rural neighborhood. The property had a 1,435-foot driveway that angled uphill, with an elevation gain of 60-feet and about a 16% gradient, passing in front of Side Alpha. The structure was a private dwelling with a large, irregular-shaped Type V wood-frame construction. The exterior basement entrance was located at the bottom of a set of steps located on Side Delta at the Side Charlie/Side Delta corner. The structure was a main square with three support beams, one running along Side Delta, the second running along Side Bravo, and the third protruding diagonally out from the Side Bravo-Side Charlie corner. A patio was attached to the back of the structure on Side Charlie. The structure sat on the highest point of 11 acres, with the rear yard enclosed by a five-foot metal fence. (**see Photo 1, Photo 2, and Photo 3**)

Photo 1. Side Alpha of the fire structure. (*Courtesy of the Division of Fire and Rescue Services*)

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Photo 2. Side Bravo of the fire structure. The 100-gallon propane tank was located on the Side Bravo/Side Charlie corner in the flower bed. The propane was not installed at the time of this photograph.
(*Courtesy of the Division of Fire and Rescue Services*)

Photo 3. Side Charlie and Side Delta of the fire structure. The exterior steps to the basement were located on Side Charlie/Side Delta corner, as indicated by the yellow arrow. (*Courtesy of the Division of Fire and Rescue Services)*

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The structure had an open floor plan, built of lightweight material using engineered structural elements, which contributed to the fire load and early collapse. The structure was an unprotected wood frame construction. The first floor and exterior walls were sheathed in an external insulation finishing system (EIFS) and manufactured stone veneer (MSV). The EIFS was imitation stucco and was a one-coat system with fiberglass mesh installed over oriented strand board (OSB) panels and wooden wall studs. The MSV was imitation stone, individual pre-cast concrete stones, installed over OSB panels and wooden wall studs.

The first floor had a master bedroom with a full bath, an office, two half-baths, a dining room, a game room, a kitchen with a breakfast nook and pantry, a laundry room, a family room, garage, and exterior covered patio as shown in Diagram 2.

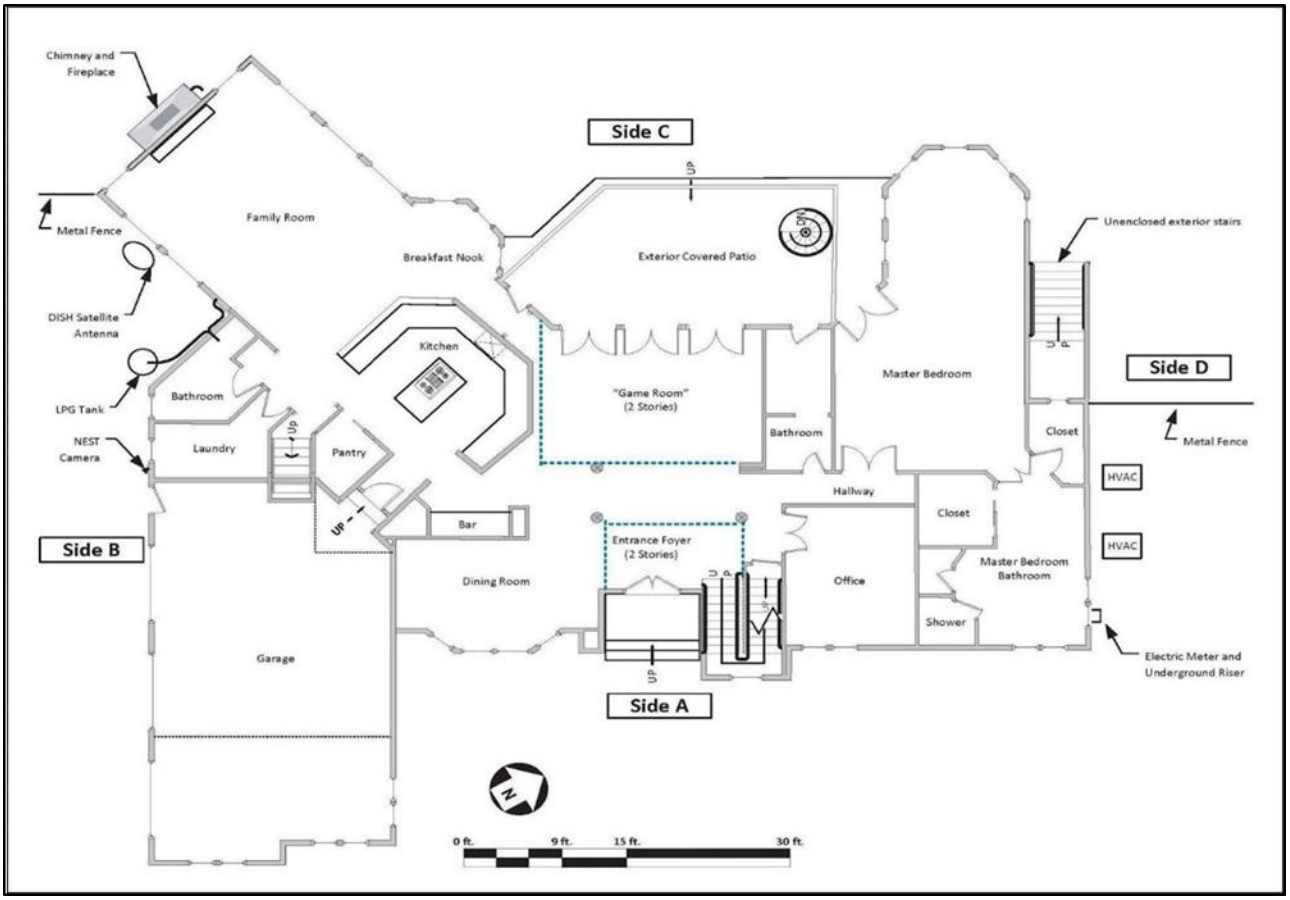

Diagram 2. First floor house plan.
(*Courtesy of the ATF)*

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The second floor had three bedrooms and two full baths (**see Diagram 3**).

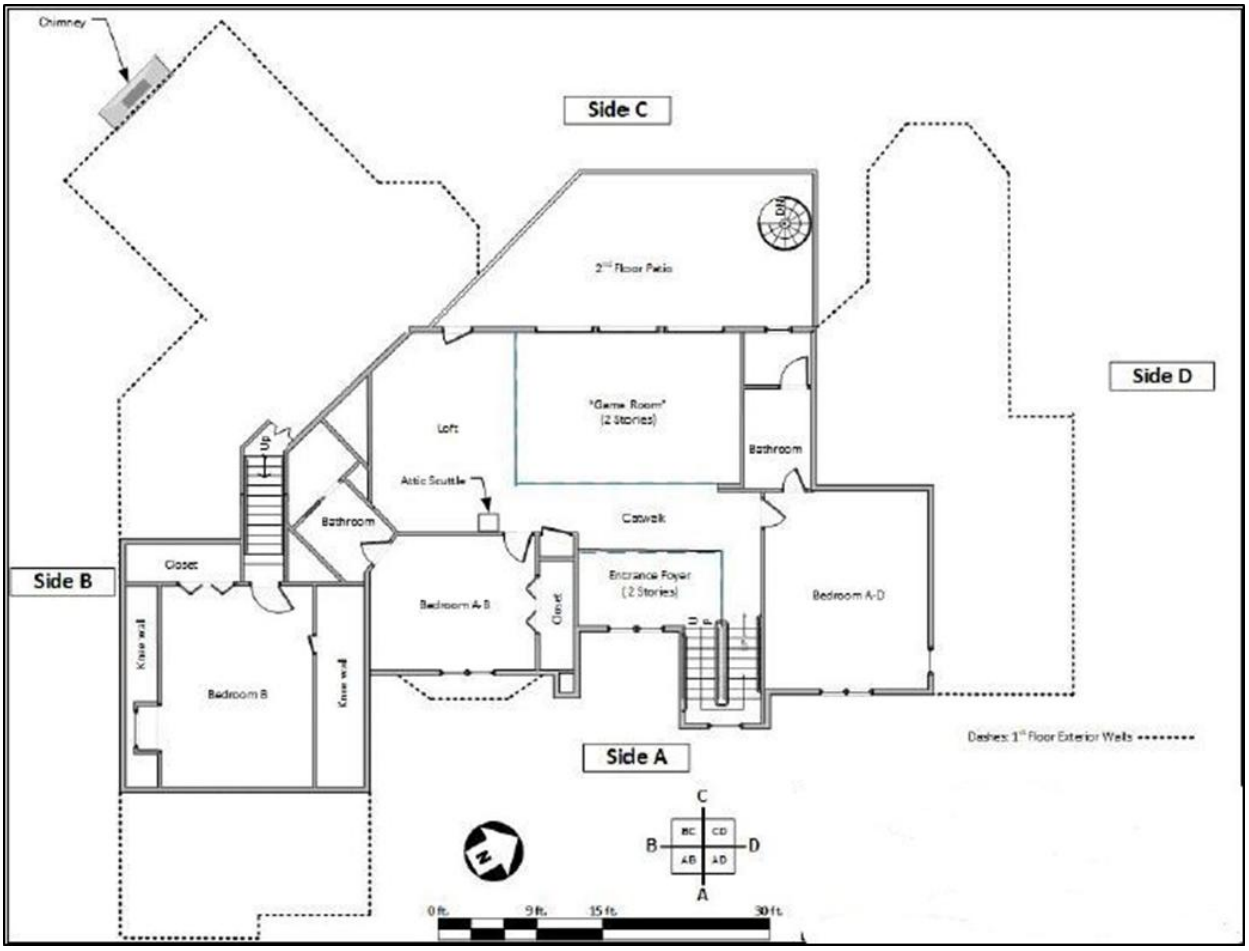

Diagram 3. Second floor house plan.
(*Courtesy of ATF*)

The basement was unfinished. The exposed foundation walls were poured concrete, and the floor was a poured concrete slab. The basement ceiling was the first floor duct space with exposed wood trusses, Glulam wood beams, and OSB floor decking. The utility system components ran through the duct space including electrical branch circuit wiring, liquid propane gas (LPG) lines of corrugated stainless steel tubing (CSST), audio-visual coaxial cable, heating, ventilation and air-conditioning (HVAC), HVAC clothes dryer ducts, water pipes, sewer pipes, and the alarm system wiring. The ceiling height was seven feet-ten inches (7'10") off the finished floor (O.F.F.) to the bottom of the parallel chord trusses. The ceiling height to the underside of the exposed OSB floor deck was eight feet-ten inches (8’10") O.F.F. The interior finish on the basement perimeter walls consisted of plastic-faced fiberglass insulation over wood studs attached to the poured concrete foundation walls. The basement interior walls consisted of gypsum board over wood studs or open (unfinished) wood studs. Except for the Side

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Delta exterior door, there were no windows or ventilation openings to the exterior from the basement (**see Photo 4**).

Photo 4. The unfinished basement. The framed stud wall that divided the basement had not been installed at the time of this picture. The red outline shows the approximate location of the framed stud wall.
(*Courtesy of the Division of Fire and Rescue Services*)

Near the center of the basement, just south of the interior basement stairs, was a wood-framed dividing wall that extended from Side Alpha to Side Charlie. The wall was finished with gypsum board on both sides. The dividing wall had two doors, one on Side Alpha and the other on Side Charlie. Both doors were closed at the time of the incident.

The roof was typical truss construction covered with asphalt shingles. There were several entrances to the home, the front door on Side Alpha, the garage on Side Bravo, several French doors on Side Charlie, and an exterior staircase to the basement on Side Delta. There were several large windows that may have impacted ventilation and contributed to the rapid deterioration and extreme fire conditions.

Construction significantly impacted this incident, two factors specifically stood out to investigators. First, the house's first floor was finished with 12-inch x 12-inch ceramic tile, which was laid on a cement board on top of oriented strand board (OSB) sheathing. The combination of these materials was extremely heavy and posed a substantial dead load. About a 3-4-foot-wide section of this flooring

completely collapsed into the basement. It is suspected that this is where E251A fell through the first floor into the basement. The remainder of the flooring was partially suspended on the first floor. Second, the unfinished basement was constructed with parallel chord trusses and a concrete slab floor. Large houses, such as the one in this incident, have large open areas in the structure made with long spans of lightweight floor trusses. The longer the span, the higher the risk of catastrophic collapse during a fire. Unprotected parallel chord truss constructed basements pose serious safety concerns in fire conditions. Underwriters Laboratories (UL) Fire Safety Research Institute (FSRI), a global safety certification company, evaluated the collapse of four types of flooring systems in fire conditions. In their report, *Improving Fire Safety by Understanding the Fire Performance of Engineered Floor Systems*, UL FSRI found that of the four tested flooring systems, parallel chord truss flooring collapsed in the shortest amount of time, about six minutes, and began deflecting shortly after the three-minute mark. At this incident, the combination of the first-floor tile flooring and the unprotected parallel chord truss basement construction created conditions particularly conducive for a quick floor collapse [UL FSRI 2006].

Also, the residence was not protected with an automatic fire sprinkler system. The residence had fire alarm system with battery back-up interconnected residential smoke detectors. It is unknown if the smoke detectors were operational at the time of the fire. An alarm control panel (ACP) was present on the basement Side Delta wall. The owner told investigators that the alarm system was not functioning at the time of the fire. There were no automatically transmitted fire or burglar alarm systems received through 9-1-1 at the time of the fire. Finally, the home was also built with a gas-piping system, CSST, discussed as a contributing factor later in this report.

Timeline

The timeline is a summary of events that occurred as the incident evolved. Not all incident events are included in this timeline. This timeline lists the dispatch communications, fire division response, fireground communications and fireground operations. Times are *approximate* and were taken from the county fire dispatch log or from various N*ational Fire Incident Reporting System* (NFIRS) fire reports, and the Division of Fire & Rescue Services' *After Action Report and Improvement Plan*.

Time	Fireground Operations, Response, and Details
August 11, 2021	
16:00 Hours	• An exterior security camera at the residence recorded a lightning strike. The security camera featured a large flash with concurrent thunder immediately afterwards. About 14 minutes later, the recording stopped due to a power or internet services failure.
16:46 Hours	• Initial 9-1-1 call from a neighbor who reported a house on fire across the street from her residence.

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Time	Fireground Operations, Response, and Details
16:48 Hours	• ECC transmitted a pre-alert for Box 23-11 on Channel 9-Alpha.
16:49 Hours	• ECC transmitted the first Alarm Assignment for Box 23-11 on Channel 9-Alpha. • Dispatched units: Engine 231, Engine 251, Engine 152, Engine 153, Engine 331, Ambulance 239, Rescue Squad 3, Truck 23, Truck 41, Tanker 23, Tanker 33, Tanker 1, BC901, SFT900 • Engine 251 had recently cleared an incident and was returning to their quarters; however, Engine 251 became the first due company.
16:50 Hours	• 9-1-1 caller told the ECC that Engine 251 passed the driveway to the residence.
16:51 Hours	• After turning around, Engine 251 split lay up the driveway to the house. • Engine 251 laid 500 feet of hose from the common driveway split to the house. • E251A provided his on-scene report: “Engine 251 is on-scene, large 3½, 2 ½ – story single family. We do have a working fire. Go ahead and start RIT and tanker task force.”
16:52 Hours	• Engine 251 parked on the Side Alpha/Side Bravo corner. • ECC transmitted a Rapid Intervention Alarm for Box 23-11 on Channel 9-Delta. • Dispatched units: Engine 31, Truck 50, Ambulance 259, Medic 23, Battalion 903 • Truck 23 arrived on-scene. • BC901 to Engine 231, “Do you have a primary water supply?”
16:53 Hours	• Engine 231 said a neighboring property had two large ponds, though one might have access issues. • Engine 231 also said there is a hydrant at an intersection about a mile to the west. • ECC transmitted a Tanker Task Force for Box 23-11 on Channel 9-Delta. • Dispatched units: Tanker 713, Tanker 17, Engine Tanker 114, Mutual Aid Tanker 1, Engine/Tanker 204, and Engine 311, SFT900 due, Tanker Task Force
16:54 Hours	• Chief 23-1 and Tanker 23 responded to Box 23-11.
16:55 Hours	• Chief 23 to Dispatch, “I’m on the scene, Side Alpha, two-story house with heavy fire showing. I'll have Command on Side Alpha.”

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Time	Fireground Operations, Response, and Details
	• OPSAC900 arrived on-scene and went to Side Charlie.
16:56 Hours	• Engine 231 on-scene. • Truck 23 said that the 360-degree size-up of the residence was complete. There is a single floor in the back, heavy fire on side Charlie. • E251A said he had not completed his "360."
16:56 –16:59 Hours	• Radio communications between Command and companies trying to establish a water supply to Engine 251.
17:00 Hours	• OPSAC900 told IC that he and E251A have two lines in service. They stated the next hoseline needed to go inside and hold the interior. • E231A told Engine 231 he was going to stretch a hoseline to the front door (Side Alpha). • Engine 231B told Command that E231 was almost out of water. • "Mayday, Mayday, Mayday, E251A has fallen through the floor in the fire room."
17:01 Hours	• "Command copies the Mayday. Engine 231, Engine 231 officer can you copy?" • OPSAC900 told Command, "E251A fell from the fire room on Side Charlie into the basement. He was just in the window and fell through the floor." • E251A radioed, "I am in the basement." • Command to Dispatch, "Send the Fire Task Force, ok?" • OPSAC900 told Command, "I've got the backup hoseline off the crosslay of Engine 251. I'm holding the fire in check where E251A fell through the floor, but I'm running out of water. I need this to be the primary hoseline."
17:02 Hours	• E251B said that Engine 251 was out of water. • ECC transmitted the Fire Task Force for Box 23-11 on Channel 9 Delta. • Dispatched units: Engine 23, Engine 12, Quint 14, Rescue Squad 14, Rescue Squad 24, Ambulance 158, and Medic 31 • SFT901 arrived on-scene.
17:03 Hours	• *15-minute notification: Time-on-scene 15 minutes* • Chief 15-1 to Command, "Alright, I am with him right now and he has a line running. E251 officer, can you hear me?" • E251A radioed, "I can only hear your radio. I had to remove myself from the fire room. I was burning up." • A PASS alarm was audible in the background.

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Time	Fireground Operations, Response, and Details
17:04 Hours	• Chief 15-1 to Command, "We've got a hoseline in the building now. They are going to try to get to the basement and get him out."
17:07 Hours	• Operations Assistant Chief 900 told Command, "I'll take Charlie Division. Right now, we've got crews assembling and we still have verbal contact with E251A." • "We're unable to make access via the fire floor to get down to the basement." • "I've just sent the Rescue Squad (3) and the Captain from 231 to another basement entrance to see if they can transverse from the other side of the house to make access, ok?" • A PASS alarm was audible in the background. • Command to OPSAC900, "I did. You are now the Charlie Division. Do you have sufficient companies and are you working on an alternate entrance to the basement?"
17:08 Hours	• "Charlie Division to E251A, come in?" • E251A, "Go ahead." • Charlie Division to E251A, "Where are you? What quadrant?" • E251A "I think I'm in the C corner. They hit the fire. Now I'm stuck, and I'm burning up". • E251A radioed, "Guys, I've had it."
17:09 Hours	• E251A radioed, "Hey guys, tell my family I love them." • A PASS alarm was audible in the background.
17:10 Hours	• Command to Dispatch, "I am requesting a second Alarm for Box 23-11."
17:11 Hours	• ECC transmitted a second Alarm for Box 23-11 on Channel 9-Delta. • Dispatched units: Engine 141, Paramedic Engine 735, Engine 713, Engine 172, Engine 122, Ambulance 339, Reserve Engine 171, Tanker 714, Engine Tanker 224, Tanker 22, Tower 735, and Quint 11
17:12 Hours	• Engine 231A to Command, "I'm with the captain off Rescue Squad 3 and a firefighter. We found E251A and he is currently unconscious. We're heading your way and need EMS to the Side Delta." • Command to Dispatch, "Requesting aviation priority one, Category A." • The landing site is on-scene.
17:13 Hours	• Command to all units on the fireground, "If you're not engaged in the firefight, I need you to transition to set up for a master stream operations."

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Time	Fireground Operations, Response, and Details
17:16Hours	• Command to all units, hold your radio traffic. • Rescue 3 to Command, "The firefighter is out and appears to be unconscious." • Firefighter in the care of Medic 23. • The Mayday was cleared by OPSAC900 on Tactical Chief 9 Delta
17:18Hours	• *15-minute notification: Time-on-scene 30 minutes* • Command was told E251A was in cardiac arrest.
17:19 Hours	• Command told all first Alarm companies they have PAR.
17:20Hours	• Command to all companies operating at Box 23-11, "Okay for clarification on the fireground, we are transitioning to a defensive attack, a defensive attack."
17:24 Hours	• Chief 4-1 to Command, "Confirming, it looks like we do have propane going into the house, but we can't find the tank or the shut-off."
17:25Hours	• Command said, "Okay, it is probably buried out in the yard somewhere. We're going to have to look for the cap. I'll see if I can find somebody to do that."
17:27 Hours	• Chief 4-1 to Command, "I found the tank and the propane is shut off."
17:29 Hours	• E251A transported via Trooper 3 to a trauma center in Washington, DC. • Charlie Division reported the fire extended to the second floor in the rear.
17:33 Hours	• *15-minute notification: Time-on-scene 45 minutes*
19:45 Hours	• E251A declared deceased.
22:00 Hours	• Command told the ECC that the fire was under control. • All DFRS members relieved on-scene by mutual aid companies. Members transported to the division's fire training center.
August 12, 2021 07:00 Hours	• Command told the ECC that the fire was out.

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Personal Protective Equipment

At the time of the incident, E251A was wearing full turnout gear, an SCBA, a portable radio, and work/station uniform. On August 31, 2021, NIOSH investigators inspected the PPE which included helmet, turnout coat, turnout pants, boots, gloves, and protective hood at the division's Resource Management Bureau. Investigators also inspected the portable radio and SCBA. The turnout gear was not considered a contributing factor in this incident. No further evaluation of the turnout gear was conducted by NIOSH.

E251A was wearing a NIOSH Approved® Scott® Safety Air-Pak® Model X3, 45-minute, 5500 psi unit, NIOSH Approval Number TC-13F-722CBRN (SCBA). The SCBA was delivered by a NIOSH investigator on September 7, 2021, to the NIOSH's National Personal Protective Technology Laboratory (NPPTL) in Morgantown, West Virginia, for evaluation and testing. Testing was conducted on September 15, 2021. No evidence was identified to suggest that the SCBA unit contributed to the fatality. The entire SCBA investigation report is available on the NIOSH PPE webpage.

Weather Conditions

On August 11, 2021, the area experienced rainstorms throughout the day. The hour prior to the initial 9-1-1 call at 16:46 hours, the temperature dropped from about 79 to 73 degrees Fahrenheit. Precipitation started between 16:00 hours and 16:10 hours, accumulating up to 0.16 inches, and wind conditions reached 25 mph [Weather Underground 2021].

Sixty-three lightning strikes were reported within a five-mile radius of the structure (see Photo 5). An exterior security camera at the residence recorded a lightning strike at 16:00 hours (i.e., a large flash with concurrent thunder immediately afterwards). Small pieces of debris were heard falling and hitting the roof and siding. Around 16:14 hours, a power or internet service failure stopped the camera recording.

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Photo 5. Visual representation of the lightning strikes (yellow tacks) in and around the area of the fire structure (red dot) between 15:59 and 16:00 hours on August 11, 2021.
(*Courtesy of the Division of Fire and Rescue Services)*

Investigation

On August 11, 2021, at 16:46 hours, 9-1-1 received a call from a neighbor standing in the driveway to the northeast of the fire building reporting a fire at a residence. At 16:48 hours, the county's ECC dispatched a pre-alert for Box 23-11. On the way back to their quarters after a run, the crew of Engine 251 saw a structure fire alert on their mobile data terminal (MDT) and went to the scene.

At 16:49 hours, the county's ECC dispatched Box 23-11 on Channel 9-Alpha for a reported house fire and directed companies to respond and operate on Channel 9-Delta. As Engine 251 neared the address, they observed low-lying smoke conditions coming across the road. Engine 251 drove past the driveway and performed a quick three-point turn in a different driveway. Simultaneously, the ECC updated the incident address for Box 23-11. Engine 251 came to the split in the driveway and dropped a 4-inch supply line before proceeding up the long driveway towards the house. E251A (officer) communicated that Engine 251 was on-scene and laid a supply line halfway up the lane. At 16:51 hours, E251A directed his driver to position on the Side Alpha/Side Bravo corner of the house just before the garage. Engine 251 was unable to go further because of the smoke's volume. Smoke conditions worsened on the Side Bravo exterior, and the crew could no longer see in front of them. E251A transmitted an initial on-scene radio report, "Engine 251 is on-scene, large 3½, 2 ½ – story single family. We do have a working fire. Go ahead and start RIT and tanker task force."

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Observing most of the fire in the family room on Side Bravo, Engine 251C (jumpseat firefighter) deployed the officer's side 200-foot 1¾-inch crosslay to Side Bravo. Because of exterior smoke conditions, Engine 251C and E251A donned their facepieces and went "on air." The crew from Engine 251 advanced the line to Side Bravo and began to apply their stream interior through a set of picture windows on the first floor, just to the right of the chimney, into the family room. Meanwhile, Engine 251B secured the supply line to his pump, assisted with stretching Engine 251's line, charged it, then began laddering Side Alpha. At 16:52 hours, the ECC transmitted the following units on the Rapid Intervention Alarm response for Box 23-11:

- Engine 31 (E31)
- Truck 50 (TR50)
- Ambulance 259 (A259)
- Medic 23 (M23)
- Battalion Chief 903 (BC903)

Truck 23 arrived on-scene. Truck 23's officer walked from Side Alpha towards Side Delta to get a view of Side Charlie. He did not hear E251A provide a 360-degree size-up report. As he was walking, Truck 23's tiller firefighter (TR23C) laddered the residence. To get to Side Charlie, Truck 23A walked around the outside of the fence, which prevented him from entering the yard on Side Delta. He could not get a good view of Side Charlie or Side Delta from this position.

While enroute, BC901 transmitted to Engine 231, "I think the property to the west of the fire building is showing a pond. I didn't hear your primary water source. I don't think anyone called it out yet." BC901 contacted Engine 231A about the primary water source who responded, "There are two large ponds, though one might have access issues. The next is a hydrant about one mile from house."

As they approached the scene, Engine 231A contacted Engine 251B to ask if there was enough supply line to pick up the split-lay at the driveway entrance. Engine 251B laid 500 feet, and confirmed Engine 231 could complete the split. At 16:53, the ECC transmitted the following for the Tanker Task Force for Box 23-11 on Channel 9-Delta:

- Tanker 713
- Tanker 17 (T17)
- Engine/ Tanker 114 (ET114)
- Tanker 1
- Engine/Tanker 204 (ET204)
- Engine 311 (E311)
- SFT900

Engine 231 arrived and laid out 800 feet of 4-inch large diameter hose (LDH) to complete the split lay from the main road up to where Engine 251 dropped their line. As Engine 231A and Engine 231C made their way to the command post on Side Alpha, Engine 231B secured Engine 251's supply line to a discharge outlet, sending tank water up to Engine 251. Most of the water was consumed by filling the 500-foot 4-inch LDH laid by Engine 251.

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At 16:54 hours, Chief 23 arrived and drove up to the house and around the yard on Side Bravo to gain a visual. He ultimately positioned on Side Alpha, and established Command from his vehicle. A few seconds later, the Operations Assistant Chief 900 (OPSAC900) and the Fire Chief (Chief 900) arrived. Under direction from Chief 23, OPSAC900 donned his turnout gear, and went to Side Charlie to check on E251A's status and get a better view the fire conditions. Chief 900 went to the command post (CP) to assist the IC with resource and situation status on the tactical worksheet.

From his position outside the Side Delta gate, at 16:56, Truck 23A transmitted, "360 of the residence showing a single floor in the back with heavy fire on Side Charlie." Just 17 seconds later, E251A communicated, “Engine 251 to Command, I have not been able to complete the 360.” On his way to Side Charlie, OPSAC900 deployed an additional crosslay from Engine 251 and stretched the hoseline to Side Charlie. As OPSAC900 reached Side Charlie, he told E251A he was going to advance his line to knock down the exterior fire on Side Charlie.

Engine 331 was the fifth due engine, responsible for fill-site operations but it was the third engine to arrive. The officer asked the IC whether he wanted Engine 331 to stay as the fifth due engine or take the third position. The IC told Engine 331 to take the third engine position, but Command did not announce an order change for the two engines not yet on-scene. No engine was reassigned to the fill-site.

Tanker 33 arrived on scene as the first due tanker and was assigned to be the nurse tanker. The Tanker 33 driver did not think he could make it up the driveway because Engine 231 was blocking the driveway, and he did not feel comfortable driving through the yard. Tanker 33 positioned on the main road in front of Engine 331 and began off-loading the folding dump tanks per division SOP.

With both hoselines working on Side Charlie and E251A inside the structure, OPSAC900 and E251A discussed fire extension towards Side Delta. After the discussion, E251A proceeded to the patio on Side Charlie around 16:58 hours. OPSAC900 made eye contact with E251A. E251A asked OPSAC900 to hand him the hoseline through the window. OPSAC900 responded, “No, we're not going in there.”

At 17:00 hours, OPSAC900 called Command with the following message, "Myself and Engine 251 have two lines in service, trying to knock the bulk of the fire. The next hoseline line needs to go to the inside and hold the interior." E251A entered the kitchen/breakfast nook area through the doorway on Side Charlie. After making the transmission, OPSAC900 observed E251A standing inside of the structure in the breakfast nook area adjacent to the family room and kitchen, just inside the bay windows. Engine 251A entered the kitchen/breakfast nook area through the doorway on Side Charlie (**see Photo 6**).

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Photo 6. The doorway outlined in red was used by Engine 251A to enter the kitchen/breakfast nook area.
(Courtesy of the Division of Fire and Rescue Services)

After losing water for a brief period, OPSAC900 walked his hoseline back a few feet to check for kinks. When he returned, he no longer saw E251A standing inside the structure and assumed that E251A walked back outside. At this point in the incident, Truck 23A forced the front door open to prepare for the next hoseline to enter Side Alpha. He made entry into the house to do a quick search. Truck 23A noticed a rush of air coming in behind him, so he secured the front door while Engine 231A and Engine 231C worked on stretching a third hoseline from Engine 251 to the front door. Engine 152A, Engine 152C, and Engine 152D arrived on-scene and made their way up to the CP. Engine 152A told Chief 900 he could advance the next hoseline into Side Alpha since both hoselines were working on Side Charlie. Chief 900 approved.

At 17:00, E251A transmitted on Channel 9-Delta: " Mayday, Mayday, Mayday, Engine 251A has fallen through the floor in the fire room." Sixteen seconds later Command stated, "Command copies the Mayday. Engine 231, Engine 231's officer, can you copy?" Engine 231A responded, "Yeah, can you confirm if he fell into the basement or if he is just stuck in the first floor." OPSAC900 responded, "Hey, he fell from the, uh, bulk of the fire room here on the Charlie Side into the basement. He was just in the window and fell through." At 17:01, E251A confirmed, "I am in the basement." The IC requested the ECC transmit a Fire Task Force Alarm for Box 23-11. As Engine 231, Engine 152, and Truck 23 masked up on the front steps, they agreed that they would split up and try to locate E251A

and the interior basement steps. Engine 231A directed Engine 231C to drop the attack hoseline and get the RIT pack.

OPSAC900 began flowing water towards the floor through the bay window from Side Charlie while Engine 251C also flowed water towards the floor in the family room from Side Bravo. OPSAC900 and Engine 251C observed fire growth in the basement. OPSAC900 radioed Command and said, “I've got the back-up line off Engine 251. I’m holding the fire in check where he fell through the floor, but I’m running out of water and need to be the primary line.” Twelve seconds later, E251A communicated, “I had to evacuate from where I was. I was burning up.” E251A, facing high heat, evacuated from the basement fire room, then manually activated his PASS device. Meanwhile, Engine 231, Engine 152, and Truck 23 were operating on the first floor, directly above the basement, working to locate E251A.

Engine 231C was separated from Engine 231A, who was searching for basement stairs. After encountering a large volume of fire and heat in the kitchen area and having no charged hoseline on the first floor, Truck 23C exited the structure. He returned with an uncharged 300-feet of 1¾-inch attack hoseline that was left near the front door by Engine 231C. Truck 23C took the attack hoseline inside with Engine 152D, who was also separated from his crew.

Chief 15-1 arrived on scene, stopped at the CP, and was directed by Chief 900 to go to Side Charlie to help. After getting around back, Chief 15-1 communicated to Command, “Alright, we need water in this line right now (referring to the hoseline that OPSAC900 was operating). No one has gotten to this guy, and he is still in the basement.” Command responded, “Ok do you have a visual on him now?" Chief 15-1 said, "I do not; who is it?" Command responded, “E251A. OPSAC900 should be on the back and has a protection line on him right now." Chief 15-1 said, "Alright, I'm with him right now, and he has a line running. Engine 251 officer, can you hear me?" At 17:03, E251A responded, “I can only hear your radio. I had to remove myself from the fire room. I was burning up.”

At 17:04, E251A told Command, "Probably the best thing you could do is drop a ladder down in this hole and put the fire out, and I'll walk out." Several seconds later, Chief 15-1 called Command, "We've got a line in the building now, and they are going to try to get to the basement and get him out." Chief 900 said, “I've got a roof ladder coming around to the rear.” OPSAC900 called Command and said, “I have verbal contact with the firefighter. He did fall through the floor. A company from 31 and E231 have a line on the interior trying to keep the fire in check and make access to him. Give me the next company to standby with RIT equipment for the extraction on the Charlie Side.”

At 17:05, about four minutes after the Mayday, ECC activated the Mayday alert tone. They requested all units not involved with the Mayday to switch to radio Channel 9-India. Immediately Chief 900 responded, “That's negative, all units do not change channels. Everyone remain on Channel 9-Delta. Dispatch, I've got it.”

Engine 31, equipped with ladders and a RIT bag, headed to the bay window on Side Charlie to assist in extracting E251A. At the direction of OPSAC900, Engine 31 attempted to place a 16-foot roof ladder through the bay window down into the basement but had difficulty seating the heel of the ladder on the basement floor. Once Engine 31A got the ladder seated as much as possible, Engine 152A tried to

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descend the ladder into the basement. As he began, the small section of flooring between the ladder and the Side Charlie exterior wall began to collapse, causing the heel of the ladder to slide.

Frustrated by not finding the interior stairs to the basement, Engine 231A exited the structure from Side Charlie toward Side Delta to find another way into the basement. As soon as he got to the Side Charlie/Side Delta corner, he immediately saw the exterior basement steps and notified OPSAC900.

At 17:07 hours, OPSAC900 notified Command, “I’ll take Charlie Division. Right now, we've got the crews assembling. We still have verbal contact. We're unable to make access via the fire floor to get down there. I've just sent the Rescue Squad and the Captain from Engine 231 to another basement entrance to see if they can traverse from the other side of the house to make access, OK?"
Twenty seconds later, E251A made an inaudible transmission; however, his PASS alarm could be heard in the background.

Unaware of the exact path he traveled, E251A made his way, most likely through a narrow framed-in hallway, to an open space along Side Alpha, Quadrant Alpha where he would eventually be located. The hallway that he most likely took ran from Side Alpha to Side Charlie, dividing the basement in two.

OPSAC900 responded to E251A's inaudible transmission, “Charlie Division to E251A Mayday, can you copy?” Inadvertently, Chief 900 responded, “I did. You are now Charlie Division. You have sufficient companies, and you are working on an alternate entrance to the basement. OPSAC900 responded, “Yeah, OPSAC900 to Engine 251A, come in.”

At 17:08:08 hours, E251A responded, “Go ahead.” OPSAC900 responded, “What quadrant are you in?” E251A responded, “I think I'm in the C corner; they hit the fire, now I'm stuck, and I'm burning up.” OPSAC900 responded, “Ok I copy. I'm getting ready to send Battalion 903 in the alternate basement door with Rescue Squad 3. He’ll be the RIT Group Supervisor. They are coming to you. He is advising he fell through in the Charlie quadrant, which should have been the floor just inside the door where we were operating okay Rescue Squad 3?”

OPSAC900 directed Engine 231A, Rescue Squad 3's crew, and BC903 to the exterior basement door on Side Delta. In preparation for entry to the basement, a 200-foot 1¾-inch hoseline was stretched from Tanker 1 and positioned on Side Bravo to the exterior basement steps on Side Delta.

At 17:08 hours, E251A attempted to transmit three separate times. The radio rejected the first two attempts, and the third was not understood. Eight and a half minutes after declaring his Mayday, E251A made his final successful radio transmission at 17:09, saying, “Hey guys, tell my family I love them.” At this time, crews were preparing for entry into the basement. Between this transmission and 17:10 hours, there were three more attempts to transmit a message by E251A, but the radio system rejected all transmissions.

Within a couple of minutes from E251A making his final transmission, the exterior basement doors were forced open, and Rescue Squad 3B and 3D, along with Engine 231A, entered the basement

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accompanied by personnel from Engine 31 with a charged hoseline. As Rescue Squad 3B, Rescue Squad 3D, and Engine 231A entered from Side Delta, they began moving towards Side Bravo where they believed E251A had fallen through the floor. They encountered thick black and brown smoke from floor to ceiling as they entered. The crew from Engine 31 and Rescue Squad 3A entered behind Rescue Squad 3B, Rescue Squad 3D, and Engine 231A. While two members advanced the hoseline, Engine 31A and Engine 31D dropped off the hoseline and began searching for E251A.

At 17:11 hours, OPSAC900 called Command, “Smoke conditions are worsening on the Charlie Side. We have thick brown turbulent smoke running the roofline. I recommend you put the master stream up to prepare for once we make the rescue. It looks like we are losing the attic and upper floor.” Seeing conditions worsen, Chief 900 checked on the units he believed were operating on the first floor. Chief 900 called Engine 231A on the radio. OPSAC900 responded, “Chief, Engine 231A redeployed with Rescue Squad 3 to the basement as part of the rapid intervention group. We’re not sure where this firefighter went. I think he was holding the fire on the interior of the fire floor.” No one knew that Engine 231C had run low on air and exited the building several minutes before.

Several feet into the basement, Rescue Squad 3B, Rescue Squad 3D, and Engine 231A heard E251A’s PASS activated and moved toward the sound. Rescue Squad 3B and Rescue Squad 3D encountered a wall in the exterior portion of the hallway. The crew quickly located a door and made entry. Visibility was about two feet from the floor to ceiling, and they could see E251A. Rescue Squad 3B, Rescue Squad 3D, and Engine 231A moved through the doorway, throwing boxes out of the way to make a path to E251A.

E251A did not have his helmet or facepiece on. Engine 231A radioed to Command, "Engine 231A to Command, Rescue Squad 3A, Rescue Squad 3D, and Engine 231A firefighter. We found Engine 251 and he is currently unconscious. We're heading your way. We need EMS to the Delta Side." In response, Command immediately requested aviation. When Rescue Squad 3B and Rescue Squad 3D entered the room, they observed heavy smoke from the ceiling to about a foot off the ground and moderate heat. Shortly after, heat and smoke conditions worsened, creating zero visibility.

At 17:14 hours, Chief 900 made a radio request to OPSAC900, “Can you confirm when the extraction is complete so I can evac and complete a PAR?” OPSAC900 responded, “Sorry, I have a lot of manpower outside, but there may be people still on the first floor. You're going to have to verify that because I'm over here overseeing the extraction.” After attempting to deploy E251A's Drag Rescue Device (DRD) with no success, Rescue Squad 3D attempted to do an SCBA waist strap conversion to assist with extraction. Conditions began rapidly deteriorating, and they moved to a rapid brute force removal. As they began extracting E251A, they were met by Engine 231A, who was holding his position to help guide the crew from Rescue Squad 3 back towards the exit. With the added assistance from Engine 31, E251A was removed from the basement. Crews quickly removed his gear and started CPR and other critical life-saving measures.

At 17:16 hours, Chief 900 reported to Command, “Command to ECC, sound the evacuation tone.” Chief 900 spent the next several minutes attempting to get a PAR check completed because of the many violations of the crew integrity policy. The operations would eventually transition to a defensive

operation. The fire at Box 23-11 was declared under control at 2200 hours. Command told Dispatch at 07:00 hours on August 12, 2021, that the fire was out.

Fire Origin and Cause

The fire origin and cause investigation was conducted by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), the county's Office of the Fire Marshal, the county's Sheriff's Office, the Howard County Office of the Fire Marshal, and Fire Arson Investigation Consultants Inc. Investigators identified the fire resulted from a lightning strike. The ignition sequence began with the lightning strike, which induced the failure of the CSST system, causing ignition of fugitive gas escaping from at least one of the four perforations formed by arc-melting along the fireplace CSST service run. The flaming fugitive gas then ignited combustibles, primarily wood structural framing within the area of origin.

Based on the fire scene examination, physical evidence, witness statements, and documentation, the fire on August 11, 2021, at Box 23-11 originated in the Side Bravo/Side Charlie quadrant of the unfinished basement.

The fire was classified as natural, which includes fires resulting from lightning, earthquake, wind, and flood. The collapse of the first floor family room and corresponding fire damage was consistent with a fire originating in the basement and extending upwards. The fire was observed venting from the first floor family room windows in the Side Bravo quadrant on arrival.

Cause of Death

On the death certificate, the medical examiner listed E251A's cause of death as inhalation of products of combustion and the manner of death was accidental.

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 fatality:

- Low frequency/high risk incident
- Incident management system
- Crew integrity
- IRIC
- Professional development
- Corrugated Stainless Steel Tubing (CSST) system

Recommendations

Recommendation #1: For low-frequency, high-risk incidents, fire departments should ensure ICs implement an incident management system that prioritizes personnel accountability and

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maintains effective incident communications. As a part of IMS oversight, the IC can:

- ***Conduct a thorough scene size-up and risk assessment***
- ***Develop a strategy and incident action plan specific to large-area residential structures that includes the eight functions of command***
- ***Anticipate and forecast incident progression***
- ***Implement a functional personnel accountability system***
- ***Establish and maintain effective incident communications***
- ***Assign a staff aide or ICT to support the IC***

Discussion: At this incident, E251A did not complete a 360-degree size-up upon arrival. The officer of Truck 23 communicated a size-up to Command on arrival. The IC did not declare a strategy or communicate an incident action plan (IAP). This is especially important when encountering a fire in a large area residential structure with a limited water supply. Personnel accountability was not in place from the time of Mayday and until the removal of E251A from the basement. Fireground communications quickly became overwhelmed when the Mayday occurred. Initial arriving chiefs did not have a staff aide or ICT to help with personnel accountability and fireground communications.

Scene Size-up and Risk Assessment

Incident strategy and tactics (offensive, defensive, transitional) are dictated by the initial size-up of the first arriving chief or company officer. Unless the first arriving unit is faced with an obvious life safety issue (e.g., visible victims), a detailed scene size-up and 360-degree walkaround should be conducted. If physical barriers, the size and/or shape of a structure, prohibit a detailed scene size-up to Side Bravo, Side Charlie, and Side Delta, the IC may delegate this responsibility to other arriving resources on the initial alarm assignment. Until the 360-degree assessment is complete ICs should be cautious in committing fire crews. Even after committing fire crews, the IC is still responsible for constantly monitoring changing conditions to immediately adjust crew commitments or withdraw crews all together.

The initial size-up includes the following [SKCFTC 2023]:

- Responding considerations:
  - Evaluation of the structure location
  - Access routes and the best direction to approach
  - Primary and secondary water supply locations
  - Apparatus placement
  - Building construction and occupancy
  - Time of day and weather conditions
  - Current resources responding & needed resources
  - Additional updates received (radio, MDT)
- Arrival considerations for the first arriving officer/initial incident commander:
  - Select the best tactical position for apparatus placement
  - Identify a positive water supply and/or establishing the water supply if needed
  - Evaluate the fire conditions
  - Provide the initial radio report (IRR) to all responding units

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- Use strategic decision-making from arrival until units clear the incident.
- Initial Radio Report (IRR):
    - The announcement of the initial radio report automatically establishes that all additional responding units shall Stage Level 1, except for the first arriving Engine and Command Officer.
    - Critical fireground factors
    - Risk vs. benefit analysis
    - Initial incident action plan
    - Initial strategy declaration
    - Resource evaluation
- 360° Size-up:
    - Use of a thermal imager (TI) is mandatory at all incidents and will be completed as early into the incident as possible.
    - Size-ups that can't be completed due to building size or obstructions should be delegated to an individual or company to continue the process so that all sides of the incident are visualized.

Ensuring firefighter safety is a continuous process throughout the incident. A risk management plan ensures that the risks are evaluated and matched with appropriate actions and conditions. Risk management practices provided by NFPA 1550 [NFPA 1550 2024]:

- Only engage in activities with significant risk if there is a chance to save lives. If there is no possibility of saving lives or property, do not put members at risk.
- Identify routine property protection activities that may pose safety risks and take steps to minimize these risks.
- Focus on defensive operations when the risk to fire department members is too high.

Strategy and Incident Action Plan

The challenges of conducting operations at single family dwellings with large square footage demand an advanced understanding of building construction, engineering, and fire dynamics. Additionally, it requires integration of adaptive fire management principles that involve distinctively unique firefighting methodologies, practices, and tactical deployment. From an incident management standpoint, these incidents call for a more rigorous level of command resiliency, tactical patience, and discipline.

NFPA 1700, Guide for Structural Fire Fighting, provides direction to develop the initial and ongoing operational strategy required for fire control of occupancies such as large area residential structures. Additionally, NFPA 1700 provides options on science-based tactical considerations for fire control and extinguishment in special circumstances. Section 12.9 provides guidance for fighting fires in large area residential structures or large estate dwellings [NFPA 1700 2024].

Fires at single family dwellings with large square footage and unique architectural features are low frequency/high risk events. A fire department should have a deployment strategy in place that addresses staffing, incident management, appropriate tactics, adequate water supply, and other

resource/logistical management issues [NIOSH 2010]. Fire departments should be aware of the structure size as it relates to areas of the structure that can be covered by a 200-foot hoseline.

Incident Management System

The first officer arriving on scene is responsible for evaluating incident conditions, developing an incident action plan, determining how to complete tactical objectives, addressing safety, deploying and assigning operating companies, and determining a need for additional resources [Brunacini 2002]. Using SOPs, the IC can outline an organizational structure to effectively manage the incident scene. The command organization must develop at a pace that stays ahead of the tactical deployment of personnel and resources. The eight functions of command define standard activities that are performed by the IC to achieve tactical objectives include [Brunacini 2002]:

1 Deployment
2 Assume, confirm, position command
3 Situation evaluation (size-up)
4 Strategy development/incident action planning
5 Communications
6 Organization
7 Review and revision
8 Continue, support, and terminate command

At most incidents the initial IC is a company officer. The company officer of the first arriving unit must formally establish Command and give an arrival report. The company officer should remain in Command until properly relieved by a member of higher rank who is on scene.

Forecasting

The IAP is developed based on forecasting the direction of the incident. Where the fire has been and where it is going are two of the most important parts of forecasting. An IC must have a system in place where the rate of assigning companies to the emergency scene doesn't exceed the span of control. The IC accomplishes this by forecasting and establishing responsibilities, either geographically (division) and/or by function (group), that divide the incident scene into a more manageable framework. The IC should transmit a preliminary report followed by progress reports to fire dispatch. These reports should describe current conditions and the status of fireground operations suppression. For example [FDNY 2011]:

- *Doubtful or doubtful will hold* (e.g., The situation remains doubtful until changed by the transmission of "probably will hold" or "under control")
- *Probably will hold* (e.g., There is enough apparatus, equipment, and personnel to contain the fire or emergency and prevent any further extension or escalation)
- *Under control* (e.g., Final extinguishment of the fire or control of the emergency will be accomplished by the apparatus, equipment, and personnel on the scene)
- *Conditions improving* (e.g., Indicates that the fire forces are making headway, but that final extinguishment has not been achieved).

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Use of a Functional Personnel Accountability System

A personnel accountability system is a system that readily identifies both the location and function of all members operating at an incident scene [NFPA 1550 2024]. The philosophy of the personnel accountability system starts with company unity and unity of Command. It is possible to fulfill unity initially and throughout the incident by documenting the situation and resource status on a tactical worksheet or a resource status/accountability board.

A personnel accountability system should be used to collect and maintain the status and location of the members working in, or potentially working in, the hazard zone of an incident. An integral part of the accountability system is to make sure firefighters assigned to and operating in the hazard zone are accounted for throughout the entire incident. All members operating at an incident are responsible for understanding and participating in this system. The IC should be responsible for overall accountability for the incident. However, ICs may delegate accountability of resources to other appropriate staff members to meet goals, objectives, and tasks as needed.

For a personnel accountability system to work properly, there should be an SOP/SOG that defines each function's responsibility, and the hardware needed to ensure effective workflow on the fireground. Another key to the success of the personnel accountability system is training (both classroom and practical) to secure this process for emergency incidents.

Fireground Communications

At this incident, the total time of the "Mayday Period" was 15 minutes and 52 seconds (15:52). The incident audio by department members indicates the following:

- The Mayday was initiated via voice only.
- The radio subscriber's emergency features were not activated (i.e., Emergency Alert Button).
- There was little to no radio discipline during the Mayday Period (limiting transmissions or maintaining radio silence during rescue efforts).
- There were 278 transmission attempts during the Mayday Period.
- There were 100 transmission rejects during the Mayday Period because other radios were actively talking on the talkgroup.
- There were 17 noted rejects for E251A (i.e., times when the E251A attempted to transmit but could not).
- The total talk time during the Mayday Period was 14 minutes and 46 seconds.
- The total talk time during the Mayday Period for E251A was 00:00:54.6 seconds.
- The total talk time during the Mayday Period for command officers/administrative units was 9 minutes and 28 seconds.
- Total talk time during the Mayday Period Dispatch was: 00:00:21.7 seconds.
- There was only 67 seconds of free airtime during the entire Mayday period. This equates to less than 5 seconds per minute of available talk time on the specific radio system talk group.

The five types of radio communication directed to the IC are Mayday Traffic, Priority Traffic, Roof Report, Routine Traffic, and Status Changes [Hamilton County Fire Chiefs Association (HCFCA)

2023]. The IC should be positioned in a strategic CP outside the hazard zone to send and receive information.

Companies operating in the hazard zone are subject to hazard-zone distractions that can cause communication problems. The IC needs to understand this when communicating with operating companies. Companies also must understand that their portable radios provide the only communications link to the outside world [SKCFTC 2023]. Radio communications connect the tactical and task levels with the IC working on the strategic level. Face to face communications should be used whenever possible in the following circumstances:

- Company officers communicating with their crew members
- Company officers communicating with other company officers in their work area
- Tactical level bosses communicating with units assigned to their geographic location

Dividing the incident scene into divisions or groups may organize communications. When the IC assigns a division/group supervisor to a key tactical position, this manages the span of control and enhances the communications process [SCKFTC 2023]. This limits unnecessary radio traffic to keep it clear for more priority transmissions.

Staff Aide or ICT Functions

An ICT can also be known as a field incident technician, emergency incident technician, staff aide, or staff assistant. A staff aide/ICT is defined by NFPA 1550, Standard on Emergency Responder Health and Safety, as a firefighter or fire officer assigned to an operational chief officer to assist with the logistical, tactical, and accountability functions at an emergency incident [NFPA 1550 2024]. In Chapter 21 – Command Safety in NPFA 1550, 21.6 – Assignment of Staff Aides states, “The incident commander and members who are assigned a supervisory responsibility that involves three or more companies or crews under their command shall have an additional person (staff aide) assigned to facilitate the tracking and accountability of the assigned companies or crews” [NFPA 1550 2024].

The key functions of an ICT include conducting a 360-degree scene size-up and risk assessment, maintaining radio and other communications (e.g., MDT, cell phone), maintaining a tactical worksheet, and performing any other related duties that will assist in efficient command operations. An ICT may be assigned with the battalion chief to the hazard zone as part of a tactical assignment (e.g., division or group supervisor).

Recommendation #2: For low-frequency, high-risk incidents, fire departments should ensure all companies operating on the fireground maintain crew integrity throughout the incident.
Companies can:

- ***Operate based on the assignment given by the IC***
- ***Communicate critical incident benchmarks to the IC***
- ***Deploy to rescue members during the initial stages of an incident***
- ***Use a thermal imager during the scene size-up and while operating in the hazard zone***

Discussion: At this incident, the crew of Engine 251 separated on arrival. E251A went to Side Charlie and Engine 251C went to Side Bravo. Multiple crews reassigned themselves to various tasks or

assignments, especially after the Mayday occurred. These tasks or assignments were not communicated to IC nor were crews accounted for during fireground operations. Critical incident benchmarks that involved incident activities such as fire attack, water supply, and search and rescue were not communicated. As there was not a formal RIC established for the incident, E231, TR23, and E152 were immediately redirected to locate and rescue E251A.

Crew Integrity

Crew integrity is essential to fireground accountability. NFPA 1550 Paragraph 10.5.6 states, "Company officers shall maintain an ongoing awareness of the location and condition of all company members." Paragraph 10.5.7 states, "Where assigned as a company, members shall be responsible to remain under the supervision of their assigned company officer" [NFPA 1550 2024]. It is the responsibility of every firefighter and company officer to maintain communication or contact with crew members by visual observation, voice, or touch while operating in the hazard zone.

Technology, such as thermal imaging, is one tool to aid with accountability in zero visibility. A Mayday should be called if any member cannot be accounted for during a PAR. Rapid determination of missing responders is critical if an unplanned event occurs [NFPA 1550 2024].

Incident accountability was discussed in the previous recommendation around incident management. Regarding crew integrity during incident management, considerations include [FIRESCOPE 2015; NFPA 1550 2024]:

- Follow accountability procedures to track individuals regardless of their location or assignment at the incident (e.g., hazard zone, on-deck, rehab).
- Account for personnel who arrive on-scene by other means besides apparatus.
- Maintain crew integrity to avoid "freelancing" by individual crewmembers.
- Provide all personnel the ability to communicate with assigned supervisors.
- Ensure the division or group supervisor can account for different crews by means of an "identifier."
- Conduct an accounting of all members at certain points during the incident/event, when benchmarks are met, conditions change, or assignments are complete.
- Provide a process to rapidly account for all responders on-scene.

Task, Location, and Objectives

Assigning tactics in order of accomplishment can aid in the coordination of fireground activities. Companies should communicate their progress reports on the tactical objectives assigned to them by Command. Incident operations are conducted around the completion of the tactical priorities. As such, incident communications should be direct to maximize the available free airtime.

When assigning any unit into the hazard zone, the initial IAP should include the [SKCFTC 2023]:

- Tasks of the initial arriving unit
- Location of the tasks
- Objectives of the tasks

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An assigned tactic serves as the basis for feedback to the IC. If a company is unable to complete the tactic, the IC needs to know as soon as possible to adjust the IAP. The IC must understand why the company cannot complete the assigned tactic. Informing the IC of situations such as no water, unanticipated conditions, or conditions that have deteriorated since the original assignment provide the IC with insight to adjust the IAP appropriately. [USFA 2009].

Communication of Critical Incident Benchmarks
Command must consider and account for changing fireground operations, because they are responsible for staying ahead of the fire by forecasting the direction of the incident. Without this information, the IAP becomes out of sequence with the phase of the fire. It is the IC's responsibility to do whatever is required to stay effectively informed and to ensure that critical incident benchmarks are communicated [NIOSH 2009, NIOSH 2010].

To ensure that the proper benchmarks are communicated at fireground incidents, fire departments should develop and maintain a consistent process for communicating critical benchmarks in the form of an SOP/SOG that includes [NIOSH 2014a, NIOSH 2014b, NIOSH 2015, NIOSH 2018a]:

- Hands-on classroom
- Practical training programs with annual live fire training
- Defined department deployment model
- Incident management system
- Radio equipment (mobile and portable radios), and adequate radio channels (dispatch, tactical, and command channels)

Because the IC is located at the CP, interior crews should communicate interior conditions to the IC as soon as possible because it may change the IC's strategy and IAP. Interior crews should provide reports of the interior conditions as soon as they enter the fire building with regular updates, especially when benchmarks are met (e.g., "primary search complete, all clear" and "the fire has been knocked down").

Thermal Imagers
Thermal imagers enhance firefighter safety by supporting tasks such as size-up, search and rescue, fire attack, and ventilation. Firefighters should be properly trained in the use of a thermal imaging camera and be aware of their limitations. Thermal imagers used by the fire service should be compliant with NFPA 1801, *Standard on Thermal Imagers for the Fire Service* [NFPA 1801 2021].

At a structure fire, the thermal imager may help identify the location of the fire or the extent of fire involvement before firefighters are deployed into a structure. In near zero visibility conditions, thermal imaging enables primary searches to be completed quickly and with an added degree of safety because it tracks and locates other firefighters. The use of thermal imaging technology may also be invaluable when a structure has larger floor areas or unusual floor plans [NIOSH 2011]. Thermal imagers may also provide the potential to detect a fire that is isolated or hidden within parts of a structure. However, research by Underwriters Laboratories has shown that there are significant limitations in the ability of these devices to detect temperature differences behind structural materials such as the exterior finish of a building or outside compartment linings (i.e., walls, ceilings, and floors).

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From a ventilation perspective, firefighters can use thermal imaging to identify areas of heat accumulation, possible ventilation points, and significant building construction features. This helps ensure proper and effective ventilation that successfully removes smoke and heat from a building.

Recommendation #3: Fire department SOPs/SOGs are consistently updated to ensure adequate staffing and professional development opportunities to support skills and competencies to manage Type V and Type IV incidents. Possible opportunities and activities:

- ***Train all firefighters and fire officers in fireground survival procedures***
- ***Conduct training on rural water supply operations***
- ***Provide annual proficiency training and evaluation on fireground operations, including live fire training, to all members involved in emergency operations***
- ***Train all members and dispatchers on the safety features of portable radios including the EAB***
- ***Train on awareness of CSST and the hazards associated with it***

Discussion: In this incident, E251A did not activate the EAB on his portable radio. The IC had no formal training or credentialing in the ICS. The fire division did not have a formal incident management training for members who were expected to function on the strategic, tactical, and task level. Members who functioned in ICS positions typically gained their competencies through on-the-job experience.

Adequate Deployment and Staffing

Fire departments should consider deployment strategies to ensure that adequate resources are on scene to conduct fire suppression operations for likely hazards in their jurisdiction. These strategies should involve a comprehensive risk assessment within the community. The risk assessment should consider factors such as service demands on the department, demographics, socioeconomics, building and occupancy types, and other characteristics that can help identify the likelihood of fire.

The first resource on scene must determine the structure's size to develop an incident strategy. This information should be transmitted to the dispatch center and all responding resources as part of the preliminary size-up report.

If the available staffing and deployment are insufficient for the incident, the initial strategy should focus on primary search and at least a single hoseline to protect the firefighters assigned to a primary search. The IC should consider a defensive position until additional resources arrive. During this time, the fire will continue to grow and have negative effects on the structural integrity of the building, making an offensive attack much less desirable and certainly more dangerous.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* requires a minimum full alarm assignment of 14 firefighters and 1 command officer, for a residential structure fire in a typical 2,000 square-foot, two-story single-family dwelling without a basement and with no exposures within eight minutes of travel time [NFPA 1710 2020]. If an aerial or platform is in operation, 17 members are required. This staffing allows for one attack line to be placed in operation

on the first floor or second floor, with one back-up line, one search and rescue crew (three firefighters), one ventilation crew (two firefighters), and a two-member RIC.

Best practices suggest that residential structures that exceed these characteristics, but do not fit a high-rise or high-hazard occupancy, should receive a minimum full-alarm assignment of 26 firefighters, one command officer, and one ICT for a total of 28 personnel on the scene of a structure fire within eight minutes of travel time [NFPA 1710 2020]. This staffing allows for two attack hoselines to be stretched to an upper floor, one back-up hoseline, at least two search and rescue crews, one interior forcible entry/ventilation crew, one exterior ventilation crew (two or three firefighters), and a four-person RIC. The standard also requires staffing of engine companies and truck companies with a minimum of four on-duty personnel [NFPA 1710 2020].

Fireground Survival

Calling a Mayday is a complex behavior that includes the affective, cognitive, and psychomotor domains of learning and performance [Grossman and Christensen 2008; Clark 2005]. Any delay in calling a Mayday reduces the chance of survival and increases the risk to other firefighters trying to rescue a downed firefighter. Fire departments should ensure that any members who may enter an immediately dangerous to life and health (IDLH) environment meet the Mayday competency standards of the AHJ throughout their active-duty service. [IAFF 2010; Clark 2005; Clark 2008; USFA 2009].

Once in distress, firefighters must immediately declare a Mayday. Mayday communication must provide the location of the firefighter in as much detail as possible and, at a minimum, should include the division (floor) and quadrant. It is imperative that firefighters always know their location when in IDLH environments to effectively give their location in the event of a Mayday.

The extreme level of stress encountered when firefighters become lost, disoriented, injured, trapped, or run low on air during rapid fire progression can have psychological and physiological effects. A firefighter who is breathing carbon monoxide quickly loses their cognitive ability to communicate correctly and can unknowingly move away from an exit and other firefighters before becoming unconscious. The window of survivability closes quickly because of the lack of oxygen and high carbon monoxide concentrations in an IDLH environment [Clark 2005; Clark 2008]. Reaction to the extreme stress of a life-threatening situation, such as being trapped, can result in sensory distortions, and decreased cognitive processing capability [Grossman and Christensen 2008]

Mayday training is frequently limited to breathing apparatus emergencies, egress through small openings, and emergency window egress. It is necessary to place additional emphasis on appropriate procedures for tactical withdrawal under worsening fire conditions and structural collapse situations. Firefighter training programs should include training on air management and emergency communications, familiarity with their SCBA, radio, and PPE, crew integrity, reading smoke, fire dynamics and fire behavior, entanglement hazards, building construction, and signs of pending structural collapse. The IAFF developed the IAFF Fire Ground Survival Program to ensure that training for Mayday prevention and Mayday operations is consistent between all firefighters, company officers, and chief officers [IAFF 2010].

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Firefighters must transmit a Mayday while still having the capability and sufficient air. Firefighters may need to move away from intense fire conditions before calling the Mayday. The next step is to manually activate their PASS device. To conserve air while waiting for rescue, firefighters should try to stay calm and focused on their situation avoiding unnecessary physical activity. After initiating a Mayday, firefighters should survey their surroundings to get their bearings and determine potential escape routes, such as windows, doors, hallways, changes in flooring surfaces, etc. Firefighters should also stay in radio contact with the IC and other rescuers. In addition, firefighters can attract attention by maximizing the sound of their PASS device (e.g., by pointing it in an open direction), pointing their flashlight toward the ceiling or moving it around, and using a tool to make tapping noises on the floor or wall. A crew member who initiates a Mayday call for another person should quickly try to communicate with the missing member via radio. If unsuccessful, initiate another Mayday providing relevant information on the missing firefighter's last known location. The IC needs to initiate an operational retreat whenever the operational area is deemed unsafe for emergency personnel. An emergency egress signal should sound [IAFF 2010; LAFD 2016]. For example, repeat short air horn blasts about 10 seconds long, followed by 10 seconds of silence.

Mayday training should include situations dealing with uncontrolled SCBA emergencies, egress through small openings, emergency window egress, building collapse, and other situations that are possibly encountered during a Mayday situation. Firefighters need to be trained to recognize when they are in trouble, know how to call for help, and understand how ICs and others need to react to a responder in trouble [Jakubowski and Morton 2001].

Rural Water Supply

Establishing water supply at the fireground is a critical operations benchmark. In areas with limited or no hydrants, a comprehensive preplanning process is needed. This process may include information on map book pages, case notes, or comments on the dispatch to a defined address. For areas without a hydrant, this preplan information should be in a water supply preplan book. Water supply preplan books are sent to applicable engine and tanker/tender companies and shared with automatic aid and mutual companies [Fire and Rescue Departments of Northern Virginia 2021].

While enroute to the fire, the first engine officer on scene should initiate the incident's water supply plan. Using area preplans, the officer can designate dump sites, fill sites for the shuttle operation, or relay positions for incoming units. The scene size-up and risk assessment conducted on arrival should include an estimate of fire flow requirements and anticipated water supply. When water requirements exceed the amount available from nearby hydrants or the amount of water carried by the first Alarm apparatus, a water supply group and water supply group supervisor should be designated [FCFCA 2015].

Annual Proficiency Training and Evaluation

To ensure proficiency and competency of fire department members, fire departments should conduct annual skills evaluations to verify minimum professional qualifications and prevent the degradation of skills and abilities. Proficiency evaluation and training provides an opportunity to ensure that all fire officers and firefighters are competent in fireground operation knowledge, skills, and abilities. This process should include annual live fire training.

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As members progress through various job duties and responsibilities, the department should ensure the necessary knowledge, skills, abilities for the defined position. They must be able to demonstrate competencies for that position. The training and education process should also provide ongoing development of existing skills [NFPA 1550 2024]. NFPA 1410, *Standard on Training for Initial Emergency Scene Operations*, defines basic evolutions, which are adaptable to local conditions and serve as a method for the evaluation of minimum acceptable job performance during initial fireground operations [NFPA 1410 2020]. Proficiency training for fireground operations and emergency incidents should include scene size-up, situational awareness, use of an incident management system, personnel accountability system, strategy and tactics, search and rescue, hoseline operations, ladder operations, ventilation, thermal imagers, fireground communications, use of RICs, and Mayday management and operations.

Prior to conducting hands-on evolutions, classroom instruction on fire behavior, heat transfer, personal protective equipment, fire control, and hazards specific to the incident should ensure the understanding of fuel interactions, ventilation, suppression, weather on the fire, and the capabilities of their equipment.

Portable Radios

The NIOSH Safety Advisory *The Importance of Understanding and Training on the Portable Radio Emergency Alert Button (EAB)* was developed based on a line of duty death. Each firefighter should be equipped with a portable radio and trained on its use and safety features. This training process should extend to the fire department's dispatchers because they are responsible for designating a channel for emergency alert button (EAB) transmission [NFPA 1550 2024; NIOSH 2022].

The safety features on portable radios include:

- EAB, commonly referred to as the "orange" button on top of a portable radio or remote speaker microphone
- The man-down notifier (MDN)
- The dispatcher's ability to "alert" a portable radio

In addition, several portable radio manufacturers are developing the ability for a dispatcher or on-scene ICs to remotely activate a firefighter's EAB [NIOSH 2022; NFPA 1802 2021]. The EAB is preprogrammed to send an emergency transmission on a designated channel or talkgroup. When operating on a simplex channel or in the direct mode, the radio can revert to a channel/talkgroup monitored by the IC or a dispatch center. The communication system administrator must program the transmission channel/talkgroup for the EAB.

The EAB is activated by pressing it for at least 1 second, but not more than three seconds. When the EAB is activated, the portable radio identifies the user's department identification or riding position (e.g., Engine 19 Officer). This signal overrides any other communication over the selected radio channel for 10 to 30 seconds depending on the programming. Once activated, the portable radio operating on a trunked system is given priority access to the talkgroup until the EAB is reset. While in the EAB mode, transmissions will be at the device's highest radio frequency (power), and an audible beacon will sound at full volume until the EAB is reset [NIOSH 2022, NFPA 1802 2021].

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The MDN is an alternate way to activate the EAB. The MDN can be activated in two ways: 1) a specific radio tilt angle, or 2) a combination of the radio tilt angle and the lack of radio motion. The MDN function alerts the firefighter that the EAB is about to activate, which allows the firefighter to dismiss the transmission [Motorola 2014; NIOSH 2022; NFPA 1802 2021].

The dispatcher can also "alert" a firefighter's portable radio. This is used when trying to locate a lost, missing, or down firefighter. The "alert" will continue to sound until reset but at the volume set on the portable radio.

IC Competencies

The ICS is the process used to manage hazard zone operations to ensure the incident starts in control, stays in control, and ends in control. This process should be used and applied the same way for all incidents [SKCFTC 2023]. It provides a standard approach to manage the incident. The ICS should not create additional challenges for the IC. The principles of ICS are based on the eight functions of command developed by Fire Chief Alan V. Brunacini [Brunacini 2002]. NFPA 1550, Standard for Emergency Responder Health and Safety [NFPA 1550 2024], and NFPA 1026, Standard for Incident Management Personnel Professional Qualifications [NFPA 1026 2024] provide specifics on ICS training, qualifications, and operationalization.

The first arriving resource should establish command of an incident. The initial scene size-up is communicated to the initial responding units with or without a command officer on the scene. The strategy and tactics for an incident are dictated by the size-up, initial risk assessment, and situational report from the first arriving officer or resource. If physical barriers or building size make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta should be delegated to another fire department resource. The priority is to get a fire department unit to Side Charlie of the structure. Unless an obvious life-safety issue exists, interior firefighting operations should not commence until a report from Side Charlie is received [SKCFTC 2023].

There are necessary tasks that need to occur at any fire regardless of the occupancy, such as the initial on-scene report upon arrival, initial risk assessment, situational report, water supply, deployment of hoselines and back-up hoselines, search and rescue, ventilation, initial RICs, ground and aerial ladder placement, fire attack and extinguishment, and salvage and overhaul. Any change to operational priorities or responsibilities based on the scene size-up should be clearly communicated to Command, all responding units, and the dispatch center via the assigned tactical radio channel [FDNY 2011; TSFRS 2014]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

CSST Training

Firefighters should be aware of the risks associated with CSST and understand how to recognize and approach a CSST fire. Phoenix Advocates offers free training addressing these topics (Phoenix Advocates 2025).

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Recommendation #4: Governing municipalities (federal, state, regional, and local) should develop and implement legislation which prohibits the use of corrugated stainless-steel tubing in residential, commercial, and industrial structures.

Discussion: The home was built with a gas-piping system, CSST, providing LPG to the stove and fireplace both located on Side Bravo of the structure. All other utilities in the residence were electric. This incident was from a lightning induced failure of CSST located in the basement of the residence. Multiple CSST arc holes occurred under a thermally thick tile kitchen floor. The tile floor collapsed into the burning basement as E251A attempted to fight the fire on the first floor, causing him to fall into the burning basement below. The floor collapse occurred above the location of the CSST gas line, and the officer immediately transmitted Mayday calls for assistance, but was unable to self-extricate. This incident was like a previous NIOSH firefighter fatality investigation that identified CSST as a contributing factor to a fire when lightning caused the CSST to fail and leak propane gas [NIOSH 2018a].

When a lightning strike is suspected, firefighters should rule out fire spread in concealed spaces containing combustible structural members on all levels of the residence. This includes the duct space between the basement and the first floor. Firefighters should also be aware that CSST arc holes and subsequent gas ignition can occur from arcing contact of the CSST with energized electrical branch circuits, unrelated to lightning exposure. Not all CSST related fires result from lightning.

The Flynn and Laird Act of 2022 (Maryland House Bill 1052) took effect on October 1, 2022. The Act expressly prohibits the use of non-arc-resistant jacketed CSST in (Maryland PSC 2025):

- The new construction of a customer-owned natural gas or liquefied propane piping system in a building
- A natural gas or liquefied propane piping system in a renovated property if the renovation affects more than 50% of the total square footage of the property
- A natural gas or liquefied propane piping system that requires the addition of a new gas line to the gas piping system

In 2025, additional legislation was signed in Maryland (SB0175) to further increase CSST safety standards and ban the sale, transfer, or distribution of non-jacketed CSST [Jacoby 2025].

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Additional Information

International Association of Fire fighters Fire Ground Survival Program

The IAFF Fire Ground Survival Training addresses Mayday prevention and Mayday operations for firefighters, company officers, and chief officers. Firefighters 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 through the Assistance to Fire fighters (FIRE Act) grant program, this comprehensive fireground survival training program applies the lessons learned from fire fighter fatality investigations conducted by the NIOSH. It was developed by a committee of subject matter experts from the IAFF, the IAFC, and NIOSH.

Disclaimer

The information in this report is based upon dispatch records, audio recordings, witness statements, and other information that was made available to the National Institute for Occupational Safety and Health (NIOSH). Information gathered from witnesses may be affected by recall bias. The facts, contributing factors, and recommendations contained in this report are based on the totality of the information gathered during the investigation process. This report was prepared after the event occurred, includes information from appropriate subject matter experts, and is not intended to place blame on those involved in the incident. Mention of any company or product does not constitute endorsement by NIOSH, Centers for Disease Control and Prevention (CDC). In addition, citations to websites 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 websites. All web addresses referenced in this document were accessible as of the publication date. *NIOSH Approved is a certification mark of the U.S. Department of Health and Human Services (HHS) registered in the United States and several international jurisdictions.*