1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

Firefighter Dies after Falling Through a Floor at a Large Area Residential Structure Fire – Maryland

Executive Summary

Crews operating in a defensive strategy working to knock down the fire in 8,400 square foot single-family home.
(Photo courtesy of the Fire and Rescue Department)

On July 23, 2018, a 34-year-old male career firefighter died due to prolonged exposure to high temperatures and thermal injuries after falling into the crawlspace at a large residential structure fire. The residential structure was a custom designed 8,400 square feet single-family home. At approximately 0120 hours a lightning strike ignited a fire in the home. At 0151 hours, the homeowner called 9-1-1 to report a lightning strike, the odor of smoke in the home, but no visible fire in the home. The county's communication center dispatched a local box alarm (Box 5-62) for a single-family structure at 0152 hours for a lightning strike and smoke in the building. Engine 51 (E51), Engine 101 (E101), Tower 10 (TWR10), Battalion Chief 1 (BC1), and Paramedic 56 (P56) were dispatched. At 0157 hours, the homeowner called back and stated, "We have fire in our house due to lightning." He then repeated his address, and said, "I don't see a flame but our whole house is filled with smoke." E51 arrived on-scene at 0200 hours. The officer of E51 (E51A) reported they had a two-story, single-family dwelling with smoke showing. E51A requested a full first alarm box assignment for Box 5-62. After initially positioning on Side Alpha, E51 re-positioned to Side Charlie to access the swimming pool as a water source. Tower 10 arrived at 0202 hours and positioned on Side Alpha. BC1 arrived on-scene at 0204 hours and confirmed the initial report. BC1 assumed Command and declared an offensive strategy. At 0208 hours, E51 entered the structure through the laundry room door near the garage on Side Charlie. Command

Firefighter Dies after Falling Through a Floor at a Large Area Residential Structure Fire – Maryland

did not receive a complete report of conditions and operations on Side Charlie. Due to lack of smoke in the laundry room, E51 repositioned their hoseline to the lower basement entrance (Side Charlie/Side Delta) based on the size-up by the BC1 aide, stating there was floor to ceiling smoke in the basement. When E51 entered the basement on lower Side Charlie, they did not advise Command of the change in grade. At 0213 hours, after being informed by the BC1 aide, Command advised all units "We do have an all clear from the occupants, occupied times three, all clear of the house. We do have an all clear." At 0216 hours, E101 officer (E101A) advised Command, "We have heavy fire on floor number one, Side Charlie" but did not have an exact location of the fire. Command was not advised that the crew from E101 pulled a pre-connected hose line from E51 and went back to the 1st floor laundry room. Tower 10A transmitted, "Tower 10 to Command, "It's gonna be Quadrant Two, 101 and Engine 51 are making entry right now. We have made access to the basement, still smoke from floor to ceiling. We've closed the door back up. Only crews you should have in are on the first level entering side Charlie." E101B (deceased firefighter) entered the laundry room door advancing a 1¾-inch hoseline through the laundry room and into the kitchen/breakfast area with E101A trailing a significant distance behind. At approximately 0220 hours, E101B fell through the 1st floor into a basement level crawlspace with heavy fire conditions. Two Mayday emergency transmissions were made. The first Mayday was by E101A on Bravo 1 (the tactical channel used for this incident). The second by E101B on Bravo 2 (an unmonitored radio channel). Command deployed a rapid intervention crew (RIC) which had been staged on Side Alpha at 0218 hours, to enter the basement at approximately 0227 hours. The rescue group located E101B, who was removed from the structure at 0244 hours. Once outside the structure, E101B received advance life support care and was moved to Medic 105 (M105) to be transported to a local trauma hospital. E101B was pronounced deceased at 0312 hours.

Contributing Factors

- *Lack of crew integrity*
- *Lack of complete scene size-up*
- *Below-grade fire*
- *Large area residential structure*
- *Lack of a defined incident action plan*
- *Inadequate fireground communications*
- *Missed critical incident benchmarks*
- *Member operating on the wrong radio channel*
- *Task saturation of the incident commander*
- *Lack of personnel accountability*
- *Wind/weather*

Key Recommendations

- *Fire departments should ensure that crew integrity is properly maintained by visual (eye-to-eye), direct (touch), or verbal (voice or radio) contact at all times when operating in an immediately dangerous to life and health (IDLH) atmosphere. The intent is to prevent firefighters from becoming lost or missing*
- *Fire departments should ensure incident commanders conduct a detailed scene size-up and risk assessment during initial fireground operations and throughout the incident including Side Charlie*

Firefighter Dies after Falling Through a Floor at a Large Area Residential Structure Fire – Maryland

- *Fire departments should develop and implement a standard operating procedure/guideline (SOP/SOG) to identify below-grade fires and ensure that appropriate tactical operations are implemented*
- *Fire departments should ensure that a deployment strategy for low frequency/high risk incidents is developed and implemented for large area residential structures with unique architectural features*
- *Fire departments should ensure that incident commanders develop an incident action plan (IAP) that matches conditions encountered during initial operations and throughout the incident*
- *Fire departments should ensure that critical incident benchmarks and fire conditions are communicated to incident commanders throughout the incident. This is accomplished with effective fireground communications*
- *Fire departments should have a procedure to ensure all members operating in the hazard zone have their radios on the designated radio channel*
- *Fire departments should ensure all members and dispatchers are trained on the safety features of their portable radio, particularly the features useful during a Mayday*
- *Fire departments should develop a process to prevent task saturation of incident commanders during multi-alarm incidents*
- *Fire departments should ensure that the member assigned to the resource status and situation status function is not given other duties during an incident*
- *Fire departments should develop a formal training program that defines the job duties and functions for staff aides, incident command technicians, or staff assistants*
- *Fire departments should ensure incident commanders maintain control of situation status, resources status, and communications to ensure the completion of tactical objectives*
- *Fire departments should incorporate the principles of Command Safety into the incident management system during the initial assumption of command. This ensures that strategic-level safety responsibilities are being incorporated into the command functions throughout the incident*
- *Fire departments should review and/or develop SOG/SOPs to ensure that water supply is established during initial fireground operations, particularly in areas with limited or no hydrants*
- *Fire departments should ensure adequate staffing and deployment of resources based on the community's risk assessment*
- *Fire department should periodically review and, if necessary, revise their SOP/SOG on the deployment of rapid intervention crews (RICs)*
- *Fire departments should use resources from the National Institute of Standards and Technology (NIST), Underwriter's Laboratories (UL) Fire Fighter Safety Research Institute (FSRI), and the International Society of Fire Service Instructors (ISFSI) to develop and revise operational procedures on fireground tactics and provide training in fire dynamics in structures for all firefighting staff*
- *Fire departments should consider having all members carry a wire cutting tool*

Firefighter Dies after Falling Through a Floor at a Large Area Residential Structure Fire – Maryland

- *Fire departments should ensure that all members engaged in emergency operations receive annual proficiency training and evaluation on fireground operations, including live fire training. This training should be conducted with automatic aid and mutual aid fire departments*
- *Fire departments should ensure adequate incident scene rehabilitation is established in accordance with NFPA 1584, Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises*
- *Fire departments should consider a radio protocol that identifies the unit they are calling first (receiver), then identifies themselves (sender).*

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

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

Firefighter Dies after Falling Through a Floor at a Large Area Residential Structure Fire – Maryland

Introduction

On July 23, 2018, a 34-year-old male career firefighter died due to prolonged exposure to high temperatures and thermal injuries after falling into a crawlspace at a large area residential structure fire. On July 23, 2018, the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On August 7, 2018, a safety and occupational health specialist, a general engineer, and a medical officer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Maryland to investigate this incident.

An opening meeting was held with the fire chief, executive staff of the fire department, and a member of the International Association of Fire Fighters (IAFF) local. Subsequently, NIOSH investigators met with the fire department arson investigator, the physician who conducted the autopsy for the Maryland Office of the State Medical Examiner, members of the department's internal safety review board investigating this incident, dispatchers with the county's Communication Center, the assistant chief of the bureau of education and training, the assistant chief of the safety bureau, the supervisor of the county's maintenance shop, and the department's self-contained breathing apparatus (SCBA) maintenance staff. The NIOSH investigators reviewed the fire department's standard operating procedures (SOPs); training records for Engine 101B, Engine 101A, and Battalion 1; witness narratives from the incident report; and dispatch and tactical channel radio transmissions.

The NIOSH investigators visited and photographed the fire scene. Interviews were conducted with the firefighters, fire officers, and deputy chiefs who responded to the incident. NIOSH investigators also met with agents from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) investigating this incident and members of the Underwriters Laboratories, Firefighter Safety Research Institute.

The NIOSH investigators inspected and photographed the deceased firefighter's personal protective gear and SCBA. The Fire and Rescue department requested NIOSH evaluate E101B's SCBA. The NIOSH investigators transported the SCBA to the NIOSH National Personal Protective Technology Laboratory (NPPTL) in Morgantown, West Virginia on August 18, 2018. On September 11, 2018, representatives of the Fire and Rescue department, arson investigators, county police officers, ATF special agents, and technicians from the SCBA manufacturer traveled to Morgantown, West Virginia to observe the evaluation and testing of Engine 101B's SCBA. During the NIOSH evaluation, the SCBA's data log information was successfully downloaded. After the evaluation was complete, the SCBA and other equipment were returned to the Fire and Rescue department.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

NIOSH investigators returned to the Fire and Rescue department on October 24 - 28, 2018 and January 2, 2019, to complete interviews with Fire and Rescue department personnel and members of the county's communication center.

Fire and Rescue Department

The county where this incident occurred is a charter government with its own legislative and executive branch. With no incorporated towns or cities within the county, the county government provides all local government services to its residents. This includes public safety provided by the county police and the Fire and Rescue department. This combination fire and rescue department provides fire suppression, prevention, training, and investigation, as well as rescue services and emergency medical services to 321,113 residents in a 253 square-mile area that includes urban, suburban, and rural communities. The department also provides and receives automatic aid to and from surrounding communities. The department operates 13 stations staffed with 491 career firefighters and supported by 474 volunteer firefighters. Six stations are staffed by career firefighters. The other seven stations are operated by independent fire companies, some of which own the fire stations and have an administrative and operational staff that supports the career department. These seven fire stations are staffed by a combination of career firefighters and volunteer firefighters. The Fire and Rescue department operates three shifts, working 24-hours on, 48-hours off.

Every fire station has at least one engine and one paramedic unit assigned. Many stations also house apparatus such as ladder or truck company, a heavy rescue unit, brush trucks, foam and dry chemical units, and water tenders. The number and type of responding units are determined by the department's deployment model (Fire and Rescue Department's General Order 100.17 - *Standard of Coverage*). The department has developed an SOP for alarm assignments used by the county's communications center. A local alarm assignment for smoke in a building includes the dispatch of two engine companies, one truck company, an emergency medical services (EMS) transport unit, and a battalion chief and staff aide. A full box alarm adds the following to the assignment: 2 additional engines, 2 additional trucks or squads, an additional EMS transport unit, an EMS supervisor, and the safety officer. Minimum staffing for engines includes one officer and two firefighters. Minimum staffing for trucks is one officer and three firefighters. Minimum staffing for a medic unit is two members. The riding position correlates with the assigned portable radio, SCBA, and personnel accountability system. (**See Figure 1**).

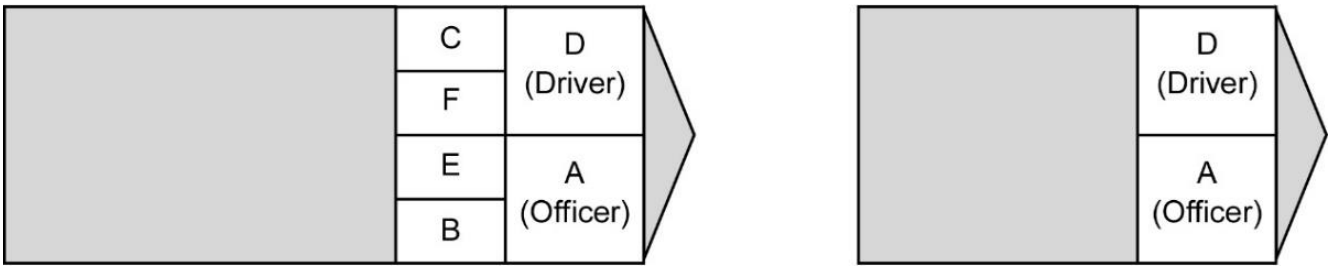


Figure 1: Riding positions and radio designations by type of apparatus.
(Figure courtesy of the Fire and Rescue Department.)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Most of the fire apparatus and vehicles are serviced and maintained by the county's fleet maintenance division. All apparatus were serviced and tested according to the requirements of the National Fire Protection Association (NFPA) 1901, *Standard for Automotive Fire Apparatus* [NFPA 2016b], and NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Emergency Vehicles* [NFPA 2017].

Divisions

Emergency Services Bureau

The Fire and Rescue department's General Order 100.17 – *Standard of Coverage* establishes the minimum staffing levels for fire and non-fire emergencies. Under General Order 100.17 – *Standard of Coverage*, the regular staffing by apparatus is:

- Special Services includes aerial apparatus, squads: four members
- Extrication Unit includes aerial apparatus with extrication equipment, squads, and rescues: four members
- Engines - three or four members
- Tankers - apparatus carrying 1,500 gallons or more of water: two members
- EMS Transport Units: two members
- Battalion Chiefs – battalion chief and aide: two members
- Chief Officers and Staff Personnel: one member.

Additionally, under the order, the staffing levels sent to a residential structure incident are separated into two categories: rural and metro. The specific list of equipment and personnel that respond to each category are detailed in **Table 1**.

A "Working Fire Task Force" for a single-family structure in a metro (hydranted) area brings two engines, one special service, one ambulance, and one BC (if they have not already responded), totaling 13-16 personnel. In addition, several on-call personnel are alerted and given discretion as to their physical response: one on-call BC, one on-call Assistant Chief, one Fire Communications Liaison, one Public Information Officer, and one Fire Investigator. If responding to a rural (non-hydranted) area, three additional tankers are alerted for response.

A "2nd Alarm" for a single-family structure in a metro (hydranted) area brings two engines, one special service, one ambulance, one additional Field Safety Officer, and one Battalion Chief (on-call) which totals 13-16 personnel. Additionally, all on-call personnel are obligated to respond (as opposed to using discretion). An air unit, the fire department chaplain, the department bus, and a canteen unit are also alerted. If the response is to a rural (non-hydranted) area, one tanker is also alerted for response.

A "3rd Alarm" for a single-family structure in a metro (hydranted) area brings three (3) additional engines. If to a rural (non-hydranted) area, one (1) tanker is also alerted for response.

In 2018, the Fire and Rescue department responded to 38,709 alarms of which 352 were structure fires. See *Appendix One* for the complete list of the department's runs in 2018.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

UNIT TYPE	UNIT STAFFING	LOCAL ALARM SINGLE FAMILY (METRO)	FIRST ALARM (BOX) SINGLE FAMILY (METRO)	LOCAL ALARM SINGLE FAMILY (RURAL)	FIRST ALARM (BOX) SINGLE FAMILY (RURAL)
Engine	3 to 4	**2 Engines** 6-8 personnel	**4 Engines** 12-16 personnel	**2 Engines** 6-8 personnel	**5 Engines** 15-20 personnel
Tower/Truck	4	**1 Truck/Tower** 4 personnel	**3 Truck/Tower** 12 personnel	**1 Truck/Tower** 4 personnel	**3 Truck/Tower** 12 personnel
EMS Transport Unit	2	**1 Medic Unit** 2 personnel	**2 Medic Units** 4 personnel	**1 Medic Unit** 2 personnel	**2 Medic Units** 4 personnel
Squad	4	(0)	**(*)**	(0)	(*)
Tanker	1	(0)	(0)	**1 Tanker** 1 personnel	**2 Tankers** 2 personnel
Battalion Chief	2	**1 BC with staff aide** 2 personnel	**1 BC with staff aide** 2 personnel	**1 BC with staff aide** 2 personnel	**1 BC with staff aide** 2 personnel
Field Safety Officer	1	(0)	**1 FSO**	(0)	**1 FSO**
Medical Duty Officer	1	(0)	**1 EMS Supervisor**	(0)	(1) 1 personnel
TOTAL PERSONNEL	**-**	**14-16** personnel	**32-36** personnel**	**15-17** personnel	**37-42** personnel**

Table 1: The Fire and Rescue department's deployment model for urban/suburban response and rural response in July 2018.
(Figure courtesy of the Fire and Rescue Department.)

**Squads are optional if closer, but are somewhat interchangeable with Towers/Trucks, so staffing is included with the Towers/Trucks.*

A second on-duty BC is alerted for the Local Alarm and for the 1st Alarm Box assignments. The second BC is given discretion as to their physical response.* ***Note: *In this incident, the second on-duty BC responded within two minutes of the initial arriving unit's scene size-up and request for a 1st Alarm Box assignment increasing the staffing by two members.*

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Bureau of Education and Training

The level of performance demonstrated by a fire department is usually a good indication of the type, frequency, and quality of the training provided. The Fire and Rescue department has a state-of-the-art training center and a full-time training staff. The department not only provides daily in-service training conducted by company officers, but also provides scheduled training for officer development and specialty training for drivers, apparatus operators and specialty teams.

The minimum goal of any fire department training program should be to teach each person in the department to operate at acceptable and safe performance levels for his or her rank and assignment. Although national and state consensus standards for firefighter training are certainly considered, the specific requisite training for a firefighter is determined by their authority having jurisdiction (AHJ).

In addition to the NFPA standards, Maryland Occupational Safety and Health (MOSH) established the Maryland *Fire Service Health and Safety Consensus Standards* for fire departments within the state. Under the MOSH Consensus Standards, agencies with a duty to respond to an emergency incident, "must provide training and resources to responders commensurate with the duties required at those incidents" [Maryland OSHA, 2002].

The MOSH Consensus Standard also addresses minimum qualifications and training to ensure an individual is qualified to perform a certain function. Under the standard, a pre-emergency responder's training is to be "determined by the AHJ, based on the level of anticipated response" [Maryland Department of Labor, Licensing and Regulation, 2002]. However, for personnel classified as emergency medical responder, emergency medical technician (EMT), cardiac rescue technician and paramedic, the individual must obtain the appropriate license or certification from the Maryland Institute for Emergency Medical Services System (MIEMSS). Because both NFPA and MOSH standards are voluntary. Maryland fire departments are provided the flexibility of establishing their own training standards and programs.

The department's recruit training is a 26-week, formal program that largely corresponds directly with the national and state industry consensus training standards. It includes the following:

- Maryland Emergency Medical Technician Basic (EMT/B)
- Emergency Vehicle Operators Course (ProBoard certified)
- NFPA 1001, Standard for Fire Fighter Professional Qualifications [NFPA 2013a], Firefighter I and II, Hazardous Materials, Awareness and Operations (ProBoard certified)
- Technical Rescue training courses (e.g., auto extrication, machinery extrication, etc.)
- Firefighter survival and rescue training
- Incident Command System (ICS)
- Safety training.

Incumbent personnel receive formal and informal training through a variety of sources including in-station, multi-company, quarterly officer training, regional, and conference and/or seminar attendance opportunities. Additionally, the department conducts battalion level training as needed, such as rapid intervention and Mayday management.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

In 2018, rapid intervention and Mayday management training focused on integrating the incident command system (ICS) at the battalion and company level for a Mayday firefighter rescue during a high-rise operation. Additionally, training in modern fire dynamics focused on the complexity of the modern fire environment (e.g., faster fire propagation, unanticipated events, and more rapidly occurring dynamic fire situations) based on recent changes in construction materials and design.

In the Fire and Rescue department there are three broad categories of fire rescue service responders. Each of the following groups have different minimum training requirements:

- career members
- county volunteer members (assigned to career staffed stations by the Assistant Chief of the Emergency Services Bureau)
- corporate volunteer members (members of corporate volunteer fire departments that operate in coordination with Fire Administration).

Bureau of Occupational Safety and Health

The department's Bureau of Occupational Safety and Health (BOSH) has developed programs addressing members' safety, health, wellness, risk management, and exposure support. The department offers and encourages an annual fitness assessment and requires an annual medical evaluation with medical fitness for duty requirements consistent with NFPA 1582, *Standard on Comprehension Occupational Medical Program for Fire Departments*, for both career and volunteer operational firefighters [NFPA 2018a]. The BOSH's wellness program includes an anti-tobacco policy. As a condition of employment, persons selected for all future training classes shall not use tobacco products in any form throughout the term of their employment whether on-duty or off-duty. Any use of tobacco products during the term of employment shall constitute grounds for disciplinary action and/or termination.

Staffing for the BOSH consists of:

- One assistant chief: Program Manager
- One battalion chief: Accident & Injury Investigation & Review
- One captain: Health Maintenance Coordinator (NFPA 1582 compliant)
- One lieutenant: Fire Fighter Peer Support (Behavioral Health) and Physical Fitness
- One administrative assistant: Statistical data and data analysis
- Each shift safety officer is assigned to an operational battalion chief (three shifts)
- One civilian Risk Management Analyst and Programs Administrator (Senior Analyst).

The Fire and Rescue department has an Occupational Safety and Health Committee which is involved with the development and revision of policy and procedures.

Training and Experience

The hiring process for the Fire and Rescue department is administered by the county's human resources department. Minimum qualifications for applicants include being at least 18 years of age, a Class "C" driver's license, a high school diploma or GED, and documentation of eligibility to legally work in the United States. Those meeting the application requirements are invited to take the written

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

civil service examination. The written examination consists of multiple-choice questions in the following areas: video-based human relations, animated mechanical aptitude, reading, and math. The exam must be completed within two hours and twenty minutes. Applicants passing the civil service examination are placed on the hiring list.

Those passing the written examination must then pass a candidate physical ability test offered at the county's public safety training center. The next step in the hiring process is an interview by members of the fire department and personnel from the Human Resources department. Selected applicants are offered conditional employment, based upon:

- Passing a background check
- Meeting the medical requirements in accordance with NFPA 1582, *Standard on Comprehension Occupational Medical Program for Fire Departments* [NFPA 2018a].
- Passing a drug screen
- Passing a psychological evaluation
- Completing the 26-week fire training academy.

The candidate then becomes a probationary firefighter and is assigned to the Emergency Services Bureau. The probationary period lasts 12 months.

The state of Maryland requires training for volunteer firefighters that meets or exceeds the requirements of NFPA 1001*, Standard for Fire Fighter Professional Qualifications* [NFPA 2013a]. These requirements include Fire Fighter I, Hazardous Materials Awareness, Hazardous Materials Operations, and First Responder. The process requires annual recertification. In the state of Maryland, the training hour requirements are:

- Firefighter I: 108 hours
- Firefighter II: 60 hours
- First Responder: 45 hours
- Hazardous Materials Awareness: 12 hours
- Hazardous Materials Operations: 24 hours

The department's fire academy, operated by the Bureau of Training and Education, runs for 26 weeks and consists of NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter I, Fire Fighter II, Hazardous Materials Awareness, Hazardous Materials Operations, EMT Basic, Firefighter Safety and Survival, Vehicle Rescue Technician, Confined Space Rescue Technician, Swiftwater Rescue, Trench Rescue, Structural Rescue Awareness, Weapons of Mass Destruction (WMD) awareness, and Emergency Vehicle Operator.

The recruit class topics cover EMT-Basic, Fire Fighter I, Fire Fighter II, Hazmat Operations, Vehicle Operator, self-contained breathing apparatus (SCBA) training, personal protective equipment (PPE) training, ladder training, interior firefighting, and other subjects. The Bureau of Education and Training is certified by ProBoard and the Commission on Accreditation of Allied Health Education Program – ALS/Paramedic Program Accreditation. This allows recruits to receive ProBoard certification for Fire Fighter I, Fire Fighter II, Hazmat Awareness and Hazmat Operations.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

The firefighter from Engine 101 (E101B) was hired by the Fire and Rescue department in 2005. He had 13 years of fire experience and was promoted to lieutenant posthumously. The firefighter was certified as NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I & II, NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner, Fire Inspector I, II, & III*, NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness, Hazardous Materials Operations, Hazardous Materials Technician, and NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications,* including Confined Space Rescue Technician, Rope Technical I and II, Trench Technical Rescuer I and II, and Vehicle and Machinery Rescue Technician. Department training records show E101B had completed 85 classes totaling over 1000 classroom and practical training hours during his 13-year career.

The lieutenant (E101A) was hired by the Fire and Rescue department in 1999, had 20 years of experience, and was promoted to lieutenant in 2006. The lieutenant was certified to NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I & II; certified Maryland Emergency Medical Technician Paramedic; NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner, Fire Inspector I*, NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness and Hazardous Materials Operations; NFPA 1021, *Standard for Fire Officer Professional Qualifications*, Fire Officer I & II, NFPA 1041, *Standard for Fire and Emergency Services Instructor Professional Qualifications*, Fire Instructor I & II; NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications,* Vehicle and Machinery Rescue Technician I & II; and National Fire Academy's *Health and Safety Officer*. E101A was also currently certified by Blue Card as a Hazard Zone Incident Commander. During the officer's 20-year career, department training records show158 classes totaling over 3600 classroom and practical training hours were completed.

The incident commander was hired by the Fire and Rescue department in 1985 and had 33 years of fire experience. He was promoted to battalion chief in 2007. Training records indicate the following training: certified to NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I, II, and III; NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner*, Fire Inspector I, II, and III; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness, Hazardous Materials Operations, and Hazardous Materials Technician; NFPA 1021, Standard for Fire Officer Professional Qualifications, Fire Officer I & II, NFPA 1041, *Standard for Fire and Emergency Services Instructor Professional Qualifications,* Fire Instructor I, II, and III; and NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications,* and Vehicle and Machinery Rescue Technician I & II. The Incident Commander (IC) was also certified by Blue Card as a Hazard Zone Incident Commander.

Apparatus, Staffing, and Communications

The Fire and Rescue department's General Order 410.01, *Communications*, applies to all Fire and Rescue department operations, as well as the county's department of police, information technology bureau, and communications division (communications center) that administers all 9-1-1 call-taking and fire dispatch services in the county. The county's communications center coordinates all county

radio communications including facilitation of police, fire, and emergency medical calls. The communications center is operated by the county's department of police, with a uniformed Fire Captain and Fire Lieutenant serving as Fire Communication Liaisons from fire and rescue services to support fire operations. The liaisons are on an administrative work schedule and do not have any official management function in the command center.

The county's communication center is staffed with 80 personnel, which are assigned to four shifts. Dispatcher tours are 0700 – 1900 hours and 1900 – 0700 hours. The work schedule is 2-day tours, 2-night tours, and then four days off.

All county agencies use the 800-megahertz (MHz) radio system. There are numerous tactical radio channels available during an incident.

All fire apparatus and vehicles are equipped with automatic vehicle locators, which is a system that dispatches the closest company or unit to an incident and is tied to the computer-aided dispatch (CAD) system.

Training for dispatchers consists of the following:

- New telecommunicators attend a 6-week classroom training program
- One week of fire department training
- All telecommunicators are trained and certified as emergency medical dispatchers and trained and certified in cardiopulmonary resuscitation (CPR) using the International Academies of Emergency Dispatch for training
- One year of training with field training officer
  - Two tracks: Law enforcement or Fire
  - Must spend two years in a discipline before moving to the other track.

Building Construction

The single-family home was located on a three-acre lot in a suburban neighborhood. The structure was large and uniquely shaped. The Maryland State Department of Assessment and Taxation listed the structure size as 7,313 square feet of above grade living area and 1,100 square feet of finished basement. The basement did not cover the entire structure (**See Photo 1**).

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Photo 1. The 8,413 square foot custom-built home showing Side Alpha.
(Photo courtesy of the Fire and Rescue Department.)

For the purposes of this report, the western side (main entrance) of the structure was the front, or Side Alpha. The left (northern) side of the structure was Side Bravo; the rear (eastern/southeastern) side of the structure was Side Charlie; and the right (southern) side of the structure was Side Delta (**See Photo 2**).

The general shape was two rectangles with an offset of approximately 30 degrees at the approximate center of the structure. There was a bump-out portion at the approximate center of Side Charlie, terminating with an octagonal turret-type feature. The overall centerline length of the structure (Side Bravo to Side Delta) was approximately 145 feet, accounting for a 30-degree offset. The depth of the structure varied. The northern (toward Side Bravo) rectangular portion was approximately 40 feet wide (Side Alpha to Side Charlie). The southern rectangular portion was approximately 50 feet wide. The width of the structure at the location of the bump-out portion increased to approximately 85 feet, from the nearest Side Alpha wall.

The structure was wood frame construction with a brick veneer. The roof had multiple pitches consisting of wood sheathing covered with asphalt shingles. The structural components were a combination of nominal dimensional lumber, open web trusses, and engineered wooden I-beams.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Photo 2. An aerial view of the home showing the sides of the house as defined by the Fire and Rescue department.
(Photo courtesy of the Fire and Rescue Department.)

Side Alpha had two exterior entrances: an arched main entranceway that led into the foyer and a smaller side door that led into the 1st floor kitchen (**See Diagram 1**).

Side Bravo had two floors above grade and no basement. The 1st floor had a 3-car garage while the 2nd floor was bedrooms. To the left of the garage was an exterior door leading into the laundry/mudroom. The laundry/mud room had a doorway with a pocket door, which connected to an open area with a two-section stairway to the 2nd floor. At the stairway to the left was a step-down family room. The family room had a stairway down to the finished basement. At the stairway straight ahead was the kitchen and to the left a breakfast area (**See Diagram 1**).

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

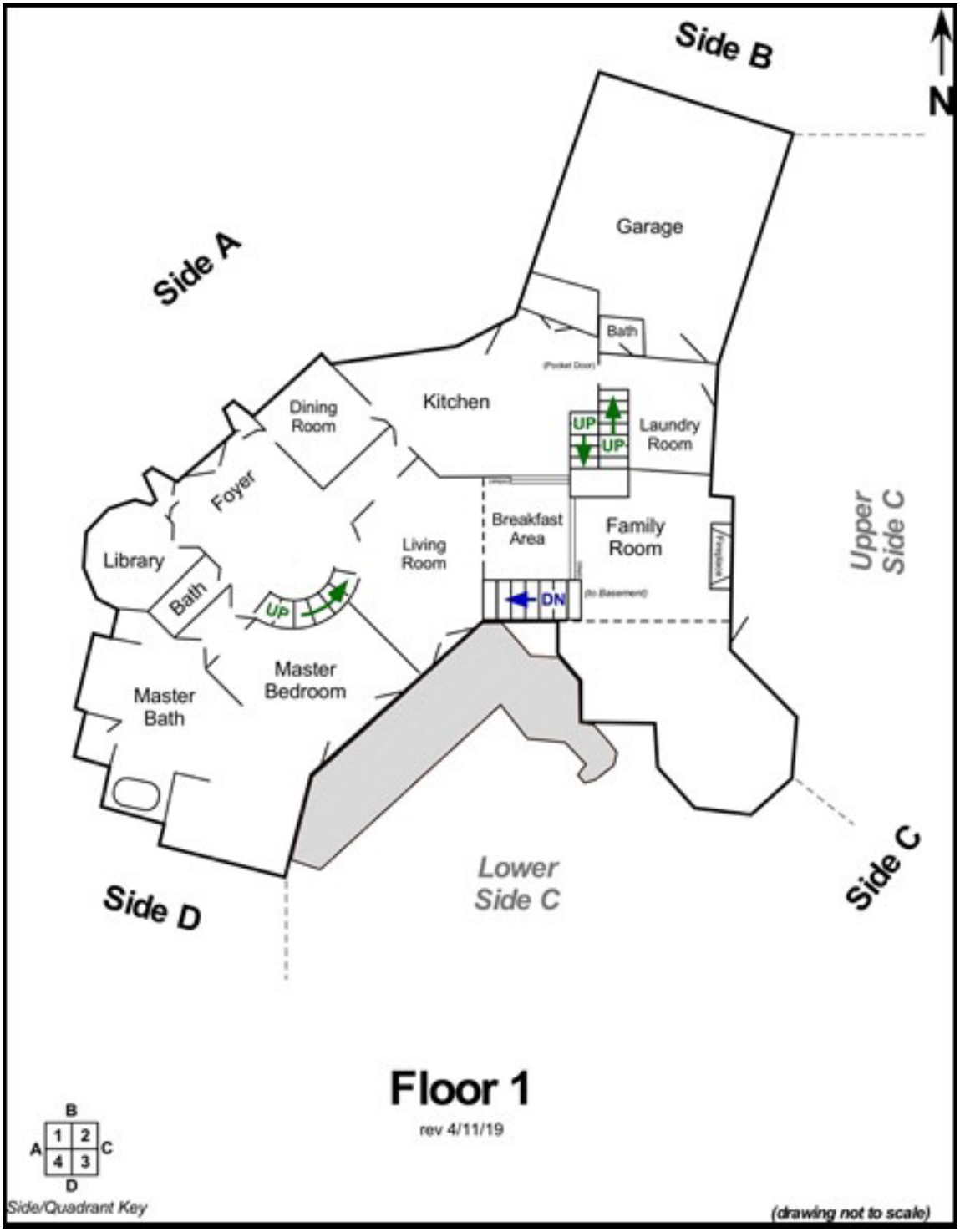


Diagram 1. Diagram of the 1st floor.
(Diagram courtesy of the Fire and Rescue Department.)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

From the exterior, upper Side Charlie transitioned to lower Side Charlie with a change in grade and about a 30-degree change of direction to the south. On lower Side Charlie there was an open-air deck on 1st floor. Below the deck were double glass doors providing access to a finished basement. The finished basement extended beneath approximately half of the structure from Side Delta to the center of the home ending at a crawlspace. The crawlspace was essentially below the 1st floor kitchen, breakfast area, and the family room (**See Diagram 2**). The crawlspace was only accessible from the basement utility room by a short set of stairs at the utility room's Side Alpha/Side Bravo corner. Access to the crawlspace was hidden from view with little or no indication of its existence. Tongue-and-groove hardwood floors covered the entire first floor except for the breakfast area which had marble tile. The kitchen, breakfast area, and the family/TV room were directly above the crawlspace (**See Diagrams 1 and 2**). The underside of the floor system for 1st floor, which is the crawlspace ceiling, consisted of unprotected dimensional lumber supported by solid lumber joists. Height of the crawlspace varied due to differing floor levels of the areas above, with an estimated average height of approximately four to five feet.

The crawlspace was divided into two confined sections: a "finished" section (on the northern side) and an "unfinished" section (on the southern side) (**See Diagram 2 - dotted line**). Various household items were stored in both sections, which created a cluttered and confined area in both sections. The flooring of the finished (northern) crawlspace consisted of platform-type floor assembly of plywood and linoleum on top of a moisture barrier. The unfinished (southern) section had earth covered by moisture barrier and plywood panels. The walls of both sections were concrete masonry units (e.g., cinder block).

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

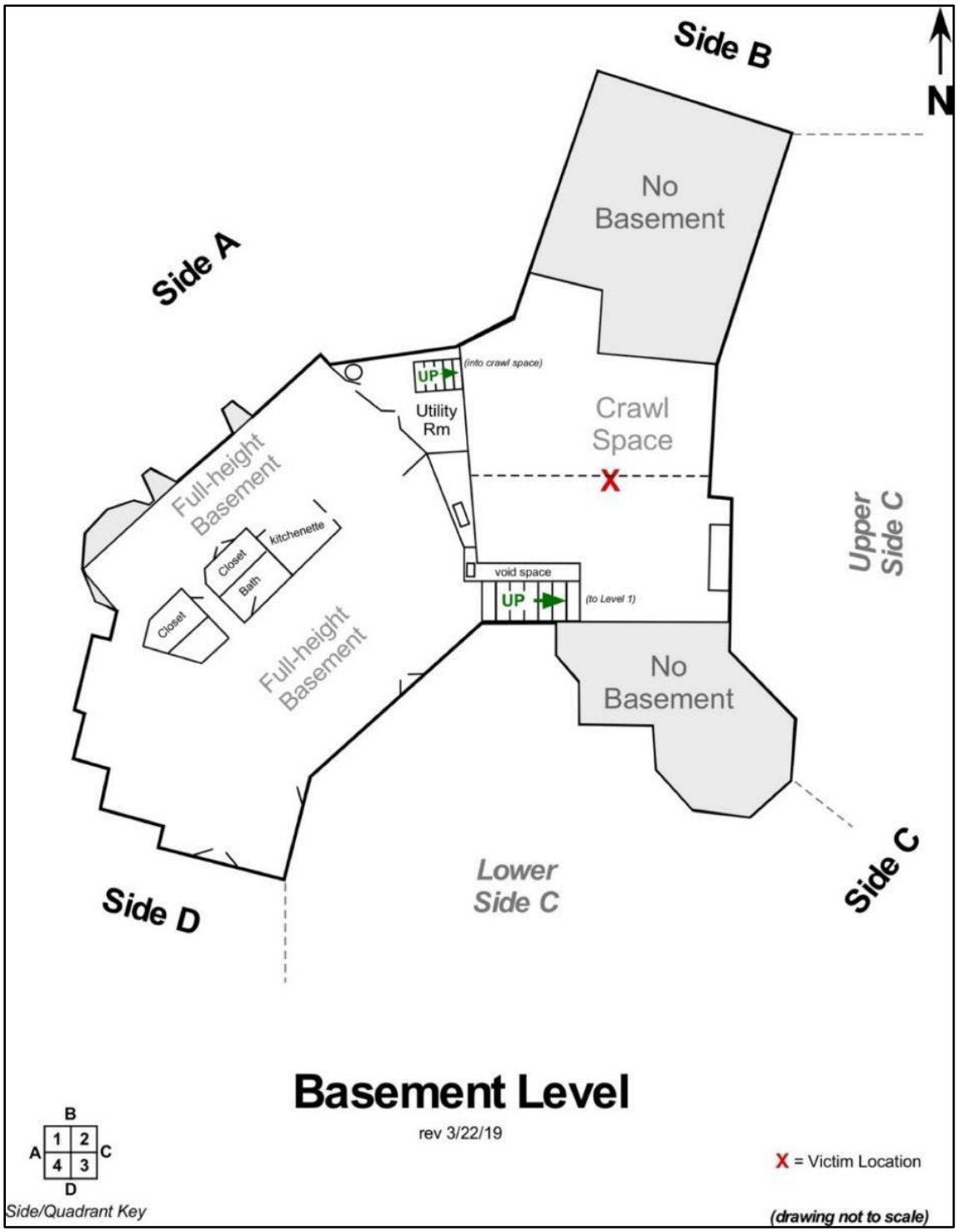


Diagram 2. Sketch of the basement. The red "X" marks the approximate location where E101B was found.
(Diagram courtesy of the Fire and Rescue Department.)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

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. This timeline also lists the changing fire behavior indicators and conditions reported, as well as fire department response and fireground operations. 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.

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
Lighting struck a tree in the rear (Side Charlie) of the affected residence. ***Note:*** *for the sequence of events for the lighting strike go to the* ***Fire Cause Section****.*	**1:52:14 Hours**	
The county's communication center dispatched Local Box 5-62: "Paramedic 56, Paramedic E101, Engine 51, Tower 10, and Battalion 1 respond for visible smoke from a lightning strike."	**01:52:14 Hours**	
"Tower 10 with 4." The communication center acknowledges.	**01:54:16 Hours**	
"Engine 51 with 5." ***Note:*** *No staffing level transmission given from E101, M56, P56, and BC1.*	**01:54:19 Hours**	
Communication center, "Engine 51, Tower 10, Engine 101, Paramedic 56, Battalion Chief 1, you are responding to Box 5-62 for a lightning strike."	**01:54:23 Hours**	
E51 to communication center, "We have a single-family, two-story house with smoke showing, go ahead and start a full box."	**2:00:29 Hours**	
	02:00:44 Hours	E51 to TWR10: "Tower 10 take the front of the building."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:01:23 Hours	E51 advanced a 1¾-inch hoseline to Side Alpha of the structure. "Battalion 1 to Engine 51, the map shows a pool in the back. If you can, position E51 to use your hydraulic pump."
Communication center, "Upgrading Box Alarm 5-62. Dispatching Tower 7, Paramedic Engine 71, Paramedic Tower 3, Engine 111, Paramedic 105, EMS 1, and Safety 1 to upgrade Box 5-62 to a building fire and operating on Bravo 1."	**02:01:56 Hours**	
	02:02:14 Hours	TWR10 advised they were on location, position Side Alpha.
	02:02:24 Hours	E101 advised they had arrived on scene, second engine.
	02:03:07 Hours	Paramedic105 advised they were enroute.
	02:03:11 Hours	E71 advised they were enroute, PAR 4.
	02:03:32 Hours	51A to BC1, "We pulled around back to use the pool and we're going to make entry from the back. The owner advised E51A, that most of the heavy smoke was in the basement."
BC1 to communications center, "Battalion 1 is on scene and confirming a large two-story single-family dwelling with smoke showing. We are committing to an offensive strategy; Battalion 1 is assuming Command."	**02:03:55 Hours**	BC1 acknowledged E51A.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:04:31 Hours	Command to E51," I am assigning you Fire Attack Group Supervisor. You're going to have yourself and Tower 10." Command to E51, "Is your operator going to access the swimming pool for water supply?"
	02:04:54 Hours	E51A to Command, "That's correct. We are on Side Charlie, making an attack from Side Charlie. I suggest other units come in from Alpha."
	02:05:07 Hours	Command to E51A, "Give me a visible report on Side Charlie from the basement as soon as you can."
	02:06:05 Hours	BC1 Aide to Command, "I've got two-story Side Charlie, smoke in the basement with glass slider access on Side Delta and Side Charlie, a finished basement, and I do have smoke conditions."
	02:07:43 Hours	E101 to Command, "We are two out, Side Charlie."
	02:07:51 Hours	E51 entered the structure through the laundry room door near the garage on Side Charlie.
	02:08:01 Hours	Command to E101A, "101 you're advising that you're on Side Charlie and you're with 51? Is that correct? "

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:08:12 Hours	E101A to Command, "We are outside the building, but we are (with E51), second line pulled, two-out." ***Note:*** *E101B pulled a 300-foot 1¾-inch hoseline off E51 and pulled the hoseline to the doorway of the laundry room.*
	02:08:46 Hours	E51A to Command, "We are going to reexamine if we have access to the basement. We're going to come in through the basement slider."
	02:09:34 Hours	E71A to Command, "I am getting close to the incident now. Do you need me to come to the scene or grab secondary water supply?"
	02:09:42 Hours	Command to E71A, "No, you are going to have to bring water. I believe E101 has laid in from our street. If you can, lay in from the main road to E101's supply line. I'm not even sure what we've got on the remainder of the assignment, but somebody got to get that hydrant on the main road at the next street up."
	02:10:19 Hours	Command to E71A, "Go ahead and forward lay from the hydrant to E101's supply line."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:10:55 Hours	TWR10A to Command, "Yeah, I was just telling the Lieutenant on 51 to redeploy their line to the basement. We're currently exterior right now, Side Charlie, getting ready to make entry." ***Note:*** *E101B has pulled a 300-foot 1¾ -inch hoseline of E51 to the basement entrance. E51's 200-foot hoseline is too short and won't reach the basement entrance.* ***Note:*** *No water supply has been established 10 minutes into the fireground incident and 20 minutes have elapsed since the original 9-1-1 call.*
	02:11:41 Hours	TWR10C to Command: "Electric in the garage is secured." Command acknowledged.
	02:12:12 Hours	Command to P56, "56, IRIC on Side Alpha."
	02:12:41 Hours	Command to all units, "We do have an ALL CLEAR from the occupants, occupied times three, ALL CLEAR of the house. We do have an ALL CLEAR."
Battalion 2 (BC2) reported on scene. County communications acknowledged Truck 7 (TR7) and BC2 on scene.	**02:12:53 Hours**	

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:13:01 Hours	Command to BC2: "I am going to have you assume Charlie Division when you can get here and get around there."
	02:14:00 Hours	E111 on the scene. E111 is the 4th due Engine. E11 picked up E71's supply line at the hydrant.
	02:14:56 Hours	Command to E51A: "Fire Attack, Engine 51, CAN Report."
	02:15:09 Hours	E51B to E51D: "Engine 51 charge the 300-foot line."
	02:15:30 Hours	Fire Attack to Command, "Go ahead and have somebody place positive pressure at the front door. We have smoke in the basement and can't find the fire at this time."
	02:15:48 Hours	E101 to Command, "We have heavy fire on floor Number One, on the Charlie Side."
	02:16:17 Hours	E101A to Command, "We need to redeploy our line back up to the initial entrance." E101B was ordered to back out of the basement by E101A. E101B and E101A abandoned their attack line (300-foot) and pulled another 200-foot 1¾-inch hoseline from E51 to the laundry room.
	02:16:25 Hours	Command to E101A: "When you are talking about the initial entrance, you're talking the Alpha Side, is that correct?"

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:16:33 Hours	E101A to Command: "Yes, Side Charlie." Command acknowledged, "No, you mean the initial entrance on Side Charlie?"
	02:17:43 Hours	TWR10A to Command, "It's going to be quadrant two, E101 and E51, are making entry right now. We have made access to the basement, still have smoke from floor to ceiling, I closed the door back up. Only crews you should have interior are on the 1st level entering Side Charlie."
	02:18:07 Hours	Command to TWR10A, "Very well. Command to E71 and T7, hold do not make that attack."
	02:18:29 Hours	Command to T7A: "Truck 7, I want you to assume RIT, Truck 7, I want you to assume RIT. From that position where you're located. You've got E51, E101, and Tower 10, they've entered from Charlie Side." T7 acknowledged.
Command acknowledged the communication center, that the incident was at the 15-minute mark. Command to communications center, "Go ahead and give me the Task Force." Communication center acknowledged.	**02:19:10 Hours**	

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:19:45 Hours	E101B: Open Mic. ***Note:*** *E101B was operating on Bravo 2, an unmonitored talk group. E101B's key up was not heard on fireground or the communications center.*
"Communication center is upgrading box alarm to the Task Force for Box 5-62." "Dispatching Engine 61, Engine 91, Squad 1, HR, PIO, on call center supervisor, on call Fire Investigator, on call Battalion Chief, on call Safety Officer, due to respond Bravo 6, Bravo 6."	**02:20:22 Hours**	
	02:20:11 Hours	E101A: "Mayday, Mayday, Mayday. E101B is in the basement to the left." ***Note:*** *E101B had fallen through the 1st floor into a crawlspace, which was used as a storage area. The crawlspace contained active fire and high heat conditions.*
	02:20:31 Hours	E101A to Command, "101 is in the basement now, I believe he's in the basement now."
	02:20:47 Hours	Command to E101A, "E101A, I've got you on the MAYDAY. T7 RIT deploy from the Charlie Side, you've got a Mayday from E101, all units hold the air. E101 go ahead with your MAYDAY."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:21:05 Hours	E101A to Command (Bravo 1), "He's in the basement, hoseline trying to pull him up, go through the basement." ***Note**: E101B to Command (Bravo 2), transmitted a clear Who, What, Where consistent with MAYDAY training.* *E101B was operating on Bravo 2. A simultaneous transmission on Bravo 1 prevented radios operating on scan mode from hearing any transmissions outside of Bravo 1 talk group. Communications center did not hear the transmission on Bravo 2.*
	02:21:44 Hours	Command to E51A, "Very well, 51, you're trying to find her." Command to E101A, "E101A, I understand that you've fallen into the basement?"
Command to communications center, "Give me a 2nd Alarm and keep them on Bravo 6."	**02:22:05 Hours**	
Communications center is upgrading Box Alarm 5-62 to 2nd Alarm. "Dispatching Paramedic Engine 22, Paramedic Engine (pause for correction) Automatic Aid Engine 849, Automatic Aid Truck 29, Air Unit 17, MAB 13, Chaplain, Command 17, and Canteen 6 respond on a 2nd Alarm for Box 5-62. It is going to be for a house fire now with a Mayday. You're going to operate on Bravo 6, Bravo 6."	**02:22:56 Hours**	

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:22:27 Hours	E71 to Command, "We are redeploying the hoseline around Side Delta, to Side Charlie. I'll team up with Truck 7."
	02:23:19 Hours	TWR10A to Command, "I have 101's officer." Command acknowledged: "Tower 10, you've got 101's officer, are you out of the structure?"
	02:23:42 Hours	TWR10A to Command, "Correction, Engine 51's officer."
	02:24:00 Hours	Charlie Division to Command, "We've got E101 Officer out. we are still looking for E101B." ***Note**: The was the first reference that E101B was the Mayday emergency.*
	02:25:15 Hours	Division Charlie to Command, "E101B fell through the floor. He is on the hoseline. He went down with the hoseline and could not get pulled up. Units are inside, right now, uh, searching for him."
	02:25:53 Hours	Division Charlie to Command, "E101B is one floor below the grade level at the front door. The only area, that has exposed at the grade level, is the Delta Side, as well as the lower part of the Charlie Side."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:26:15 Hours	Command to Division Charlie, "Charlie can you confirm a PAR for E51's crew and Tower 10's crew?" Division Charlie acknowledged E101A was accounted for at this time. The only person that was unaccounted for was E101B.
	02:26:38 Hours	Command to Division Charlie, "E101B is from E101and you have E101 Officer? You have her out and we have contact with E51A and Tower 10A?",
	02:27:44	Command to E51D, "What about the third member of E51's crew?" E51D acknowledged, "Engine 51C has not been located, as of yet."
	02:28:00 Hours	E101B's PASS manually activated.
	2:28:55 Hours	Command to T7D, "Okay, Engine 51C has come out under his own power and he is sitting on the back deck. Command to E51C, "I want you to return to Engine 51, to your crew."
	02:29:12	Division Charlie to Command, "E51C is direct on that. One priority addition, we have Engine 51E who is unaccounted for. So, we have E101B and E51E still unaccounted for. Engine 51C is safe outside."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:29:33 Hours	E51 to Command, "E51E is with me and E51B is with me. It is unknown where E51C is at this time? Correction, he is now with me. Also, be advised, the laundry room doorway that we initially went in, is about to flash."
	02:30:45 Hours	Command to Division Charlie, "Charlie Division, the initial Fire Attack Group was E51, E101, and Tower 10. Then RIT came around, it was Truck 7, E71 and now I'm sending you Tower 3." Division Charlie Supervisor acknowledged.
	02:31:33 Hours	E51D to Command: "Be advised, we are at less than a ¼ tank of water. We are out of water." ***Note: A continuous water supply still had not been established.*** "Engine 111A to Engine 71D, 111 to 71, water is on the way, 71 Operator?"
Communications center to Command: "Getting the emergency identifier from E101B portable." ***Note:*** *The emergency identifier on Bravo 2 was likely activated by the man down feature. The communication center did not report E101B's identifier from the portable radio.*	**2:33:12**	

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:37:35 Hours	E51D to Command: "Hydraulic pump is deployed and activated. I have a water source." Command acknowledged.
	02:39:39 Hours	Command to E61, "Alright Squad 6, form up with Engine 91 and Engine 22. You're going to go to the rear. Squad 6, you're going to have the second RIT. Truck 6, correction Squad 6, you are now assuming RIT number two." E61 acknowledged, "Okay, that's E61, E91, and 22. We are going to be the second RIT."
	02:42:06 Hours	RIT to Command, "We've got E101B. Need EMS to the Charlie side basement door." Command acknowledged: "Alright RIT, you have E101B and you're on the Charlie side basement door. EMS 1 are you direct? Division Charlie are you direct?"
	02:42:34 Hours	Command to communications center, "Go ahead and give me the evacuation tone. Charlie Division, I want all units pulled out, with E101B found. All units pulled out and give me a PAR as soon as you can."

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	02:43:39 Hours	"Division Charlie to Command, "E101B is out of the building." Command acknowledged: "Division Charlie, I'm direct, E101B is out of the building. We are evacuating, and I need PARs on everything that went in." ***Note:*** *The rapid intervention group located and extricated E101B 15 minutes and 5 seconds after entry. E101B was extricated from structure, 22 minutes and 11 seconds after the Mayday was initially declared (Appendix 3).*
	02:46:36 Hours	Command to all units on the fireground, "All units on the fireground, units are PAR. We are going to commit to a defensive strategy, defensive strategy."
Medic105 was enroute to the local hospital. E101B was unconscious with CPR in progress.	**02:54:48 Hours**	
E101B pronounced deceased at the local trauma hospital	**0312 Hours**	
Command to communications center, "Place the fire at Box 5-62 under control."	**1008 Hours**	
Command to communications center, "Place the fire for Box 5-62 out."	**1158 Hours**	

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Personal Protective Equipment

At the time of the incident, the E101B was wearing a turnout coat and pants, a helmet, a protective hood, boots, and gloves that met the current requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* [NFPA 2018b]. The self-contained breathing apparatus (SCBA) and the personal alert safety system (PASS) that E1010B was wearing were certified to the 2013 edition of NFPA 1981, *Standard on Open Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services* [NFPA 2013b].

At the police department's evidence room, the NIOSH investigators inspected E101B's helmet, protective hood, turnout coat, turnout pants, left glove, and boots. The helmet showed significant thermal degradation. The protective hood had some minor discoloration. The turnout coat had charring on the outer shell, left side, back, and right side. The turnout coat moisture barrier was charred on the left shoulder and the thermal barrier showed thermal damage. The turnout pants had charring on the front of the right leg of the outer shell. The turnout coat and turnout pants had been cut off the E101B firefighter to provide emergency medical care. The glove and boots had some thermal damage.

In addition to the NIOSH visual inspection, the fire department hired a subject matter expert (SME) to examine the PPE worn by E101B. The SME's report stated, "The examined items were subjected to a rigorous visual inspection on all surfaces of the clothing items to assess how the specific areas of damage might be related to the protective qualities of the respective items. The protective garments (coat and pants) were further examined for their compliance with the purchase specification for the fire department." "No defects or issues were found with the quality of the examined clothing items that could be considered as contributing to the adverse injuries sustained by E101B. All clothing items were found to meet the relevant edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* at the time of their manufacture except for the protective hood, for which the product label was missing." "Certain portions of the clothing reached temperatures well over 500°F with some of these areas being at high temperatures for extended periods of time." "Complete degradation of trim material on the garments and helmet indicated temperatures in excess of 600 to 700°F."

A summary of the NIOSH SCBA evaluation is included as **Appendix Two**. The full evaluation report is available upon request from NIOSH NPPTL or available from the NIOSH NPPTL PPE website.

Appendix Three shows a diagram of the data log from the SCBA worn by E101B. The diagram includes breathing air rate, the PASS alarm activation, and temperature alarm activation.

The breathing air in the cylinder of the SCBA was tested and certified to the 2013 edition of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection* [NFPA 2013c]. (**See Appendix Four**).

The personal protective equipment was not considered a contributing factor in the fatality in this incident. NIOSH investigators conducted no further evaluation or testing of the personal protective equipment.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Weather

During the early morning of July 23, 2018, the area was experiencing light rain with thunderstorms. At 01:51 hours, the temperature was 73 degrees Fahrenheit (73° F), relative humidity was 100%, winds were from the east southeast (ESE) at 14 miles per hour (mph) with wind gusts to 24 mph. The barometric pressure was 29.71 inches [Weather Underground 2018].

Investigation

On July 23, 2018, at 01:51:03 hours, the county's communication center received a 9-1-1 call from a homeowner reporting an odor of smoke in his home. The caller stated that "we're not sure what is on fire, we just smell smoke, and everyone is out of the house." The 9-1-1 dispatcher verified that the resident did not see fire. He only smelled the odor of smoke. The caller also indicated that there was a recent lightning strike in the area. ***Note:*** *Information obtained during the investigation of this incident indicated that the lightning strike occurred at approximately 0120 hours, but the neither the county communication center nor the responding units were aware of the time of the lightning strike.*

The communications center dispatched a local box for a single-family structure in a Metro (hydranted) area at 01:52:14 hours on Dispatch Channel Alpha 1. The dispatcher stated that there was "visible smoke from a lightning strike." The dispatcher assigned local Box 5-62 to operate on tactical channel Bravo 1. Companies dispatched for Box 5-62 were: Engine 51 (PAR 5), Engine 101 (PAR 3), Tower 10 (PAR 4), Paramedic 56 (P56) (PAR 2), and Battalion 1 (PAR 2). ***Note:*** *This residence was in a suburban area with limited fire hydrants. The closest fire hydrant was approximately 1260 feet from the residence and was ultimately used in the incident. The communication center did not dispatch a rural local alarm assignment for Box 5-62 per department SOP based on a hydrant within 2000 feet of the structure.*

E51 arrived on scene at 02:00:29 hours and saw low lying smoke, like a fog across the front lawn on Side Alpha. Also, smoke was showing from both floors of the residence. ***Note:*** *The structure involved is located on a three-acre lot in a suburban neighborhood. This structure was a large, uniquely shaped, mansion-type, single-family dwelling. The structure size was 7,313 square feet of above grade living area and 1,100 square feet of finished basement.*

Upon arrival, E51A advised the communications center that they had a two-story single-family dwelling with smoke showing. E51A requested this incident be upgraded to a full box. The communications center dispatched a first alarm single-family structure fire box (Metro hydranted area) at 02:01:56 hours. Companies dispatched were Truck 7 (PAR4), Paramedic Engine 71 (PAR 4), Paramedic Truck 3 (PAR 5), Engine 111 (PAR 3), Paramedic 105 (PAR 2), EMS 1 (PAR 1), and Safety 1 (PAR 1). Battalion 2 (PAR 2) self-dispatched, which was a standard practice for the Fire and Rescue department on full box alarms.

While enroute, BC1 referenced a fire department map on the vehicle's mobile data terminal (MDT). The map showed no hydrants on the street and BC1 advised E51A that there was a swimming pool on Side Charlie. At 02:01:23 hours, BC1 ordered E51 to reposition to Side Charlie and use the swimming pool as a water supply. Prior to these orders, E51 stretched a 200-foot 1¾-inch pre-connect hoseline to

a door near the Side Alpha/Side Bravo corner. Prior to operating the hoseline, E51A ordered E51 to move to Side Charlie near the swimming pool. The crew from E51 carried the deployed 1¾-inch hoseline to Side Charlie as the apparatus was moved.

E101, as the second arriving engine, backed into the driveway in preparation to reverse lay from E51 to the street. However, E51 repositioned to Side Charlie of the structure before E101 began the reverse lay operation from E51. Pulling out of the driveway, E101 then repositioned and laid a supply line from the driveway entrance toward Side Alpha of the structure. After repositioning to Side Charlie, E51A spoke to the homeowner. The homeowner reported most of the heavy smoke was in the basement. At 02:03:32 hours, E51A radioed BC1 with this information. At 02:03:55 hours, BC1 advised the communications center that BC1 was on scene of a large two-story single-family dwelling with smoke showing, BC1 was assuming Command, and an offensive strategy was announced.

At 02:04:31 hours, Command assigned E51 and TWR10 to the Fire Attack Group, with E51A as the Fire Attack Group supervisor. Command also asked if E51 was using the swimming pool as a water source. At 02:04:54 hours, E51A advised that they were establishing a water supply using the swimming pool. Also, they were making an attack from Side Charlie. E51A said that other crews should make an attack from Side Alpha. At 02:05:07, Command asked E51A for a status of conditions in the basement as soon as possible.

At approximately 0205 hours, Command ordered his aide to conduct a 360-degree walkaround of the structure. At 02:06:05 hours, the BC1 aide reported to Command that there was smoke in the finished basement with double glass doors on Side Charlie and Side Delta. **Note:** *Both Side Charlie and Side Delta had upper and lower (below grade) levels. Both lower levels had sets of double glass doors.*

At 02:07:51 hours, with a charged hose line, noting smoke conditions but no visible flames, E51 and TWR10 entered the house through the laundry room door on the 1st floor. They advanced the 1¾-inch hoseline about 8 feet into the laundry room. The initial floor of entry into the laundry room and conditions observed in the structure were not reported to Command. E51B had the nozzle and penciled the ceiling, and water came back. The thermal imager from his SCBA showed some heat at the ceiling and floor, but no fire. TWR10A and E51E also had thermal imagers that indicated the same conditions plus they observed indications of fire below them and all crews exited the structure. These conditions were not transmitted to Command**.** E101 pulled a second 1¾-inch hoseline to the laundry room door as a backup hoseline. E101 did not make entry into the structure at this time.

At 02:08:46 hours, crews were out of the laundry room. E51A advised Command that the Fire Attack Group (which now included E101) was going to try and access the basement through the glass doors on Side Charlie. Moving to the lower level of Side Charlie, E101B advanced a 300-foot 1¾-inch hoseline and E51 moved their 200-foot 1¾-inch hoseline. However, E51's 200-foot hoseline did not reach the basement entrance of the structure. E101B entered the basement on the lower level of Side Charlie with the 300-foot charged hoseline with crews from E51 and TWR10.

At 02:09:07 hours, Engine 71 radioed Command inquiring whether they needed to secure secondary water supply. Command, recognizing that the first two engine companies had not secured a continuous

water supply, confirmed that E71 would need to secure water. Command instructed E71 to connect "that hydrant on the next street up" to the supply line E101 laid at the entrance to the driveway. As determined during the NIOSH interviews, the water supply issues temporarily distracted Command from managing fireground operations.

At 02:10:55 hours, TWR10A called Command and advised that E51 was going to redeploy their 200-foot 1¾-inch hoseline to the basement. E51, E101, and TWR10 were getting ready to make entry into the basement through the glass door on Side Charlie. Command confirmed with TWR10A that TWR10 and E101 are making entry with E51, from that same location, on Charlie Side, which TWR10A acknowledged. ***Note:*** *A continuous water supply was not established 10 minutes into fireground operations.*

At 02:11:23 hours, TWR10C advised Command that the power to the house had been secured (de-energized) at the electrical panel in the garage. At 02:12:01 hours, Command called P56 to confirm they were functioning as the initial rapid intervention crew (IRIC). P56D acknowledged and stated they were on Side Alpha.

At 0212 hours, BC2 and T7 arrived on scene. Command assigned BC2 as Division Charlie at 0213 hours.

At 02:15:30 hours, the Fire Attack Group supervisor (E51A) called Command, and requested positive pressure be established at the front door stating, "We have smoke in the basement and can't find the fire at this time." As crews entered the basement, E101A called Command. E101A advised heavy fire on the 1st floor on Side Charlie. E101A requested that their hoseline be redeployed to the initial entrance. ***Note:*** *At this time, a portion of the 1st floor family/TV Room was beginning to fail or had already collapsed. When the companies opened the basement door, this completed a flow path through the basement, into the crawl space, and then out the open laundry room door. This was the fire that E101A and TWR10D witnessed through the* ***1st floor*** *double glass doors of the entrance to the TV Room on Side Charlie. The fire would flare up every time someone opened the basement door. Once the basement door was closed, the fire would lessen* (**See Photo 3**)*. Winds were blowing 14 mph and gusting to 24 mph could have contributed to the fire flaring up every time the basement door was opened. NIOSH investigators came to this conclusion based on multiple interviews with fire officers, firefighters, investigators, and the review of photographs.*

Command was initially confused by the location and asked E101A if they were going back to Side Alpha. At 0217 hours, E101A clarified that the entrance was on Side Charlie. TWR10A advised Command that they, along with E51 and E101B, had made basement entry and found smoke, floor to ceiling. However, due to the report of fire showing on the first floor from E101A, the crews exited the basement and closed the basement door. The only crews inside at this point were on the 1st floor, Side Charlie going in the laundry room. Upon the report of fire on the first floor, E101B dropped the 300-foot hoseline at the basement door and went to E51 and pulled a 200-foot 1¾-inch hoseline to the 1st floor laundry room door.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Once E71 completed the water supply, Command assigned E71 and T7 to Side Alpha. A firefighter from P56 working with the engine and truck forced the front door. The firefighter described the conditions on the 1st floor as deteriorating. Smoke was sucking in and out and was brown in color. At 02:18:07 hours, Command stopped E71 and T7 from entering the structure based upon TWR10A's size-up of the conditions in the basement. Command assigned T7 as a RIC and put E71 "On Deck" on Side Alpha. **Note:** "*On Deck" is a forward staging position located just outside the immediate hazard zone, safely distanced from the entrance of a tactical position or division. Once a crew is assigned to an On Deck position, they are first and foremost a rapid intervention crew until they are given an assignment into the hazard zone.*

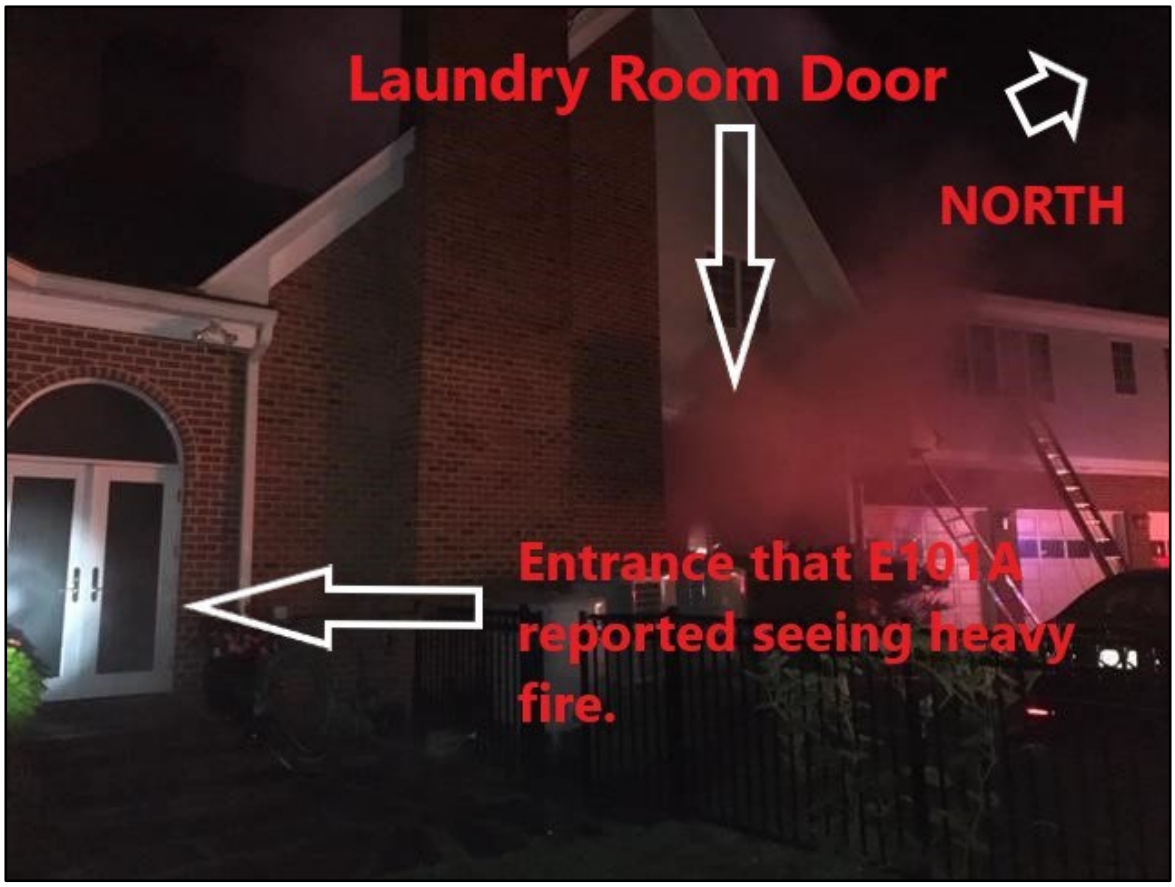


Photo 3. The double doors on the left were where E101A reported seeing heavy fire. The doorway with the heavy smoke showing is the entrance to the laundry room. The time is approximately 0215 hours.
(Photo courtesy of the Fire and Rescue Department.)

The communications center transmitted the 15-minute mark to Incident Command at 02:19:09 and the IC requested a Task Force assignment at 02:19:10 hours. ***Note:*** *At 02:20:22 hours, the communications center dispatched a Task Force comprised of Engine 61, Engine 91, Squad 1, HR, PIO, on call center*

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

supervisor, on call Fire Investigator, on call Battalion Chief, and on call Safety Officer on Bravo 6. ***Note:*** *The 15-minute mark was based on BC1 assuming Command rather than the arrival of the 1st due apparatus E51, which was at 0200 hours. Also, this was almost 30 minutes since the 9-1-1 call and 60 minutes since the lightning strike that occurred at approximately 0120 hours.*

At 02:17:43 hours, E101B entered the 1st floor laundry room. E101A was several feet behind him when E101B made entry. E51 was moving their hoseline to the entrance of the laundry room. At approximately 02:19:45 hours, the floor of the 1st floor breakfast area was beginning to fail or had already collapsed into the crawl space. E101B fell into the hole and into the basement's crawlspace with the hoseline (**See Diagram 3**). Whether the floor had collapsed prior to his entry into the room or whether his weight contributed to the collapse is unknown.

Conditions in the crawlspace were fire and high heat conditions. At 02:20:11 hours, E101A called a Mayday: "Mayday, Mayday, Mayday, E101B is in the basement to the left" on Bravo 1. E101A's Mayday transmission was immediately acknowledged by Command, but Command was unclear who was experiencing the Mayday.

At 02:21:05 E101A transmitted on Bravo 1 "E101B is in the basement, trying to pull him up, go through the basement." Simultaneously, E101B transmitted a clear *Who-What-Where* statement on Bravo 2. Any radio on scan would not have heard E101B's transmission due to the concurrent transmission on Bravo 1. Because Bravo 2 was unmonitored by the communications center, and the fireground was operating on Bravo 1, E101B's transmission was not heard by either Command or the communications center.

E51 and TWR10 were operating in the zero-visibility laundry room trying to find E101A and E101B. E51B advanced towards the breakfast area on the 1st floor and found E101A reaching into the hole hoping to reach/pull E101B out. According to NIOSH interviews, E51B began flowing water into the hole. After getting E101A away from the edge, E51B also reached into the hole hoping E101B could grab his arm/hand. Due to deteriorating fire and structural conditions, E51B, E101A, and TWR10 had to exit the laundry room.

P56 established the initial rapid interview crews (IRIC) at 0212 hours. At 0218 hours, T7 and E71 were positioned on Side Alpha and Command assigned T7 as RIC with E71 "on-deck." At 0222 hours, E71 and a member of P56 joined T7 on the RIC. E71 took their 300-foot 1¾-inch hoseline from Side Alpha to Side Charlie via Side Delta. Both E71A and T7A were doing a quick 360-degree walkaround on the structure. The crew from T7 was gathering tools for the RIC operation.

At 0227 hours, Command tried to conduct a PAR for E51. E51A and E51B were located at E51 in the driveway. Command requested a PAR for E51C, who was unaccounted for at this time. At 02:28:02 hours, T7D, the driver/operator of T7, radioed Command that E51C was with T7 at the basement door. At 02:28:55 hours, Command advised E51C to return to his crew at E51.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

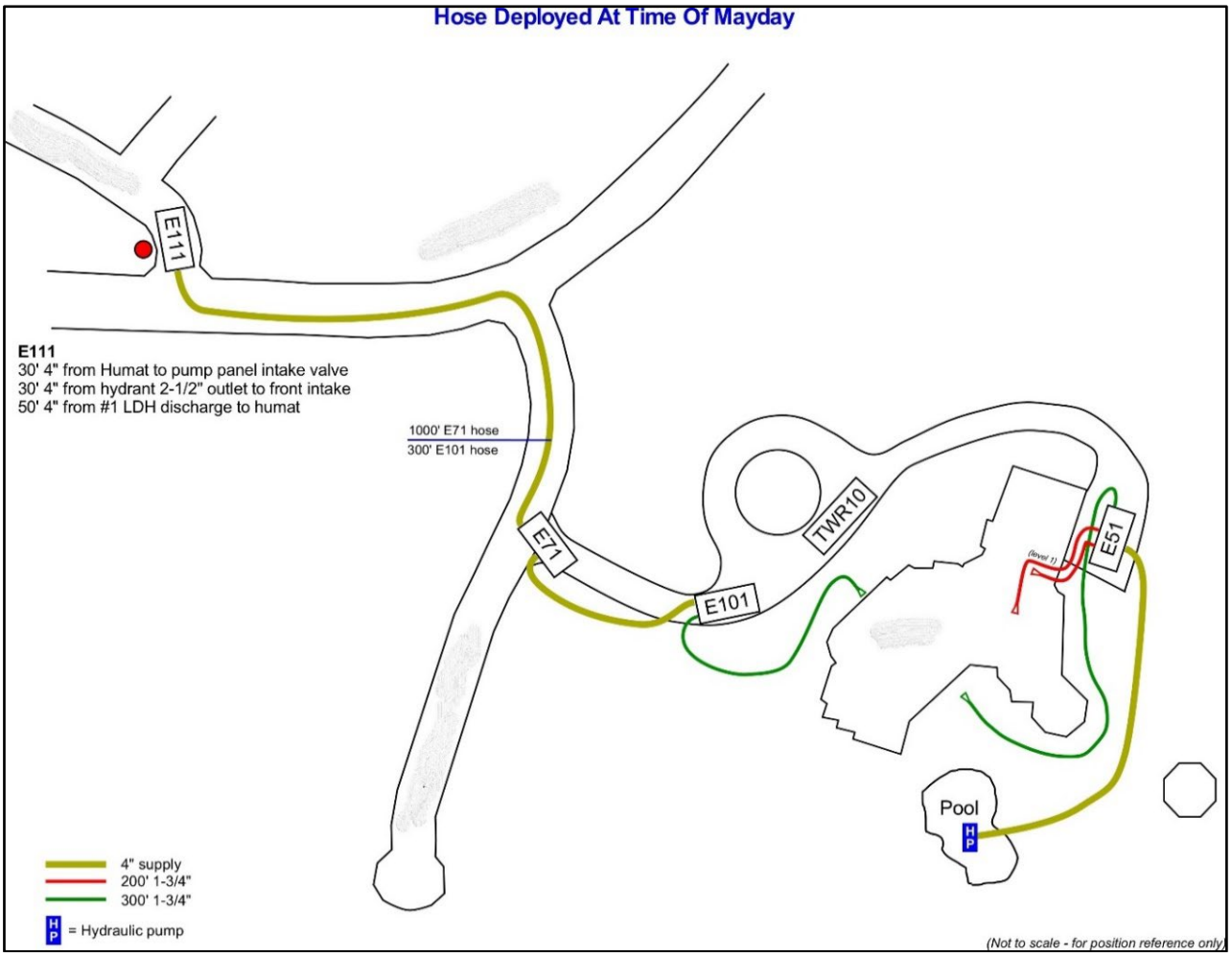


Diagram 3. The placement of hoselines and supply lines at the time of the Mayday. The time was 0219 hours.
(Diagram courtesy of the Fire and Rescue Department.)

At 02:29:12 hours, the Division Charlie supervisor advised Command that E51E and E101B were missing. At 02:29:33 hours, E51A called Command and advised that E51E was with the crew at E51. At approximately 0228 hours, E71, T7, and P56D entered the basement through the Side Charlie glass doors to rescue E101B. E71A and T7A were the first members of the rapid intervention group to enter the basement. They reported "cold smoke" conditions creating poor visibility for the members entering the basement. E71A took a few seconds to map the layout of the basement with the use of their thermal imager. A right-handed search was initiated by the members of the RIC. E71B was on the nozzle of the 300-foot 1¾-inch hose line that was initially deployed from E101 on Side Alpha. E71C was positioned on the hose line with E71B. T7B, T7C, T7A, and P56D made entry to begin the search. T7D initially remained on the exterior to prepare the RIC bag for additional air supply if needed.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

As crews were moving forward into the basement, they encountered furniture in their path, smoke conditions that were described as having a black-oily residue consistency, and a slippery floor potentially from the residue in the air. T7C and P56D located the second set of steps that led up to the crawlspace where E101B was located. They could hear the fire in the same direction. T7C wiped his SCBA face-piece and could see a glow. They notified E71B that the fire was in that direction. They continued through the door and ascended the steps into the crawlspace where E101B was located.

Members of the rapid intervention group stated that as they got to the top of the steps, visibility was low, the heat increased and they heard E101B's PASS alarm. Fire was observed on both sides of them. E71A encountered wires hanging from the ceiling level, which were pushing against his chest. He removed his wire cutters and began to cut the wires. The wires and the various storage items continuously impeded the rescue attempt.

E71C was the first member of the RIC to find E101B by following the sound of the activated PASS alarm. He felt his hand come across E101B's gear and felt around to see how he was positioned. E71C stated that when he found him, E101B was very stiff, lying face down and slightly on his left side. They stated that there was no visible fire in that area, only smoke conditions. As E71C began to pull E101B toward the steps, E71A made it to their location to assist (**See Diagram 4**). E71A believed they dragged E101B approximately 25–30 feet to the steps in the utility room. T7C arrived at their location to assist with the removal of E101B.

At this point in the operation, members from TWR10, T3, and E22 were inside the basement completing searches and standing by to provide additional assistance. T7B moved E101B down the steps to the main level of the basement. Members of the rapid intervention group noticed some of their low-air alarms on their SCBA were activated at this point. As E101B was removed from the basement, crews had to move the furniture to make a straight path to the exterior. Other members in the basement assisted by removing E101B the rest of the way to the exterior. E101B was transferred to EMS personnel at the basement level for treatment and transport. At 02:43:39 hours, the Charlie Division supervisor advised Command that E101B was out of the house. E101B was extricated from the structure in 22 minutes and 11 seconds after the Mayday initially declared. The rapid intervention group located and extricated E101B in 15 minutes and 5 seconds after entry.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

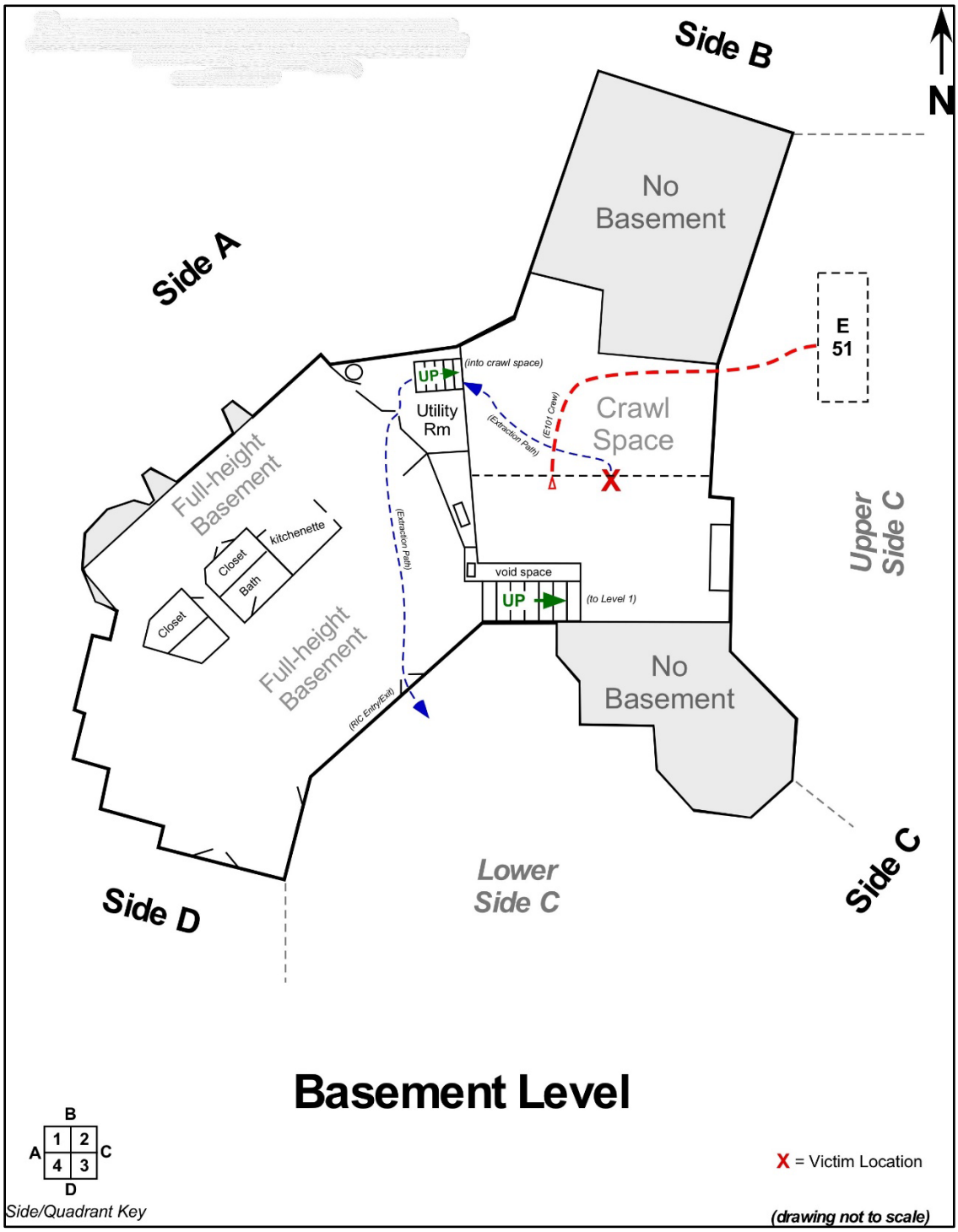


Diagram 4. The blue dotted line shows the path that the rapid intervention group took to locate E101B and exit the structure.
(Diagram courtesy of the Fire and Rescue Department.)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

The rapid intervention group consisted of E71, T7, P56D, T3, E22, E61 and TWR10.

At 02:46:36 hours, Command made an announcement on Bravo 1 that all companies were to evacuate the building and operations were changed to a defensive strategy. A personnel accountability report was conducted, and all members were accounted for at the incident scene.

Medical care was initiated on E101B once he was out of the house on Side Charlie. He was moved to a stretcher and taken to P105 for transportation to a local hospital. P105 was enroute to the hospital at 0254 hours. E101B was pronounced deceased at 0312 hours.

The fire was declared under control at 1008 hours. The fire for Box 5-62 was declared out by Command at 1158 hours.

Fire Origin and Cause

The origin of the fire for Box 5-62, as determined by the Fire and Rescue department's Office of the Fire Marshal, was the unfinished crawlspace below the 1st floor family room and breakfast area. Investigators identified the ignition sequence of the fire to be a lightning strike which induced the failure of the flexible corrugated stainless-steel tubing (CSST) system used to distribute propane gas throughout the building. This caused the ignition of fugitive gas escaping from the hole formed by the arcing process which then ignited the wood floor assembly. The classification of the fire cause was determined to be natural. Natural fire causes involve fires started without direct human intervention or action, such as fires resulting from lightning, earthquake, wind, and flood.

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:

- Lack of crew integrity
- Lack of complete scene size-up
- Below-grade fire
- Large area residential structure
- Lack of a defined incident action plan
- Inadequate fireground communications
- Missed critical incident benchmarks
- Member operating on the wrong radio channel
- Task saturation of the incident commander
- Lack of personnel accountability
- Wind/weather

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Cause of Death

According to the post-mortem examination by Maryland Office of the Chief Medical Examiner, the cause of death was due to prolonged exposure to high temperatures and thermal injuries. Toxicologic analysis showed a normal carboxyhemoglobin saturation strongly suggesting the firefighter did not experience carbon monoxide poisoning from the combustion products of the fire.

Recommendations

Recommendation #1: Fire departments should ensure that crew integrity is properly maintained by visual (eye-to-eye), direct (touch), or verbal (voice or radio) contact at all times when operating in an immediately dangerous to life and health (IDLH) atmosphere. The intent is to prevent firefighters from becoming lost or missing.

Discussion: When a company is assigned to operate in an IDLH environment, all members should enter, work, and exit together to reduce the risk of firefighters becoming lost or missing. Crew integrity means firefighters stay together as a team of two or more. Crew integrity starts with the company officer ensuring that all members of the company understand their riding assignment and have the proper personal protective equipment, proper tools, and proper equipment. Upon arrival at the incident, when a company is given a task to perform by Command, the company officer is responsible for clear communication to ensure the crew understands the assignment and the means and methods that will be used. Companies working at the task level have the greatest risk as they work within IDLH atmospheres which is inside the hazard zone. Therefore, all firefighters need to strictly follow the established personnel accountability system.

The task level is where the work is performed by assigned companies. The strategic and tactical levels are in place to support the task level. Task level activities are supervised by company officers working with company members directly in the hazard zone. The task level is critical because it addresses the incident's problems while taking place in the hazard zone which can kill or injure firefighters. All activities outside the hazard zone are in place to support units working on the task level.

Task level responsibilities include:

- Following all staging procedures
- Being properly assigned into the hazard zone
- Properly using the personnel accountability system
- Staying together as a company
- Attaching all members to a hoseline
- Maintaining an adequate air supply to safely exit the hazard zone
- Recognizing maximum depth into a structure is 175 feet and based on air supply
- Avoiding freelancing [Blue Card 2018; NFPA 2021a].

Company officers should give an accountability report upon exiting the hazard zone to either Command or their assigned division or group supervisor.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

It is every firefighter's responsibility to stay connected with crew members. The officer has the ultimate responsibility for crew integrity by ensuring no members are separated or lost. The officer should maintain constant contact with their assigned members by sight, touch, voice, or radio contact when operating in the hazard zone, and ensure members stay together as a company or crew. If any of these elements are not adhered to, crew integrity is lost, and firefighters are placed at great risk. Accepted crew communication practice has always been to be within sight, sound, or touch to maintain crew integrity. Background noise from other crews moving throughout the structure, saws operating on the roof, water flowing from hoselines, and apparatus noise from outside the structure can make it extremely difficult for crews to effectively communicate. When company officers call out to crew members for their locations and receive a non-specific response such as "over here," the officer has limited information and is unable to maintain crew integrity. A firefighter stating, they are "near a door or window" is a specific response that enables the officer and crew to form mental pictures and develop a virtual map while entering the structure. These mental pictures and virtual maps may be utilized in a rescue situation.

If a member becomes disoriented, the member should move toward the officer's voice to assist with their reorientation. Company communication methods should be determined by the company officer while establishing company operating procedures. Members should report to their officer, which ensures personnel accountability and firefighter safety [Fire and Rescue Departments of Northern Virginia 2013a]. A company officer can keep track of their personnel in zero visibility conditions by calling out to their crew members. This is also necessary when conducting a personnel accountability report (PAR). A best practice is to use the member's last name because crew members may have the same first name.

If a firefighter becomes separated and cannot re-connect with their crew immediately, the firefighter should attempt to communicate via portable radio with the company officer. If reconnection is not accomplished after three radio attempts, or reconnection does not take place within one minute, a Mayday should be declared. If conditions are rapidly deteriorating, the Mayday should be declared immediately. In addition to declaring a Mayday, the firefighter should activate the radio's emergency alert button (if available), followed by manually turning on their PASS alarm [NIOSH 2022b]. Similarly, if the company officer or the firefighter's partner recognizes they have a separated member, they should immediately attempt to locate the member by radio or by voice. If contact is not established after three attempts or within one minute, a Mayday should be declared immediately [IAFC 2012].

Crew integrity is also essential to fireground accountability. All firefighting operations should be conducted under the department's accountability system. A personnel accountability system should have the capability of always identifying who is operating in the hazard zone, their assignment, and their location. Whatever accountability system a fire department uses, the system needs to be able to identify the location of assigned crews within a small geographic area of an incident scene. When a firefighter becomes lost or missing, the personnel accountability system needs to be able to identify that firefighter. Personnel accountability should be managed at the point of entry to maintain continual awareness of firefighters in the hazard zone. Tags or passports collected only at the command post can't maintain awareness of whether firefighters are in or out of a building [IAFC 2012].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

At this incident crew integrity was not maintained.

Recommendation #2: Fire departments should ensure incident commanders conduct a detailed scene size-up and risk assessment during initial fireground operations and throughout the incident, including Side Charlie.

Discussion: The strategy and incident action plan (IAP) (tactics) of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. One 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 an observation or report from Side Charlie is received. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta may be delegated to another engine company or other resource on the 1st Alarm. Even if a 360-degree size-up is conducted, resources should be assigned to Side Charlie. Ideally, Side Charlie resources would include an engine with a hoseline, but any unit engine, truck, medic unit, or chief could be assigned. [Fire and Rescue Departments of Northern Virginia 2013b]. The 360-degree size-up is an ongoing task that should be assigned to the safety officer.

At any incident, life safety is always the 1st priority, followed by incident stabilization (2nd priority) and then property conservation (3rd priority). The ability to ensure 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 the actions and conditions. Incident commanders should use the following risk management principles:

- Activities that present a significant risk to the safety of firefighters shall be limited to situations that have the potential to save endangered lives.
- Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of firefighters, and the actions shall be taken to reduce or avoid these risks.
- No risk to the safety of firefighters shall be acceptable where there is no possibility to save lives or property [Brunacini 2002].

A radio report of conditions, including those on Side Charlie, should be transmitted over the assigned tactical channel to the incident commander (IC) and the dispatch center. The transmission should include the following:

- Smoke and fire conditions, with an emphasis on identifying the seat of the fire. The initial radio report from the first arriving unit for a structural fire should include the signal for a working fire, number of stories, type of occupancy, and location of fire. This lays the foundation for additional reports and serves as notification to responding units as to the type of SOP to implement
- If there are critical building description information available through the critical incident dispatch system (CIDS) for the response address, then this information would aid in implementing or adjusting SOPs. The CIDS could contain information that would necessitate alternative actions to fulfill identified operational goals

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- Building features: e.g., number of stories (particularly if there is a difference between Side Alpha and Side Charlie)
- Basement access and type
- Any other life or safety hazards [FDNY 2011].

Any change to operational priorities or responsibilities based on the above size-up shall be clearly communicated to Command, all responding units, and the dispatch center via the assigned tactical radio channel [TSFRS 2014]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

The International Association of Fire Chiefs (IAFC) has developed a set of *Rules of Engagement for Structural Firefighting* that will improve risk assessment and safety for firefighters [IAFC 2012]. The Rules of Engagement serve as a best-practice model procedure for fire departments to adopt in their own SOPs. The Rules of Engagement are also an excellent training document. The Rules of Engagement integrate several nationally recognized safety-related programs and principles. They include risk-assessment principles from NFPA 1500 and 1561. The Rules of Engagement align with the concepts in the IAFF's *Fire Ground Survival Program* and lessons learned from numerous firefighter fatality investigations conducted by NIOSH's Fire Fighter Fatality Investigation and Prevention Program [IAFF 2010; NIOSH 2022a]. The IAFC Rules of Engagement recognize that those at most risk are the firefighters and company officers operating in the hazard zone and integrate them into the risk-assessment and decision-making process. These rules allow firefighters to say no to unsafe conditions or practices and report such situations, without penalty, through a structured process. The Rules of Engagement has been formally adopted by an increasing number of fire departments and fire service organizations. They are considered to be the standard of practice for the fire service [IAFC 2021].

Rules of Engagement for Fire Fighter Survival

1. Size-up your tactical area of operation.
2. Determine the occupant survival profile.
3. DO NOT risk your life for lives or property that cannot be saved.
4. Extend LIMITED risk to protect SAVABLE property.
5. Extend VIGILANT and MEASURED risk to protect and rescue SAVABLE lives.
6. Go in together, stay together, and come out together.
7. Maintain continuous awareness of your air supply, situation, location, and fire conditions.
8. Constantly monitor fireground communications for critical radio reports.
9. Report unsafe practices or conditions that can harm you. Stop, evaluate and decide.
10. You are required to abandon your position and retreat before deteriorating conditions can harm you.
11. Declare a Mayday as soon as you THINK you are in danger.

The Incident Commander's Rules of Engagement for Fire Fighter Safety

1. Rapidly conduct, or obtain, a 360-degree situational size-up of the incident.
2. Determine the occupant survival profile.
3. Conduct an initial risk assessment and implement a SAFE ACTION PLAN.
4. If you do not have the resources to safely support and protect firefighters, seriously consider a

defensive strategy.
5. DO NOT risk firefighter lives for lives or property that cannot be saved. Seriously consider a defensive strategy.
6. Extend LIMITED risk to protect SAVABLE property.
7. Extend VIGILANT and MEASURED risk to protect and rescue SAVABLE lives.
8. Act upon reported unsafe practices and conditions that can harm firefighters. Stop, evaluate and decide.
9. Maintain frequent two-way communications, and keep interior crews informed of changing conditions.
10. Obtain frequent progress reports and revise the action plan.
11. Ensure accurate accountability of every firefighter's location and status.
12. If after completing the primary search, little or no progress toward fire control has been achieved, seriously consider a defensive strategy.
13. Always have a rapid intervention team in place at all working fires.
14. Always have firefighter rehab services in place at all working fire [IAFC 2012].

Many fire departments have adopted the acronym SLICE-RS by the International Society of Fire Service Instructors [ISFSI 2013]. This process has been specifically designed to help 1st arriving company officers apply recent research on modern fuels and fire dynamics to their early strategic and tactical decisions on the fireground:

- Size-up all scenes
- Locate the fire
- Identify and control the flow path
- Cool the heated space from a safe location
- Extinguish the fire
- Rescue and Salvage (are actions of opportunity that must be considered not only at the initiation of operations but throughout the incident) [NFPA 2014].

The acronym SLICE-RS is not designed to replace the well-known RECEO-VS method that was developed by Chief Lloyd Laymen and has been widely adopted by the fire service over the years. SLICE-RS is to be used by the first arriving company officer as well as RECEO-VS [NFPA 2014].

In his book *Fire Fighting Tactics*, Chief Lloyd Layman used S-RECEO-VS. The "S" is for size-up. The first arriving officer or fire department resource should size-up or provide an estimate of the situation upon arrival. Chief Layman promoted the importance of size-up just as SLICE-RS supports this process today [Layman 1953]. This information is important to the fire service when discussing fireground tactics (**See Diagram 5**).

S-RECEO-VS is:

- Size-up or estimate of the situation
- Rescue
- Exposures
- Confinement
- Extinguishment

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- Overhaul
- Ventilation
- Salvage [Layman 1953].

Diagram 5. Lloyd Layman's "Basic Division of Firefighting Tactics"

Based on a risk-benefit analysis, the first-arriving engine company officer should initiate development of the appropriate organizational structure to manage the incident. If there is a need to initiate interior offensive operations, they should be initiated as quickly as possible.

While enroute to the fire, the first-arriving engine officer needs to begin to set up for water supply operations. With the appropriate area preplan, the officer can designate fill sites, dump sites, or relay positions that will allow in-coming units to take their pre-determined positions. This should be done before or in conjunction with committing crews to interior operations [Fire and Rescue Departments of Northern Virginia 2013a].

Procedures developed for fireground operations should be flexible enough to allow the change due to:

- Life hazard (first priority)
- Problems with water supply and water application
- Volume and extent of fire, requiring large caliber streams
- Location of the fire, inaccessible for hoseline operations
- Materials involved in the fire and explosion potential compounding the problem
- Exposure problems where further fire spread would be a major concern
- Stability of the structure, which would be dependent on the condition of the structural components of the building and the intensity and duration of the fire [Brunacini 2002; IFSFI 2013].

The initial scene size-up, risk assessment, and IAP are essential for any structure fire, but this is especially true for large structures due to a variety of complexities. An incident of this magnitude

necessitates a complete scene size-up and risk assessment as part of the decision-making process. In addition, the scene size-up for large occupancies require more time versus a 2,000 to 3,000 square foot residential structure. The limited size-up at this incident hampered the response.

Recommendation #3: Fire departments should develop and implement a standard operating procedure/guideline (SOP/SOG) to identify below-grade fires and ensure that appropriate tactical operations are implemented.

Discussion: Below-grade fires, particularly those in private dwellings, are one of the most dangerous and most difficult fire locations for firefighters to identify 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 initially detect; may be difficult to access; require additional staffing for hoseline placement, operation, and ventilation; and firefighters may be working over the fire [NIOSH 2018]. There is increased risk to firefighters is due to:

- 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.

During below-grade fire operations, every firefighter should remember access and ventilation. Access includes how easily a firefighter can get water in and how they can make an attack via a window or door. Ventilation may not exist in a below-grade areas; however, wind can pressurize the structure and contribute to erratic fire behavior. For structures with no exterior access to basement or below-grade area, the main way for air and smoke to move through the home will be from the basement, up the stairs toward an open door or windows above grade.

If the fire has not penetrated the structure, a bi-directional flow will occur at the doorway. The air supply to the fire is inefficient and limited, therefore the potential of flashover is reduced when no exterior ventilation access to the basement is present.

Potential ventilation via windows or doors connected to the below-grade compartments enables rapid changes in fire growth. Uni-directional exhaust flows in the stairwell(s) may result in an increased burning rate of contents and any wood floor assembly, increasing the potential for floor collapse and reducing safe operating time on the floor above. Ventilation of below-grade space was a key factor in firefighter line of duty deaths including the Pang Fire (Seattle, WA); the Cherry Road Fire

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

(Washington, DC); the Squirrelsnest Lane Fire, Colerain, OH; the Berkley Way Fire, San Francisco, CA; and the Pater Road Fire, Hamilton, OH. [Madrzykowski and Weinschenk 2018].
Key factors in recognizing a below-grade fire include:

- fire or smoke venting from a cellar window, smoke pushing from the chimney (especially during warmer weather)
- evenly distributed smoke with no visible fire on the 1st floor
- floorboards may not be hot. Look for smoke around the edges of the baseboard or HVAC duct penetrations
- smoke from eaves, attic windows or louvered attic vents especially in older homes with balloon frame construction [Kerber et al. 2012; Madrzykowski and Kent 2011].

Below-grade fires in dwellings with balloon construction will likely extend to the attic via hidden voids. Units operating above the basement need to stretch enough hoseline to reach the upper floors. Intermediate floors need to be checked for fire before a hoseline is committed to the top floor. Floor and wall voids in balloon frame construction are ***all*** interconnected and can spread fire throughout the building in unexpected ways. Flooring systems and floor coverings are good insulators and may not transfer a significant amount of heat from a basement fire. Laboratory experiments, field-testing, and modeling have shown that in post-flashover basement fires with platform construction and engineered lumber sub-floors, even after the floor supports start to lose the structural integrity:

- high heat conditions may not be generated on the floor above
- thermal imagers may not provide clear information on the level of hazard
- floor supports that hold up to a strike from a tool during sounding may not be able to carry the weight of a firefighter or firefighters [Kerber et al. 2012; Madrzykowski and Kent 2011].

SOPs/SOGs need to consider numerous factors that affect fire-fighting operations. This will ensure essential strategic-, tactical-, and task-level functions are performed by the IC, division/group supervisors, company officers, and firefighters. Additionally, this process compliments the defined knowledge, skills, abilities, competencies, and fireground experience to assist:

- ICs to plan and implement an effective strategy and IAP
- division/group supervisors to formulate and follow tactics
- company officers to successfully carry out assigned tasks
- firefighters to effectively perform their duties and functions [FDNY 2013].

A fire department's SOP/SOG for below-grade fires needs to include the following topics:

- community risk assessment
- scene size-up
- building construction
- strategy and tactics
- use of a thermal imager
- ventilation considerations
- proper size and adequate hoselines.

Below-grade fires are one of the most challenging situations for firefighters. As with all fires, a risk assessment and an occupant survivability profile should be conducted to evaluate the risks for lives and

property. Fire departments should conduct a post-incident analysis for significant incidents, especially below-grade fires. Fire departments should periodically update their community risk assessment program and SOPs/SOGs based on recommendations from post-incident analysis reports.

If the size-up indicates there is a fire in the basement (e.g., floor to ceiling smoke and not lifting significantly once the basement walk-out door was opened) then the basement needs to be investigated and cleared before crews can safely operate above. Opening a door is ventilation and will increase the size of a ventilation-limited fire. Basement fires also 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 #4: Fire departments should ensure that a deployment strategy for low frequency/high risk incidents is developed and implemented for large area residential structures with unique architectural features.

Discussion: The challenges of conducting operations at single family dwellings that have large square footage ranging from 6,000 to 10,000 square feet, require an advanced understanding of building construction, engineering, and fire dynamics. They also necessitate an integration of adaptive fire management principles that require distinctively unique firefighting methodologies, practices, and tactical deployment. These occupancies are not your typical single-family dwellings and cannot be managed with conventional strategies, tactics, and standard deployment. From an incident management standpoint, these incidents require a more rigorous level of command resiliency, tactical patience, and disciple.

Since no two fire departments are alike, there is no standard scale to measure and evaluate frequency and severity of risk. Some fire departments will have a greater or lesser degree of tolerance for risk than others. The intent of the risk management process is for a fire department to develop a standard level of safety. This standard level of safety defines the parameters of the acceptable degree of risk under which members perform their job functions.

When assuming command of a large area residential fire, fire officers may resort to what they did at a similar incident, or what they've seen and heard most frequently. These individuals use memory recall to try and find a match in terms of training, experience, and competencies for developing effective strategy and tactics. If there is nothing to draw from, the individuals will resort to actions that they are familiar with or comfortable with relating the incident. The process is methodical and needs to start from the beginning of the incident with the arrival of the 1st Alarm companies. If steps are skipped or missed, it becomes very difficult to change the outcome as the incident progresses. There is very little room for deviation at large single-family dwellings on the tactical level and task level. The tactics for firefighting operations at a large area residential fire should occur based upon departmental procedures or guidelines.

Frequency is how often something occurs, and severity (risk) is a measure of the consequences if an undesirable event occurs (**See Figure 2**). Each risk has its own set of factors that will dictate how the

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

fire department determines the severity of the consequences. Priority of the risk is in direct relation to inherent risks that have had a harmful effect on the fire department and its members [NFA 2009].

Fires at single family dwellings with large square footage and unique architectural features are low frequency/high risk events. A fire department should have a deployment strategy in place to effectively manage these types of incidents. The deployment strategy should address staffing, incident management, appropriate tactics, adequate water supply, and other resource/logistical management issues.

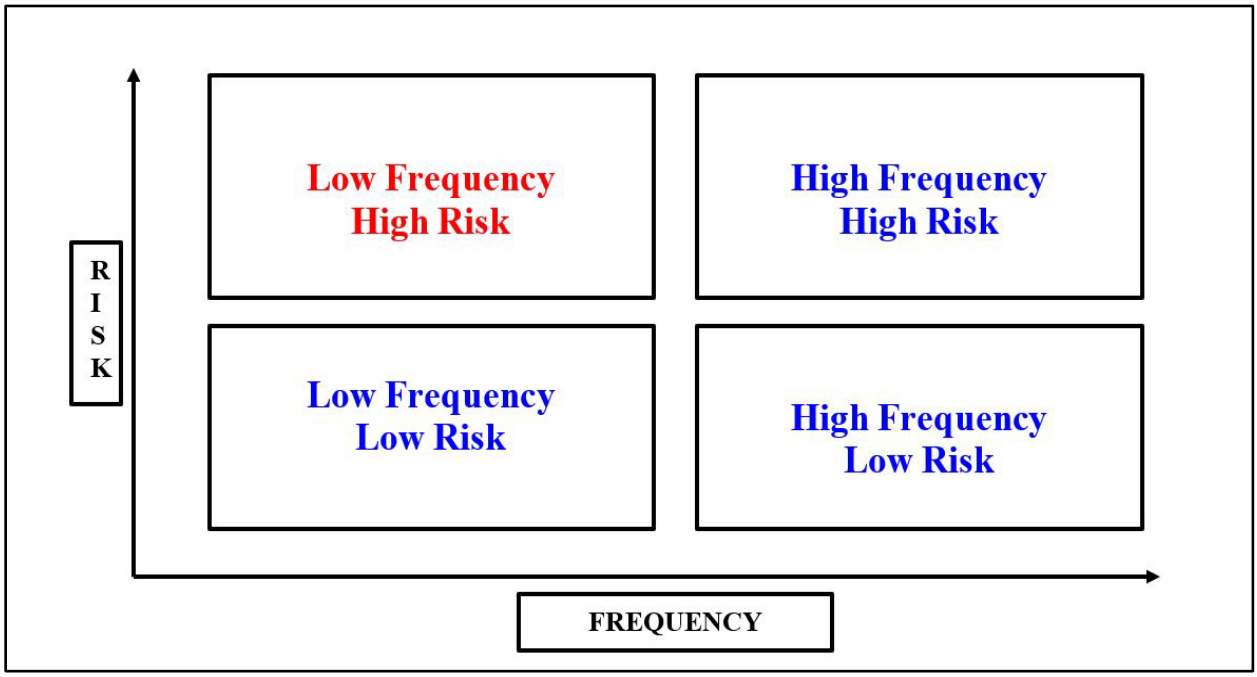


Figure 2. Risk versus Frequency.
The frequency is inversely proportional to inherent risks potentially harmful to firefighters.
(Courtesy of Graham Research Consultants.)

A good indication of a low frequency/high risk incident is the description of the structure size as it relates to areas of the structure that can be covered by a 200-foot hoseline. This includes the maximum depths into the structure at which safe operations can take place (**See Figure 3**). Using this structure description method will provide a more consistent classification of structure size, basing it on a core operational task – hoseline deployment for interior firefighting operations.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

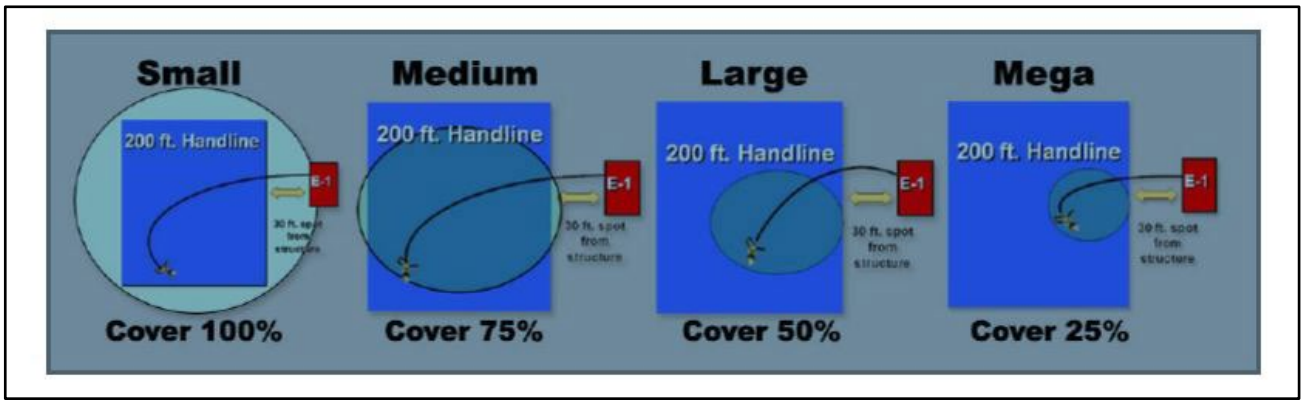


Figure 3. This figure shows the coverage of a 200-foot hoseline based upon the size of the structure.
(Diagram courtesy of the Fire and Rescue Department.)

At this incident, fireground operations became overwhelmed due to the size and complexity of the structure and the difficulty in locating the fire. Command was at a disadvantage due to the multiple tactical changes on Side Charlie. The contour of the structure created issues for officers trying to identify and describe their location to Command. Also, the lack of available water supply created issues that affected the incident. Agencies that utilize pre-connected hose lines should be aware of the limitations of the hose length when accessing large area residential structures. This was an issue when E51 had to move from Side Alpha to Side Charlie and then two different access points on Side Charlie. The hoseline length was too short to enter the structure at the basement level.

Recommendation #5: Fire departments should ensure that incident commanders develop an incident action plan (IAP) that matches conditions encountered during initial operations and throughout the incident.

Discussion: Fireground operations are very dynamic and fast-paced. An IC needs to determine a strategy then develop an IAP to ensure implementation of actions are taken to control the incident. ICs should follow the decision-making model that includes:

- identifying incident critical factors (through a situational evaluation or "size-up")
- consider the standard risk management plan
- declare the strategy (offensive or defensive)
- set tactical objectives.

This model will lead to the development of the IAP, which serves as the tactical road map to effectively manage the incident. The IAP defines where and when resources will be assigned throughout the incident, along with tasks and objectives [NFPA 2014].

To ensure a standard outcome of each incident, ICs should match the standard conditions to standard actions. This is the core of the ICS and the basis for all operations. Standard actions would include identifying the incident's critical factors before taking any action, and regular updating of the

incident's critical factors and size-up to determine if the strategy and/or IAP needs to be modified. These actions require current, accurate, and relevant information. The overall goal of this systematic evaluation process continually produces standard, safe, well-managed incident outcomes [Blue Card 2018].

The defined strategy established by ICs describe the overall approach to incident operations and drives the IAP. The IAP provides the tactical assignments required to achieve the offensive/defensive objective. The order of occurrence is key—the strategic goals are developed first and followed by the development of tactical objectives that can be assigned to responding companies. At each incident, ICs should start with a standard placement-oriented operational plan that develops a strong, dependable beginning for command and control of the incident. [Brunacini 2002; Fire and Rescue Departments of Northern Virginia 2013a].

The initial IC, most often, is a company officer who arrives on-scene prior to a command officer. The company officer should conduct a detailed size-up and communicate the size-up to all responding resources, including the dispatch center. The company officer then assumes command and defines the strategy and IAP. The company officer may not have the ability or time to record the IAP on paper and provide documentation when transferring command. In this case, a verbal IAP is appropriate. As with this or any incident, events can occur very quickly before a detailed tactical worksheet or written IAP is developed [Brunacini 2002; Harms, 2010].

The initial IAP can be as simple as a verbal transmission to all units assigned to an incident. Once an officer assumes command, the overall strategy – either offensive or defensive is communicated. Command can make specific assignments to arriving companies along with tactical objectives such as search, rescue, fire attack, ventilation, utility control, and exposure protection. The responding command officer should be monitoring radio communications and documenting tactical objectives on a tactical worksheet, if possible. When the chief officer arrives on-scene, an update from the initial IC can occur (face-to-face or by radio). The command officer will then assume command at a stationary location. By following this process, the initial and subsequent incident commanders will be in 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 developed by an IC that reflects the overall incident strategy, tactics, risk management, with member safety at the forefront. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2014] requires the following:

- 5.3.12.1 The incident commander shall be responsible for developing and/or approving an IAP
- 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 6**).

Offensive Incident Action Planning

When an incident's critical factors and the risk management plan indicate an offensive strategy, Command will define the tactical objectives which typically require entering the structure (hazard

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

zone) to control the incident hazards. An offensive IAP is based on the standard offensive tactical priorities.

Offensive strategy tactical priorities and their corresponding completion benchmarks are:

- Water on the fire
- Life Safety: Primary and Secondary "All Clear"
- Fire Control: "Under Control"
- Property Conservation: "Loss Stopped"
- Customer Stabilization: Short term.

The offensive tactical priorities establish the major operational activities required for a complete, integrated effort, and they identify the three major functions needed to establish the overall incident response [Blue Card 2018].

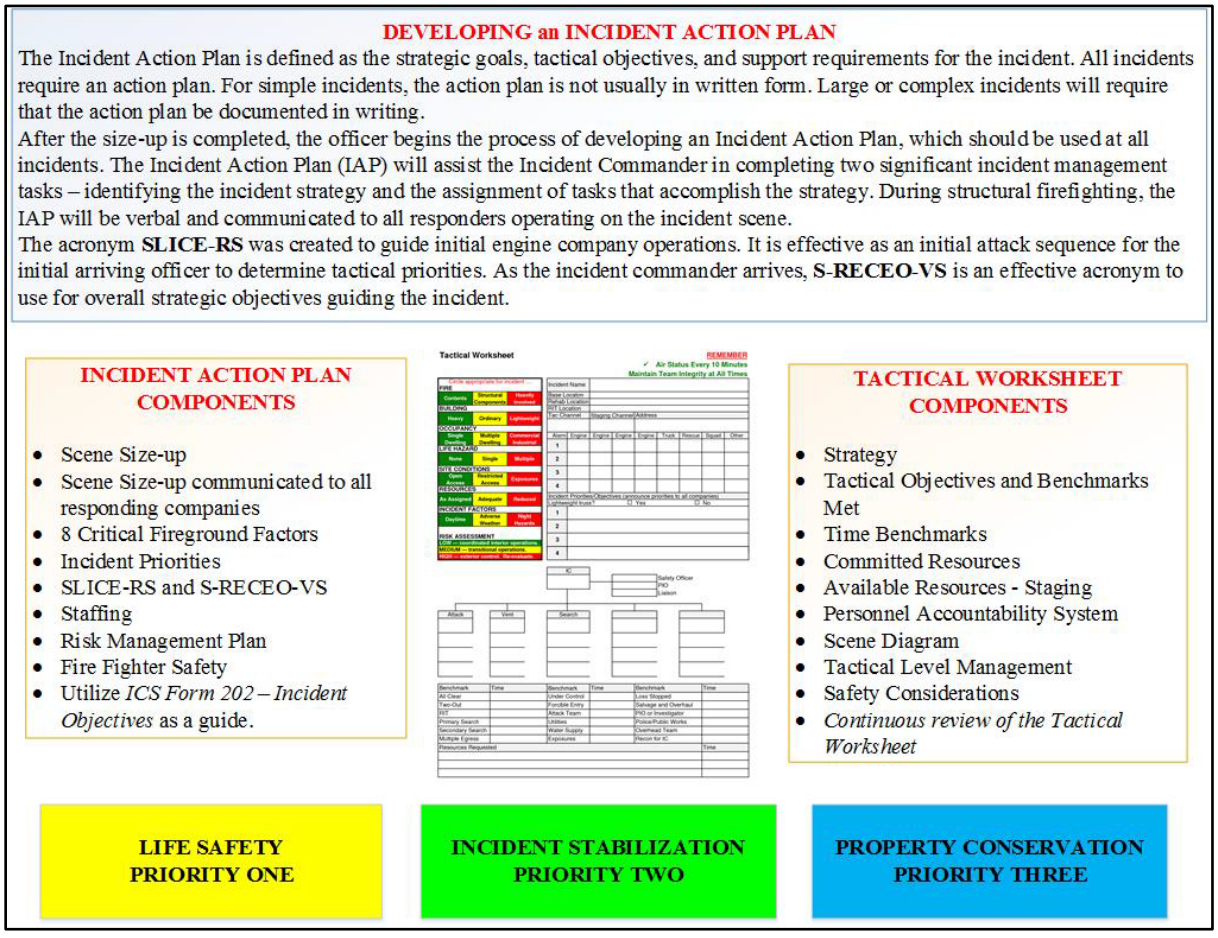


Diagram 6. A guide for developing an incident action plan at Type V and Type IV incidents. For these types of incidents, the incident action plan is most often communicated verbally.
(*Courtesy of FireFighterCloseCalls.com.*)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Defensive Incident Action Planning
A defensive situation occurs when the incident has evolved to the point that lives and property are no longer savable and offensive tactics are no longer effective or safe. The defensive strategy is based on protecting firefighters and property (exposures).

Firefighter safety is the number 1 defensive priority.
Defensive strategy tactical priorities and their corresponding completion benchmarks:

- Define the hazard zone and keep firefighters out of the potential collapse zone(s)
- Establish cut-offs—Forward progress stopped
- Search exposures—Primary and Secondary "All Clear"
- Protect exposures— "Fire Control"—Loss Stopped.

Defensive operations represent a standard organizational response to situations that cannot be controlled with offensive tactics. When conditions go beyond the safety systems required for interior operations, Command needs to conduct defensive operations from outside the hazard area. Command needs to write off lost property and decide where the cut-off will take place. If defensive operations are conducted from the onset of the incident, a primary search will not be completed for the involved structure(s). During defensive operations, Command will coordinate the rotation of crews for rest and rehydration.

A basic defensive IAP includes the following tasks:

- Complete scene size-up
- Identify critical fireground factors
- Determine the need for additional resources
- Evaluate fire spread/write-off lost property
- Determine collapse zones and ensures no entry
- Search exposures
- Protect exposures
- Prioritize master streams; provide big, well-placed streams
- Surround and drown [Blue Card 2018].

As an incident progresses, Command needs to continually review and update the IAP. This should occur when benchmarks are met, conditions change, or benchmarks have not been achieved. The following list serves as a guide for Command to consider:

- Firefighter safety
- Consider changing operational modes – go defensive
- Matching the current strategy with the current conditions
- Location of fire attack
- Effect of the fire attack
- All affected areas searched ("All clear")
- Timing and support
- Adequate back-up
- Adequate staffing and resources
- Develop "Plan B"

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- Corrective actions to the current conditions (Fire Control, All Clear, Loss Stopped) [Blue Card 2018].

The IC in this incident established an IAP as based on the situation initially encountered. The configuration of the structure created issues for officers trying to describe to the various sides of the structure to Command. Additionally, the incident escalated, and Command became involved with other tasks. Departments need to consider requesting additional chief officers on each alarm from automatic aid or mutual aid departments to ensure for command safety.

Recommendation #6: Fire departments should ensure that critical incident benchmarks and fire conditions are communicated to incident commanders throughout the incident. This is accomplished with effective fireground communications.

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 [Blue Card 2018].

Radio communications allow the tactical and task levels to connect with the IC working on the strategic level. While radio communication does not put water on the fire, the overall outcome of the incident can be traced back to the quality of the radio communications among the participants [Blue Card 2018]. 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

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- 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 2010].

Radio discipline is essential for 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.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Fire departments should consider an incident management system training and a certification program for company officers and chief officers. The program would benefit officers who serve in the role of IC plus supervise and manage emergency and hazard zone operations for every day, local National Incident Management System, Type V and Type IV incidents [NFPA 2014].

Recommendation 7: Fire departments should have a procedure to ensure all members operating in the hazard zone have their radios on the designated radio channel.

Discussion: Effective incident communications provide the connection among the three management levels of the organization: strategic, tactical and task levels. Incident communications are the information "carrier" that the team uses to connect, commit resources, and create effective, coordinated action. Radio communications are the way that the tactical and task levels connect with the IC working on the strategic level. In most cases, the overall outcome of the incident is directly connected to the quality of the radio communications among the participants [Blue Card 2018].

Many hazard zone distractions can cause communications problems. ICs need to understand this when communicating with operating companies. Companies also need to understand that their portable radios provide the only communications link to the outside world. The command system depends upon coherent communications between the IC and the operating units.

Radio channels should be assigned at the time of dispatch. Changing radio channels in the middle of an operation can jeopardize communications [Abbott 2016]. Therefore, radio channels should not be changed unless necessary. All hazard zone operations and Mayday operations should remain on the same tactical channel when a Mayday has been declared. Connecting all hazard zone companies to the Mayday operation helps the IC and division/group supervisors to assist the firefighter who is experiencing a Mayday.

Once a tactical radio channel is assigned, the company officer has the responsibility to ensure that all members are on the correct tactical channel, including the proper talk group. This is especially important before the company enters the hazard zone. In addition, firefighters and fire officers operating in the hazard zone should avoid using radios in the scan mode. The problem is that if the dispatch channel is scanned every time a dispatcher transmits or receives a message, it interferes with the fireground operation, which interrupts radio communications. Critical messages may be missed, lost, or delayed.

Recommendation 8: Fire departments should ensure all members and dispatchers are trained on the safety features of their portable radio, particularly the features useful during a Mayday.

Discussion: Like turnout gear and SCBA, the portable radio assists firefighters operating in the hazard zone. Therefore, each firefighter should be equipped with a portable radio and trained on its use and safety features. This training process should extend to the fire department's dispatchers because the dispatchers are a critical component of the response and responsible for designating a channel for emergency alert button (EAB) transmission [NFPA 2021; NIOSH 2022b].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

The design of portable radios changed significantly when NFPA issued 1802, *Standard on Two-Way, Portable RF Voice Communications Devices for Use by Emergency Services Personnel in the Hazard Zone* [NFPA 2021]. This standard resulted from the findings and recommendations of a NIOSH line of duty death investigation [NIOSH 2012], the safety investigation report from the affected fire department, the IAFF, and the IAFC [NFPA 2021].
The safety features on portable radios include:

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

In addition, several portable radio manufacturers are developing the ability for a dispatcher or on-scene ICs to remotely activate a firefighter's EAB.

Emergency Activation Button (EAB) [NIOSH 2022b, NFPA 2021]
The EAB is preprogrammed to send an emergency transmission on a pre-designated channel or talkgroup. A talkgroup is defined as a group of radios addressed as a single entity by the system and the functional equivalent to a conventional repeater channel. When operating on a simplex channel or in the direct mode, the radio can revert to a channel/talkgroup monitored by the IC or a dispatch center. The communication system administrator must program the transmission channel/talkgroup for the EAB.

The EAB is activated by pressing it for at least 1 second, but not more than 3 seconds. When the EAB is activated, the portable radio identifies the user's department identification or riding position (e.g., Engine 19 Officer). This signal overrides any other communication over the selected radio channel for 10 to 30 seconds depending on the programming. Once activated, the portable radio operating on a trunked system is given priority access to the talkgroup until the EAB is reset. While in the EAB mode, transmissions will be at the device's highest radio frequency (power), and an audible beacon will sound at full volume until the EAB is reset [NIOSH 2022b, NFPA 2021].

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

Dispatcher Alert
The third safety feature is the dispatcher's ability to "alert" a firefighter's portable radio. This is a valuable function when trying to locate a lost, missing, or down firefighter. The "alert" will continue to sound until reset but is only as loud as the volume is set on the portable radio.

For these three safety features to operate properly, the firefighter must take several key actions before entering the hazard zone. The portable radio must be on the channel that has been assigned to the incident and is being monitored by the dispatcher or IC. If the portable radio is

on a different channel, dispatch or the IC may not be alerted or notified of the Mayday. Also, the scan function on the portable radio needs to be turned off when operating in the hazard zone.

At this incident the EAB and the man-down notifier were not activated, and the fallen firefighter was on an unmonitored radio channel. The portable radio safety features should be detailed in a fire department's SOP/SOG on fireground communications and Mayday protocols. In addition, all firefighters and dispatchers should be properly trained and demonstrate competency with portable radio safety features on an annual basis.

Recommendation #9: Fire departments should develop a process to prevent task saturation of incident commanders during multi-alarm incidents.

Discussion: Since the inception of the ICS, the duties and responsibilities of ICs have significantly increased. As an incident escalates, it is difficult for one individual to effectively manage a complex emergency operation. The IC needs to address issues dealing with situation evaluation, deployment management, strategy, the IAP, communications, personnel accountability, firefighter and responder safety, the tactical worksheet, RIC, and other essential job tasks. To ask one person to command and control a complex incident is unfair to this individual, the firefighters, and the citizens we protect [Brunacini AV, and Brunacini N 2004]. Front loading the incident with support for the IC is essential, especially during the first hour of the incident, which is most often when firefighters are seriously injured or killed [Brunacini AV, and Brunacini N 2004].

Many fire departments have a process in place to support the initial IC. This is especially important when the command officer does not have a staff aide, incident command technician, or chief's aide. This process can include dispatching an additional battalion chief on the working alarm assignment. If this battalion chief is going to be assigned to supervise a division or group, then another battalion chief should be dispatched.

The essential element is to ensure that ICs have the necessary support to command and control an incident. When an incident starts to escalate, a process is needed to immediately provide resources to develop a strong command structure and presence during the first hour of an incident. Additionally, this process helps ensure a smooth transition from a small incident to a large incident. An additional battalion chief can function as the planning section chief to allow the IC to focus on operational issues.

Recommendation #10: Fire departments should ensure that the member assigned to the resource status and situation status function is not given other duties during an incident.

Discussion: A personnel accountability system readily identifies both the location and function of all members operating at an incident scene [NFPA 2014]. The philosophy of the personnel accountability system starts with the same principles of an incident management system—company unity and unity of command. Unity can be fulfilled initially and maintained throughout the incident by documenting the situation status and resource status on a tactical worksheet.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

An integral part of the accountability system is to ensure that the firefighters who are assigned and operating in the hazard zone are accounted for during initial operations and continues through the entire incident. Also, a process should be in place to periodically check that all members operating in the hazard zone are accounted for by this system.

One of the most important functions of command safety is for the IC to initiate a personnel accountability system that includes the functional and geographical assignments at the beginning of operations and continues until the termination of the incident. NFPA 1561, 8.12.4, states "The incident commander and members who are assigned a supervisory responsibility that involves three or more companies or crews under their command shall have an additional member(s) (e.g., staff aide) assigned to facilitate the tracking and accountability of the assigned companies or crews" [NFPA 2014].

A functional personnel accountability system requires the following:

- Development and implementation of a departmental SOP/SOG
- Necessary components and hardware, such as an accountability board, individual name tags, and company name tags
- Training for all members on the operation of the system
- Strict enforcement during emergency incidents.

A functional personnel accountability system should be able to identify:

- All members operating in the hazard zone (who)
- Where all members are in the hazard zone (where)
- The conditions in the hazard zone (conditions)
- What actions are being taken in the hazard zone (actions)
- Paths of access and egress in and out of the hazard zone (exits)
- Rapid intervention crew(s) (RIC) and assign them.

There are many different methods and tools for resource accountability. Some examples are:

- Tactical worksheets
- Command boards
- Apparatus riding lists
- Company responding boards
- Electronic bar-coding systems
- Accountability tags or keys (e.g., PASSPORT System) [NFPA 2014].

Resource accountability should be assigned to personnel who are responsible for maintaining the location and status of all assigned resources at an incident. As an incident escalates, resource status would be placed under the Planning Section. This function is separate from the role of the IC. The IC is responsible for the overall command and control of the incident. Due to the importance of responder safety, resource status should be assigned to a dedicated member as the size and complexity of the incident dictates. Several positions could function in this role including a staff aide, incident command technician, staff assistant, chief officer, or other designated member. As the incident escalates and tactical-level management components (e.g., divisions or groups) are assigned, the resource status officer (accountability officer) works with the division or group supervisors to maintain an on-going

tracking and accountability of members [FIRESCOPE 2017]. A properly initiated and enforced personnel accountability system enhances firefighter safety and survival. It is vital that resources can be identified and located in a timely manner.

An important aspect of a personnel accountability system is the personnel accountability report (PAR). A PAR is an on scene roll call in which each supervisor reports the status of their crew when requested by the IC [NFPA 2014]. The PAR should be conducted every 15–20 minutes or when benchmarks are met.

The personnel accountability system should include an SOP/SOG that defines each function's responsibility and the necessary hardware to ensure its success on the fireground. Classroom and practical training should be conducted to ensure its proper function during emergency incidents.

Recommendation #11: Fire departments should develop a formal training program that defines the job duties and functions for staff aides, incident command technicians, or staff assistants.

Discussion: The staff aide (e.g., chief's aide, emergency incident technician, incident command technician, field incident technician, or staff assistant) is an essential component of the incident management system [Brunacini 2002]. Functions of the staff aide can include any of the following: maintaining the tactical worksheet; maintaining personnel accountability of all members operating at the incident (resource status and situation status); monitoring radio communications on the dispatch, command, and fireground channels; controlling information flow by computer, fax, or telephone; and accessing reference material and pre-incident plans [Brunacini AV and Brunacini 2004; LAFD 2011; NFPA 2014]. NFPA 1561, 8.6, states, "the incident commander and members who are assigned a supervisory responsibility that involves three or more companies or crews under their command shall have an additional person (staff aide) assigned to facilitate the tracking and accountability of the assigned companies or crews" [NFPA 2014].

Some fire departments use firefighters as staff aides and other fire departments use fire officers to serve as a staff aide for ICs. Regardless of the rank of the staff aide, the assigned personnel should be trained in the duties and responsibilities to proficiently function and meet the expectations of ICs. The staff aide, in support of the IC, has three primary responsibilities:

- resource status
- situation status
- command post communications [Fire and Rescue Departments of Northern Virginia 2013a].

Tasks that may be required to fulfill these functions include:

- Determine and track status of resources
- Track units and members
- Anticipate the need for additional resources based upon assignments being made
- Manage command channel communications
- Provide progress reports
- Monitor secondary tactical channels if utilized in the operation
- Anticipate and recommend logistical needs to support the operation

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- Brief incoming chief officers as necessary.

In some cases, the staff aide will be in a separate vehicle than the chief. When the staff aide arrives prior to the chief, the staff aide should report to Command and assists the IC with the three primary responsibilities described above [Fire and Rescue Departments of Northern Virginia 2013a]. After conferring with the IC, the staff aide's primary effort should be to set up the command post, while the IC maintains focus on the command and control of the incident. The IC will determine whether to operate from the front of the vehicle or to move to the rear.

Once the command post is set up and ready to support communications, resource and situation tracking, both the IC and the staff aide may operate from the rear of the vehicle using the command board(s) and radio headsets for incident management. A single staff aide may not be able to solely manage all three of the primary responsibilities. It is the responsibility of ICs to ensure these three responsibilities are completed and assign additional aides as necessary.

The staff aide should set up and manage the personnel accountability system. Proper collection and movement of accountability tags and/or passports is a major responsibility of the staff aide. The staff aide is responsible for tracking members and units who are operating in the hazard zone as well as those in staging. This includes accounting for companies:

- assigned individually as a single resource
- assigned to groups, divisions, or branches
- assigned to staging and at base
- still be enroute.

It is a function of the staff aide to advise Command as companies become engaged, as resources are depleted, and of the remaining resources in staging.

The primary activity for situation status is tracking critical tasks that need to be assigned, are underway, or already completed. The staff aide should be very familiar with the various command boards used in managing an incident.

The staff aide documents the activities taking place at the incident. This documentation should include sketching the building outline or footprint and showing the location of apparatus.

Progress reports are also a part of situation status and provide a verbal update of the progress of the actions underway. They also provide a mental picture for other units and officers who are on-scene or in staging. These reports are recorded and allow for recovery of the information for evaluation purposes after the incident.

The staff aide requests, sets up, and communicates on the Command channel. The role of the staff aide is to support Command, not to run the incident or make strategic or tactical decisions. The staff aide is the voice of Command and transmits additional alarms, directions to companies, and progress reports. The staff aide should be proficient in the use of the radio system, cell phones, the ICS, and the personnel accountability system [Fire and Rescue Departments of Northern Virginia 2013a].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

At times, additional assistance at the command post may be required. The staff aide should point out the need for such assistance to Command. This assistance may be in the form of a fire company, EMS unit, or staff officers. The command post support staff, under the direction of the IC, will be primarily concerned with managing additional communications functions, maintaining accountability of operational units, and documenting situation status and information [Fire and Rescue Departments of Northern Virginia 2013a].

Special command units are available from some departments. These units, such as a Field Command or Field Communications Unit, also should be considered to support command operations at multiple alarm or long-term incidents.

As the incident expands, an officer could be assigned as a division supervisor or group supervisor. The assigned officer will proceed to the division or group, evaluate conditions, and report these conditions to the IC. If directed by Command, the assigned officer will assume responsibility for directing resources and operations within their assigned area of responsibility. Division/group supervisors assigned to operate within the hazard zone needs to be with a second individual, which would be the staff aide. The staff aide can assist the division/group supervisor by maintaining accountability of the resources assigned to that particular division/group. The division/group supervisor and the staff aide should be equipped with the appropriate protective clothing and equipment for their area of responsibility [LAFD 2011].

During NIOSH interviews with the battalion aides and battalion chiefs involved in this incident, the Fire and Rescue department did not seem to have a formal process to train battalion aides on their job duties and responsibilities.

Recommendation #12: Fire departments should ensure incident commanders maintain control of the situation status, resource status, and communications to ensure the completion of tactical objectives.

Discussion: Fireground SOPs/SOGs define the strategic goals and tactical objectives for the coordinated deployment of departmental resources for specific incidents and occupancies. SOPs/SOGs are based on factors including department staffing; deployment capabilities; training competencies; apparatus, tools, and equipment; community risk assessment and building information, including height, area, construction class, and type of occupancy; and potential life hazards.

The IC develops and communicates a strategy and tactical objectives based on the scene size-up and risk assessment. This is a process that must be made in a short period of time during a dynamic situation. Most importantly, the strategy and tactics should include an observation and/or report from all sides of the structure, especially Side Charlie [Fire and Rescue Departments of Northern Virginia 2013a]. This will ensure command can develop essential strategic, tactical, and task level functions are performed by division/group supervisors, company officers, and firefighters.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Strategic Level. This organizational level is designed around the IC and incident advisory team operating in the command mode. The strategic level identifies activities required for overall operational control. Strategic-level responsibilities include the following:

- determining the appropriate strategy: offensive or defensive
- establishing a strategic plan for the incident
- setting priorities
- obtaining and allocating resources
- predicting outcomes and planning
- assigning and communicating specific objectives to tactical-level units.

Tactical Level. The first management "subdivision" of incident scene organization is accomplished by assigning division/group responsibilities. Officers at this level are responsible for the tactical deployment of assigned resources, evaluation, and communication with the IC. The IC delegates responsibilities to them while "supervising" their work directly or by radio transmission.
When Command appoints division supervisors, one of the most critical functions of Command is to ensure the division supervisor is accountable for all resources assigned under their span of control and for coordination with Command, the operations section chief, or other supervisory personnel at the same level. The division supervisor has the following responsibilities:

- Implement and manage the division IAP, which matches IC's IAP
- Implement a risk management plan in the division
- Complete tactical priorities in the division
- Ensure positions always match conditions in the division
- Coordinate with other division supervisors as needed
- Manage the passport accountability system within the division
- Assist with division air management
- Manage work-rest cycles within the division [Blue Card 2018].

Task Level. The task level of the organization is where the work is performed by assigned companies and other resources. The strategic and tactical levels are in place to support the task level. Company officers routinely supervise task-level activities [NFPA 2014]. This process compliments the defined knowledge, skills, abilities, competencies, and fireground experience by assisting:

- The IC in planning and implementing an effective strategy and IAP
- Division/group supervisors in formulating and following tactics and maintaining accountability of assigned resources
- Company officers in successfully carrying out assigned tasks
- Individual members in effectively performing their duties [FDNY 2011; FIRESCOPE 2017].

The first arriving resource will communicate the initial on-scene report upon arrival, life safety issues, initial risk assessment, identification of water supply, deployment of hoselines and back-up hoselines, search and rescue, ventilation, identification of initial RIC(s), ground and aerial ladder placement, fire attack and extinguishment, and salvage and overhaul. Task level changes to operational priorities or responsibilities based on the above size-up should be communicated from the company officer to Command, all responding units, and the dispatch center via the assigned tactical radio channel [FDNY

2011; TSFRS 2014]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

The procedures developed for fireground operations should be flexible enough to allow for change if any of the following issues are present:

- Life hazard (must be given first priority)
- Problems with water supply and water application
- Volume and extent of fire require large caliber streams
- Location of the fire is inaccessible for hand-line operations
- Materials involved in the fire and explosion that can potentially compound the problem
- Exposure problems where further fire spread would be a major concern
- Instability of the structure, dependent on the condition of the structural components of the building, the intensity, and the duration of the fire [Brunacini 2002; ISFSI 2013].

The incident command system (ICS) provides for the systematic development of a complete, incident specific, functional command organization to increase the effectiveness of command and firefighter safety. Functional units handle the most important incident activities. As the incident grows in size and/or complexity, functional unit management is assigned to additional individuals to maintain a reasonable span of control and efficiency. The system expands and contracts organizationally based upon the needs of the incident. Span-of-control recommendations should be followed closely so that the organizational structure is not larger than required. In addition, ICs should operate from a vehicle away from the hazard zone to effectively manage and control the incident.

Recommendation #13: Fire departments should incorporate the principles of Command Safety into the incident management system during the initial assumption of command. This ensures that the strategic-level safety responsibilities are being incorporated into the command functions throughout the incident.

Discussion: The purpose of command safety is to provide ICs with the necessary resources to use, follow, and incorporate safety into the incident management system. Command safety is used as part of the eight functions of command developed by Fire Chief Alan V. Brunacini. The principles of command safety describe how ICs should use the regular, everyday command functions to complete the strategic-level safety responsibilities during incident operations. Using the command functions creates an effective way to ensure a close connection between incident safety and incident command.

The eight functions of command are:

- Deployment
- Assume, confirm, and the positioning of command
- Situation evaluation
- Strategy/incident action planning
- Communications
- Organization
- Review, evaluate, revise
- Continue, support, and terminate command [Brunacini 2002; NFPA 2014].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

A vital command function involves the IC using the initial scene size-up, knowledge of critical factors (building type, occupancy, life safety, fire conditions, and available resources), the standard risk management plan, the forecast of incident conditions, and a standardized decision-making process to select either an offensive or defensive strategy. The choice of strategy (offensive or defensive) is independent of location (inside or outside) as it relates to the hazard area or hazard zone. The strategy may change over the course of an incident, but only one of the two strategies can be used at one time [Blue Card 2018].

An offensive strategy means that personnel are actively and directly attempting to knock down and extinguish a fire. A defensive strategy occurs when the IC decides the best course of action is to contain the problem. Examples include firefighters building containment around a leak or spill or only putting water on the fire building and threatened exposures outside the hazard zone. Any change of strategy needs to be the result of deliberate defendable thought and be communicated.

The two separate strategies create a clear, *understandable* plan that describes in basic terms how close the emergency responders will handle an incident's hazards. The IC's overall strategic decision is based on the incident's critical factors weighed against the risk management plan (**See Diagram 7**).

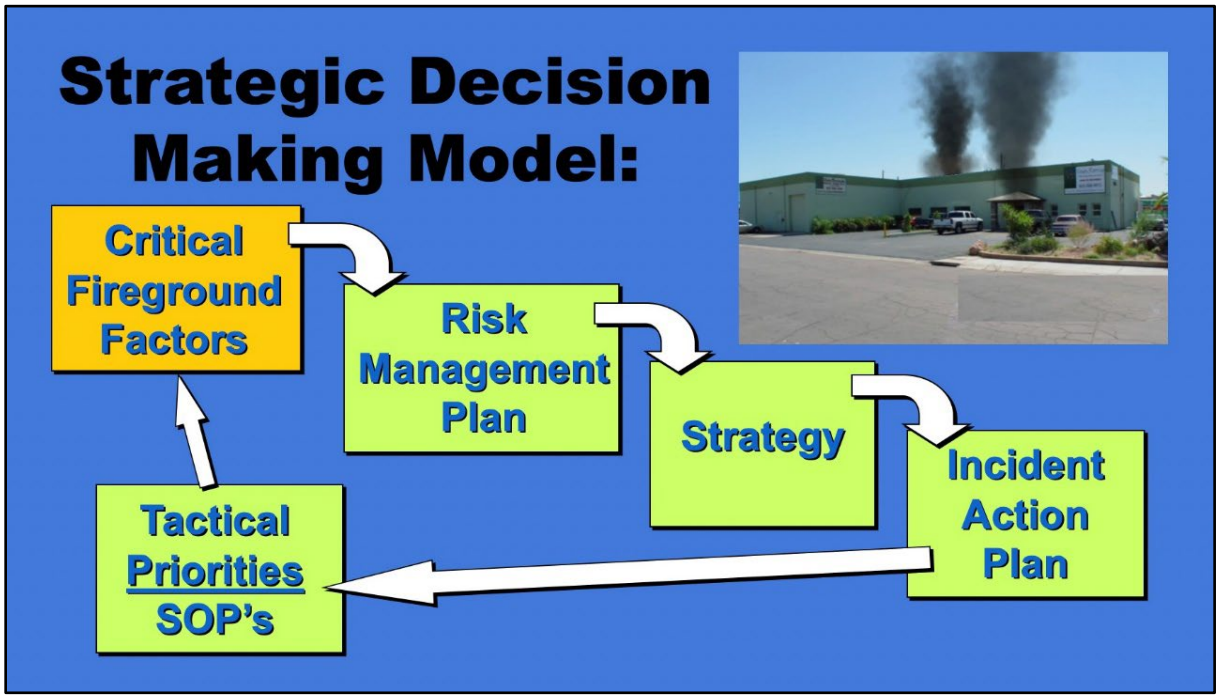


Diagram 7. This model conforms the decision-making process into a standard sequence. The incident commander identifies the incident's significant critical factors and develops a risk management plan. The incident commander then bases the strategy and incident action plan on the evaluation of those factors. This leads to the tactical priorities for the incident.
(Diagram courtesy of Blue Card.)

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Declaring the incident strategy up front, as part of the initial radio report will:

- Announce to everybody the overall incident strategy
- Eliminate any question on where firefighters will be operating on the incident scene inside the structure [Blue Card 2018].

Offensive and defensive strategies should not be combined.

Once the overall incident strategy has been determined and the IAP developed, the IC should manage the completion of the tactical priorities for the chosen strategy. Each strategy has a different set of tactical priorities to complete. Tactical priorities provide the IC with a simple, short list of major categories that are designed to act as a practical guideline during the difficult initial stages of fireground planning. The IAP should be short and simple. A complicated IAP tends to break down during this critical time.

Generally, the IC tries to achieve the same basic objectives from one incident to the next. Tactical priorities offer a regular set of tools to develop a standard approach to solve incident problems. With this standard approach, ICs can manage the basic work sequence at every incident in the same manner.

Recommendation 14: Fire departments should review and/or develop SOG/SOP to ensure that water supply is established during initial fireground operations, particularly in areas with limited or no hydrants.

Discussion: The establishment of a water supply at a fireground is a critical operations benchmark. In areas with limited or no hydrants, a comprehensive preplanning process is needed. This process may include information on map book pages, case notes, or comments on the dispatch to a defined address. For non-hydrant areas, this preplan information should be assembled in a water supply preplan book and sent (electronically or by hard copy) to applicable engine and tanker/tender companies. In addition, this information should be shared with automatic aid and mutual companies [Fire and Rescue Departments of Northern Virginia 2019].

While enroute to the fire, the first-arriving engine officer should initiate the incident's water supply plan. Using area preplans, the officer can designate dump sites, fill sites for the shuttle operation, or relay positions for in-coming units. Upon arrival, the first-arriving officer's scene size-up and risk assessment should include an estimate on the fire flow requirements on the anticipated water supply. This information allows the development of an appropriate IAP and dictates whether an offensive operation is appropriate. The first-arriving officer should then communicate the IAP to all responding resources and dispatch.

It is vital that an adequate water supply is maintained throughout the incident. ICs should reassess the water supply regardless of whether the incident is served by fire hydrants or requires a rural water supply [Fire and Rescue Departments of Northern Virginia 2019]. When water requirements exceed the amount available from nearby hydrants or the amount of water carried by the 1st alarm apparatus, a water supply group and water supply group supervisor should be designated. All units in the water supply group will be under the management of the water supply group supervisor. The water supply

group supervisor is the individual responsible for resourcing adequate water supplies required to implement the tactics outlined by the IC [FCFCA 2015].

At this incident, the county's Communications Center did not dispatch a Tanker/Tender Task Force for Box 5-62, despite the structure being in an area with limited fire hydrants. BC1 recognized there was a swimming pool on Side Charlie and while enroute ordered E51 to use the swimming pool as a water source during initial fireground operations. As a result, the first two arriving engines did not lay a supply line as they arrived on scene. Subsequent efforts by Command to address the water supply issue distracted Command from command and control of fireground operations.

Recommendation #15: Fire departments should ensure adequate staffing and deployment of resources based on the community's risk assessment.

Discussion: Fire departments should implement deployment strategies to ensure that adequate resources are on scene to conduct fire suppression operations for the likely hazards within their jurisdiction. These deployment strategies should involve a comprehensive assessment of risk within the community and consider factors such as service demands on the department, demographics, socioeconomics, building and occupancy types, and other elements that can help to identify the likelihood of fire. Fire departments also should consider obstacles that firefighters will encounter during firefighting operations, such as, potential life safety issues, fire suppression systems, building location (accessibility), and water supply issues. The first arriving resource needs to determine the structure size which is considered when implementing a strategy for an incident. This information should be transmitted to the dispatch center and all responding resources as part of the preliminary size-up report.

In 1984, results of the *Dallas Fire Department Staffing Level Study* were published and the 91 various simulations that were conducted indicated that inadequate staffing results in the following problems:

- Delays in the performance of critical tasks
- Increased risk to victims because of the length of delays is increased, the likelihood of survival decreases
- Loss of critical functions
- A cumulative effect created by combined delays and the lost functions on the part of each crew resulting in an even greater loss of overall effectiveness
- Increased physiological stress on firefighters as they try and compensate for the lower staffing level
- Increased risk to the firefighter when aggressive procedures are undertaken without the support to complete them safely [McManis Associates et al. 1984] (**See Table 2**).

Insufficient numbers of emergency response units or inadequate staffing levels on those units exposes civilians and firefighters to increased risk. It also drains already limited fire department resources and stresses the emergency response system by requiring additional apparatus to respond from further distances. Failing to assemble enough resources on the scene of a fire in time to stop the spread and extinguish the fire, conduct a search, and rescue any trapped occupants puts responding firefighters and occupants in a dangerous environment [Averill JD, et al., 2010; 2013].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

If the available staffing and deployment are insufficient for the situation encountered, the risk assessment should steer the initial strategy toward focusing on primary search and deploying at least a single hose line to protect the firefighters assigned to a primary search. Prior to having the resources for this approach, incident commanders should consider a defensive position until additional resources arrive. During this time, the fire will continue to grow and have negative effects on the structural integrity of the building, making an offensive attack much less desirable and certainly more dangerous.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* requires a minimum full alarm assignment of 14 firefighters and 1 command officer, for a total of 15 members on the scene of a residential structure fire in a typical 2,000-foot, two-story single-family dwelling without a basement and with no exposures within 8 minutes of travel time [NFPA 2016a]. If an aerial or platform is in operation, 17 members are required. This staffing allows for one attack line to be placed in operation on the 1st floor or 2nd floor, with one back-up line, one search and rescue crew (3 firefighters), one ventilation crew (2 firefighters), and a 2-member RIC.

However, best practices suggest that residential structures that exceed these characteristics, but do not fit a high-rise or high-hazard occupancy, should receive a minimum full-alarm assignment of 26 firefighters, one command officer, and one incident command technician, for a total of 28 personnel on the scene of a structure fire within 8 minutes of travel time [NFPA 2016a]. This staffing allows for two attack hoselines to be stretched to an upper floor, one back-up hoseline, at least two search and rescue crews, one interior forcible entry/ventilation crew, one exterior ventilation crew (2-3 firefighters), and a four-person RIC.

NFPA 1710 also requires staffing of engine companies and truck companies with a minimum of four on-duty personnel. Match resources to service demands and risk, the standard also states that companies shall have a minimum of five on-duty members in jurisdictions with high numbers of incidents, or six on-duty members in jurisdictions with tactical hazards, high-hazard occupancies, or dense urban areas as identified by the authority having jurisdiction (AHJ) [NFPA 2016a].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

	Engine Company	Ladder/Truck Company
Unit Effectiveness	With a firefighter functioning as a pump operator for an engine or pumper, only two members are available to position attack line. This is almost impossible if the fire is in the rear of a building or on an upper floor of a building. This is much easier with a third firefighter's help to stretch the hoseline.	With a firefighter functioning as the aerial operator to position the aerial, * this leaves only two members to preform "forcible entry" and form a single 2-person search and rescue team. * A tower ladder requires two firefighters. One firefighter to operate the bucket and one firefighter to operate the platform.
Flexibility	Depending on the circumstances, the 4th firefighter can hook-up the supply line to the hydrant or act as forcible entry when the engine company arrives on scene first.	If all three members enter the building that only allows for a single "search and rescue team" since members cannot operate alone. If four members enter the building, they can form two teams.
Assigning a company officer as a Division/Group Supervisor	Using the company officer as a division/group supervisor either makes the division/ group ineffective or leaves the engine company with one firefighter operating by themselves. The incident commander should consider combining companies to increase company staffing and enhance crew integrity and personnel accountability.	Using the company officer as a division/group supervisor either makes the division/ group ineffective or leaves the ladder/truck company with one firefighter operating by themselves. The incident commander should consider combining companies to increase company staffing and enhance crew integrity and personnel accountability.

Table 2: The impact of decreasing company staffing from 1 officer and 3 firefighters to 1 officer and 2 firefighters.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

The effectiveness when increasing staffing per company from three firefighters to four firefighters was more pronounced when measured for a larger building than the one assumed by NFPA 1710 that was used to justify a 15-member response in 8 minutes [NFPA 2016a] (**See Diagram 8**). The community served by the fire department in this investigation was comprised of buildings with basements, close exposures, and more than two floors, indicating that the increase in efficiency would be greater than that calculated by National Institute for Standards and Technology (NIST) for smaller structures [Averill et al. 2010].

At the scene of a structure fire, the driver/operator of the first engine company on the scene must remain with the apparatus to operate the pump. This leaves one firefighter to assist the operator in securing a water source from a hydrant and two firefighters to deploy a hoseline and stretch it to the fire. After assisting the operator, the third firefighter should begin to assist the other two firefighters with advancing the hoseline into the building and to the location of the fire. Before initiating firefighting operations, the officer of the first arriving engine company conducts a complete 360-degree walk around of the structure to assess the situation, determines the extent of the fire, requests any additional resources, and assumes Command [NFPA 2016a]. The driver/operator of the first arriving ladder company must remain with the apparatus to operate and position the aerial device, while the other three firefighters perform critical fireground tasks, such as ventilation and search and rescue.

The initial full alarm assignment to a single-family dwelling structure fire in a typical 2000 square foot, two-story single-family dwelling without basement and with no exposures shall provide for the following:

- Establishment of incident command outside of the hazard area for the overall coordination and direction of the initial full alarm assignment with a minimum of one member dedicated to this task
- Establishment of an uninterrupted water supply of a minimum of 400 gallons per minute (GPM) for 30 minutes with supply line(s) maintained by an operator
- Establishment of an effective water flow application rate of 300 gpm from two hoselines, each of which has a minimum flow rate of 100 gpm with each hoseline operated by a minimum of two members to effectively and safely hoseline maintain the line
- Provision of one support member for each attack and backup line deployed to provide hydrant hookup and to assist in laying of hoselines, utility control, and forcible entry
- Provision of at least one victim search and rescue team with each such team consisting of a minimum of two members
- Provision of at least one team, consisting of a minimum of two members, to raise ground ladders and perform ventilation
- If an aerial device is used in operations, one member to function as an aerial operator to maintain primary control of the aerial device at all times
- Establishment of a RIC consisting of a minimum of two properly equipped and trained members [NFPA 2016a].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

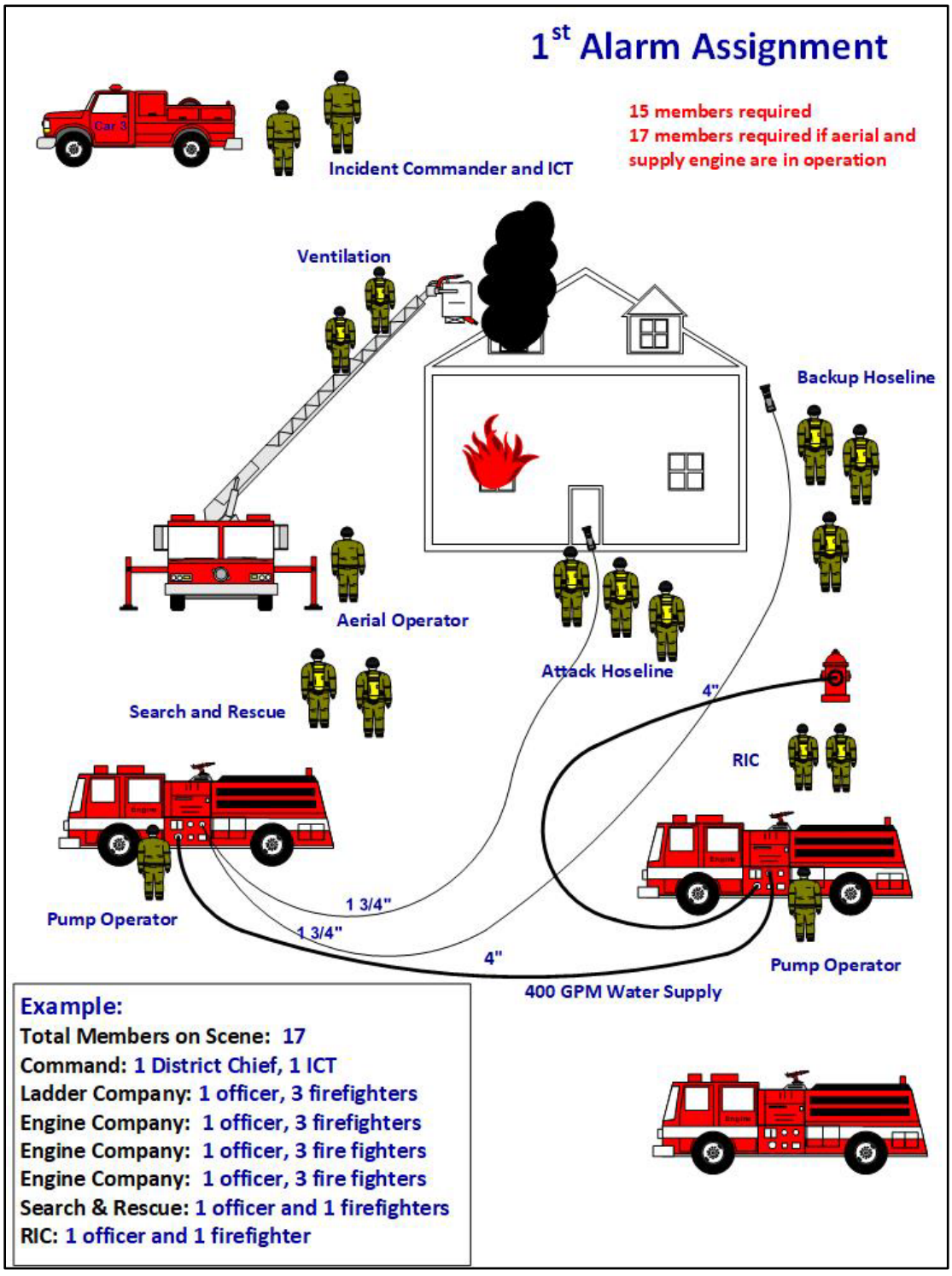


Diagram 8: Initial full alarm assignment for a 2,000 square-foot, two-story single-family dwelling capability deployed within 8 minutes per NFPA 1710.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

There can be incidents or areas where the response criteria are affected by circumstances such as response personnel who are not on duty, unstaffed fire station facilities, natural barriers, traffic congestion, insufficient water supply, and density of the population or property. The reduced level of service should be documented in the written organizational statement by the percentage of incidents and geographical areas for which the total response time criteria are achieved.

The evaluation of the fire department's provided level of service needs to be measured against the authority having jurisdiction's (AHJ) established service delivery performance objectives. These objectives should be based on a jurisdictional risk assessment and established based on a 2000-square foot two-story, single-family home without a basement and having no exposures. The AHJ's response objectives should account for numerous factors such as the circumstances affecting response personnel, adopted building codes, required fire/life safety-related engineering controls, accepted turnout/travel times, complexity of facilities, and occupancy hazards within the jurisdiction [NFPA 2016a].

NFPA 1710 requires the following:

- **4.1.2.5.1*** The fire department shall evaluate its level of service and deployment delivery and alarm handling time, turnout time, and travel time objectives on an annual basis.
- ***A.4.1.2.5.1*** The evaluation of a fire department's provided level of service needs to be performed against the AHJ established service delivery performance objectives. These objectives should be based on a jurisdictional risk assessment. The objectives established within this standard are based on a 2000-square foot (186 m2), two-story, single-family home without a basement and having no exposures. The AHJ's response objectives should be established based on numerous factors such as the circumstances affecting response personnel, adopted building codes, required fire/life safety-related engineering controls, accepted turnout/travel times, complexity of facilities, and occupancy hazards within the jurisdiction. ***Note:*** *The Annex material is provided for information purposes and is not a requirement of the standard.*
- **4.1.2.5.2*** The evaluations shall be based on emergency incident data relating to level of service, deployment, and the achievement of each time objective in each geographic area within the jurisdiction of the fire department.
- ***A.4.1.2.5.2*** The collection of data is required to determine the organization's ability to meet its locally determined objectives and the performance objectives contained in the standard with regard to emergency incidences (warning lights and sirens). Organizations respond to numerous types of emergency and nonemergency incidents. While the collection and analysis of all of the response data is important, attainment of the 90 percent objective is only to be evaluated against emergency incident responses. ***Note:*** *The Annex material is provided for information purposes and is not a requirement of the standard.*
- **4.1.2.6** The fire department shall provide the AHJ with a written report annually.
- **4.1.2.6.1** The annual report shall define the geographic areas and/or circumstances in which the requirements of this standard are not being met.
- **4.1.2.6.2** The annual report shall explain the predictable consequences of these deficiencies and address the steps that are necessary to achieve compliance.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

At this incident, the initial dispatch was for two engine companies, one truck company, one medic unit and one battalion chief. The total staffing for response to Box 5-62 was 14 members, who were responding to an 8,400 square foot structure in an area with limited water supply. Based upon the deployment model for a high risk, large area residential occupancy, the minimum response should have been four engine companies with a staffing of four, two trucks with a staffing of four, one medic with staffing of two, a tanker task force with three tankers with a staffing of two each, and two battalion chiefs with a staffing of two each.

Recommendation #16: Fire departments should periodically review and, if necessary, revise their SOP/SOG on the deployment of rapid intervention crews (RICs).

Discussion: To ensure compliance with 29 CFR 1910.134 *Respiratory Protection* [OSHA 1998], fire departments must maintain a RIC when members are operating in an immediately dangerous to life and health (IDLH) or potentially IDLH atmosphere [NFPA 2018c]. In some organizations, the crew is known as a rapid intervention team (RIT), or a firefighter assist and search team (FAST).

The RIC function should be incorporated into the department's incident management system and personnel accountability system [NFPA 2014]. The needs of critical fireground operations and staffing should be continuously evaluated regarding firefighter safety. Resource assignments should always be made with the goal of having the RIC function in place. When ICs need additional resources, the consideration of deploying the RIC for an operational assignment without additional resources on-scene to function as the RIC should be carefully assessed [NFPA 2014].

The following restrictions regarding the use of RIC should be considered by the IC during fireground operations:

- The RIC should not be used for firefighting operations until another company is on-scene to operate as the RIC
- The RIC is dedicated to assist and, if necessary, rescue members who become lost, trapped, distressed, or involved in other serious life-threatening situations
- The RIC should not be used to provide relief for operating companies until the fire/incident has been declared "under control" by Command
- If a RIC unit officer is assigned to other duties by a superior officer, the RIC unit officer should remind such officer of RIC designation [Toledo Fire & Rescue Department 2012; TSFRS 2014].

When ICs order the RIC to work, the IC should immediately assign another on-scene company to stand by as the RIC. At a minimum, ICs should request an additional alarm and designate a company or companies to function as the RIC. The remainder of the companies should report to staging. If no units are available, the IC should assign at least two members to act as a RIC while awaiting a special-called RIC to arrive. An engine company may be designated as the RIC pending arrival of an additional ladder company or rescue company. This ensures compliance with OSHA's "2 In/2 Out" rule under 29 CFR 1910.134, *Respiratory Protection* [OSHA 1998].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Many fire departments have a defined response plan for the dispatch of an additional company (engine, truck, squad, rescue, and/or command officer) to respond to an incident and stand by as the RIC. Based upon the complexity, magnitude, configuration of the structure or geographical layout of the incident, the IC may deploy an additional RIC/FAST by location or function [NFPA 2014].

The RIC officer/rescue group supervisor and RIC members/rescue group members will coordinate with Command to formulate rescue plan contingencies and continue to monitor the radio and fireground conditions. The RIC process is not a passive assignment. This is a process of ongoing information gathering and diligent scene monitoring until the unit is released by the IC. The RIC function is a critical component for firefighter safety.

To ensure that firefighters and fire officers are properly trained to conduct RIC operations, they should meet the requirements of NFPA 1407, *Standard for Training Fire Service Rapid Intervention Crews* [NFPA 2015a].

Recommendation #17: Fire departments should use resources from the National Institute of Standards and Technology (NIST), Underwriter's Laboratories (UL) Fire Fighter Safety Research Institute (FSRI), and the International Society of Fire Service Instructors (ISFSI) to develop and revise operational procedures on fireground tactics and provide training in fire dynamics in structures for all firefighting staff.

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 are 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 varying building designs 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 due to the increased flow of fire, heat, and smoke toward their position. 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 to attack the fire from the upwind side [FDNY 2013].

Firefighters need to be aware and understand that the critical first step in evaluating the potential for a wind-impacted fire is recognition of any smoke movement in the flow path, wind speed, smoke being forced under doors, and/or pulsing smoke or fire. The IC and company officers must be notified immediately when any of these conditions are observed. The communication of this critical information to the IC and company officers operating inside the building must be acknowledged.

Since the widespread use of bunker gear and SCBA, fire suppression operations were sometimes conducted from the interior of the structure under the assumption that this would reduce water damage and limit fire damage to structures. These operations 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 is 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. A repeated objection to this tactic was based on the belief that harm might occur to people trapped in the structure or the amount of water damage to the structure. Structural integrity can be lost in less than 5 minutes once the floor assembly becomes involved in fire [Zevotek et al. 2018].

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. 2018].

The challenges and tactical considerations from basement fires have also been studied by NIST, the UL Fire Safety Research Institute (FSRI), and the International Society of Fire Service Instructors (ISFSI) [Kerber et al. 2012; Madrzykowski 2013; Madrzykowski and Weinschenk 2018]. Many firefighters have been injured or killed while trying to extinguish a below-grade fire. Prior research has shown below-grade fires present a high risk to firefighters. This risk stems from unexpected floor collapse and high heat. Prior research also indicated the tools that firefighters have traditionally used to

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

determine the structural integrity of the floor such as thermal imagers and sounding the floor for stability are unreliable and therefore should be combined with other tactics to increase safety.

The key points are:

- Size-up is critical
- Below-grade fires are likely to be ventilation-limited
- Coordinating ventilation with water application is required to limit the growth of a ventilation-limited fire
- Water application in the below-grade space is key to smoke cooling
- Effective water application into below-grade space reduces the hazard throughout the structure
- Options exist to make a coordinated and effective attack
- It is best to fight the fire on its own level.

The FSRI and ISFSI study extended earlier research by increasing the size of the basement and incorporating three different ventilation and access conditions to the basement [Madrzykowski and Weinschenk 2018]. Those access conditions include no exterior access to the basement, limited exterior access to the basement, and exterior access to the basement. The results of the experiments showed the importance of identifying a basement fire, controlling ventilation, and flowing an effective hose stream into the basement from a position of advantage as soon as possible.

The basement experiments highlighted the importance of identifying a basement fire during size-up and subsequently choosing the appropriate tactics to coordinate ventilation with suppression. In all experiments, the basement fires were ventilation limited. Additional ventilation without suppression was shown to increase the hazard to any occupants trapped in the structure. Various nozzles and appliances (Bresnan distributors, piercing nozzles, and cellar nozzles) were used to flow water into the basement. Water streams applied through the floor, through a small window remote from the seat of the fire, and through a basement level access door controlled the fire and reduced the hazard throughout the structure.

Effective water application into the basement cooled the fire gases to prevent flashover, slowed the destruction of the structure and the floor assembly, and reduced the hazard from fire. This made it possible for a fully protected firefighter to enter the basement. Effective water application also supported search operations and reduced the threat from heat and toxic gases for any trapped occupants [Madrzykowski 2013].

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.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

- **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].

This information is presented to educate the fire service and to ensure that fire departments 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 fire behavior and providing the fire service with the knowledge needed to modify essential fire-fighting tactics. While firefighting will never be without risk, this research represents a vital contribution to overall efforts to reduce risks and to save lives.

Although there is no evidence that the following recommendations (Recommendations 18-21) would have prevented this fatality, they are being provided as a reminder of best safety practice for the fire service.

Recommendation 18: Fire departments should consider having all members carry a wire cutting tool.

Discussion: While there are varying opinions related to the type of wire cutters to use and the location to carry them, most will agree that whatever type carried, they should be capable of cutting through common types of wires and conduit found in residential and commercial structures. “Cable Cutters” are recommended because they have shown to be the best combination of cutting ability and ease of use. The size and shape of the Cable Cutter’s blade helps prevent the tool from slipping off the material during a cut (**See Photo 4**).

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Photo 4. An example of a pair of wire cutters useful to firefighters during firefighting operations.
(***NIOSH Photo***)

Wire cutters can help free firefighters that have become entangled in a variety of wires such as cable television wires, plastic air conditioning duct work coiled wire, and suspended ceiling wire supports. The utility of the tool becomes readily apparent to any firefighter in an entanglement training prop.

The ideal location to carry wire cutters is a pocket accessible by either hand. In the past, the radio chest pocket found on most turnout coats was an excellent location. However, as radios have decreased in size, the radio pocket has also become smaller. Storing cutters in the smaller pocket can result in the handles of the cutters being exposed and becoming an entanglement hazard themselves. If a chest pocket is not a viable option, the next best location is a pocket accessible to the dominant hand. In our experience the chest/radio pocket is the best option, especially if you wear a radio strap.

In this incident, it is unclear if E101B was entangled in wires or if a pair of wire cutters could have allowed a self-rescue. However, as a member of the RIC, the captain of Engine 71 had a pair of wire cutters. He used the wire cutters to untangle other members of the rapid intervention group who became tangled in loose wires in the crawlspace.

Recommendation #19: Fire departments should ensure that all members engaged in emergency operations receive annual proficiency training and evaluation on fireground operations, including live fire training. This training should be conducted with automatic aid and mutual aid fire departments.

Discussion: To ensure the proficiency and competency of fire department members, fire departments should conduct annual skills evaluation to verify minimum professional qualifications. This evaluation should address the qualifications specific to the member's assignment and job description with the goals of preventing skills and abilities degradation and ensuring the safety of members. Proficiency evaluation and training provides an opportunity to ensure that all fire officers and firefighters are competent in fireground operation knowledge, skills, and abilities. This process should include annual live fire training.

NFPA 1500, *Standard for a Fire Department Occupational Safety, Health, and Wellness Program,* requires a fire department to establish and maintain a training, education, and professional development program with the goal of preventing occupational deaths, injuries, and illnesses [NFPA 2018c]. This ensures members are trained and competencies are maintained in order to execute all responsibilities effectively, efficiently, and safely. This process is consistent with the organizational

statement that establishes the existence of the fire department, the services the fire department is authorized and expected to perform, the organizational structure, and the job descriptions and functions of fire department members [NFPA 2018c].

As members progress through various job duties and responsibilities, the department should ensure they have necessary knowledge, skills, abilities, and are able to demonstrate competencies for the defined position. The training and education process should also ensure the ongoing development of existing skills [NFPA 2018c].

NFPA 1410, *Standard on Training for Initial Emergency Scene Operations*, defines basic evolutions that can be adapted to local conditions and serves as a method for the evaluation of minimum acceptable job performance during initial fireground operations [NFPA 2020]. Proficiency training for fireground operations and emergency incidents should be conducted annually. This training should include scene size-up, situational awareness, use of the incident management system, personnel accountability system, strategy and tactics, search and rescue, hoseline operations, ladder operations, ventilation, thermal imaging cameras, fireground communications, use of RICs, and Mayday operations.

Recommendation #20: Fire departments should ensure adequate incident scene rehabilitation is established in accordance with NFPA 1584, Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises.

Discussion: NFPA 1584, *Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises* establishes the minimum criteria for developing and implementing a rehabilitation process for fire department members at incident scene operations and training exercises while operating within an incident management system [NFPA 2022] The physical and mental condition of personnel should be monitored as part of the overall assessment. This ensures a firefighter's health does not deteriorate to the point it affects the safety of themselves or other firefighters or endangers the safety and integrity of the operation. ICs should consider the circumstances of each incident and make suitable provisions for rest and rehabilitation for personnel. This process should include medical evaluation and treatment, food and fluid replenishment, and rest and relief from extreme climatic conditions.

NFPA 1584 states that an IC should establish rehabilitation operations when emergency operations pose a safety or health risk to firefighters and other responders. Rehabilitation operations should be provided in accordance with fire department SOPs, NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* and NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2014; NFPA 2018a, NFPA 2022].

Incident scene rehabilitation ("Rehab") is a term often used for the care given to firefighters and other responders while performing their duties at an emergency scene. When the size of the operation or geographic barriers limit member's access to the rehabilitation area, the IC should establish more than one rehabilitation area. The site should be far enough from the effects of the operation that members can safely remove their personal protective equipment and can be afforded physical and mental rest

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

[USFA 2008]. Once "Rehab" area(s) have been established, this information must be communicated over the radio, so all members know the location of "Rehab" or know where to report when assigned to "Rehab."

Several considerations for rehabilitation sites are as follows:

- Should be in a location that will provide physical rest by allowing the body to recuperate from the demands and hazards of the emergency or training evolution
- Should be far enough away from the scene that personnel may safely remove their turnout gear and SCBA and be afforded physical and mental rest from the stress and pressure of the emergency or training evolution. Provisions should be available to have SCBA cylinders refilled
- Should provide suitable protection from the prevailing environmental conditions. During hot weather it should be in a cool, shaded area, and during cold weather it should be in a warm, dry area
- Should enable personnel to be free of exhaust fumes and noise from apparatus, vehicles, or equipment, including those involved in the rehabilitation group operations
- Should be large enough to accommodate multiple crews based on the size of the incident
- Should be easily accessible by emergency medical service units
- Should allow prompt re-entry back into the emergency operation upon complete recuperation
- Crews assigned to rehab will be instructed to turn portable radios off and/or have radio and thermal imager portable batteries recharged or exchanged [USFA 2008] (**See Diagram 9**).

The Rehab Group supervisor should secure all necessary resources required to adequately staff and supply the rehabilitation area. The supplies should include the following items:

- Fluids: water, activity beverage, oral electrolyte solutions, and ice
- Food that is easy to prepare and serve:
    - soup, broth, or stew in cold weather
    - sandwiches, energy bars, or fruit in hot weather
- Medical devices: blood pressure cuffs, stethoscopes, oxygen administration devices, cardiac monitors, intravenous solutions, and thermometers
- Other: awnings, fans, tarps, fans, heaters, dry clothing, extra equipment, floodlights, blankets and towels, traffic cones, and fire line tape (to identify the entrance and exit of the rehabilitation area)
- Hygiene facilities to decontaminate all exposed skin surfaces
- Restroom facilities [USFA 2008].

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

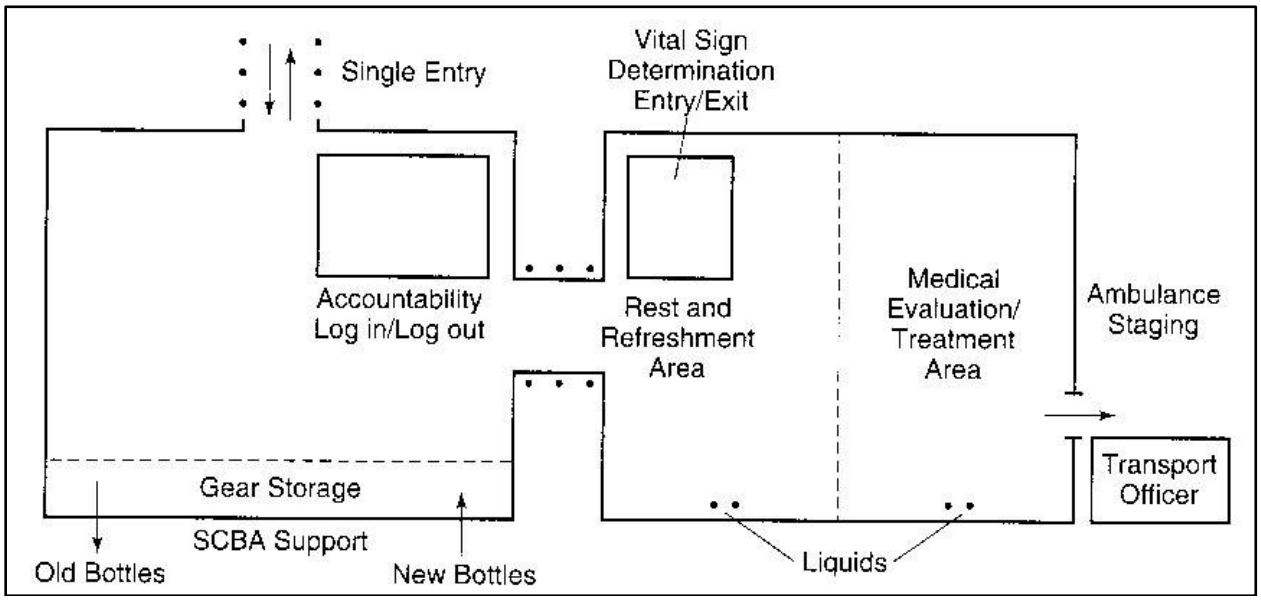


Diagram 9. An example of how a "Rehab" area can be organized. There are many ways to establish an effective "Rehab" area.
(*Diagram courtesy of the United States Fire Administration.*)

At this incident, informal rehab was located on Side Charlie near the swimming pool. On-scene rehabilitation for responding personnel was established late in the incident. The Communications Center requested a canteen at 0222 hours and then again at 0410 hours but did not receive a response.

The rehabilitation area on Side Charlie was only supplied with drinking fluid from the suppression apparatus, which ran out quickly. Personnel from the county's Department of Police were able to purchase water, sports drinks, and snacks from a convenience store at approximately 0500 hours and deliver the supplies to the incident scene.

Working fireground incidents need a rehab area. The rest and refreshment area can help firefighters rest and recover. The evaluation and treatment area can screen, treat, and transport injured firefighters.

Recommendation 21: Fire Departments should consider a radio protocol that identifies the unit they are calling first (receiver), then identifies themselves (sender).

Discussion: Many national organizations have adopted the military protocol format for effective radio communications. In this protocol the sender states the intended receiver's radio designation first and then follows with the sender's designation.

Getting the receiver's attention upfront in the message may prevent the receiver from requesting a repeat or missing the message. Saying the receiver's attention upfront in the message, the receiver is less likely to reply. Remember that the amount of radio traffic during responses is generally high and

firefighters typically listen for their own radio designation before "tuning in" to radio traffic. This methodology reduces confusion and preserves airtime for more important messages [NIMSC 2010].

The *Order Model* outlines the communications steps we follow to ensure messages are always received and understood despite the rushed, confusing and dangerous conditions we typically face during operations [IAFC and NFPA 2015]. The order model also standardizes how the incident's participants will exchange two-way radio communications. The *Order Model's* required steps are:

- When the sender is ready to transmit a message, they call the receiver to determine if they are ready to receive the message
- The receiver then acknowledges the sender
- When the sender receives the readiness reply, they can transmit the message
- The receiver then gives a brief restatement of the message to acknowledge the receipt of the message
- The sender restates the message if misunderstood [Blue Card 2018].

Using the *Order Model* will significantly decrease the amount of radio traffic on the emergency scene. It will also help reduce order confusion and enhance responder safety and accountability.

References

Abbott D [2016]. The Mayday Project. Firehouse. February 1, 2016. Date accessed: November 17, 2022.

Averill JD, Moore-Merrell L, Barowy AM, Santos R, Peacock RD, Notarianni K, Wissoker D [2010]. Report on Residential Fireground Field Experiments. NIST Technical Note 1661. Gaithersburg, MD: National Institute of Standards and Technology. Date accessed: October 31, 2022.

Averill JD, Moore-Merrell L, Ranellone RT Jr, Weinschenk CG, Taylor N, Goldstein R, Santos R, Wissoker D, Notarianni K, Butler KM [2013]. Report on High-Rise Fireground Field Experiments. NIST Technical Note 1797. Gaithersburg, MD: National Institute of Standards and Technology. Date accessed: October 31, 2022.

Blue Card [2018]. Blue card command SOPS. Phoenix, AZ: BShifter. Date accessed: October 31, 2022.

Brunacini AV [2002]. Fire command: The Essentials of Local IMS. Quincy, MA: National Fire Protection Association.

Brunacini AV, Brunacini N [2004]. Command safety: The IC's Role in Protecting Firefighters. Phoenix, AZ: Across the Street Publications.

FCFCA [2018]. Franklin County Fire Chiefs Association, Standard Operating Guideline, Rural water supply operations—water supply officer. Greenville, MA: Franklin Regional Council of Governments. Date accessed: October 31, 2022.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

FDNY [2011]. Critical information dispatch system (CIDS). In: Communications manual. New York, NY: Fire Department of New York.

FDNY [2013]. Wind impacted fires in fireproof multiple dwellings, Addendum 3. Firefighting procedures. Volume 1. New York, NY: Fire Department of New York.

FIRESCOPE [2017]. Field Operations Guide (FOG), ICS 420-1. Riverside, CA: FIRESCOPE. Date accessed: October 31, 2022.

Fire and Rescue Departments of Northern Virginia [2013a]. Command officer operations. Fire and Rescue Departments of Northern Virginia, Firefighting and emergency operations manual. 3rd ed. Fairfax County, VA: Fire and Rescue Departments of Northern Virginia. Date accessed: October 31, 2022.

Fire and Rescue Departments of Northern Virginia [2013b]. Engine company operations. Fire and Rescue Departments of Northern Virginia, Firefighting and emergency operations manual. 2nd ed. Fairfax County, VA: Fire and Rescue Departments of Northern Virginia. Date accessed: October 31, 2022.

Fire and Rescue Departments of Northern Virginia [2019]. Water supply for suburban and rural firefighting. Fire and Rescue Departments of Northern Virginia, Firefighting and emergency operations manual. 5th Edition. Fairfax, VA. The Northern Virginia Fire Operations Board. Date accessed: October 31, 2022.

Harms T. [2010]. Using tactical worksheets. Fire Rescue Magazine 4(5). Date accessed: October 31, 2022.

IAFC [2012]. Rules of Engagement for Structural Firefighting. Fairfax, VA: International Association of Fire Chiefs.

IAFC and NFPA [2015]. Fire Officer: Principles and Practice. Chapter 4: Fire Officer Communications (Fire Officer I). 3rd Edition. Burlington, MA: Jones & Bartlett Learning LLC. Date accessed: November 15, 2022.

IAFF [2010]. Fire Ground (FG) Survival Training. Washington, DC: International Association of Fire Fighters. Date accessed: November 15, 2022.

ISFSI [2013]. ISFSI Position statement—Fire dynamic research in tactical operations. Stillwater, OK: International Society of Fire Service Instructors. Date accessed: October 31, 2022.

Kerber S [2012]. Analysis of changing residential fire dynamics and its implications on firefighter operational timeframes. Fire Technology 48:865-891.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Kerber S, Madrzykowski D, Dalton J, Backstrom B [2012]. Improving fire safety by understanding the fire performance of engineered floor systems and providing the fire service with information with tactical decision making. Northbrook, IL: Underwriters Laboratories. Date accessed: October 31, 2022.

Layman L [1953]. Firefighting tactics. Boston, MA: National Fire Protection Association.

LAFD [2011]. Los Angeles Fire Department command post training. Los Angeles, CA: Los Angeles Fire Department.

McManis Associates, John T. O'Hagan and Associates [1984]. Dallas fire department staffing level study. Dallas, TX.

Maryland OSHA [2002]. Maryland *Fire Service Health and Safety Consensus Standards*. Annapolis, MD: Department of Labor, Licensing, and Regulations, State of Maryland. Date accessed: October 31, 2022.

Madrzykowski D, Kent J [2011]. Examination of the thermal conditions of a wood floor assembly above a compartment fire. Gaithersburg, MD: National Institute of Standards and Technology, NIST Technical Note 1709. Date accessed: October 31, 2022.

Madrzykowski D [2013]. Fire dynamics: The science of firefighting. International Fire Service Journal of Leadership and Management 7:7-15. Date accessed: October 31, 2022.

Madrzykowski D and Weinschenk C [2018]. Understanding and fighting basement fires. Columbia, MD: Underwriters Laboratories, Fire Fighter Safety Research Institute. Date accessed: October 31, 2022.

Motorola [2014]. Motorola Solutions, Inc, APX 6000XE Model 1 User Guide. Schaumburg, Il. Motorola Solutions, Inc.

NFA [2009]. Health and safety officer course (HSO). Emmitsburg, MD: Federal Emergency Management Agency, United States Fire Administration, National Fire Academy.

NFPA [2013a]. NFPA 1001, Standard for fire fighter professional qualifications. Quincy, MA: National Fire Protection Association.

NFPA [2013b], NFPA 1981, Standard on open-circuit self-contained breathing apparatus (SCBA) for emergency services. Quincy, MA: National Fire Protection Association.

NFPA [2013c]. NFPA 1989, Standard on breathing air quality for emergency services respiratory protection. Quincy, MA: National Fire Protection Association.

NFPA [2014]. NFPA 1561, Standard on emergency services incident management system and command safety. Quincy, MA: National Fire Protection Association.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

NFPA [2015a]. NFPA 1407, Standard for training fire service rapid intervention crews. Quincy, MA: National Fire Protection Association.

NFPA [2016a]. NFPA 1710, Standard for the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments. Quincy, MA: National Fire Protection Association.

NFPA [2016b]. NFPA 1901, Standard for automotive fire apparatus. Quincy, MA: National Fire Protection Association.

NFPA [2017]. NFPA 1911, Standard for the inspection, maintenance, testing, and retirement of in-service emergency vehicles. Quincy, MA: National Fire Protection Association.

NPFA [2018a]. NFPA 1582, Standard on comprehension occupational medical program for fire departments. Quincy, MA: National Fire Protection Association.

[NFPA 2018b]. NFPA 1971, Standard on protective ensembles for structural firefighting and proximity firefighting. Quincy, MA: National Fire Protection Association.

NFPA [2018c]. NFPA 1500, Standard on fire department occupational safety, health, and wellness program. Quincy, MA: National Fire Protection Association.

NFPA [2020]. NFPA 1410, Standard on Training for Initial Emergency Scene Operations. Quincy, MA: National Fire Protection Association.

NFPA [2021]. NFPA 1801, Standard on Two-Way, Portable RF Voice Communications Devices for Use by Emergency Services Personnel in the Hazard Zone. Quincy, MA: National Fire Protection Association.

NFPA [2022]. NFPA 1584, Standard on the rehabilitation process for members during emergency operations and training exercises. Quincy, MA: National Fire Protection Association.

NIMSC [2010]. Model procedure guides. Haslet, TX: The National Incident Management System Consortium. Date accessed: October 31, 2022.

NIOSH [2009]. Nine career fire fighters die in rapid fire progression at commercial furniture showroom - South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2007-18. Date accessed: October 31, 2022.

NIOSH [2010]. Two Career Fire Fighters Die and 19 Injured in Roof Collapse during Rubbish Fire at an Abandoned Commercial Structure – Illinois. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2011-02. Date accessed: October 31, 2022.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

NIOSH [2012]. A Career Lieutenant and Fire Fighter/Paramedic Die in a Hillside Residential House Fire – California. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2011-12. Date accessed: October 31, 2022.

NIOSH [2013a]. Career captain sustains injuries at a 2½ story apartment fire then dies at hospital—Illinois. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2012-28. Date accessed: October 31, 2022.

NIOSH [2013b]. Career fire fighter dies during fire-fighting operations at a multi-family residential structure fire—Massachusetts. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2011-31. Date accessed: October 31, 2022.

NIOSH [2014]. Two career fire fighters die in a rapid fire progression while searching for tenants—Ohio. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2014-02. Date accessed: October 31, 2022

NIOSH [2018]. Workplace solutions: preventing deaths and injuries to fire fighters working at basement and other below-grade fires. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Publication No. 2018-154. Date accessed: October 31, 2022

NIOSH [2022a]. Fire Fighter Fatality Investigation and Prevention Program. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Date accessed: October 31, 2022.

NIOSH [2022b]. The Importance of Understanding and Training on the Portable Radio Emergency Alert Button (EAB) during a Mayday. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Publication No. 2023-100. Date accessed: October 31, 2022.

OSHA [1998]. 29 CFR 1910.134 Respiratory protection. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. Date accessed: October 31, 2022.

Toledo Fire & Rescue Department [2012]. Rapid intervention team (RIT) standard operating procedure C82. Toledo, OH: Toledo Fire & Rescue Department.

TSFRS [2014]. Rapid intervention team, interim procedure 2014-003. Township of Spring, PA: Township of Spring Fire & Rescue.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

USFA [2008]. Emergency incident rehabilitation. Washington, DC: U.S. Department of Homeland Security, U.S. Fire Administration. Date accessed: October 31, 2022.

Weather Underground [2018]. Weather History. Atlanta, GA: The Weather Underground. accessed: October 31, 2022.

Zevotek R, Stakes K, Willi J [2018]. Impact of fire attack utilizing interior and exterior streams on firefighter safety and occupant survival: full scale experiments. Underwriters Laboratories (UL), Firefighter Safety Research Institute. Date accessed: October 31, 2022.

Investigator Information

This incident was investigated by Murrey Loflin, Investigator, Dr. Thomas R. Hales, Medical Officer, and Matt Bowyer, General Engineer, all with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. The report was written by Murrey Loflin and Thomas Hales. An expert technical review was provided by Robert M. Neamy, Deputy Chief (retired) Los Angeles Fire Department and Peter Van Dorpe, Chief of Training (retired) of the Chicago Fire Department, and (retired) Chief of the Algonquin-Lake in the Hills Fire Protection District. Additional expert review was provided by Steve Kerber and Dan Madrzykowski of the Underwriters Laboratories, Firefighter Safety Research Institute. 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. Videos relevant to this incident include, Suppression Tactics in Single-Family Homes, Understanding and Fighting Basement Fires, Impact of Ventilation on Fire Patterns, Vertical Ventilation and Suppression Tactics in Single Family Homes.

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 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.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety*
(2020 edition)
The primary focus of the revision to NFPA 1561 in the 2020 edition was 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 IC 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.*

Disclaimer

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (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. Mention of any company or product does not constitute endorsement by NIOSH or CDC.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Appendix One

Fire & Rescue Department's Alarms for 2018

Incidents by Situation Found

From '1/1/2018' To '12/31/2018'

*Note: Under our new Aether FireRMS system, these counts include out of county mutual aid for which a given station was due. Comparing these numbers to hard copy reports from years past may reveal discrepancies for this reason.

Primary Situation	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 13	Total
10 - Fire, other	0	1	0	0	0	0	0	0	0	0	0	0	1
11 - Structure Fire	38	46	18	24	13	67	42	12	43	15	23	9	352
12 - Fire in mobile property used as a fixed structure	0	1	0	2	0	1	0	0	0	0	0	0	4
13 - Mobile property (vehicle) fire	25	14	10	13	2	22	9	8	15	25	12	2	158
14 - Natural vegetation fire	12	9	12	8	5	11	7	9	5	6	9	7	100
15 - Outside rubbish fire	29	12	0	2	3	10	9	8	9	4	2	9	97
16 - Special outside fire	4	10	1	0	1	10	15	2	14	2	2	2	63
20 - Overpressure rupture, explosion, overheat, other	0	0	0	0	0	0	1	0	0	0	1	0	2
21 - Overpressure rupture from steam (no ensuing fire)	1	0	0	0	0	1	1	0	0	0	0	0	3
22 - Overpressure rupture from air or gas - no fire	0	0	0	0	1	1	2	0	0	0	0	0	4
30 - Rescue, emergency medical call (EMS), other	3	5	6	1	1	8	3	3	3	1	2	3	39
31 - Medical assist	6	20	5	4	3	19	10	7	12	7	4	7	104
32 - Emergency medical service (EMS)	2037	4360	1330	830	908	3202	4870	1596	4336	1770	1468	461	27188
33 - Lock-In	2	6	1	0	2	6	12	2	16	6	2	1	56
34 - Search for lost person	1	0	2	0	1	1	1	1	2	1	0	0	10
35 - Extrication, rescue	14	11	6	5	8	17	37	5	15	8	7	2	135
36 - Water or ice-related rescue	9	13	1	1	1	2	3	5	3	2	6	0	46
40 - Hazardous condition, other	4	4	3	0	1	9	6	1	2	3	1	1	35
41 - Combustible/flammable spills & leaks	40	70	23	12	28	107	51	34	75	23	15	15	493
42 - Chemical release, reaction, or toxic condition	3	9	0	1	3	14	17	4	11	6	9	1	78
44 - Electrical wiring/equipment problem	24	86	38	29	35	42	57	37	36	24	31	17	456
45 - Biological hazard	0	0	0	1	0	1	0	0	0	0	0	0	2
46 - Accident, potential accident	6	5	2	0	0	9	4	7	10	12	1	0	56
48 - Attempted burning, illegal action	0	1	1	0	0	0	3	2	2	0	1	0	10
50 - Service call, other	5	20	3	1	4	7	13	5	14	9	2	1	84
51 - Person in distress.	12	21	5	1	7	33	40	2	32	24	8	5	190
52 - Water problem	23	42	6	0	10	33	42	17	56	16	10	5	260
53 - Smoke, odor problem	3	2	1	1	0	6	10	1	6	3	0	1	34
54 - Animal problem or rescue	1	1	0	0	2	0	1	2	6	1	0	1	15
55 - Public service assistance	53	105	43	14	15	94	83	65	156	68	35	29	782
56 - Unauthorized burning	3	3	4	1	3	5	3	6	8	1	1	1	41
57 - Cover assignment, standby at fire station, moveup	29	28	25	21	10	37	37	17	14	24	21	19	283
60 - Good intent call, other	24	80	28	10	28	71	91	29	103	53	13	12	542
61 - Dispatched and canceled en route	500	463	168	187	165	617	381	216	411	210	291	91	3700
62 - Wrong location	84	77	23	22	19	112	78	28	104	34	37	15	633
63 - Controlled burning	3	4	1	1	0	0	3	1	3	1	0	1	18
64 - Vicinity alarm	1	0	0	0	0	0	0	0	0	0	1	0	2
65 - Steam, other gas mistaken for smoke	25	32	9	8	8	52	58	16	32	24	22	6	292
70 - False alarm and false call, other	7	28	11	1	0	33	17	7	41	8	7	1	161
71 - Malicious, mischievous false alarm	9	12	3	0	17	39	22	8	49	13	8	2	182
72 - Bomb scare	0	0	0	0	0	1	0	0	1	0	0	1	3
73 - System or detector malfunction	57	127	32	10	39	133	125	57	197	42	34	30	883
74 - Unintentional system/detector operation - no fire	79	113	32	14	44	135	172	73	145	72	54	29	962
99 - Type Unknown	12	28	5	1	12	20	14	4	25	11	11	5	150
Total	3188	5869	1858	1226	1399	4988	6350	2319	6012	2529	2151	792	38709

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Appendix Two
Summary of Personal Protective Equipment Evaluation
Status Investigation Report of two
Self-Contained Breathing Apparatus
Submitted by the
NIOSH Division of Safety Research
for the Fire Department

NIOSH Task Number 22491

Background
As part of **the National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program (FFFIPP), Investigation F2018-13 MD**, the National Personal Protective Technology Laboratory (NPPTL) agreed to examine and evaluate a SCBA under NIOSH Task Number 22491.

This SCBA status investigation was assigned NIOSH Task Number 22491. The NIOSH Firefighter Fatality Investigation and Prevention Program investigators and the Fire and Rescue department were advised that NIOSH NPPTL would provide a written report of the inspection and any applicable test results.

The SCBA unit was delivered by a NIOSH investigator from the Division of Safety Research who were assigned to investigate the Fire and Rescue department's fatal event. The investigator delivered the unit to Lab H1513 for secure storage at the NIOSH facility in Morgantown, West Virginia on August 20, 2018. The SCBA unit remained in secure storage in Lab H1513 throughout the inspection and testing process.

On August 23, 2018, NPPTL employees Jay Tarley and Angie Andrews inspected the SCBA unit. These employees identified the SCBA from the Fire and Rescue department and visually examined the devise, component by component, in the condition received to determine the conformance of the unit to the NIOSH-approved configuration. The unit was an MSA Model G1, 4500 psi, 45-minute unit; with NIOSH Approval Numbers TC-13F-0798CBRN.

SCBA Inspection
On August 23, 2018, NPPTL employees Jay Tarley and Angie Andrews inspected the SCBA unit. These employees identified the SCBA as a Department of Fire and Rescue Services SCBA and visually examined the devise, component by component, in the condition received to determine the conformance of the unit to the NIOSH-approved configuration. The unit was a MSA Model G1, 4500 psi, 45-minute unit; with NIOSH Approval Numbers TC-13F-0798CBRN.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

SCBA Testing
Summary and Conclusions

The SCBA unit inspected and evaluated by NPPTL was a MSA Model G1, 45-minute, 4500 psi unit with NIOSH Approval Numbers TC-13F-0798CBRN. The corresponding facepiece and cylinder were provided with the unit. A cylinder, not involved in the incident, was provided by the fire department for testing. Overall, the SCBA was in fair condition with some heat damage and soot found on the straps, as well as melted debris. The NFPA approval label was present and readable. The PASS, HUD, and alarm systems functioned as designed.

The SCBA did not meet the test requirement of the NIOSH Positive Pressure Test during the first run. The inhalation breathing resistance was negative (-.25) for the first 10 minutes of the test then became positive and stayed positive the remainder of the test. This could possibly be explained by a piece of debris jarring loose from pressure of the air.

The unit was tested again and met the test requirements of the NIOSH Positive Pressure Test, as the SCBA maintained a positive pressure for the 45-minute minimum duration of the test. The unit passed all of the other NIOSH tests, as well as meeting the requirements of the NFPA "Airflow Performance" test.

In light of the information obtained during this investigation, NIOSH NPPTL has proposed no further action on its part at this time. The SCBA was returned to the shipping container to be shipped back to the Fire and Rescue department.

If this unit is to be placed back in service, the SCBA must be repaired, tested, cleaned, and any damaged components replaced and inspected by a qualified service technician, including such testing and other maintenance activities as prescribed by the schedule from the SCBA manufacturer. Typically, a flow test is required on at least an annual basis.

The investigation under task number TN-22491 will be considered closed.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Appendix Three
SCBA Data Log Information

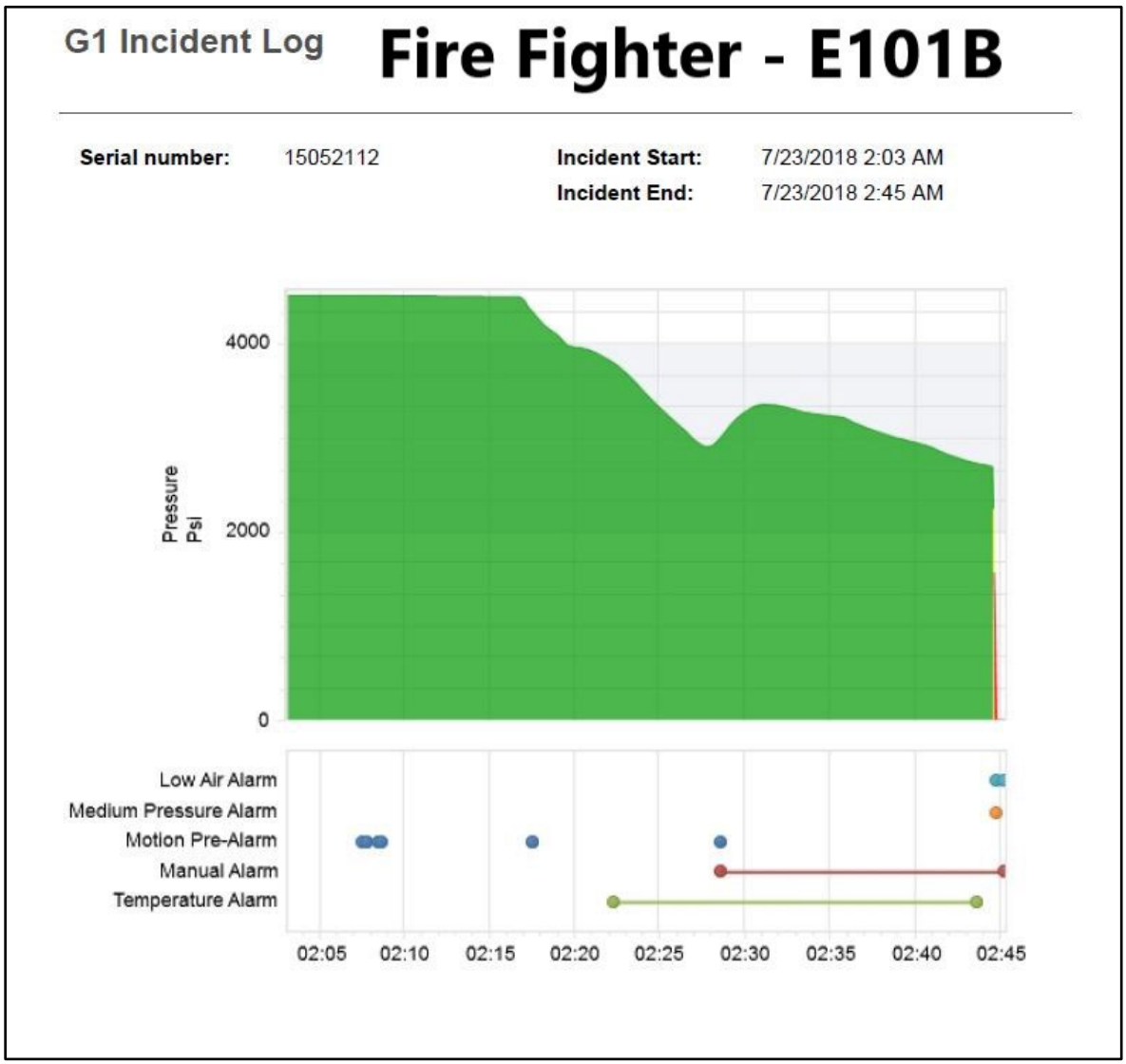


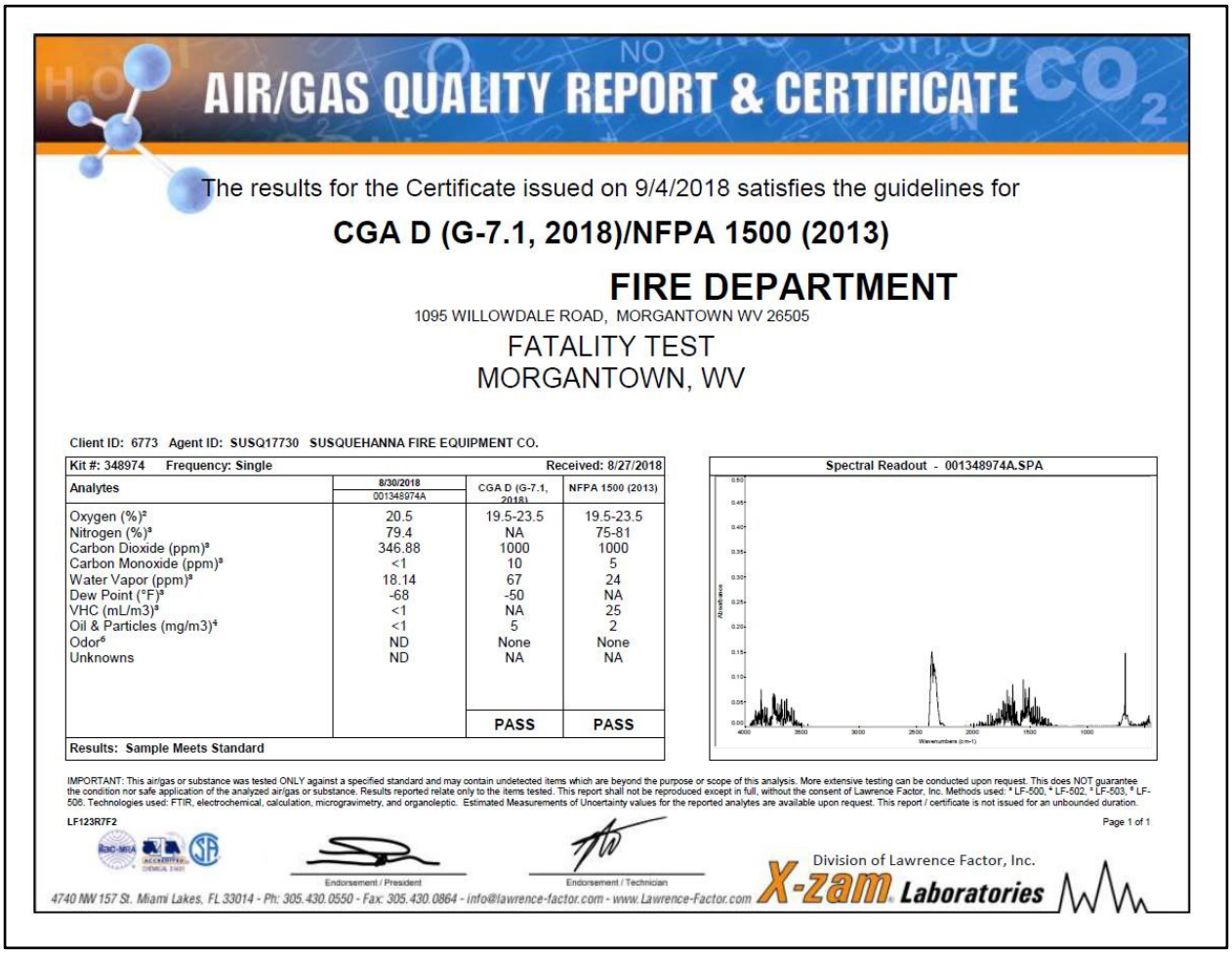
Figure 4. The SCBA data log information for the firefighter from E101B.

PASS Alarm: E101B manually activated his PASS Alarm at approximately 0229 hours. **PASS Internal Temperature Alarm:** activated at approximately 0222 hours and went off at approximately 0244 hours.

MAYDAY occurred at **0220 hours** and E101B was out of the structure at **0243 hours**.

Firefighter Dies after Falling Through a Floor at a Residential Structure Fire – Maryland

Appendix Four
Air/Gas Quality Report
SCBA Cylinder – E101B



AIR/GAS QUALITY REPORT & CERTIFICATE

The results for the Certificate issued on 9/4/2018 satisfies the guidelines for

CGA D (G-7.1, 2018)/NFPA 1500 (2013)

FIRE DEPARTMENT

1095 WILLOWDALE ROAD, MORGANTOWN WV 26505

FATALITY TEST
MORGANTOWN, WV

Client ID: 6773 Agent ID: SUSQ17730 SUSQUEHANNA FIRE EQUIPMENT CO.

Kit #: 348974 Frequency: Single Received: 8/27/2018

Analytes	8/30/2018 001348974A	CGA D (G-7.1, 2018)	NFPA 1500 (2013)
Oxygen (%)[2]	20.5	19.5-23.5	19.5-23.5
Nitrogen (%)[3]	79.4	NA	75-81
Carbon Dioxide (ppm)[3]	346.88	1000	1000
Carbon Monoxide (ppm)[3]	<1	10	5
Water Vapor (ppm)[3]	18.14	67	24
Dew Point (°F)[3]	-68	-50	NA
VHC (mL/m3)[3]	<1	NA	25
Oil & Particles (mg/m3)[4]	<1	5	2
Odor[5]	ND	None	None
Unknowns	ND	NA	NA
		PASS	PASS

Results: Sample Meets Standard

Spectral Readout - 001348974A.SPA

IMPORTANT: This air/gas or substance was tested ONLY against a specified standard and may contain undetected items which are beyond the purpose or scope of this analysis. More extensive testing can be conducted upon request. This does NOT guarantee the condition nor safe application of the analyzed air/gas or substance. Results reported relate only to the items tested. This report shall not be reproduced except in full, without the consent of Lawrence Factor, Inc. Methods used: * LF-500, * LF-502, * LF-503, * LF-506. Technologies used: FTIR, electrochemical, calculation, microgravimetry, and organoleptic. Estimated Measurements of Uncertainty values for the reported analytes are available upon request. This report / certificate is not issued for an unbounded duration.

LF123R7F2 Page 1 of 1

Endorsement / President Endorsement / Technician

Division of Lawrence Factor, Inc.
X-zam Laboratories

4740 NW 157 St. Miami Lakes, FL 33014 - Ph: 305.430.0550 - Fax: 305.430.0864 - info@lawrence-factor.com - www.Lawrence-Factor.com

Figure 5. Results of the air quality report and certification for the SCBA cylinder used by E101B.