1000 FREDERICK LANE, MORGANTOWN, WV 26508 · 304.285.5916

Lieutenant Dies from a Floor Collapse in Residential Structure Fire with Unpermitted Renovations – Illinois

Executive Summary

On December 4, 2021, a 38-year-old lieutenant (the officer of Engine 6 North) died after falling into the basement when the floor collapsed at a residential structure fire. On December 3, 2021, at 23:04 hours, a Still Alarm for mutual aid box alarm system (MABAS) Box 30 was dispatched for a residential structure fire. The county dispatch center (TwinComm) dispatched Engine 48 (E48), Engine 41 (E41), Engine 6 North (E6N), Tender 1 North (T1N), Car 1 South, Car 1 North, Deputy Chief 2 South (DC2S), and Deputy Chief 2 North (DC2N). Car 1 South arrived on-scene at 23:14 hours and found a fire in the attached garage that had extended into the house. Car 1 South established himself as the incident commander (IC) on arrival. E48 arrived on-scene at 23:14 hours. IC ordered E48 to stretch a 2½-inch and 1¾-inch hoseline towards the garage. As E6N arrived on-scene at 23:18 hours, E48 initiated an exterior attack on the garage. DC2S arrived on-scene at 23:18 hours and was assigned as the accountability officer. E48 moved to Side Alpha to make entry through the front door. Upon entry, they noticed the entire attic space was involved in fire. The officer of E6N (E6NA) (deceased firefighter) and the officer of T1N (T1NA) joined E48 to enter the house. Car 1 North arrived at 23:21 hours and was assigned as Operations Section Chief/Division Alpha Supervisor. The two firefighters from E6N went to Side Charlie with a 1¾-inch hoseline to knock down the porch fire. At 23:28 hours, DC2N arrived on-scene and was assigned as Division Charlie Supervisor.

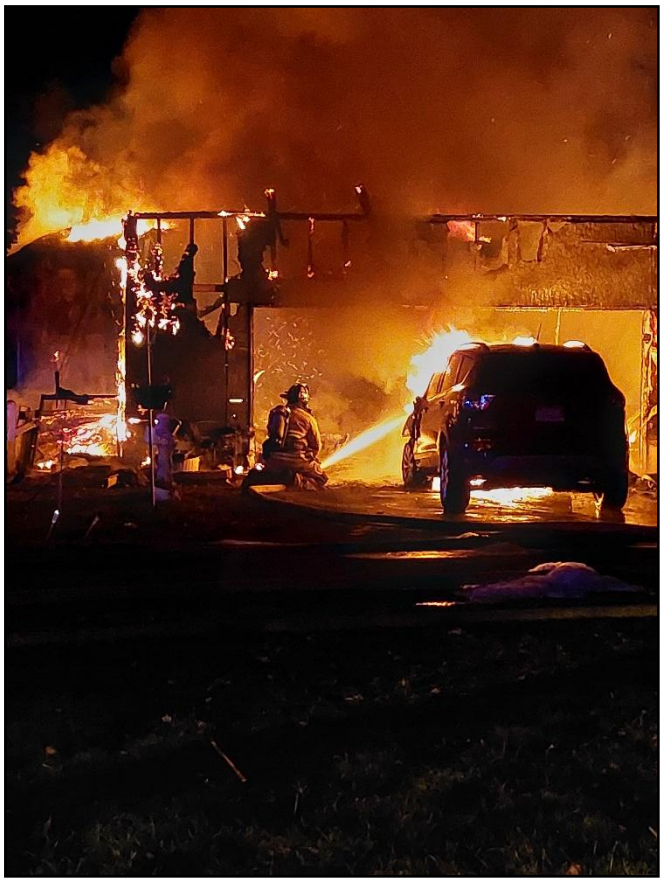

Photo 1: A firefighter from Engine 48 attempting to knock down the fire in the garage. ***(Courtesy of Heather Smith - Eye on News)***

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At 23:29 hours, fireground operations were at 15 minutes. At this time E48, E6NA, and T1NA exited the structure together after their self-contained breathing apparatus (SCBA) end of service time indicators (EOSTIs) sounded. After a cylinder change, the crew from E48 reentered the structure through the front door on Side Alpha. E6NA and T1NA reentered the house through the front door, but split up and went to different rooms to pull ceilings. T1NA pulled ceiling until he was completely out of air. As he left the structure through the front door, he encountered two firefighters from E41. T1NA went to the rehabilition area and met a firefighter from E48, who was with him on the initial fire attack. During this time, the accountability officer had E6NA on a team with two other firefighters in the building. At 23:44 hours, fireground operations were at 30 minutes. A crew of three firefighters were then assembled and directed to enter the building and report to the E6NA for an assignment. Interior operations continued with firefighters from multiple departments rotating in and out of the structure. At 23:54 hours, Car 1 North advised IC that the fire was under control and major overhaul was underway. At approximately 23:59 hours, E6NA met face-to-face with the incoming firefighters and then headed towards the outside. Since his crew had already been sent to rehab, E6NA was alone at this point. Fireground operations were at 45 minutes at this time.

At approximately 00:01 hours on December 4, a radio report was transmitted on MABAS Red of a partial floor collapse. As E6NA exited the building, he fell through a fire weakened portion of the floor into the basement near the Side Alpha/Side Delta corner of the family room floor. E6NA transmitted a Mayday at approximately 00:04 hours on the dispatch channel. Most crews were operating on the MABAS Red and did not hear the Mayday. Car 1 North declared emergency traffic and asked for the member who called the Mayday to repeat the message. There was no response. A personnel accountability report (PAR) was initiated at approximately 00:06 hours. A firefighter from Squad 1 (a part of Car 1 North) was initially thought to be the missing firefighter. This firefighter was found on Side Charlie. After approximately 10–12 minutes, a message was transmitted over MABAS Red stating, “We have PAR.” Car 1 North advised IC that all interior crews were accounted for at this time. At approximately 00:37 hours, firefighters in the rehabilitation area could not locate E6NA. A search operation was initiated. During the search, IC advised the house had a full basement. The presence of a basement was unknown to initial responding units because all the basement windows were boarded up and painted over to match the siding of the structure. A crew went to the basement steps but could not enter because of debris from the 1st floor collapse. A crew from a mutual aid fire department entered a front bedroom/office and cut a hole in the 1st floor. A crew from mutual aid fire department Engine 6 (DCE6) used an attic ladder to enter the basement through the hole. DCE6 reported heavy smoke, no visibility, and no visible fire.

Shortly after entering the basement, a crew member heard an SCBA personal alert safety system (PASS) alarm sounding. The crew located E6NA with his SCBA facepiece and regulator intact and his helmet on. DCE6 reported to IC that they found E6NA and requested emergency medical services (EMS) at approximately 00:52 hours. The third attempt to remove E6NA from the basement was successful. E6NA was transferred to EMS personnel for care at approximately 01:02 hours. He was transported by ambulance to a local trauma hospitial and was pronounced deceased at 01:41 hours. The fire was marked under control at approximately 02:00 hours by IC. The fire was declared out at approximately 06:45 hours.

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Contributing Factors

- *Scene size-up and risk assessment*
- *Personnel accountability*
- *Crew integrity*
- *Basement fire*
- *Professional development*
- *Lithium-ion battery fire*
- *Emergency communications*
- *Unpermitted occupancy renovations*

Key Recommendations

Fire departments should:

- *Ensure initial and ongoing size-ups and risk assessments are conducted throughout the incident.*
- *Train ICs to provide ongoing accountability to include immediately establishing divisions/groups with a supervisor to communicate conditions and critical benchmarks.*
- *Use a personnel accountability system to identify the location and function of all personnel operating at an incident.*
- *Ensure company officers and firefighters maintain crew integrity.*
- *Ensure fire department operations include Standard Operating Procedures (SOPs)/Standard Operating Guidelines (SOGs) for identifying basements and below-grade fires.*
- *Ensure the implementation of a training, education, and professional development program is based upon each rank.*
- *Raise awareness about the fire dangers of lithium-ion battery-powered products among community members through fire and life safety education programs.*

Public Safety Answering Points (federal, state, regional/county, and local) should:

- *Ensure a communication SOP and equipment is in place for dispatchers to support fireground operations and the IC, including the ability to receive emergency alert button (EAB) signals from portable radios as well as monitor and record all radio traffic during fireground operations.*

Governing municipalities (federal, state, regional/county, and local) should:

- *Ensure the applicable fire and life safety codes are enforced for renovations in residential occupancies and relevant information is shared with the fire department.*

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For further information, visit the program at www.cdc.gov/niosh/firefighters/fffipp/ or call 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On December 4, 2021, a 38-year-old lieutenant (the officer of Engine 6 North) died after falling into the basement when the floor collapsed at a residential structure fire. On December 8, 2021, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. At the request of both fire departments involved in the incident and the International Association of Fire Fighters (IAFF), a field investigation was conducted October 16–23, 2022. Two investigators representing the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Illinois to investigate this incident. The NIOSH investigators met with the fire chief and deputy chief of Fire Department North, the fire chief and deputy chief of Fire Department South, as well as fire officers and firefighters from both departments that responded to the incident. Additionally, NIOSH investigators met with and interviewed members of the mutual aid fire protection district and city fire department that responded to the incident. NIOSH investigators also met with the medical examiner that conducted the autopsy, investigators from the Illinois State Fire Marshals Office, and an investigator from the Illinois Department of Labor. NIOSH investigators reviewed fire department training records, SOPs, incident scene photographs, drawings and videos, and training records of the deceased firefighter.

Fire Departments

The two fire departments that initially responded to the incident are identified as Fire Department North and Fire Department South in this report. Fire Department South was first due to the fire at MABAS Box 30. The two cities are separated by a river and operate on an automatic aid response. Previously, both fire departments were under the direction of the same fire chief. At the time of this incident, each fire department had its own fire chief and staff.

Fire Department South

Fire department South is a combination department with one station staffed with four members per shift. Each shift works a 24-hour on, 48-hour off schedule (i.e., 56-hour work week). The department covers around 89 square miles and responds to about 1,100 calls annually. The department protects a city population of 8,500 and rural population of 13,000. The department consists of a fire chief, one deputy chief, three captains, 12 firefighters, and four paid-on-call firefighters. The deputy chief also serves as the training officer.

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Fire Department North
Fire Department North is a combination department with 21 career firefighters and four paid-on-call firefighters. Fire Department North has two stations staffed with five personnel that work a 24-hour on, 48-hour off schedule (i.e., 56-hour work week). The department covers around 83 square miles and responds to about 1,500 calls annually. The department protects a city population of 14,500 and a rural population of 11,000. The department's rank structure includes firefighter, lieutenant, captain, deputy chief, and fire chief.

Training, Education, and Experience

Illinois Office of the State Fire Marshal
The Illinois Office of the State Fire Marshal (OSFM) does not mandate minimum training requirements for firefighters. However, the OSFM does maintain and oversee a Division of Personnel Standards and Education (DPSE) which promotes, encourages, and assists local governments to improve the levels of education and training standards for local firefighters. While this program is strictly voluntary, the OSFM and the DPSE highly encourage local governments to adopt and complete firefighter certification programs. This includes offering a reimbursement program for firefighter training costs. Additional information about the DPSE's programs can be found on the Division's website, and the General Assembly's Illinois Administrative Code which includes training facilities, examinations, and a current list of certifications.

Fire Department Training
Both fire departments require *Illinois Basic Fire Fighting* course (240 hours), *Advanced Fire Fighting* (120 hours), *Hazardous Materials Awareness* and *Hazardous Materials Operations* (40 hours), and emergency medical technician (EMT) (130 hours) training for recruits. **Table 1** shows the training and International Fire Services Accreditation Congress (IFSAC) certifications on record for EN6A (deceased firefighter).

Table 1. Training and certification for EN6A in reverse chronological order

Training Requirement	Hours	Date of Completion
Fundamentals of Basic Interior Structural Fire Fighting	80	November 2007
Hazardous Materials Operations	24	November 2007
NFPA 1001, Fire Fighter I (IFSAC)	192	December 2007
Fire Fighter Candidate School	346	December 2007
Basic Auto Extrication	16	January 2008
Emergency Vehicle Driving Training	40	March 2008
Flammable Liquids and Gas Fire Fighting	8	May 2008
USFA Building Construction Principles: Combustible	16	September 2008
NFPA 1001, Fire Fighter II (IFSAC)	80	November 2008
Pump Operations	40	October 2009
Rope Rescue Operations	24	February 2010
IAFF Hazardous Materials Technician	80	March 2011
Aerial Operations	24	August 2011
AHA First Responder	40	December 2012

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IAFF Hazardous Materials Technician	80	March 2011
Aerial Operations	24	August 2011
AHA First Responder	40	December 2012
NFPA 1041 – Fire Instructor I	40	April 2018
NFPA 1021 – Fire Officer I	80	November 2018
NFPA 1041 – Fire Instructor 2	40	April 2020

Staffing, Apparatus, and Communications

The "Still" Alarm for MABAS Box 30 consisted of several apparatus (s**ee Table 2**).

Table 2: Response to the "Still" Alarm at MABAS Box 30

Apparatus	Staffing
Engine 48	3 – Captain, Firefighter, Engineer
Engine 41	2 – Captain, Firefighter
Engine 6 North	3 – Acting Captain, Acting Lieutenant, Engineer
Tender 1 North	2 – Engineer, Firefighter
Car 1 South	1 – Fire Chief
Deputy Chief South 2	1 – Deputy Chief
Car 1 North	1 – Fire Chief

Communications

Fire department communications in the county are under the direction of the county sheriff. Radio communications are conducted on very high frequency (VHF) on 153.83 megahertz (MHz) (Dispatch) and 154.265 megahertz (MHz) (Tactical Channel). MABAS Red is the Interagency Fire Emergency Radio Network (IFERN) frequency (154.2650 MHz) as well as the recently designated IFERN2 frequency (154.3025 MHz). IFERN has been used to coordinate mutual aid activities outside of a MABAS Box Alarm event between fire departments with different primary radio frequencies.

Depending on county location, there were sometimes challenges in the radio transmission reaching the county's radio repeater system, as was the case in this incident. No radio communications on MABAS Red were recorded at TwinComm. Since this incident, there have been efforts to add additional repeaters throughout the county.

Building Construction

The house in this incident was a one-story ranch built in 1972 with a fully finished basement, attached two-car garage, and a gable roof. The structure was built on a poured cement foundation and walls. The attic space was open from Side Bravo to Side Delta (**see Photo 2 and Photo 3**).

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Photo 2. Side Alpha of the house. The garage can be seen on Side Delta.
(Courtesy of Realtor.com)

Photo 3. Side Charlie of the house.
(*Courtesy of Realtor.com*)

There was a shed in the yard on the Side Charlie of the house near the Side Bravo corner and about 20–25 feet from the Side Bravo/Side Charlie corner was a 250-gallon above ground propane tank (**see Photo 4**). The propane tank was shut off on the night of fire, prior to the incident. The basement did not have doors to the outside. At this residence, the basement windows were boarded and painted the same color as the siding of the house (**see Photo 5)**. The stairs to the basement were between the garage and the house on Side Delta and the basement was completely finished. The structure had a

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family room, kitchen, five bedrooms (three bedrooms on the first floor and two bedrooms in the basement), and two bathrooms (both on the first floor). There was a covered porch on Side Charlie. The entrance from the garage to the house had a solid core door and screen door.

Photo 4. The concrete foundation of the house. The red circles indicate the location of the basement windows. The red arrow indicates the basement steps that were the only access to the basement. The green circles indicate the shed and propane tank. (*Courtesy of NIOSH*)

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Photo 5. A view of Side Charlie near Side Bravo. The red circle indicates the location of one the basement windows. The storage shed is to the right.
(Courtesy of the Illinois State Fire Marshal's Office)

The total living space was 1,548 square feet (**see Diagram 1**). Six residents lived in the house. There was a floor plan of the first floor, but not the basement. The house was built with dimensional lumber, wood frame, and Type V construction. There were two 2-inch x 10-inch main beams that went from Side Bravo to Side Delta. The floor joists were 2-inch x 6-inch and went from Side Alpha to Side Charlie. The flooring was tongue and grove in 3-inch slats. The walls were made of 2-inch x 4-inch and covered with sheetrock.

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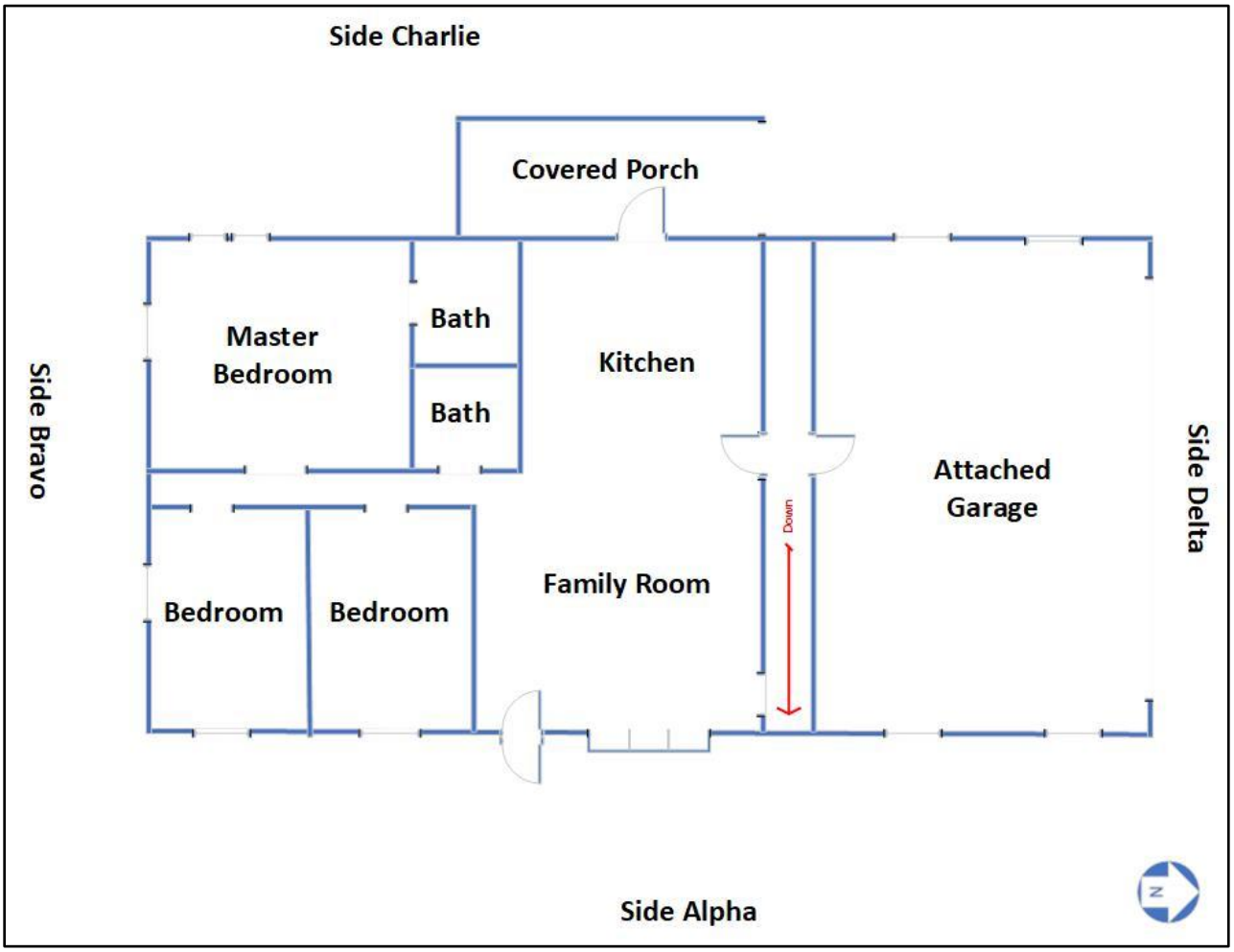

Diagram 1. The floor plan (first floor) (*Prepared by NIOSH*)

Timeline

The following timeline is a summary of events that occurred as the incident evolved. Not all incident events are included in this timeline. The times are approximate and were obtained by examining the dispatch records, audio recordings, witness statements, and other available information. All times are approximate and rounded to the closest minute. The timeline is not intended, nor should it be used, as a formal record of events.

Time	Fireground Operations, Response, and Details
December 3, 2021 **23:04 – 23:05 Hours**	• TwinComm dispatched a Still Alarm for MABAS Box 30 that included E48, E41, E6N, T1N, Car 1 South, Car 1 North, DC2S, and DC2N for a residential structure.

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Time	Fireground Operations, Response, and Details
23:12 – 23:13 Hours	• E48 could see a glow in the sky while enroute to the fire and requested a 1st Alarm for MABAS Box 30.
23:14 Hours	• Car 1 South on-scene and assumed IC. • IC requested all responding companies to switch to MABAS Red tactical channel. • E48 on-scene. • Fire venting through the roof of the house.
23:15 Hours	• IC advised TwinComm that all occupants were out of the house, but two pets were still inside. • IC advised that the garage roof and a vehicle were involved with fire. • IC notified E48 the fire extended into the house, to back into the driveway, and prepare for rural water supply operations. • IC requested E48 to stretch a 1¾ -inch hoseline and a 2½ -inch hoseline.
23:16 Hours	• Car 1 North arrived on-scene and was assigned as Operations Section Chief/Division Alpha Supervisor.
23:18 Hours	• DC2S on-scene, assigned as the accountability officer, and set up vehicle as the Command Post. • Tender 46 (T46) enroute.
23:18 Hours	• E6N arrived on-scene. • T1N arrived on-scene and ordered to drop water via their dump tank.

23:19 Hours	• IC conducted a 360 size-up starting at Side Delta to Side Charlie.
	• IC contacted TwinComm to request the power company to disconnect the power to the structure.
	• IC was on Side Bravo.
	  ○ Checked the above ground 250-gallon propane tank that was 20–30ft from the structure.
	  ○ Propane tank had been secured.
	• IC ordered E6N to Side Charlie.
	• IC ordered E48 to make entry into the house.

23:20 Hours	• E48, E6NA, and T1NA entered the house, encountering heavy fire in the attic.
23:21 Hours	• Car 1 North arrived on-scene and assigned as Operations Section Chief/Division Alpha Supervisor.
23:22 Hours	• Tender 10 and Tender 6 enroute.

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Time	Fireground Operations, Response, and Details
23:23 Hours	• IC on Side Alpha met with Car 1 North.
23:24 Hours	• E6N firefighters attempted to knock down the fire on the rear porch. • E6NA found and rescued a missing dog in the Side Bravo/Side Charlie Corner of the first floor.
23:26 Hours	• Tender 46 on-scene.
23:28 Hours	• DC2N arrived on-scene and assigned as Division Charlie Supervisor.
23:29 Hours	• *15 minutes on-scene time.*
23:29 Hours	• Engine 41 arrived on-scene.
23:39 Hours	• E48, E6NA, and T1NA exit the house to change cylinders. • Fire Protection District Engine 6 (FPDE6) on-scene and assigned as rapid intervention crew (RIC) with four personnel. • FPDE6 performed a confirmatory check of the scene and noted the absence of a basement.
23:40 Hours	• Crew from Engine 41 entered the house to continue firefighting operations.
23:44 Hours	• *30 minutes on-scene time.*
23:54 Hours	• Car 1 North advised IC that the fire was under control and major overhaul was underway. • The message was communicated to TwinComm by IC.
23:59 Hours	• Interior crews were leaving the structure for a cylinder change and rehabilitation. • 45 minutes on-scene time.
December 4, 2021	
00:00 Hours	• E6NA fell through a weakened portion of the first floor into the basement. The floor collapse was near the Side Alpha/Side Delta corner of the family room.
00:01 Hours	• A radio report was transmitted on MABAS Red of a partial floor collapse.

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Time	Fireground Operations, Response, and Details
00:04 Hours	• E6NA transmitted a Mayday on the dispatch channel. Most crews were operating on the MABAS Red and did not hear the Mayday. • The Car 1 North declared emergency traffic. He asked for the member who called the Mayday to repeat the message with no response.
00:06 Hours	• A PAR was initiated.
00:14 Hours	• Fireground operations were at 60 minutes. Car 1 North advised IC that all interior crews were accounted for at the time.
00:16 Hours	• A message was transmitted over MABAS Red stating, "We have PAR." • A firefighter from Squad 1 North was thought to be the missing firefighter but was located on Side Charlie.
00:17 Hours	• Fireground operations were continued.
00:29 Hours	• *Fireground operations were at 75 minutes.*
00:37 Hours	• Firefighters from E6N in the rehabilitation area could not locate E6NA. • A search was initiated for E6NA. • IC advised the house had a full basement.
00:44 Hours	• *Fireground operations were at 90 minutes.* • A mutual aid company was assigned to cut a hole in the 1st floor of a front bedroom/office to access the basement. • They had tried to access the basement from the steps in the garage. Due to the floor collapse, there was no access to the basement from the steps.
00:52 Hours	• DCE6 used an attic ladder to enter the basement through the hole in the 1st floor. • DCE6 reported heavy smoke, no visibility, and no visible fire. • DCE6 located E6NA on the basement floor due to his PASS alarm sounding. • DCE6 initiated the rescue of E6NA.
00:59 Hours	• *Fireground operations were at 120 minutes.*
01:02 Hours	• After three attempts, DCE6 removed E6NA from the basement. • E6NA was transferred to an EMS medic unit for treatment and transport to a local hospital.
01:41 Hours	• E6NA was declared deceased.

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Time	Fireground Operations, Response, and Details
02:00 Hours	• IC advised TwinComm that the fire was under control.
06:45 Hours	• IC advised TwinComm that the fire was out.

Personal Protective Equipment

At the time of the incident, the deceased firefighter was wearing full structural firefighting turnout gear, a NIOSH Approved® SCBA, a portable radio, and work/station uniform. On October 17, 2022, NIOSH investigators inspected the personal protective clothing which included helmet, turnout coat, turnout pants, boots, gloves, and protective hood. Investigators also inspected the portable radio and SCBA. The turnout gear was not considered to be a contributing factor in this incident. No further evaluation or testing of the turnout gear was conducted by NIOSH.

The SCBA was a 3M™ Air-Pak™ 75-4500 (2013 edition of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*). The unit was placed in service in 2015. After this incident, the unit was inspected by 3M Scott technicians and was placed back in service in Car 1 North's vehicle. The SCBA was shipped to 3M Scotts manufacturing facility in North Carolina for evaluation. Engineers were unable to pull records of the PASS going into alarm mode on December 3 or 4, 2021. No further evaluation or testing was done on this SCBA unit. The SCBA was not considered to be a contributing factor in this incident.

Weather Conditions

On December 3, 2021, at 23:09 hours, the temperature was 29°F, the dew point was 28°F, humidity was 96%, there was no wind or gusts, the barometric pressure was 29.40 inches, there had been no precipitation within the past 24 hours, and conditions were foggy.

Investigation

On December 4, 2021, a 38-year-old lieutenant (E6NA) died after falling into the basement when the floor collapsed at a residential structure fire. A "Still" Alarm for MABAS Box 30 was dispatched for a residential structure fire at 23:04 hours on December 3, 2023. Twin Comm dispatched E48, E41, E6N, T1N, Car 1 South, Car 1 North, DC2S, and DC2N. Car 1 South arrived on-scene at 23:14 hours and found a fire in the attached garage that had extended into the house. Car 1 South established themselves as IC. E48 arrived on-scene at 23:14 hours. IC ordered E48 to stretch a 2½-inch and 1¾-inch hoseline towards the garage (**see Photo 6**). As E6N arrived on-scene at 23:18 hours, E48 initiated an exterior attack on the garage. DC2S arrived on-scene at 23:18 hours and was assigned as the accountability officer. E48 moved to Side Alpha to enter through the front door. E6NA and T1NA joined E48 to enter the house. Upon entry, they noticed the entire attic was on fire. Car 1 North arrived at 23:21 hours and was assigned Operations Section Chief/Division Alpha Supervisor. The two firefighters from E6N went to Side Charlie with a 1¾-inch hoseline to knock down the porch fire.

At 23:28 hours, DC2N arrived on-scene and was assigned as Division Charlie Supervisor. At 23:29 hours, fireground operations were at 15 minutes. At 23:39 hours, E48, E6NA, and T1NA exited the

structure together after their SCBA EOSTIs were sounding. After a cylinder change, the crew from E48 reentered the structure through the front door on Side Alpha. After arriving on-scene, FPDE6 performed a confirmatory check of the scene and (incorrectly) noted the absence of a basement.

Photo 6. An E48 firefighter deployed a hoseline to knock down the fire in the garage and vehicle.
(Courtesy of Heather Smith - Eye on News)

E6NA and T1NA entered the house together but then split up and went to different rooms to pull ceilings. T1NA pulled ceilings until he was completely out of air. As he left the structure through the front door, he met two firefighters from E41. T1NA went to the rehabilitation area and met a firefighter from E48, who was with him on the initial fire attack. During this time, the accountability officer had E6NA on a team with two other firefighters in the building. At 23:44 hours, fireground operations were at 30 minutes. A crew of three firefighters entered the building and to report to E6NA for an assignment. Interior operations continued with firefighters from multiple departments rotating in and out of the structure. At 23:54 hours, Car 1 North advised the IC that the fire was under control and major overhaul was underway. This message was transmitted to TwinComm by IC. At about 23:59 hours, E6NA met with incoming firefighters and then headed towards the outside. Since his crew had already been sent to rehab, E6NA was alone at this point. Fireground operations were at 45 minutes at this time. At approximately 00:01 hours on December 4, a radio report was transmitted on MABAS Red of a partial floor collapse (**see Diagram 2**).

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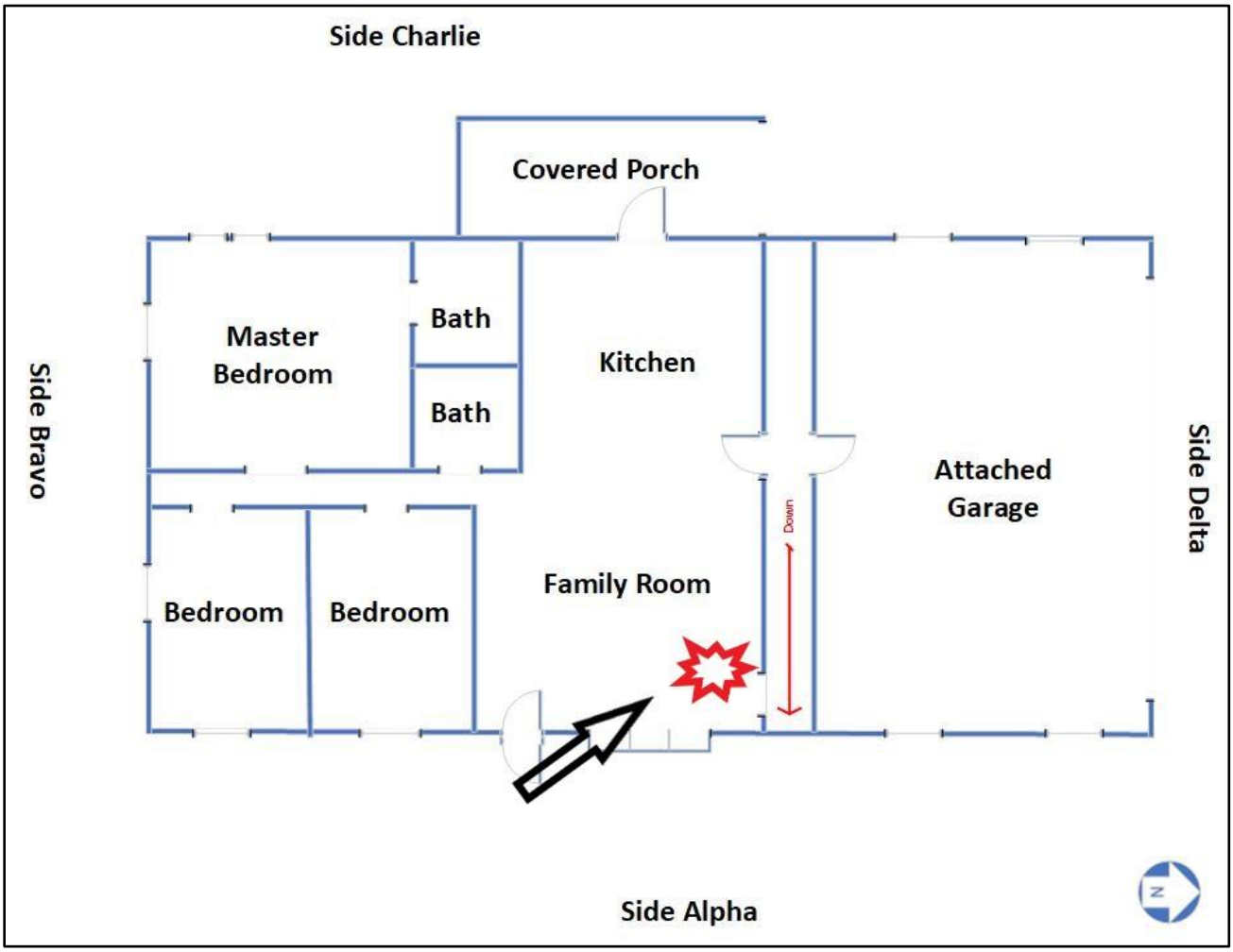

Diagram 2. The arrow shows the location in the family room where the floor collapsed and E6NA fell into the basement. (*Prepared by NIOSH*)

As he exited the building, E6NA fell through a fire weakened portion of the family room floor into the basement near the Side Alpha/Side Delta corner. E6NA transmitted a Mayday around 00:04 hours on the dispatch channel. Most crews were operating on the MABAS Red and did not hear the Mayday. Car 1 North declared emergency traffic and asked for the member who called the Mayday to repeat the message. There was no response. A photograph taken after the Mayday shows heavy fire in the family room (**see Photo 7**).

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Photo 7: When E6NA fell through the floor, the fire in the family room intensified.
(Courtesy of Heather Smith - Eye on News)

A PAR was initiated at approximately 00:06 hours. A firefighter from Squad 1 of Car 1 North was initially considered the missing firefighter. This firefighter was found on Side Charlie. After approximately 10–12 minutes, a message was transmitted over MABAS Red stating, "We have PAR." At 00:14 hours, fireground operations were at 60 minutes. Car 1 North advised IC that all interior crews were accounted for at the time. Fireground operations were continued around 00:17 hours. At 00:29 hours, fireground operations were at 75 minutes. Around 00:37 hours, firefighters in the rehabilitation area could not locate E6NA. A search operation was initiated and several crews from multiple departments attempted to locate the victim. **During the search, IC advised that the house had a full basement.** At 00:44 minutes, fireground operations were at 90 minutes. A crew went to the basement steps but could not enter because of debris from the 1st floor collapse. A crew from a mutual aid fire department entered a front bedroom/office and cut a hole in the 1st floor (**see Diagram 3**). The original size of the hole was approximately 3ft x 3ft. DCE6 widened the hole to approximately 4ft x 4ft to place an attic ladder in the hole and gain access to the basement.

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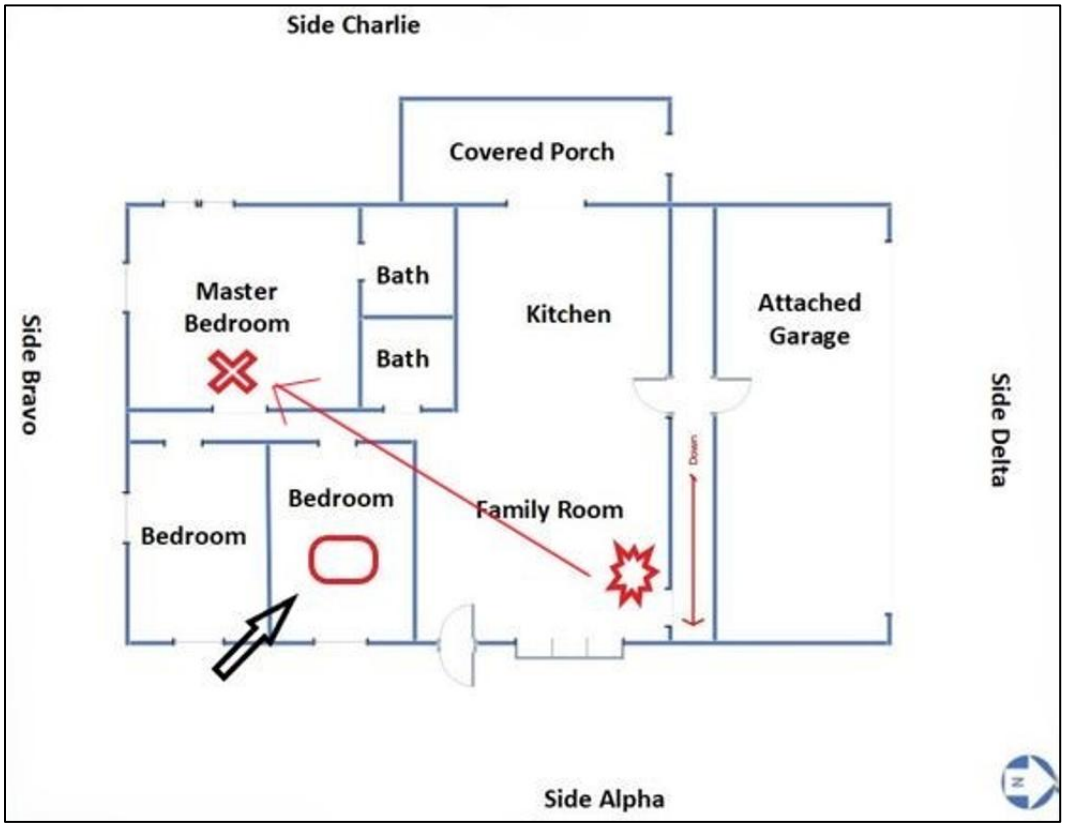

Diagram 3. The approximate path that E6NA took after falling into the basement through a hole in the family room floor and being found in the area under the master bedroom. The arrow points to the hole that a RIC company made in the bedroom to gain access to the basement. (*Prepared by NIOSH*)

DCE6 reported heavy smoke, no visibility, and no visible fire. Shortly after entering the basement, a member of the crew heard an SCBA PASS alarm sounding. The crew located E6NA with his SCBA facepiece and regulator intact with his helmet on. E6NA was located near the Side Bravo wall of the basement. DCE6 reported to IC that they found E6NA and requested EMS around 00:52 hours. At 00:59 hours, fireground operations were at 120 minutes. DCE6 moved E6NA to a pool table and applied webbing to raise him out of the basement. Two attempts to remove E6NA from the basement were unsuccessful. With additional webbing attached, the third attempt was successful. E6NA was removed and transferred to EMS personnel around 01:02 hours. He was transported by ambulance to a local trauma hospitial and pronounced deceased at 01:41 hours. The fire was marked under control at approximately 02:00 hours by IC. The fire was declared out around 06:45 hours and demobilization was started.

Fire Origin and Cause

Investigators with the Office of the Illinois State Fire Marshal listed the cause of the fire as undetermined in nature. The fire was believed to be started by a lithium-ion battery powered electric scooter whose battery went into thermal runaway after being charged with an aftermarket charger. At the time of the preliminary investigation, the heaviest concentration of heat and fire damage was in the garage around the general vicinity of the electric scooter, lithium-ion battery, and aftermarket charger.

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Contributing Factors

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

- Scene size-up and risk assessment
- Personnel accountability
- Crew integrity
- Basement fire
- Professional development
- Lithium-ion battery fire
- Emergency communications
- Unpermitted occupancy renovations

Cause of Death

According to the death certificate, the medical examiner listed the victim's cause of death as asphyxia caused by products of combustion from a structure fire.

Recommendations

Recommendation #1: Fire departments should ensure initial and ongoing size-ups and risk assessments are conducted throughout the incident.

Discussion: At this incident, there was an incomplete size-up. The initial focus was on the fully-involved garage fire and not getting crews inside the structure until later.

Continuous communication supports effective risk assessments. It also allows the IC and all personnel to be aware of changing conditions and adjust to avoid hazards or mitigate risks. Performing a complete 360° is a vital part of the scene size-up because it can be used in the risk assessment. The International Association of Fire Chiefs' *Rules of Engagement for Structural Firefighting* recommends that the first rule for ICs is to rapidly conduct or obtain a 360° situational size-up of the incident. Many incidents contain obstacles that prevent the viewing of all sides of a structure. When a 360° situational size-up is achieved, it provides the IC and personnel information about the building layout, construction, access/egress points, fire location and direction of spread, and potential obstacles or hazards [NIOSH 2017a].

A dedicated incident safety officer (ISO) can perform initial and ongoing size-ups throughout the incident. Expectations and authority for the ISO include determining hazardous incident conditions, advising the IC to modify control zones or tactics to address corresponding hazards, communicating fire behavior and forecasting growth, and estimating building/structural collapse hazards. The ISO also has the authority to stop or suspend incident operations based on imminent threats to firefighter safety [NFPA 1550 2024]. The ISO should be separate from the IC, operations, or accountability positions, so the ISO can focus on continually assessing all on-scene hazards to firefighter life and safety [NIOSH 2025].

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Recommendation #2a: Fire department should train ICs to provide ongoing accountability to include immediately establishing divisions/groups with a supervisor to communicate conditions and critical benchmarks.

Discussion: Throughout this incident, multiple firefighters rotated in and out of the structure. Although an accountability officer was assigned outside of the structure, a PAR incorrectly identified all interior firefighters being accounted for after EN6A fell into the basement.

Within a division/group, firefighters advise their supervisor of work progress. The IC should assign divisions/groups to a supervisor prior to or immediately upon arrival. The assignments include when firefighters are operating from tactical positions that the IC has little or no direct control over (e.g., out of sight). Divisions/groups who are assigned to supervisors provide accountability for crew members engaging in task level activities. All requests for additional resources or assistance within a division/group are directed to the supervisor who is responsible for communicating with the IC. Supervisors can also provide ongoing conditions, actions, needs (CAN) reports to provide the best assessment for the IC of all four sides and the interior of an incident which may influence tactics and strategy [SKCFTC 2023]. Division/group supervisors can also assist in providing personnel accountability reports when requested by the IC, ISO, or operations. When the IC does not establish divisions/groups with a supervisor, firefighters should follow established fireground operations procedures regarding who they directly report to while operating in the incident and hazard zone.

The IC and each company officer must be aware of the value of transmitting and receiving progress and benchmark information in a concise and timely manner. Company officers must understand that the IC relies on the reports of interior companies to gauge the effectiveness, safety, and value of a continued offensive attack strategy. These reports are typically relayed as situational reports or fireground benchmarks. Benchmarks, as the name implies, are transmitted from companies that are assigned specific tasks during an operation. These responsibilities may be preassigned by policy or ordered by the IC at the scene. A benchmark generally verifies that a major goal or task has been completed relative to life safety, incident stabilization, or property conservation. Once received by command, the time of completion should be recorded based on department policy. Some jurisdictions will retransmit this information over the radio for documentation purposes and to inform all units on the status of the operation.

Company officers should communicate with the IC when benchmarks are met or not met. This is an essential element of the incident action plan (IAP) because this process allows IC to consider and account for changing fireground conditions. Moreover, IC must forecast the direction of the incident to stay ahead of the fire. Without this information, the IAP can become out of sequence with fireground operations. Once an incident benchmark has been met, the IC must share this information to all companies operating at the incident. Fireground benchmarks are essential for accomplishing successful and safe outcomes. To make sure that the proper benchmarks are communicated at fireground incidents, fire departments should develop and maintain a SOP/SOG for communicating critical benchmarks consistently.

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Recommendation #2b: Fire departments should use a personnel accountability system to identify the location and function of all personnel operating at an incident.

Discussion: During the incident, DC2S arrived on-scene at 23:18 hours and was assigned as the accountability officer and thereby charged with establishing a 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]. This system is implemented during an incident to collect and maintain the status and location of the resources that may be working in an immediately dangerous to life and health (IDLH) environment. All members operating at an incident are responsible for understanding and participating in this system. The IC is responsible for but may delegate certain responsibilities to another person such as the ISO. An integral part of the accountability system is to make sure that the firefighters who are assigned and operating in the hazard zone are accounted for throughout the entire incident. A properly initiated and enforced personnel accountability system can improve firefighter safety and survival [NIOSH 2024]. A functional personnel accountability system can identify:

- Members operating in the hazard zone
- Where members are in the hazard zone
- Conditions in the hazard zone
- Actions used in the hazard zone
- Paths of access and egress in and out (i.e., exits) of the hazard zone
- RITs and their assignments

Different methods and tools are available for resource accountability, including:

- Tactical worksheets
- Command boards
- Apparatus riding lists
- Company responding boards
- Electronic bar-coding systems
- Accountability tags or keys

Recommendation #3: Fire departments should ensure company officers and firefighters maintain crew integrity.

Discussion: In this incident, E6NA and T1NA reentered the house through the front door after a cylinder change but split up and went to different rooms to pull ceilings. T1NA pulled ceilings until he was completely out of air. He left the structure through the front door without E6NA.

Crew integrity is essential to fireground accountability. NFPA 1550, Standard for Emergency Responder Health and Safety states in Paragraph 10.5.6 that company officers shall maintain an ongoing awareness of the location and condition of all company members. Paragraph 10.5.7 states that, where assigned as a company, members shall remain under the supervision of their assigned company officer [NFPA 1550 2024]. It is the responsibility of every firefighter and company officer to stay in communication or contact with crew members by visual observation, voice, or touch while operating in

the hazard zone. The company officer is ultimately responsible for crew integrity and ensuring no members get separated or lost. A Mayday should be called if any member cannot be accounted for during a personnel accountability report [NIOSH 2024].

A critical element for firefighter survival is crew integrity. The International Association of Fire Chiefs' Safety, Health, and Survival Section has redefined the Rules of Engagement for Structural Fire Fighting. One of the objectives is to ensure that firefighters are not alone at any time while entering, operating in, or exiting a building [IAFC 2012].

Recommendation #4: Fire departments should ensure fire department operations include SOPs/SOGs for identifying basements and below-grade fires.

Discussion: During this incident, at 00:37 hours, the IC advised the structure had a basement, more than 80 minutes into the incident, and more than 30 minutes after the initial Mayday.

Early identification of basements and their access opportunities is critical. This must be considered in the initial on-scene size up and a component of the 360° size up. The presence or lack of a basement must be communicated in the follow up report. Early communication is a necessity to minimize/eliminate the opportunity for fire crews to work above a basement without their knowledge. Immediate dangers include falling through the floor and working in the exhaust portion of a flow path. Additionally, fire officers and firefighters should understand building construction for their particular community. If basements are a common component of building design, then a basement must be considered as part of the scene size-up.

Beyond relying only on initial and ongoing size-ups, ICs should also use reports from firefighters working the operation. Specifically, the results of more comprehensive reconnaissance techniques such as thermal imaging, forcible entry, detailed walkthroughs, and CAN reports provided during fireground operations can help ensure hidden areas are not overlooked.

Between 1998 and 2017, NIOSH documented 24 below grade fires that resulted in 32 firefighter fatalities and 19 serious injuries. Typically, these cases involved firefighters falling through a wood floor into a burning basement, or firefighters being overwhelmed by high velocity hot gases from the basement to an upper level [Madrzykowski and Weinschenk 2018]. Project Mayday conducted by Don Abbott reported that one of the top causes of a Mayday is falling into basements. More than 2,700 career department Maydays were reported as a part of the project. Of those, 513 or almost 20%, were from falling into the basement [Mayday Monday 2021]. Similarly, more than 1,900 volunteer department Maydays were reported to the project. Of those, 456 or almost 25%, were from falling into a basement [Mayday Monday 2021]. After totaling all of these voluntary reports, more than 1,000 Mayday incidents involved falling into a basement

When a basement is present and there is a likely basement fire, tactics should reflect sound risk management decisions as outlined in an SOG/SOP. Below-grade fires, particularly those in private dwellings, are among the most dangerous and difficult fires for firefighters to locate and fight. Recognizing a below-grade fire is essential to developing proper strategy and tactical objectives. These types of fires are low frequency/high risk events for several reasons. Below-grade fires may be difficult to detect initially; may be difficult to access; require additional staffing for hoseline placement,

operation, and ventilation; and firefighters may be working over the fire [NIOSH 2018; NIOSH 2022a]. Firefighters may experience increased risks from:

- Limited entry and egress into a basement
- Unusual and/or unanticipated void spaces
- Working above the fire
- Weakened floor joists and flooring materials
- Being caught in the fire's exhaust portion of the flow path
- Unknown and frequently excessive fire loading
- Restricted ventilation options
- Utility panels and meters plus connections
- Otherwise, separate areas connected by non-fire stopped utility penetrations
- Hanging wires and ductwork
- Furniture and appliances - often disorganized distribution of the contents.

A fire department's SOP/SOG for basement or below-grade fires includes the following topics [Madrzykowski and Weinschenk 2018; Keber et al 2012; Madrzykowski et al 2025]:

- Community risk assessment
- Pre-incident planning
- Scene size-up
- Building construction
- Strategy and tactics
- Use of a thermal imager
- Ventilation considerations
- Proper size and adequate hoselines
- Limitations of sounding the floor

If the size-up indicates there is a fire in the basement (e.g., floor to ceiling smoke not lifting significantly once the basement walk-out door is opened) then the basement needs to be investigated and cleared before crews can safely work above. Opening a door is a source of ventilation and will increase the size of a ventilation-limited fire. Basement fires need to be considered ventilation limited until proven otherwise, so if the fire location is not known, then ventilation should be limited until sufficient water can be applied to what is burning.

Recommendation #5: Fire departments ensure the implementation of a training, education, and professional development program is based upon each rank.

Discussion: Fire departments should make sure that training and professional development are offered to any personnel who may be expected to perform outside of their normal functional area but within their experience level. In this specific incident, the lack of experience and knowledge prevented critical task level information from being shared with the IC as it relates to the rapidly changing fire conditions and environment.

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The primary focus of training, education, and professional development programs is to reduce injuries, illnesses, and fatalities in the fire service by providing the needed technical and academic competencies. Fire departments need to incorporate both technical skill and hands-on task completion, while also addressing academic knowledge and the understanding of "why" things are happening in their training.

When developing a professional development plan, each department must recognize the needs of the community, services offered by the fire department, and available resources such as funding, staffing, and experience levels. A goal to establishing a professional development plan should be to meet or exceed the NFPA professional qualifications. NFPA 1550, Standard for Emergency Responder Health and Safety, states in paragraph 7.1.2 that the fire department should provide training, education, and professional development for all department members commensurate with the duties and functions that they are expected to perform [NFPA 1550 2024].

Professional development plans should be customized to fit within a fire department's resources and capabilities while striving to reach a national standard. A successful professional development plan might include:

- Training programs on technical competencies (hands-on skills)
- Task and mentoring books (technical and academic competencies)
- Mentorship programs (experience)
- Self-guided study classes and programs (academic competencies)

The primary goal of all training, education, and professional development programs is to reduce occupational injuries, illnesses, and fatalities. As members progress through various duties and responsibilities, the department should make sure knowledge, skills, and abilities (KSAs) are introduced to members who are new in their position while continuing development of existing skills. A successful training plan is developed in a systematic and functional manner. Training occurs in the fire service to improve the KSAs and competencies of firefighters and fire officers. The results enhance the overall response capabilities of the department while meeting national standards. A structured plan should meet all these criteria [Clark 2017].

Every fire department should have a professional development plan. NFPA 1201, Standard for Providing Fire and Emergency Services to the Public states in 4.11 Professional Development, "The fire and emergency services shall have training and education programs and policies to ensure that personnel are trained, and that competency is maintained in order to effectively, efficiently, and safely execute all responsibilities" [NFPA 1201 2020].

When developing a formal training plan, the first step is to evaluate and build upon existing training standards, such as the NFPA professional qualifications standards. Each fire department is structured differently to meet the needs of their community. Therefore, training plans must be designed based on services provided by a fire department and the department's mission statement. NFPA 1550, Chapter 6, "Fire Department Administration," states in paragraph 6.2.2, "The fire department shall prepare and maintain written policies and standard operating procedures that document the organization structure, membership, roles and responsibilities, expected functions, emergency operations. and training requirements, including the following:

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- The types of standard evolutions that are expected to be performed and the evolutions that must be performed simultaneously or in sequence for different types of situations.
- The minimum number of members who are required to perform each function or evolution and the manner in which the function is to be performed in accordance with NFPA 1710 or NFPA 1720.
- The number and types of apparatus and the number of personnel that will be dispatched to different types of incidents in accordance with NFPA 1710 or NFPA 1720.
- The procedures that will be employed to initiate and manage operations at the scene of an emergency incident.
- Post-incident control and mitigation of emergency scene contaminants".

These programs should include information to make sure members are trained prior to performing individual duties, and that members receive ongoing professional development to maintain competency. The training plan serves as a comprehensive all-hazards approach that meets or exceeds federal, state, and local regulations as well as the needs of fire department personnel. This approach allows the department to maintain operational and response capabilities to the customers they serve. The plan is designed to be specific yet allow flexibility in the event training is made available or as departmental needs dictate. The plan includes a detailed calendar for the year, which allows the company officers and command staff to balance other duties and priorities throughout the course of the year [Clark 2017].

The responsibility of the fire service is to save lives, stabilize incidents, and conserve property. This is accomplished through effective and structured training before emergency response. A well-developed annual training plan will ensure continuity across a fire department and will maintain and improve the KSAs of all members. All members must continually improve and train new fire service members so the department can respond effectively to any emergency incident.

Recommendation #6: Fire departments should raise awareness about the fire dangers of lithium-ion battery-powered products among community members through fire and life safety education programs.

Discussion: The fire ignition source was believed to be a lithium-ion battery-powered electric scooter whose battery went into thermal runaway after being charged with an aftermarket charger.

Fire and life safety education, including education around lithium-ion battery-powered devices, is a critical element of community-risk reduction to change the behaviors and beliefs of community residents to reduce risks, injuries, and fires [IFSTA 2015]. Fire departments act on this effort by training firefighters and other personnel as Fire and Life Safety Educators (FLSEs). FLSEs coordinate and deliver educational programs that teach people about a particular risk and how to prevent it [NFPA 2024].

Examples of these programs include educating community members on the:

- Importance of smoke alarms to reduce deaths in structure fires
- Use of child safety seats to lessen injuries of children involved in vehicle accidents
- Need for carbon monoxide detectors and proper use of gas-powered appliances

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Fires that involve lithium-ion battery-powered products are an increasing trend that has resulted in both injuries and fatalities. A primary reason why these batteries catch fire and explode is because they may enter a state of uncontrolled self-heating, also known as thermal runaway [FDNY 2024]. Because of excessive heat generated by the battery cells, chemical reactions release thermal energy that transfers (runs) to the other cells in the battery pack. Thermal runaway can occur from destabilization of the battery caused by overcharging and mechanical stress from dropping or crushing [Barowy 2023].

The U.S. Fire Administration offers outreach materials, for both fire departments and FLSEs, to educate community members on the fire dangers of lithium-ion batteries. These include handouts, social media graphics, and safety messages to support use of product instructions when using, storing, or disposing of lithium-ion battery-powered products [USFA 2024]. Specific to this incident, FDNY, FSRI, and NFPA outreach materials are available that emphasizes the need for community members to only use the OEM charging cord and follow the manufacturer's instructions. These materials also educate people on the risk of batteries overheating, catching fire, or exploding [FDNY 2024; FSRI 2023; NFPA 2022].

Recommendation #7: Public Safety Answering Points should ensure a communication SOP and equipment is in place for dispatchers to support fireground operations and the IC, including the ability to receive EAB signals from portable radios as well as monitor and record all radio traffic during fireground operations.

Discussion: In this incident, E6NA called a Mayday on the dispatch channel at 00:04 hours. Most crews were operating on the MABAS Red and did not hear the Mayday. Although the portable radios of the fire department are equipped with EABs, TwinComm's system could not receive EAB signals. No radio communications on MABAS Red were recorded at TwinComm during the incident.

Effective fireground radio communication is an important tool to ensure fireground command and control, and it enhances firefighter safety and health. The radio system must be dependable, consistent, and functional to ensure that effective communications are maintained, especially during emergency incidents. There are several ways to make sure that the incident commander can effectively manage fireground communications. The best solution is to have a trained dispatcher monitoring the fireground radio channel. Dispatchers should meet the requirements of NFPA 1225, *Standard for Emergency Services Communications*. The dispatcher is in a secure environment, isolated from fireground distractions and noise. The dispatcher should have access to playback technology with the ability to listen to hard-to-understand messages. This is dependent upon the ability to monitor and record all radio traffic. The dispatcher should also have access to "identifier" information, which identifies the portable radio making the transmission [NIOSH 2017b]. Public Safety Answering Points should also have equipment that is capable of receiving EAB signals from portable radios. When an EAB is transmitted, its signal is prioritized in the radio system over other users. This allows a firefighter to indicate they are experiencing an emergency and guarantees dispatchers are notified of the priority signal [NIOSH 2022b].

Dispatchers need a thorough understanding of the incident management system, fireground strategy and tactics, and firefighting vernacular. Make sure to define the dispatcher's role during emergency operations. Responsibilities may include fireground benchmarks, notifying the incident commander of

lapsed time intervals for a PAR, emergency traffic, a Mayday, roll calls, or building evacuations [NIOSH 2017b].

Recommendation #8: Governing municipalities should ensure the applicable fire and life safety codes are enforced for renovations in residential occupancies and relevant information is shared with the fire department.

In this incident, the property owner made several unpermitted renovations that created a life safety hazard for the responding firefighters. Specifically, all basement windows were boarded up and painted over to match the siding of the structure. This disguised that there was a basement upon initial size-up and ways to access the basement after the Mayday. Neither fire department in this incident are responsible for performing residential fire inspections and the designated authority for code enforcement is the local government.

NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations*, Chapter 6 states that fire prevention inspection and code enforcement shall be conducted to ensure compliance with adopted codes and standards. The authority having jurisdiction shall determine the minimum resources, personnel, and equipment levels necessary to perform code enforcement and inspection activities.

NFPA 1201, *Standard for Providing Fire and Emergency Services to the Public*, Section 6.3 recommends that fire departments establish a good working relationship with the agency or authority responsible for enforcing the building code so that the review of the design, construction, alteration, or demolition of buildings and structures can be monitored to identify fire protection concerns. This includes sharing vital information between the entities from inspections, permits, code violations, fire protection maintenance and service, and investigation of fires or other emergencies [NFPA 1201 2020; IFSTA 2016]. This also includes relevant information from change of renovation permits and approvals.

Post-Incident Fire Department Prevention Actions

After this incident, the fire department implemented changes to incident response and fireground operations. These changes included:

- **Increased Accountability:** There is strict enforcement in respect to crew integrity, and ongoing training about crew integrity. All Officers and Acting Officers are now required to obtain certification as an ISO.
- **Updated SOPs/SOGs:** All SOG/SOPs are being revised or updated. SOP/SOG changes were made to include a joint fire incident response plan, which includes following scene size up requirements and ICS standards.
- **Revised Training:** Current revisions of existing training and development of new training are ongoing to build a professional development program within the department with a formal mentoring program. Command training is now ongoing for all fireground operations, but especially including hitting benchmarks and recording them. All Officers will be sent to classes which contain a scene size-up and reading buildings component (LDDM, Fireground Officer,

Fireground Command Officer). All Officers and Acting Officers are now required to obtain COFO or ADFO, depending on their rank.

- **Fire and life safety education program inquiries:** Currently searching for a community-based program for education on lithium batteries.

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Additional Information

Underwriters Laboratories (UL)

The Fire Safety Research Institute (FSRI), part of the UL Research Institutes, continues to work with fire departments and fire service organizations to conduct research on fire dynamics, fire safety issues, and fire ground operations. Access to reports from completed studies and information from on-going studies can be found at https://fsri.org. Access to free online training on evidence-based firefighting (more than 30 course modules in all) can be found at https://training.fsri.org. FSRI also offers a free program, Take Charge of Battery Safety: https://batteryfiresafety.org/. This site has information for both first responders and the general public on the best practices for the safe handling of Li-Ion batteries. Specific to this incident: Only use the charging equipment that comes with the product, and do not charge larger devices, such as e-scooters, overnight.

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.*