

LINE OF DUTY DEATH REPORT

F2019-02 • May 1, 2023

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

Captain Died After Crew was Trapped During a Search for a Civilian in a 3rd Floor Apartment Fire – Maine

Executive Summary

On March 1, 2019, a 32-year-old male captain was killed by rapid-fire progression while fighting a fire in a three-story apartment building. Also, four firefighters was injured. At 1105 hours, the town fire department was dispatched with automatic aid resources for a report of smoke in a 6-unit apartment building with one civilian occupant trapped. A civilian occupant was the 9-1-1 caller and trapped on the 3rd floor in an apartment bathroom. Engine 2, which consisted of a captain, 2 firefighters, and driver/operator, arrived on-scene at 1108 hours and reported heavy smoke showing from the rear of the structure. The captain from Engine 2 immediately assumed Command and requested a 2nd Alarm. The captain advised the regional communication



**The Side Charlie 3rd floor porch where the captain and firefighter 1 were removed.
(NIOSH Photo)**

center (RCC) that Engine 2 (the captain and FF1) were going to make entry into Side Alpha with a 1¾-inch hoseline to perform a primary search for a reported trapped civilian occupant. The captain of Engine 2 told the other firefighter (FF2) from Engine 2 to get a ground ladder to the 3rd floor to rescue the trapped civilian occupant. Meanwhile, the driver of Engine 2 was in the process of connecting Engine 2 to a hydrant. The captain and FF1 entered the interior stairwell through the front door on Side Alpha at 1109 hours and proceeded to the 2nd floor. A police officer identified as PD113 and FF2 placed the ground ladder to the 3rd floor bathroom window on Side Bravo where the trapped civilian was located. The trapped civilian occupant climbed out the window and onto the ground ladder. The police officer (PD113) notified RCC that the

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civilian occupant was out of the building at 1109 hours. This message was delayed getting to the captain of Engine 2 because the information was transmitted on a police channel by PD113. Engine 2 was operating on the 3rd floor when the message was transmitted on the fire channel. A decision was made to leave the hoseline on the 2nd floor and search the 3rd floor. The captain and FF1 from Engine 2 were unable to make entry into a 3rd floor apartment due to the fire. The captain made the decision to back out of the structure. The crew's exit was blocked by heavy fire traveling up the central stairway. They were forced to search for another exit. The crew made their way towards the back of the structure in the center hallway and into the fire apartment. The captain reportedly threw himself on top of FF1 as conditions deteriorated. Between 1112 - 1113 hours, the captain called a Mayday, which was not acknowledged by any resources on the fireground or by RCC. At 1114 hours, Engine 4 from a mutual aid company arrived on-scene. The lieutenant recognized that the captain and FF1 from Engine 2 were missing and called Command and initiated a Mayday. As additional companies arrived on-scene, a rapid intervention group was assigned to locate the Engine 2 crew. Also, crews began attacking the fire on Side Charlie while the rapid intervention group was trying to access the 3rd floor. FF1 was able to make his way out onto the porch on Side Charlie and called for help to the crews on the ground at 1116 hours. A ground ladder was placed to the 3rd floor on Side Charlie. FF1 climbed down the ladder and was out of the building at 1122 hours. The rapid intervention group located the captain in a room adjoining the Side Charlie porch. They moved him to the Side Charlie porch. The captain was lowered down a ground ladder and moved to a stretcher. He was out of the building at 1132 hours. EMS crews began resuscitation efforts and transported the captain to a trauma hospital in New Hampshire at 1152 hours. The captain was pronounced deceased at a trauma hospital in New Hampshire at 1201 hours.

Contributing Factors

- *Incomplete size-up and risk assessment*
- *Lack of incident management*
- *Lack of personnel accountability*
- *Inadequate fireground communications*
- *Rapid fire spread in the interior center stairwell*
- *Lack of situational awareness*
- *Lack of fire sprinkler system in a multi-family residential occupancy.*

Key Recommendations

- *Fire departments should ensure a detailed scene size-up and risk assessment is conducted during initial fireground operations and throughout the incident*
- *Fire departments should ensure that once command is assumed, command is maintained until command is transferred, the incident is stabilized, or the incident is terminated*
- *Fire departments should ensure firefighters communicate critical incident benchmarks to incident commanders throughout the incident*

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- *Fire departments should ensure that firefighters are trained in procedures for conducting search and rescue, especially above a fire*
- *Fire departments should ensure hoselines are deployed, staffed, and appropriately utilized to protect crews operating in the hazard zone*
- *Fire departments should ensure that firefighters are trained in situational awareness*
- *Fire departments should utilize a functional personnel accountability system*
- *Fire departments should integrate current fire behavior research findings developed by the National Institute of Standards and Technology (NIST), Underwriters Laboratories (UL) Fire Safety Research Institute (FSRI), and the International Society of Fire Service Instructors (IFSFI) to develop and revise operational procedures on fireground tactics and provide training in fire dynamics in structures for all members.*

Additionally, governing agencies (state, regional, and local) should consider adopting and enforcing regulations for interventions to reduce or eliminate the spread of fire in multi-family structures, including automatic sprinkler systems and self-closing doors.

The National Institute for Occupational Safety and Health (NIOSH) initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

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



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Introduction

On March 1, 2019, a 32-year-old captain was killed during a rapid-fire event in a three-story apartment building. On March 4, 2019, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. From March 18-23, 2019, two safety and occupational health specialists, a general engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program, and an environmental health Commissioned Corps officer traveled to Maine to investigate this incident. The NIOSH investigators met with and interviewed representatives of the fire departments involved with the response; the Maine Office of the State Fire Marshal, Investigation Division; the Maine Department of Labor, Bureau of Labor and Standards, Workplace Safety and Health Division; law enforcement; and representatives from the Maine Office of the State Medical Examiner. Investigators also met with representatives from the regional communications center that dispatches for the involved fire & rescue department as well as other fire departments in the region.

Fire Department

This combination fire & rescue department operates out of one fire station with 4 career members, 3 per diem members, and 20 on-call members. This department serves a population of approximately 8,500 within an area of 34 square miles. In 2019, the fire & rescue department responded to 904 alarms. The fire & rescue department is responsible for providing both emergency and non-emergency services to the town where they are located and the surrounding communities as requested. The fire & rescue department provides fire suppression, non-transport emergency medical services, vehicle extrication, fire prevention/education, issuing burning permits, and a number of other services to the community.

All career department members work a 24-on-48 off-24-on 96-off shift. The fire & rescue department currently operates 2 engines, 1 quint, 1 tanker, 1 medium duty rescue squad, 1 forestry (brush) truck, 1 boat, and 1 command vehicle. All fire & rescue department apparatus are maintained by local qualified vendors. Annual testing of fire apparatus and equipment is conducted by qualified vendors.

The fire & rescue department has written policies and procedures, which are available to all department members within their stations. These policies and procedures have been implemented and are enforced.

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Training and Experience

Fire service training in Maine is provided by the Maine Fire Service Institute (MFSI). The MFSI is a division within Southern Maine Community College. They had a full-time staff of 10 and an additional 100 instructors throughout the state of Maine at the time of the incident. MFSI produces a variety of programs in regions around the state of Maine to meet the demands of the local fire departments. Complementing the program delivery, MFSI also serves as the certification entity for all firefighter programs. MFSI accomplishes this by fostering partnerships and collaborating with local departments, regional programs, the Fire Science Programs of Southern Maine Community College and Eastern Maine Community College, and other state agencies, such as the Maine Office of the State Fire Marshal and the Maine Bureau of Labor and Standards, Bureau of Labor and Standards, Workplace Safety and Health Division.

MFSI offers National Fire Protection Association (NFPA) training including NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I which is approximately 150 hours and Fire Fighter II which is approximately 150 hours. MFSI also offers a 75-hour course which is the minimum requirement mandated for any firefighter that performs interior structural firefighting by the Maine Bureau of Labor and Standards, Workplace Safety and Health Division.

MFSI also offers the following Pro Board accredited certification training:

- NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I and Fire Fighter II
- NFPA 1021, *Standard for Fire Officer Professional Qualifications*, Fire Officer I and Fire Officer II
- NFPA 1041, Instructor I and Instructor II, *Standard for Fire and Emergency Services Instructor Professional Qualifications*
- NFPA 1035, *Standard on Fire and Life Safety Educator, Public Information Officer, Youth Firesetter Intervention Specialist and Youth Firesetter Program Manager Professional Qualifications*, Fire Life Safety Educator I.

Note: The Pro Board is a non-profit corporation that was incorporated in 1990 as the “National Board on Fire Service Professional Qualifications.” The organization is commonly known as the Pro Board.

Fire inspector certifications are through the NFPA.

Maine Bureau of Labor and Standards

The Maine Department of Labor, Bureau of Labor and Standards mandates that all firefighters be certified to meet the Interior Structural Firefighter - Minimum Training Requirements. This 75-hour course consists of 18 topics.

The curriculum is based on training requirements from the Maine Department of Labor, Bureau of Labor and Standards and NFPA 1001, *Standard for Fire Fighter Professional Qualifications*. Based upon Maine state statutes, the following apply to each fire department in the state:

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- Maine MRSA (Maine Revised Statutes Annotated) Title 26 §2102. Firefighter Training and Education
- Maine MRSA Title 26 §2103. Standards for Equipment and Clothing
- Maine MRSA Title 26 §2104. Required Provision and Use of Protective Equipment

The captain, driver/operator, and firefighter 1 (FF1) from Engine 2 completed all necessary departmental and state training to be certified as interior firefighters. Firefighter 2 was in progress of completing training but was not cleared as an interior firefighter at the time of this incident.

Timeline

The following timeline is a summary of events that occurred on March 1, 2019. Not all incident events are included in this timeline. The times are approximate and were obtained by studying the dispatch records from the RCC, audio recordings, witness statements, and other available information.

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Regional Communication Center (RCC) received 9-1-1 call from subject who stated he was trapped on the right side of a building that was on fire.	1058 Hours	
RCC received a call from a New Hampshire dispatch center regarding a structure fire. An occupant was the trapped occupant was on the top floor of an apartment building.	1059 Hours	
9-1-1 caller (trapped occupant) advised RCC, that he was located in a bathroom on the top floor. He stated he had seen smoke. Mutual aid fire departments dispatched. A town police officer 107 (PD 107) advised.	1100 Hours	

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	1102 Hours	PD 107 arrived on-scene and advised smoke showing from the rooftop and someone was hanging out of a 3 rd floor window.
	1103 Hours	PD 113 arrived on-scene and advised no access to the 3 rd floor due to the smoke.
RCC dispatched an automatic aid response in for a multi-family residential structure fire with an entrapment. The response included the town's fire department Engine 2, automatic aid Engine 4, automatic aid Ladder 1, and an automatic aid chief Car 1, and an EMS unit.	11:05:44 Hours	
Engine 2 responded.	11:05:49 Hours	
Engine 4 (automatic aid) responded to the multi-family residential structure fire.	1106 Hours	
Automatic aid chief – Car 1 arrived on-scene.	1107 Hours	Per PD 113, building almost fully involved.
RCC dispatched medic 5 (contracted EMS unit) to the multi-family residential structure fire.	11:08:34 Hours	
Medic 5 on-scene.	11:08:38 Hours	

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Town fire department Engine 2 on-scene. The captain of Engine 2 advised RCC there was heavy smoke showing from the rear of the structure. The captain assumed Command and requested a 2nd Alarm.	1108 Hours	The Engine 2 captain advised Engine 2 was stretching a hoseline via the interior stairwell to the 3rd floor to attempt to rescue the civilian. The captain of Engine 2 ordered FF2 to take ground ladder and place it to the 3rd floor to rescue the occupant. FF2 and PD 113 placed a ground ladder to the 3rd floor bathroom window. The trapped civilian occupant came out of the building and onto the ground ladder.
	1109 Hours	Per PD 113, the trapped civilian occupant was out of the building. FF1 from Engine 2 pulled a 1¾-inch hoseline to the front door and then to the 2nd floor. FF1 met the captain of Engine 2 on the 2nd floor. <i>Note: At some unknown time, Car 1 assumed Command of the incident. There is no record in the dispatch log of when this occurred.</i>
	1111 - 1112 Hours	The captain and FF1 from Engine 2 went into a 3rd floor apartment. Command radioed that the trapped civilian occupant was out of the building. The captain and FF1 moved back to the stairwell of the building.

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	1113 Hours	The captain of Engine 2 called a Mayday that was not acknowledged by Command or RCC. The captain and FF1 from Engine 2 are on the 3rd floor landing. The fire is coming up the stairwell and is also in the 3rd floor apartment they were trying to enter.
RCC dispatched Ladder 1 (automatic aid fire department) to the multi-family residential structure fire. Ladder 1 was enroute at 11:13:36 hours.	11:13:34 Hours	
Engine 4 on-scene. The officer of Engine 4 assumed Command. The officer of Engine 4 advised RCC he could not locate the crew from Engine 2 and called a Mayday. Also, the officer requested emergency traffic only.	1114 Hours	Engine 4 tried to locate the crew of Engine 2. The officer of Engine 4 called a Mayday when he found Engine 2's hoseline on the 2nd floor was burned but intact.
	1116 Hours	Crews operating on Side Charlie located a firefighter (FF1) on the 3rd floor porch. The firefighter (FF1) called for help. A request was made to Command for a ground ladder to Side Charlie.
	1117 Hours	Car 1 requested the rapid intervention group entered the interior stairwell and tried to get to the 3rd floor to locate the crew from Engine 2. Rapid intervention group placed ground ladders to the 3rd floor porch.

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Command requested an EMS unit respond to the scene.	1118 Hours	The rapid intervention group on the 3 rd floor worked to remove FF1 and locate the captain of Engine 2.
	1122 Hours	Firefighter 1 was brought down the ground ladder from the 3 rd floor.
Car 2 from automatic aid on-scene. Car 2 advised RCC that Car 2 was in Command.	1129 Hours	
Command requested an additional alarm for this incident.	1130 hours	
	1132 Hours	The rapid intervention group has the captain of Engine 2 out of the building. Command conducted a personnel accountability report (PAR). Command transitioned to a defensive strategy.
Command advised RCC the PAR was completed. All members accounted for at this time.	1136 Hours	PAR completed.
The captain and firefighter (FF2) on Engine 2 were transported by EMS to trauma hospital in New Hampshire.	1152 Hours	
Firefighter 2 declared deceased at the trauma hospital	1201 Hours	
	1218 Hours	Command conducted another PAR. All members accounted for at this time.

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Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Command advised RCC that the fire was knocked down at this time.	1222 Hours	
Command advised RCC the fire was out.	1249 Hours	
Command was terminated.	1742 Hours	

Personal Protective Equipment

At the time of the incident, the captain of Engine 2 was wearing a station/work uniform and structural firefighting ensemble which included turnout pants, turnout coat, boots, structural firefighting protective hood, and helmet. The captain was wearing a self-contained breathing apparatus (SCBA).

The structural firefighting ensemble was evaluated by NIOSH investigators and determined not to be a factor in this incident. No further evaluations were conducted.

Weather Conditions

At 1056 hours, the skies were partly cloudy, the temperature was 28 degrees Fahrenheit (F), the humidity was 37%, the winds were calm, and there had been no precipitation in the past 24 hours [Weather Underground 2019].

Investigation

On March 1, 2019, a 32-year-old captain was killed by rapid-fire progression while fighting a fire in a three-story apartment building. Four firefighters were also injured during this incident.

At 1058 hours, an adult male called 9-1-1 stating the apartment building he lived in was on fire. He stated he was on the right side of the building on the 3rd floor. At 1105 hours, an engine (Engine 2) staffed with a captain, driver, and two firefighters (PAR 4) from the town's fire & rescue department were dispatched for a multi-family residential structure fire with an occupant trapped. The initial alarm also included an engine company, ladder company, and chief officer from automatic companies. **Note:** *Due to the location of the town, mutual aid fire departments responded from Maine and New Hampshire.* As Engine 2 was approaching the scene, the captain requested a 2nd Alarm be struck due to heavy smoke showing. At 1107 hours, a mutual aid chief officer (Car 1) arrived on-scene.

At 1108 hours, Engine 2 arrived on scene. The captain assumed Command and was informed by a police officer (PD 113) on-scene that there was still a civilian occupant trapped inside. The captain and another firefighter (FF1) were going to make entry into Side Alpha with a 1¾-inch hoseline to

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perform a primary search for a reported trapped civilian (**See Photo 1**). The captain of Engine 2 told the other firefighter (FF2) to get a ground ladder to the 3rd floor to rescue the trapped civilian occupant, who was hanging out the window. Meanwhile, the driver of Engine 2 was in the process of connecting Engine 2 to a hydrant. The captain and FF1 entered the stairwell through the front door with a 1¾-inch hoseline on Side Alpha at 1109 hours. FF2 and a town police officer (PD 113) placed the ground ladder to the 3rd floor bathroom window on Side Bravo where the trapped



Photo 1: Initial arrival conditions. Showing Side Alpha and Side Delta. The victim was at window on 3rd floor on Side Bravo. The time was approximately 1108 hours.
(Photo courtesy of the town police department)

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Photo 2: The orange arrow identifies the window where the civilian was located upon arrival of the fire department. The civilian was removed from the 3rd floor window via the ground ladder.

(Photo provided by the Maine Office of the State Fire Marshal)

civilian occupant was located. The civilian occupant was able to climb down the ladder to the ground (See Photo 2). The police officer notified the regional communication center (RRC) that the civilian occupant was out of the building at 1109 hours. This message was delayed in being transmitted to the captain of Engine 2 because the police officer transmitted his message on the police channel to RCC. Engine 2 was inside performing a search of a 3rd floor apartment on Side Bravo. When Engine 4 arrived on-scene, the officer assumed Command at 1114 hours. At an unknown time, Car 1 from a mutual aid department assumed Command of this incident. There are no times in the dispatch log to indicate when this occurred.

FF1 met the captain at the landing on the 2nd floor with the charged 1¾-inch hoseline. The captain was donning his SCBA facepiece. A decision was made to leave the hoseline at the bottom of the stairs and enter the 3rd floor apartment for a right-hand, primary search. When the Engine 2 captain and FF1 reached the doorway to the apartment, they found heavy fire and a compromised exit. The

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captain and FF1 turned once more to try and enter the apartment and search for a new exit. The captain radioed a Mayday that was not acknowledged by Command or RCC.

The 2nd due mutual aid companies arrived and observed visible fire on Side Charlie. At approximately 1114 hours, a lieutenant from a mutual aid fire department (Engine 4) saw a 1¾-inch hoseline stretched from Engine 2 into the front door on Side Alpha. Engine 4 stretched another 1¾-inch hoseline to the front door and into the stairwell. The lieutenant found Engine 2's hoseline on the 2nd floor, which was burned but still intact. The Engine 4 lieutenant who assumed Command called a Mayday.

The captain and FF1 from Engine 2 were still on the 3rd floor and had made it into to the apartment (Side Charlie). The Engine 2 crew could go no further due to the fire in the apartment. Also, there was fire coming up the stairwell. With conditions rapidly deteriorating, the captain grabbed FF1 and laid on top of him. FF1 stated they stayed there for some time until FF1 heard water knocking the fire down around them. The time was approximately 1115 hours (**See Photo 3**).

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**Photo 3. Exterior fire attack on Side Charlie while Engine 2 was on the 3rd floor. The time is approximately 1114 hours.
(Photo courtesy of town police department)**

FF1 stated the room began to cool and visibility started to improve. He recognized an area of the room that was starting to show daylight through a wall. FF1 attempted to move the captain out of the apartment but got no response. The captain was unconscious. FF1 did not have the strength to move the captain and moved to the wall to get help. He went out on the porch and frantically waved his hands. Due to the water from a portable monitor in operation, FF1 was not visible from the ground. FF1 re-entered the building and attempted to move the captain. FF1 had tucked his portable radio into his turnout coat. Unable to move the captain, FF1 went out on the porch and called Command on his portable radio. FF1 advised Command of his location and that the captain was unconscious. The time was approximately 1116 hours.

Firefighters with the rapid intervention group climbed a ground ladder to meet FF1 on the 3rd floor porch. FF1 directed them to the captain. Then FF1 climbed down the ground ladder. Once FF1 was on the ground, he was walked to an EMS unit for medical treatment. The time was approximately 1122 hours.

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There was still visible fire inside of the structure on the 1st and 2nd floors while the firefighters were trying to rescue the Engine 2 captain on the 3rd floor. The captain was found in a sunroom adjoining the Side Charlie porch, on air but not breathing. The rapid intervention group moved the captain to the porch. He was then lowered down the ladder to firefighters on the ground (**See Photo 4**). Per Command, RCC was advised that the captain of Engine 2 was out of the building at 1132 hours. Once on the ground, CPR and advanced life support were started on the captain. Command initiated a personnel accountability report (PAR). At 1136 hours, Command advised the RCC that all firefighters were out of the building and all members accounted for at this time. Command also advised fireground operations were operating in a defensive strategy. At 1142 hours, Command advised the RCC to clear the Mayday.

The captain was transported to a trauma hospital in New Hampshire at 1152 hours. The captain was declared deceased at 1201 hours.

At 1218 hours, Command advised the RCC that another PAR had been conducted. All firefighters were accounted for at this time. At 1222 hours, Command advised the dispatcher that the fire was knocked down. At 1249 hours, Command advised the dispatcher the fire was out. Command was terminated at 1742 hours.

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Photo 4. Ground ladders extended to a 3rd floor porch where the captain and firefighter 1 were removed from the structure.
(Photo provided by the Maine Office of the State Fire Marshal)

Fire Cause

According to investigators with the Maine Office of State Fire Marshal, assisted by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), along with detectives from the town police department, determined the origin of the fire was on the 3rd floor exterior rear porch. The cause is “most probably disposal of smoking materials into an unapproved receptacle.”

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 fatalities:

- Incomplete size-up and risk assessment
- Lack of incident management
- Inadequate fireground communications

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- Lack of personnel accountability
- Rapid fire spread in the interior center stairwell
- Lack of situational awareness
- Lack of fire sprinkler system in a multi-family residential occupancy.

Cause of Death

According to the New Hampshire Office of the Chief Medical Examiner, the cause of death was probable hyperthermia and/or hypoxia and the manner of death was accidental.

Recommendations

Recommendation #1: Fire departments should ensure a detailed scene size-up and risk assessment is conducted during initial fireground operations and throughout the incident.

Discussion: The strategy and incident action plan (IAP) (tactics) of an incident are dictated by the size-up, initial risk assessment, and situation report made by the first arriving officer. The priority is to get fire department resources to Side Charlie as quickly as possible. However, unless an obvious life safety issue exists (e.g., visible victims requiring immediate assistance), interior firefighting operations should not commence until a report from Side Charlie is received. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the delegation of the size-up of Side Bravo, Side Charlie, and Side Delta may go to another engine company or other resource on the 1st Alarm. Even if a 360-degree size-up is conducted, the assignment of resources should go to Side Charlie. Resources could include any unit—engine, truck, medic unit, or chief—preferably an engine company with a hoseline [Fire and Rescue Departments of Northern Virginia (FRDNV) 2013]. Until the 360-degree assessment is completed, incident commanders should be cautious in committing fire crews, constantly monitor changing conditions, and be prepared to immediately adjust crew commitments or withdraw crews all together.

The tasks that need to occur at any fire, regardless of the occupancy, are an initial on-scene report upon arrival, scene size-up, initial risk assessment, water supply, deployment of handlines and back-up handlines, search and rescue, ventilation, establishment of a rapid intervention crew (RIC), ground and aerial ladder placement, fire attack and extinguishment, and salvage and overhaul.

At any incident, life safety is always the first priority, followed by incident stabilization (second priority) and then property conservation (third priority). The task of ensuring for the safety of firefighters is a continuous process throughout the incident. A sound risk management plan ensures that the risks are evaluated and matched with appropriate actions and conditions. The following risk management principles should be used during fireground operations:

- Activities that present a significant risk to the safety of members shall be limited to situations where there is a potential to save endangered lives
- Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of members, and actions shall be taken to reduce or avoid these risks.
- No risk to the safety of members shall be acceptable when there is no possibility to save lives or property

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- In situations where the risk to fire department members is excessive, activities shall be limited to defensive operations [NFPA 2018].

Fireground operations are very dynamic and fast-paced. An incident commander needs to determine a strategy and then develop an IAP. Incident commanders need to follow the decision-making model that includes identifying incident critical factors (through a situational evaluation or size-up), considering the standard risk management plan, declaring the strategy (offensive or defensive), and then setting tactical objectives. This model will lead to the development of an IAP, which serves as the tactical road map to effectively manage the incident. An IAP defines where and when resources are assigned throughout the incident, along with tasks and objectives [NFPA 2014].

To ensure a standard outcome for each incident, incident commanders should match the standard conditions to standard actions. This is the core of the incident command system and the basis for all operations. Incident commanders should identify the incident's current critical factors before taking any action. At each incident, incident commanders should start with a standard placement-oriented operational plan that develops a strong, dependable beginning for command and control of the incident [Brunacini 2002; FRDNY 2013].

Often the initial incident commander is a company officer who arrives on-scene prior to a chief officer. The company officer should provide a detailed size-up, which is communicated to all responding resources, including the dispatch center/fire alarm office. The company officer assumes command and makes decisions regarding the strategy and the IAP. Events can occur very quickly before a detailed tactical worksheet or written IAP is developed. When the company officer does not have the ability or time to record the IAP on paper, a verbal IAP is appropriate when transferring command [Brunacini 2002].

Once an officer assumes command, the overall strategy is communicated. Command should make specific assignments to arriving companies along with tactical objectives, such as search, rescue, fire attack, ventilation, utility control, and exposure protection. The responding chief officer should monitor radio communications and document tactical objectives on a tactical worksheet if possible. When the chief officer arrives on scene, an update from the initial incident commander should occur (face to face or by radio). The chief officer will then assume command at a stationary location. By following this process, the initial and subsequent incident commanders will have a stronger position to manage an incident should an emergency event occur [NFPA 2014].

NFPA 1561 defines an IAP as a verbal plan, tactical worksheet, written plan, or combinations thereof that reflects the overall incident strategy, tactics, risk management, and member safety that are developed by an incident commander. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2020] requires the following regarding an IAP:

- 5.3.12.1. The incident commander shall be responsible for developing and/or approving an incident action plan.
- 5.3.12.2. This IAP shall be communicated to all staged and assigned members at an incident.
- 5.3.20. The incident commander shall be responsible for reviewing, evaluating, and revising the IAP and overall strategy of the incident (**See Diagram 1**).

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DEVELOPING an INCIDENT ACTION PLAN

The Incident Action Plan is defined as the strategic goals, tactical objectives, and support requirements for the incident. All incidents require an action plan. For simple incidents, the action plan is not usually in written form. Large or complex incidents will require that the action plan be documented in writing.

After the size-up is completed, the officer begins the process of developing an Incident Action Plan, which should be used at all incidents. The Incident Action Plan (IAP) will assist the Incident Commander in completing two significant incident management tasks – identifying the incident strategy and the assignment of tasks that accomplish the strategy. During structural firefighting, the IAP will be verbal and communicated to all responders operating on the incident scene.

The acronym **SLICE-RS** was created to guide initial engine company operations. It is effective as an initial attack sequence for the initial arriving officer to determine tactical priorities. As the incident commander arrives, **S-RECEO-VS** is an effective acronym to use for overall strategic objectives guiding the incident.



Diagram 1: Guide for developing an IAP at Type V and Type IV incidents, which communicated verbally.

(Diagram courtesy of FireFighterCloseCalls.com.)

Recommendation #2: Fire departments should ensure that once command is assumed, command is maintained until command is transferred, the incident is stabilized, or the incident is terminated.

Discussion: The first resource or member to arrive to the scene will assume command of the incident by transmitting a standard initial radio report. The confirmation of command occurs when the dispatch center or fire alarm office repeats the initial radio report back to all responding units, confirming that the initial arriving resource is in command of the incident. Assuming command requires the first-arriving resource or member (the incident commander) to size up the incident, determine the incident's strategy and formulate an incident action plan (IAP). All of this is executed and shared with all incident participants when the incident commander (IC) transmits the initial radio report [Brunacini and Brunacini 2004].

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When the incident begins with an in-place IC, all later-arriving units will be assigned based on the IC's IAP. This puts all the incident players on the same page. Everyone knows what the problem is and what action is being taken to solve it. Effective and coordinated action is the result of beginning (and ongoing) incident operations with an in-place and in-charge IC. Once command has been established, all routine communication between the dispatch center and the incident will be directed through command. The initial incident commander shall remain in command until command is transferred or the incident is stabilized and command is terminated. A formal IC must be in place, performing the functions of command, whenever a hazard zone exists [Brunacini and Brunacini 2004].

Many times, the strength of the local incident management is the fast-attacking IC, who directly supervises the use of quick force at the beginning of the event. That action is reinforced and upgraded by response chiefs who come in behind the initial fast attacking IC to quickly establish a stationary, exterior command post that supports and expands on the fast-attacking IC's initial actions. The fast-attacking command position provides the front-end command structure for that capability.

The entire response team coming in behind a fast attacking IC need to realize that the initial IC is in an attack position, not a command position. We trade off this position disadvantage because many times this initial front end fire attack is enough to stabilize the incident. When the front-end control efforts doesn't stabilize the situation, the fast-attacking IC is not in the best position to continue command; they are in the worst position [Brunacini and Brunacini 2004].

The fast attacking command position should end in one of three ways:

- Situation is quickly stabilized
- Command is transferred from the fast attacking company officer IC (#1) to a subsequent arriving command officer (IC #2)
- If the situation is not stabilized and there is a delay in the arrival of a command officer, the fast attacking company officer IC needs to move to an exterior (stationary) command position and operate in the Command position. When this happens, the company officer has the following crew options:
 - Move up one of your crew members to company officer. Minimum 2-member company in a hazard zone
 - Assign your crew member(s) to another company in the hazard zone. This needs to be acknowledged by both the original and the receiving officer and by their inclusion in the accountability system
 - Have the crew exit with the IC and perform IC support roles
 - No crew will remain in a hazard zone without radio communications [Brunacini and Brunacini 2004].

The fast attacking company officer IC will also directly supervise and assist their crew members with the tasks required to bring the incident's problems under control.

In most cases, this initial attack wave eliminates the incident hazards. For incidents that are not quickly controlled, are escalating, or are significant in scope and size upon our arrival, the strategic and tactical operational levels need to be upgraded with chief officers as required [Brunacini AV 2002].

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Recommendation #3: Fire departments should ensure firefighters communicate critical incident benchmarks to incident commanders throughout the incident.

Discussion: Fireground benchmarks are essential for a successful and safe outcome. To ensure that the proper benchmarks are communicated at fireground incidents, fire departments should develop and maintain an SOP/SOG that specifies a consistent process for communicating critical benchmarks. This would include effective hands-on classroom and practical training programs with annual live fire training, a defined department deployment model, an effective incident management system, adequate radio equipment (mobile and portable radios), and adequate radio channels (dispatch, tactical, and command) [NIOSH 2013a, NIOSH 2013b, NIOSH 2014]. Effective incident communications provide the connection between the strategic, tactical, and task levels of management. This connection allows the team to commit resources and coordinate actions. To be effective, ICs need to coordinate the ongoing communication between and within the three operational levels (i.e., strategic, tactical, task) despite each level having its own special set of needs, capabilities, and challenges. These differences create logistical challenges for the entire team. They require a strong, well-practiced, procedures-based communications plan and positive function-based relationships among the participants [Brunacini and Brunacini 2004].

Radio communications allow the tactical and task levels to connect with the IC working on the strategic level. The overall outcome of the incident can be traced back to the quality of the radio communications among the participants. Since the IC is located at the command post (outside the hazard zone), interior conditions need to be communicated by interior crews as soon as possible to the IC. This allows the IC to modify their strategy, if needed. Subsequent updates, as well as when benchmarks are completed (e.g., “primary search complete is all clear” and “the fire has been knocked down”), are especially important to the IC. A fire department’s communications SOP/SOG should include communications necessary to gather and analyze information to plan, issue orders, and manage operations. For example:

- additional resources required
- status of searches
- is there water on the fire
- assignment completed
- unable to complete an assignment or task
- special information
- ensure all companies and resources are operating on the designated radio channel
- emergency traffic or Mayday [FIREScope 2017].

Critical incident factors and their possible consequences offer the basis for a standard incident management approach. A standard information approach is the launching pad for effective incident decision making and successful operational performance. ICs should use the critical factors, in their order of importance, to make tactical assignments for the IAP. The IC should develop a standard information system and use effective techniques to keep informed at the incident. ICs should not assume the action-oriented responder engaged in operational activities will stop what they are doing to notify the IC with a continuous supply of top-grade, objective information. It is the IC’s responsibility to do whatever is required to stay effectively informed [NIOSH 1999]. Radio discipline is essential for

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all members operating at an incident scene. Members should be trained on and use the thought process of "is my transmission necessary." Radio transmissions should be reserved for relevant messages such as benchmarks, personnel accountability reports, safety issues or concerns, needed resources, changing conditions, and emergency traffic and Mayday. Non-relevant transmissions can distract the IC and add little, if anything, to the IAP.

The following are considerations of critical incident benchmarks that should be completed during fireground operations:

- First-due company officer should assume command
- A complete size-up and risk assessment should be completed by the first-due company officer
- The first due companies should advise command if they did not lay a supply line
- Once operations were initiated on Side Charlie, the company officer should provide a description of company locations and entry locations
- When companies change locations, the division supervisor should provide a complete description of the tactical operations, including a description of the basement and its dimensions
- When command assigns a division supervisor, this should be communicated to the companies assigned to this division to ensure personnel accountability within the division
- Once the 1st Alarm companies are on-scene, a company or companies should be assigned as the rapid intervention crew (RIC)
- Companies or units assigned to RIC should operate, or be located, together
- Once officers communicate critical information about smoke or fire in a structure, Command should revise the IAP and communicate any tactical changes
- Company officers should conduct radio checks to ensure all company members are on the correct radio channel. Radios should not be on the "scan" function
- The fire agency should evaluate and simplify the selection of radio frequencies to reduce the possibility of mistakes upon dispatch
- Command should be advised when a company assigned water supply and is having trouble establishing the water supply [Brunacini and Brunacini 2004].

Recommendation #4: Fire departments should ensure firefighters are trained in procedures for conducting search and rescue, especially above a fire.

Discussion: The firefighter-oriented search can be done with a two-, three- or four-person team. With a two-person search, the oriented firefighter, carrying a thermal imager, if possible, stays in touch with the search wall. The searcher then moves about the room while staying oriented with the lead firefighter. Orientation can be accomplished by touch with the use of a strap, rope, or tool; by sight through the use of the thermal imager or the naked eye if conditions allow it; or by voice through verbal communication throughout the search [IFSTA 2018].

Search priority is based on fire behavior. Since heat, smoke and flame extend upward and outward, the immediate fire area and fire floor are the primary search areas. Next is the one floor directly above the fire spread, then the rest of the floors above, beginning with the top floor and descending. Finally, all

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floors below the fire are searched as primary searches end and secondary searches begin [IFSTA 2018].

There are two main objectives in conducting a structural search: searching for life and assessing fire conditions. A primary search is a fast, efficient, and controlled method of finding occupants before or during fire extinguishment. To sustain maximum safety, firefighters search on their hands and knees or in a squat position. This establishes orientation in the direction of travel and if struck by debris, ensures the correct bearing will be maintained. Lower temperatures at floor level give firefighters an advantage should fire conditions change [IFSTA 2018].

An occasional pause while holding a breath gives firefighters a chance to hear conditions. Firefighters can hear a victim moaning, the creaking or crackling of structures or the fire itself, or an information update via radio traffic. Such a pause allows for better orientation to the entire fireground as well as the immediate search area.

Recommendation #5: Fire departments should ensure hoselines are deployed, staffed, and appropriately utilized to protect crews operating in the hazard zone.

Discussion: The primary purpose of the initial attack hoseline is for fire suppression, but it also protects the interior fire suppression crews if they become overrun with fire, need to cool down the area, and need to protect a firefighter's egress point(s). A hoseline should be of sufficient length to advance the crew in their search for the fire and/or occupants [FDNY 2014].

In most cases, the first line is stretched via the interior stairs to the location of the fire. The purpose of this line is to protect the primary means of egress for occupants evacuating the building and to confine and extinguish the fire. An exception to stretching the first line up the interior stairs may be made when flame is issuing from windows opening onto the fire escape and endangering people trying to come down the fire escape. In this case, the first line may be operated from the street to protect people on the fire escape. A second line should be promptly stretched to the interior of the building. If the entrance door to the building is self-closing and equipped with a locking device, the first member entering the building should use a chock, rug, or other means of preventing the door from locking and thereby delaying other members trying to enter the building [FDNY 2014].

When an initial attack hoseline is deployed to an area and being operated and/or covering a search, a backup hoseline should be the next line pulled. Ideally a back-up hoseline should be at least the same size and preferably larger if the stretch length and maneuverability will allow. The back-up line is the primary protection for the crew operating the initial hoseline and can cover a retreat in case of a fire event overrunning or can assist in the search. Additionally, if the initial hoseline stretches short of the intended area, this needs to be communicated to command. This allows for the back-up hoseline of proper length to be stretched.

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Recommendation #6: Fire departments should ensure that firefighters are trained in situational awareness.

Discussion: All firefighters operating at an incident should be trained to maintain situational awareness and conduct a continuous risk assessment throughout the incident, reporting unsafe or changing conditions to the IC. The fireground dangers and hazards can and do change as the incident becomes larger and the event duration increases. The structural conditions of the fire building(s) can change significantly and endanger areas of the fireground that were not present earlier in the event.

The IFSTA *Essentials of Fire Fighting* defines situational awareness as an awareness of the immediate surroundings. On the fireground, every firefighter should be trained to be constantly alert for changing and unsafe conditions. Even though a safety officer may have been designated for the incident, all personnel are obligated to remain alert to their immediate surroundings. This applies not only to the conditions found within a burning structure, but also to the exterior fireground as well [IFSTA 2018].

One of the most critical aspects of coordination between crews is maintaining situational awareness. When situational awareness is not maintained, firefighters can develop tunnel vision and become so focused on firefighting or other operational assignments that they may fail to sense changes in their environment.

The International Association of Fire Chiefs, Safety, Health, and Survival Section developed the "Rules of Engagement for Structural Fire Fighting." These rules assist the firefighter, the IC, and the command team officers in risk assessment that enables making "Go or No-Go" decisions. The fireground creates a significant risk to firefighters and it is the responsibility of the IC and command organization officers to minimize firefighter exposure to unsafe conditions and stop unsafe practices [IAFC 2012].

The rules of engagement can assist the IC, company officers, and firefighters in assessing their situational awareness. One principle applied in the rules of engagement is that firefighters and the company officers are the members most at risk for injury or death and will be the first to identify unsafe conditions and practices. The rules integrate the firefighter into the risk assessment decision making process. When it is not safe to proceed, the rules of engagement guide decision making while still maintaining command unity and discipline.

Rules of Engagement for Firefighter Survival:

- Size-up your tactical area of operation. (Pause for a moment, look over the area of operation, evaluate individual risk exposure, and determine a safe approach to completing your tactical objectives.)
- Determine the occupant survival profile. (Consider occupant survival as part of your individual risk assessment and action plan.)
- Do not risk your life for lives or property that cannot be saved. (Do not risk your life when fire conditions prevent occupant survival and when significant or total destruction of the building is inevitable.)
- Extend limited risk to protect savable property. (When trying to save a building, limit risk exposure to a reasonable, cautious, and conservative level.)

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- Extend vigilant and measured risk to protect and rescue savable lives. (During high-risk primary search-and-rescue operations where lives can be saved, manage search-and-rescue operations in a calculated, controlled, and safe manner while remaining alert to changing conditions.)
- Go in together, stay together, and come out together, when two or more firefighters operate as a team.
- Maintain continuous awareness of your air supply, situation, location, and fire conditions.
- Constantly monitor fireground communications for critical radio reports.
- Report unsafe conditions or practices that can harm you. Stop, evaluate, decide. (Officers should prevent exposure to unsafe conditions or practices by allowing any member to raise an alert about a safety concern without penalty and by mandating supervisors address safety questions to ensure safe operations.)
- Abandon your position and retreat before deteriorating conditions can harm you. (Be aware and exit early to a safe area when you are exposed to deteriorating conditions, unacceptable risk, and a life-threatening situation.)
- Declare a Mayday as soon as you think you are in danger. (Officers should ensure firefighters are comfortable with declaring a Mayday as soon as they think they are in trouble.) [IAFC 2012].

The Incident Commander's Rules of Engagement For Firefighter Safety:

- Rapidly conduct or obtain a 360-degree situational size-up of the incident. (As part of the risk assessment plan and action development plan, determine the safest approach to tactical operations before firefighters are placed at substantial risk.)
- Determine the occupant survival profile. (Consider fire conditions in relation to the occupant survival of a rescue event before committing to a high-risk search and rescue.)
- Conduct an initial risk assessment and implement a safe action plan. (Before firefighters are placed in high-risk positions on the fireground, develop a safe action plan by conducting a size-up, assessing the survival profile, and completing a risk assessment.)
- Consider a defensive strategy when you do not have the resources to safely support and protect firefighters. (Do not commit firefighters to high-risk tactical objectives that cannot be accomplished safely due to inadequate resources on the scene.)
- Do not risk firefighter lives for lives or property that cannot be saved. Seriously consider a defensive strategy. (Do not commit firefighters to high-risk firefighting operations that may harm them when fire conditions prevent occupant survival or when significant or total destruction of the building is inevitable.)
- Extend limited risk to protect savable property. (Limit risk exposure to a reasonable, cautious, and conservative level when trying to save a building that is believed, following a thorough size-up, to be savable.)
- Extend vigilant and measured risk to protect and rescue savable lives. (During high-risk search-and-rescue operations where lives can be saved, manage search-and-rescue and supporting firefighting operations in a highly calculated, controlled, and cautious manner while remaining alert to changing conditions.)

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- Maintain frequent two-way communications and keep interior crews informed of changing conditions. (Request frequent progress reports and continually inform all interior crews of changing fire conditions observed from the exterior that may affect crew safety.)
- Obtain frequent progress reports and revise the action plan. (Obtain frequent progress reports to continually assess fire conditions and any risk to firefighters and to regularly adjust and revise the action plan to maintain safe operations.)
- Ensure accountability of every firefighter, their location, and status. (Maintain a constant and accurate accountability of the locations and status of all firefighters within a small geographic area of accuracy within the hazard zone and be aware of who is presently in or out of the building.)
- Seriously consider a defensive strategy, if after completion of the primary search, little or no progress toward fire control has been achieved.
- Always have a RIC in place at all working fires.
- Always have firefighter rehab services in place at all working fires. (Ensure all firefighters who endured strenuous physical activities at a working fire are rehabilitated and medically evaluated for continued duty and before being released from the scene.) [IAFC 2012].

In this incident, the captain was notified of a trapped civilian prior to arrival. After assuming command, the captain and firefighter 1 engaged in interior search and rescue efforts in a heroic effort to rescue the trapped victim.

Recommendation #7: Fire departments should use a functional personnel accountability system, requiring a designated accountability officer or resource status officer.

Discussion: Personnel accountability on a fireground means identifying and tracking all personnel working at the incident. A fire department should develop its own system and standardize it for all incidents. Accountability on the fireground can be maintained by several methods: a passport system, a system using individual tags assigned to each firefighter, a riding list provided by the company officer, a SCBA tag system, or an incident command board [NIOSH 2011]. Some personal alert safety system (PASS) devices incorporated into SCBA can communicate automatically with a command /control module at the incident command post, establishing an automatic accountability system. NFPA 1500 (Chapter 8, Section 8.5) and NFPA 1561 (Chapter 4, Section 4.5) contain guidelines for the development of an accountability system for fireground and other emergency operations [NFPA 2018, NFPA 2014].

The accountability process should start at the first arriving piece of apparatus. This is especially important when the initial incident commander assumes command and operates in the mobile command capacity. Accountability is assigned to the chauffeur or engineer of that piece. As the incident escalates, additional staffing and resources will be needed, adding to the burden of tracking personnel accountability. At this point a tactical worksheet should be established with an assigned accountability officer or chief's aide. In large incidents, this can also be used at the division level, with resources being assigned and tracked at the division level.

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An important aspect of a personnel accountability system is the personnel accountability report (PAR). A PAR is an organized on-scene roll call in which each supervisor reports the status of their crew when requested by the IC [NFPA 2014]. The use of a personnel accountability system is recommended by NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program* [NFPA 2018], and NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2014]. A functional personnel accountability system requires the following:

- development of a departmental SOP
- training all members
- strict enforcement during emergency incidents.

The control of the personnel accountability system should be assigned to a member of the incident command team responsible for maintaining the location and status of all assigned resources and personnel at an incident. This is a separate role from the duties of the IC. The IC is responsible for overall command and control of the incident. Due to the importance of responder safety, this function would be assigned to a personnel accountability officer or resource status officer. This position can be staffed by the chief's aide, staff assistant, field incident technician, chief officer, or other responder familiar with the department's accountability system [NFPA 2014].

There are many different methods and paper or electronic tools for accounting of resources. Some examples are as follows:

- command boards
- tactical worksheets
- apparatus riding lists
- electronic bar-coding systems
- accountability tags or keys (e.g., PASSPORT System) [NFPA 2014].

Different methods and tools for resource tracking and accountability can be used in conjunction with one another to facilitate the tracking of responders by both location and function. The components of the personnel accountability system should be modular and expand with the size and complexity of the incident [NFPA 2014].

As the incident escalates, additional staffing and resources may be needed, adding to the burden of tracking personnel. With an effective accountability system in place, the IC can readily identify the location and time of all firefighters on the fireground. A properly initiated and enforced personnel accountability system that is consistently integrated into fireground command and control enhances firefighter safety and survival by helping to ensure a more timely and successful identification.

In this incident, personnel accountability was not established until after the Mayday was called. Arriving crews who initiated RIT knew there were firefighters inside of the structure but had no immediate way of determining who was lost, missing, or trapped.

Recommendation #8: Fire departments should use resources from the National Institute of Standards and Technology (NIST), Underwriters Laboratories (UL) Fire Safety Research Institute (FSRI), and the International Society of Fire Service Instructors (ISFSI) to develop and revise

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operational procedures on fireground tactics and provide training in fire dynamics in structures for all members.

Discussion: The above organizations have conducted a series of live-burn experiments designed to replicate conditions in modern homes and residential structures and to validate previous testing done in laboratory settings. The results of these experiments enable firefighters to better predict and react to the effects of fire in these occupancies. The fire research experiments were conducted in cooperation with the Fire Department of New York; Chicago Fire Department; Spartanburg, South Carolina, Fire and Rescue; and other agencies. The live-burn tests were aimed at quantifying emerging theories about how fires are different today, largely due to new building construction and the composition of home furnishings and products. In the past, these products were mainly composed of natural materials, such as wood and cotton, but now contain large quantities of petroleum-based products and synthetic materials that burn faster and hotter and generate large volumes of fuel-rich smoke. Where a fire in a room once took approximately 20 minutes to “flashover”—igniting all the contents—this can happen with today’s furnishings in as little as 4 to 5 minutes [Kerber 2012].

Modern living spaces tend to be more open, less compartmentalized, and better insulated than homes built years ago. As a result, interior residential fires can generate oxygen-depleted, fuel-rich environments within minutes. This fire condition of hot, fuel-rich smoke (also known as a ventilation-limited fire) is highly reactive to the introduction of oxygen. Opening a door or venting a window introduces massive quantities of oxygen to this environment, which promotes explosive and rapid transition to flashover. These same conditions can occur in commercial structures as seen in the fire at the Charleston, South Carolina, Sofa Super Store [NIOSH 2009].

The NIST and FSRI experiments evaluated individual and combinations of methods for strategically ventilating and isolating fires to prevent or delay flashover. In contrast, kicking a door open or breaking a window without knowledge of conditions inside could create a portal for air that can literally fan the flames by introducing oxygen into an oxygen-limited fire environment.

A flow path is composed of at least one inlet opening, one exhaust opening, and the connecting volume between the openings. The direction of the flow is determined by difference in pressure. Heat and smoke in a high-pressure area will flow through openings toward areas of lower pressure. Based on building design and the available ventilation openings (doors, windows, etc.), several flow paths can exist within a structure. Any operation conducted in the exhaust portion of the flow path will place members at significant risk because of the increased flow of fire, heat, and smoke toward their position. Operations conducted in the flow path, between where the fire is and where the fire will travel, place firefighters at significant risk because of the increased flow of fire, heat, and smoke toward their positions. This risk is true for natural-ventilation cases with or without wind. In cases with the potential for wind to affect the heat release rate and the movement of the fire, it is important to keep the wind at your back and attack the fire from the upwind side [UL FSRI 2013]. Another important safety procedure to remember, practice, and utilize in the event of becoming trapped or in distress in the hazard zone is door control and isolation. This allows a firefighter or firefighters to have protection until a rescue can occur.

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Fire suppression operations conducted from the interior of the structure need to be coordinated with ventilation operations. Previous research and examinations of line-of-duty deaths have shown that ventilation events occurring with firefighters in the structure prior to suppression have led to tragic results [NIOSH 2009, 2012, 2013a, 2013b]. One method of reducing this risk would be the application of exterior water. Water should be directed into the structure from the exterior to cool the fire gases and reduce the heat-release rate of the fire prior to firefighters entering the building.

UL has shown that effective suppression operations, either from the interior or exterior, did not increase the potential burn injuries to the occupants. However, the delay of suppression operations provides the potential for longer occupant exposures to IDLH conditions and increased potential for further injury or death [Zevotek et al. 2019].

Based upon the NIST, FSRI, and ISFSI research cited above, the following fireground operations should be considered for implementation.

- **Size-Up**
Size-up must occur at every fire. Consideration must be given to the resources available and situational conditions, such as weather, fire location, size of the fire and building, and the construction features. Ensure a 360-degree size-up is conducted whenever possible. A tactical plan for each fire must be developed, communicated, and implemented.
- **Ventilation**
Fire departments should manage and control the openings to the structure to limit fire growth and spread and to control the flow path of inlet air and fire gases during tactical operations. All ventilation must be coordinated with suppression activities. Uncontrolled ventilation allows additional oxygen into the structure, which may result in a rapid increase in the fire development and increased risk to firefighters due to increased heat-release rates.
- **Firefighting Operations**
Given the fuel-rich environment in which the fire service operates, water should be applied to the fire as soon as possible. In many cases, water application through an exterior opening into a fire compartment may be the best first action, prior to committing fire-fighting resources to the interior. Fire departments should cool the interior spaces of a fire building with water from the safest location possible, prior to committing personnel into spaces with, or adjacent to, fully developed or smoldering (ventilation-limited) fire conditions.
- **Rapid Intervention**
Fire department rapid intervention procedures should be updated to provide water on the fire as soon as possible. During firefighter Mayday incidents, ventilation openings should be controlled [ISFSI 2013].

Fire departments should consider a change in fireground tactics based upon the research conducted by NIST, FSRI, and ISFSI [Madrzykowski 2013; Madrzykowski and Weinschenk 2018]. Much of this research has been directed toward developing a better understanding of the characteristics of modern

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fire behavior and providing the fire service with the knowledge needed to modify essential fire-fighting tactics.

Recommendation #9: Governing agencies (state, regional, and local) should consider adopting and enforcing regulations for interventions to reduce or eliminate the spread of fire in multi-family structures, including automatic sprinkler systems and self-closing doors.

Discussion: This recommendation focuses on fire prevention and minimizing the impact of a fire if one does occur. The National Fire Protection Association (NFPA) Fire Protection Handbook states: “Throughout history there have been building regulations for preventing fire and restricting its spread. Over the years these regulations have evolved into the codes and standards developed by committees concerned with fire protection. The requirements contained in building codes are generally based upon the known properties of materials, the hazards presented by various occupancies, and the lessons learned from previous experiences, such as fire and natural disasters” [NFPA 2008]. Although municipalities have adopted specific codes and standards for the design and construction of buildings, structures erected prior to the enactment of these building codes may not be compliant. Such new and improved codes can improve the safety of existing structures [NFPA 2008]. Sprinkler systems are one example of a safety feature that can be retrofitted into older structures. Sprinkler systems can reduce firefighter and civilian fatalities since such systems can contain and may even extinguish fires prior to the arrival of the fire department.

The International Code Council's International Residential Code and the NFPA 101, *Life Safety Code* requires sprinkler protection in all new one- and two-family dwellings and in most other properties [NFPA 2021]. Fire development beyond the incipient stage is one of the greatest hazards to firefighters. This exposure and risk to firefighters can be dramatically reduced when fires are controlled or extinguished by automatic sprinkler systems [Ahrens 2021]. The presence of automatic fire sprinklers also reduces the exposure risk to firefighters in rescue situations by allowing the safe egress of building occupants before the fire department arrives on scene. Finally, by controlling fire development, the exposure to hazards such as building collapse and overhaul operations are greatly reduced, if not eliminated. NFPA statistics show that most fires in sprinklered buildings are controlled prior to fire department arrival by the activation of one or two sprinkler heads.

Another important factor is requiring self-closing apartment exit doors to ensure that a fire does not spread due to an open apartment door. Closed doors can reduce the flow path of a fire, prevent fire spread, and protect other building occupants from smoke and fire. Self-closing doors are an effective method for slowing down the spread of a fire by providing sometimes critical, life-saving time for fire and rescue personnel to do their job and allow individuals to escape the fire or be rescued. It is imperative that where such doors are in place or required that they are unobstructed and that the self-closing mechanisms are always fully operational. Such self-closing mechanisms should be included as a routine inspection item to ensure proper operation of the mechanism. In situations where the mechanism is not functioning due to resident action, management should treat this as a violation of the lease and take appropriate action on a case-by-case basis. The importance of the proper functioning of self-closing doors should be addressed during regular, on-going resident education programs on fire safety.

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Finally, emergency egress doors in residential properties should never be locked from the inside preventing emergency egress. There are some exceptions in certain types of facilities, but where this is necessary there are specific procedures that must be followed in accordance with local/state requirements [USDHUD 1999].

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Investigator Information

This incident was investigated by Karis Kline, Safety and Occupational Health Specialist, Stephen T. Miles, Safety and Occupational Health Specialist, Matt Bowyer, General Engineer, with the Fire Fighter Fatality Investigation and Prevention Program, and Melanie Fowler, an environmental health Commissioned Corps officer (US Public Health Service), Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. The report was finalized by Murrey Loflin, Safety and Occupational Health Specialist with the Fire Fighter Fatality Investigation and Prevention Program. An expert technical review was provided by Jake Hoffman with the Toledo, OH Fire Department. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

Additional Information

National Institute for Standards and Technology (NIST) and Underwriters Laboratories (UL)
Over the past decade, NIST and UL's Firefighter Safety Research Institute has worked with fire departments and fire service organizations to conducted research on fire behavior, fire safety issues, and fireground operations. Since 2019, UL's website has made available [25 training videos](#) on these, and other topics.

International Association of Firefighters (IAFF) Fire Ground Survival Program

The [IAFF Fire Ground Survival Training program](#) provides training for 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 Firefighters (FIRE Act) grant program, this comprehensive fireground survival training program applies the lessons learned from firefighter fatality investigations conducted by the

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National Institute for Occupational Safety and Health (NIOSH). It was developed by a committee of subject matter experts from the IAFF, the International Association of Fire Chiefs (IAFC), and NIOSH.

[IAFC Rules of Engagement for Firefighter Survival](#). The International Association of Fire Chiefs (IAFC) is committed to reducing firefighter fatalities and injuries. As part of that effort the nearly 1,000 member Safety, Health, and Survival Section of the IAFC has developed “Rules of Engagement for Structural Firefighting” to provide guidance to individual firefighters, fire officers, and incident commanders, regarding risk and safety issues when operating on the fireground. The intent is to provide a set of “model procedures” for structural firefighting to be made available by the IAFC to fire departments as a guide for their own standard operating procedure/standard operating guideline development.

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* (2014 edition)

The primary focus of the revision to NFPA 1561 in the 2014 edition is to develop requirements directly aimed at reducing and eliminating fireground injuries and fireground deaths of fire department members. The most apparent change to this edition is the inclusion of “Command Safety” in the document title and the creation of a new chapter, “Command Safety.” This chapter is intended to provide a foundation on how to incorporate the incident management system at all emergency incidents, especially *Type V* and *Type IV* incidents.

The chapter on Command Safety clearly defines the requirements for the incident commander to meet, including establishing a fixed command post, personnel accountability, the use of staff aides, rapid intervention crews, and the appointment of a safety officer and assistant safety officer(s)(as needed), plus the expectations and authority of the safety officer. Annexes cover *Functional Assignments for High-Rise Building Incidents*, *Development of Subordinate Officers or Implementing a More Efficient Management System*, *Incident Management for the Fire Service on Type V or Type IV Incidents*, and *Structural Fire-Fighting—Risk Assessment and Operational Expectation*.

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* (2014 edition) can be purchased from the National Fire Protection Association at <http://www.nfpa.org>.

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