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## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters Following a Floor Collapse in a Row House—Delaware**

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### **Executive Summary**

On September 24, 2016, a 41-year-old lieutenant and a 51-year-old senior fire fighter died due to a floor collapse in a row house at a structure fire. Two other fire fighters were critically injured. One of the injured fire fighters, a 48-year-old female died on December 1, 2016, due to injuries sustained from the collapse and exposure to fire in the basement. Another fire fighter spent 40 days in a metropolitan hospital before being released. Two other fire fighters received burns during fireground operations and one fire fighter sustained an ankle injury. All three were treated and released from the hospital on the same day. At 0256 hours, Engine 1, Engine 5, Squad 4, Ladder 2, Battalion 2, and Battalion 1 were dispatched to a report of a residential structure fire with persons trapped. Ladder 2 arrived on-scene at 0301 hours and reported heavy fire showing from the rear of the structure. The Ladder 2 Officer requested a 4th engine be dispatched. Engine 1 and Engine 5 arrived and both laid supply lines from different directions. Battalion 2 arrived on-scene and assumed Command. Crews from Engine 1, Engine 5, and Ladder 2 went to the front door and entered the 1<sup>st</sup> floor at approximately 0307 hours. At approximately 0309 hours, the Ladder 2 Officer, a fire fighter from Engine 1, and a fire fighter from Engine 5 fell into the basement. At 0310 hours, a Mayday was transmitted for a floor collapse and fire fighters in the basement. Fire fighters were able to get the fire fighter from Engine 1 (Engine 1B) out of the basement at 0318 hours. Crews were able to get the fire fighter from Engine 5 (Engine 5B) to the base of an attic ladder placed in the basement. Crews in the basement were also searching for the Ladder 2 Officer, plus fire fighters were exiting and entering the basement. The injured fire fighter from Engine 5 moved away from the attic ladder and crews were unable to locate her. Two fire fighters from Squad 4 (Squad 4C and Squad 4D) entered the basement from Side Charlie and found the lieutenant from Ladder 2 near the Side Alpha/Side Delta



**A view of the incident scene from Side Alpha. This shows fireground operations after the collapse of the 1<sup>st</sup> floor into the basement of the structure.**  
*(Photo courtesy of fire department.)*

At 0256 hours, Engine 1, Engine 5, Squad 4, Ladder 2, Battalion 2, and Battalion 1 were dispatched to a report of a residential structure fire with persons trapped. Ladder 2 arrived on-scene at 0301 hours and reported heavy fire showing from the rear of the structure. The Ladder 2 Officer requested a 4th engine be dispatched. Engine 1 and Engine 5 arrived and both laid supply lines from different directions. Battalion 2 arrived on-scene and assumed Command. Crews from Engine 1, Engine 5, and Ladder 2 went to the front door and entered the 1<sup>st</sup> floor at approximately 0307 hours. At approximately 0309 hours, the Ladder 2 Officer, a fire fighter from Engine 1, and a fire fighter from Engine 5 fell into the basement. At 0310 hours, a Mayday was transmitted for a floor collapse and fire fighters in the basement. Fire fighters were able to get the fire fighter from Engine 1 (Engine 1B) out of the basement at 0318 hours. Crews were able to get the fire fighter from Engine 5 (Engine 5B) to the base of an attic ladder placed in the basement. Crews in the basement were also searching for the Ladder 2 Officer, plus fire fighters were exiting and entering the basement. The injured fire fighter from Engine 5 moved away from the attic ladder and crews were unable to locate her. Two fire fighters from Squad 4 (Squad 4C and Squad 4D) entered the basement from Side Charlie and found the lieutenant from Ladder 2 near the Side Alpha/Side Delta

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corner. The two fire fighters from Squad 4 pulled the Ladder 2 Officer toward the doorway on Side Charlie. They got 4 - 6 feet from the doorway when a second collapse of the 1<sup>st</sup> floor occurred at approximately 0320 hours. One fire fighter from Squad 4 (Squad 4C) and the lieutenant from Ladder 2 were covered by debris. Squad 4D was pushed toward the doorway and pulled out by a fire fighter from Engine 5 (Engine 5C). Squad 4C was removed from the structure at 0329 hours. He was transported to a trauma center and pronounced deceased. The fire fighter from Engine 5 (Engine 5B) was located and removed from the structure at 0348 hours and transported by air ambulance to a trauma center and then a medical burn center. At 0430 hours, the Ladder 2 Officer was located in the debris pile and pronounced deceased by a paramedic. He was removed from the structure and transported to a trauma center. The fire was declared under control at 0550 hours.

### **Contributing Factors**

- *Sliding glass door open on Side Charlie*
- *Lack of scene size-up and risk assessment*
- *Lack of incident management and Command Safety*
- *Lack of an incident action plan*
- *Inappropriate fireground tactics for below grade fire*
- *Lack of company/crew integrity*
- *Lack of personnel accountability system*
- *Lack of rapid intervention crew(s)*
- *Ineffective fireground communications*
- *Lack of professional development for fire officers and fire fighters*

### **Key Recommendations**

- *As part of the strategy and incident action plan, the incident commander should ensure a detailed scene size-up and risk assessment occurs during initial fireground operations, including the deployment of resources to Side Charlie. Scene size-up and risk assessment should occur throughout the incident.*

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In 1998, Congress appropriated funds to NIOSH to conduct a fire fighter initiative that resulted in the NIOSH Fire Fighter Fatality Investigation and Prevention Program, which examines line-of-duty deaths or on-duty deaths of fire fighters to assist fire departments, fire fighters, the fire service, and others to prevent similar fire fighter deaths in the future. The agency does not enforce compliance with state or federal occupational safety and health standards and does not determine fault or assign blame. Participation of fire departments and individuals in NIOSH investigations is voluntary. Under its program, NIOSH investigators interview persons with knowledge of the incident who agree to be interviewed and review available records to develop a description of the conditions and circumstances leading to the death(s). Interviewees are not asked to sign sworn statements and interviews are not recorded. The agency's reports do not name the victim, the fire department, or those interviewed. The NIOSH report's summary of the conditions and circumstances surrounding the fatality is intended to provide context to the agency's recommendations and is not intended to be definitive for purposes of determining any claim or benefit.

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



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### **Introduction**

On September 24, 2016, a 41-year-old lieutenant and a 51-year-old senior fire fighter died due to a floor collapse at a residential structure fire. Two other fire fighters were critically injured. One of the injured fire fighters, a 48-year-old female died, on December 1, 2016 (68 days later), due to burn injuries sustained from the collapse and exposure to fire in the basement. The other fire fighter spent 40 days in a burn center in a metropolitan hospital and was then released. Two fire fighters received burns during fireground operations and one fire fighter was treated for an ankle injury.

On September 26, 2016, the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of the two fire fighter fatalities. On October 10–14, 2016, an investigator, a general engineer, and a safety engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Delaware to investigate this incident. On October 19–24, 2016, an investigator and general engineer returned to complete the site investigation. NIOSH investigators met with members of the career fire department, members of four volunteer fire departments who responded on the 3<sup>rd</sup> Alarm assignment, private and county emergency medical services (EMS) agencies that responded to this incident, state fire investigators, the county's Fire Communications Bureau, state Fire Marshal's Office, state medical examiner's office; and special agents from the Bureau of Alcohol, Tobacco, Firearms, and Explosives. The NIOSH investigators visited the site and took photographs. The NIOSH investigators interviewed the incident commander, officers, fire fighters, and emergency medical services personnel who were on-scene at the time of the incident. The investigators reviewed the fire department's standard operating procedures, training records, dispatch records, and witness statements. The NIOSH investigators inspected turnout gear and self-contained breathing apparatus of the three fire fighters who died and two fire fighters who were injured in the floor collapse.

### **Fire Department**

This fire department serves as the state of Delaware's only career fire department. The fire department operates six engine companies, including Squirrt 3, Squad 4 and the other is Skyboom 2, two ladder companies, and a fireboat. *Note: Skyboom 2 is a pumper with a 55-foot telesquirt attached and Squirrt 3 is a pumper with a 55-foot articulating boom.* The fireboat is staffed with two fire fighters Monday through Friday from 0700 to 1700 hours. The fire department operates a 4-platoon (shift) system with a Kelly Day every 7 shifts. Minimum staffing by union contract is one officer and three fire fighters per company except Squad 4, which is staffed with one officer and four fire fighters. Each shift is commanded by two battalion chiefs—one battalion chief stationed in the north section of the city (Battalion 2 housed with Engine 1) and one battalion chief stationed in the south section (Battalion 1 housed with Squad 4) of the city.

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The radio designations for the department riding positions are as follows:

- Radio designation for the officer on every piece of apparatus is **Officer**.

### **Engine 1, Skyboom 2, Squirt 3, Engine 5, and Engine 6**

- Officer
- Alpha: Driver
- Bravo: Nozzle
- Charlie: Hydrant person

### **Squad 4**

- Officer (Team 1)
- Alpha: Driver (Team 1)
- Bravo: Follow in/Nozzle (Team 1)
- Charlie: Vent Enter Search (VES)/Hydrant (Team 2)  
Extra: Vent Enter Search (Team 2)

When Squad 4 responds to incidents as a 2<sup>nd</sup> due company, 3<sup>rd</sup> due company, or 4<sup>th</sup> due company, Squad 4 will operate as two teams. When the incident is in their 1<sup>st</sup> due district, the crew is not split.

### **Ladder 1 and Ladder 2**

- Officer
- Alpha: Driver
- Bravo: Follow in
- Charlie: Outside vent (Tiller)

Emergency medical services are provided through contract with a city hospital, whose emergency medical services (EMS) division operates a minimum of six basic life support (BLS) transport units 24 hours a day from each city fire station. Advanced Life Support (ALS) services in the city are provided by the county's EMS Division, with two ALS medic units are assigned daily. All fire fighters since 2002 are trained to the National Registry Emergency Medical Technician (NREMT) Emergency Medical Technician Basic level and are dispatched to all life-threatening incidents.

## **Training and Experience**

The state of Delaware has the following requirements for career fire fighters. These requirements must be successfully completed before an individual is allowed to participate in emergency response and incident scene operations. These requirements are not mandatory for the volunteer fire departments within the state. The state of Delaware has 60 volunteer fire departments, 2 military fire departments, 1 career fire department, and 1 industrial fire department.

The [Delaware State Fire School](#) offers 16 different certifications through the National Board on Fire Service Professional Qualifications (Pro-Board) and the International Fire Service Accreditation Congress (IFSAC). Information regarding the state of Delaware Fire School can be found at

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<https://statefireschool.delaware.gov/wp-content/uploads/sites/114/2017/08/RECOGNITION-GUIDELINES-APP.pdf>.

The following are certifications for fire fighters and fire officers.

- DELAWARE FIRE FIGHTER I
    - Basic Firefighting Skills (36 hours) or Fire I
    - Structural Firefighting Skills (24 hours) or Fire II
    - Hazardous Materials Response Skills or Fire II or Hazardous Materials I or II
    - Fire Fighter Self-Survival
    - Vehicle Rescue
    - Fire Fighter First Aid or emergency medical technician (EMT)
    - Or **Pro-Board/IFSAC – Fire Fighter I *plus*** – EMT
  
  - DELAWARE FIREFIGHTER II
    - Delaware Fire Fighter I  
*PLUS*
    - Firefighting Foam
    - Rope Rescue I or Ropes and Rigging
    - Arson Awareness or National Fire Academy's, *Arson Detection for the First Responder*
    - Rapid Intervention Training - Introduction
    - Crew Leader or Fire III  
*AND*
    - 4 Electives from list or **Pro-Board/IFSAC – Fire Fighter II *plus*** Crew Leader and 4 electives
  
  - DELAWARE FIRE OFFICER LEVEL I
    - Delaware Fire Fighter II  
*PLUS*
    - Emergency Vehicle Operator (EVO)
    - Driver Operator or Pumps
    - DSFS Fire Officer I Course or Company Officer Course / Skills or Strategy  
*AND*
    - 3 Electives from list or **Pro-Board/IFSAC – Fire Officer I *plus*** EVO and 3 electives
  
  - DELAWARE FIRE OFFICER LEVEL II
    - Delaware Fire Officer Level I
  
  - DELAWARE ADMINISTRATIVE OFFICER I
    - NFA - Leadership I
    - NFA - Leadership II
    - NFA - Leadership III  
*AND*
- 
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- 4 Electives from any list of electives
- APPARATUS OPERATOR I
  - Delaware Fire Fighter I or Introduction to Emergency Services
  - DSFS Driver Operator Course
  - Emergency Vehicle Operator Course
  - Emergency Vehicle Operator Competency Course

To be hired by the career fire department, an individual must be 18 years of age, have a high school/GED diploma, have military experience (optional), and a college education (optional). The city has a residency requirement that a fire fighter recruit live within the city limits within six months of employment. After five years of employment, a fire fighter can move outside the city limits. A fire fighter candidate must possess a valid state driver's license and pass a criminal background check. The city's hiring process for fire department candidates:

- Physical ability test
- Written examination
- Panel interview comprised of fire department officers
- Pre-employment medical exam
- An interview with the fire chief
- Department establishes a one-year hiring list

The fire department has the following requirements for each position or rank.

### Recruit School

- 15 weeks, 12 hour days – Monday through Friday
- NFPA 1001, *Standard on Professional Qualifications for Fire Fighter*, Fire Fighter I and Fire Fighter II (ProBoard)
- Hazardous Materials Awareness and Operations (ProBoard)
- **NREMT** Emergency Medical Technician Basic

### Probationary Fire Fighter

- At 6 months – pass a written examination and a physical agility test.
- At 12 months – pass a written examination and a physical agility test. *Note: The probationary period is completed in 12 months, but can be extended for a total of 18 months maximum.*

### Fire Fighter

- After 12 months – becomes a certified driver/operator
- At 3 years, can be certified to be an acting lieutenant and becomes a senior fire fighter
- At six years, test for lieutenant
- NFPA 1001, FF I and FF II; **NREMT** Emergency Medical Technician Basic

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### Lieutenant

- Must be a fire fighter/senior fire fighter for 6 years to test
- The testing process includes
  - Written examination
  - Assessment Center (evaluates candidates for promotion)
  - Department establishes a 2-year promotional list

### Captain

- Served 2 years as a lieutenant to test
- The testing examination includes
  - Written examination
- Department establishes a 2-year promotional list

### Battalion Chief

- By appointment of the fire chief
- Covered by union contract

### Deputy Chief

- By appointment of the fire chief
- Not covered by union contract

### Fire Chief

- Appointed by Mayor

The fire fighter from Squad 4 had the following training and certifications: NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter I ProBoard and Fire Fighter II ProBoard; NFPA 1021, *Standard on Fire Officer Professional Qualifications*, Fire Officer I ProBoard; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness Level ProBoard and Hazardous Materials Operational Level ProBoard; NFPA 1041, *Standard on Fire Service Instructor Professional Qualifications*, Instructor I ProBoard, Instructor II ProBoard; American Heart Association Health Care Provider; National Registry of Emergency Medical Technicians *Emergency Medical Technician Basic*; vehicle rescue; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00700 – *National Incident Management System*; Water Rescue I (12 hours); High Angle Rescue (24 hours); Ropes and Rigging; Rescue I – Basic Confined Space/Structural Rescue (40 hours); Airborne Tactical Extrication Platform; Heli-Technician System Operator; Rescue Hoist Refresher Course (36 hours); Rapid Intervention Team Combat Drill (8 hours); Trench Rescue – Operations Level (20 hours) and Technician Level (20 hours); Highway Incident Safety for Emergency Responders; Radiation Awareness (3 hours); Truck Company Operations (12 hours); Confined Space Rescue (24 hours); Defensive Driving Course; Marine Firefighting I – Awareness (3 hours); and Rapid Intervention Team – Introduction (12 hours).

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The fire fighter from Engine 5 had the following training and certifications: NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter I ProBoard and Fire Fighter II ProBoard; National Registry of Emergency Medical Technicians, *Emergency Medical Technician Basic*; Fireground Operations I (12 hours); First Responder (40 hours); National Fire Academy’s Emergency Response to Terrorism (12 hours); Water Rescue I (12 hours); American Heart Association Health Care Provider; Rapid Intervention Team (12 hours); NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications*, Driver Operator – Pumper ProBoard; NFPA 1041, *Standard on Fire Service Instructor Professional Qualifications*, Instructor I ProBoard; NFPA 1021, *Standard on Fire Officer Professional Qualifications*, Fire Officer I ProBoard; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness Level ProBoard and Hazardous Materials Operational Level ProBoard; Delaware Emergency Management Agency – National Incident Management System (NIMS) and Introduction to the Incident Command System; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00700 – *National Incident Management System*; National Fire Academy, *Incident Safety Officer*; Highway Incident Safety for Emergency Responders; and Emergency Vehicle Driving Training (16 hours).

The Ladder 2 Officer had the following training and certifications: Bachelor of Science (BS) Degree in Fire Science Administration; Associate of Arts and Science (AAS) Degree; National Registry of Emergency Medical Technicians, *Emergency Medical Technician Basic*; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness Level ProBoard and Hazardous Materials Operational Level ProBoard; NFPA 1021, *Standard on Fire Officer Professional Qualifications*, Fire Officer I ProBoard and Officer II ProBoard; NFPA 1041, *Standard on Fire Service Instructor Professional Qualifications*, Instructor I ProBoard and Instructor II ProBoard; NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter I ProBoard and Fire Fighter II ProBoard; NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications*, Vehicle and Machinery Rescue Technician, Rescue Technician: Confined Space, and Rescue Technician: Rope; NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents* – Structural Collapse Technician School; Defensive Driving Course; Structural Collapse “Heavy” Rescue (24 hours); Emergency Building Shoring (20 hours); Highway Incident Safety for Emergency Responders; Trench Rescue (16 hours); Rescue I – Basic Confined Space/Structural Rescue (40 hours); Rescue II – Intermediate Confined Space/Structural Rescue (40 hours); Rescue III – Advanced Confined Space and Structural Rope Rescue (40 hours); National Fire Academy’s *Incident Command System for Highrise Operations*; National Fire Academy’s *Managing Company Tactical Operations; Tactics*; and Water Rescue I (12 hours). **Note:** The Ladder 2 Officer was pursuing a Master of Arts in Organizational Leadership with a concentration in Fire/Rescue Executive Leadership.

Battalion 2, who served as the initial incident commander had the following training and certifications: Highway Incident Safety for Emergency Responders; Marine Firefighting I – Awareness (3 hours); American Heart Association Health Care Provider; IS-00100.a – *Introduction to the Incident Command System*; IS-00200.a – *Basic ICS*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*;

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IS-00700 – *National Incident Management System*; IS-00800.B – *An Introduction to the National Response Framework*; National Fire Academy’s *Fire Fighter Safety and Survival: The Company Officer’s Responsibility*; National Fire Academy’s *Incident Command for Structural Collapse Incidents*; National Fire Academy’s *Incident Safety Officer*; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness Level ProBoard, Hazardous Materials Operational Level ProBoard, Hazardous Materials Technician ProBoard, and Hazardous Materials Incidents – Command Level ProBoard; NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter I ProBoard and Fire Fighter II ProBoard; Water Rescue I (12 hours); Hampton Roads Marine Firefighting Symposium (40 hours); Rapid Intervention Team (12 hours); and Ropes and Rigging (12 hours).

The Deputy Chief of Operations (Deputy 2) assumed Command from Battalion 2. He had the following training and certifications: Associate in Applied Science – Specialized Occupations – Emergency Management Technology; NFPA 1001, *Standard on Fire Fighter Professional Qualifications*, Fire Fighter, Fire Fighter II, and Fire Fighter III; NFPA 1041, *Standard on Fire Service Instructor Professional Qualifications*, Instructor I ProBoard and Instructor II ProBoard; IS-00100.b– *Introduction to the Incident Command System*; IS-00700 – *National Incident Management System*; IS-00800.B – *An Introduction to the National Response Framework*; IS-00033.14, FEMA Initial Ethics Orientation; NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, Hazardous Materials Awareness Level ProBoard, Hazardous Materials Operational Level ProBoard, Hazardous Materials Technician ProBoard and Hazardous Materials Incidents – Command Level ProBoard; National Fire Academy’s *Fire Fighter Safety and Survival: The Company Officer’s Responsibility*, *Fire Fighter Health and Safety: Program Implementation and Management*, *Incident Safety Officer*; Leadership I, Leadership II, Leadership III, *The Incident Command System*, *Incident Command for Structural Collapse Incidents*, *Initial Company Tactical Operations*, *Managing Company Tactical Operations*, and *Building Construction I*; IS-00300.a – *Intermediate ICS*; IS-00400 – *Advanced ICS*; NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications*, *Structural Collapse Rescue*, and *Rope Rescue Technician*; Firefighting Strategy and Tactics (16 hours); National Registry of Emergency Medical Technicians, *Emergency Medical Technician Basic*; Advanced Structural Collapse (50 hours); Rescue II – Intermediate Confined Space/Structural Rescue (40 hours); Rescue III – Advanced Confined Space/Structural Rescue (40 hours); Open Water I – SCUBA Diver; Vehicle Rescue I and Vehicle Rescue II; Fundamental Factors Facing Fireground Commanders (8 hours); Firefighting Strategy (24 hours); Tactical Operations (24 hours); Company Officer (24 hours); Marine Firefighting Task Force: Level I – Awareness, Level II – Operations; American Heart Association – *Health Care Provider*; NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, *Structural Collapse Technician*, and *Trench Rescue Technician Level*; Ropes and Rigging (12 hours); *Highway Incident Safety for Emergency Responders*.

### **Equipment and Personnel**

The city police department receives all 9-1-1 calls within the city, which is the public answering point. If the call is to report a fire, medical emergency, or other type of incident that requires the response of

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the city’s career fire department, the call is transferred to the county’s dispatch center. The county dispatches for 21 volunteer fire departments, the city fire department, private EMS (hospital based EMS stationed in city fire stations) and county EMS, and the county’s police department. All automatic fire alarms are received at the county dispatch center, which is known as Fireboard. The city fire department and all county fire departments operate on 800-MHZ radio frequency.

The staffing for dispatchers at the county communications center is:

- Public Safety Operators            32 dispatchers            6 operators per shift times 4 shifts plus a power shift (one or two additional operators on-duty)
- Fire & EMS                            24 dispatchers            6 dispatchers per shift times 4 shifts
- Law Enforcement                    24 dispatchers            6 dispatchers per shift times 4 shifts

Dispatchers are county employees. The shifts for dispatchers are 0700 – 1900 hours and 1900 – 0700 hours. Dispatchers work two day tours, two night tours, and are off for four days. New dispatchers are assigned as public safety 9-1-1 operators for a minimum of two years. As a position for either fire/EMS dispatcher or law enforcement dispatcher becomes available, a public safety 9-1-1 operator is able to move to either position based upon seniority.

Dispatchers receive training using curriculum from Association of Public-Safety Communications Officials (APCO) and NFPA 1061, *Professional Qualifications for Public Safety Telecommunications Personnel* [NFPA 2018b].

### **Building Construction**

The occupancy was a Type III ordinary/masonry construction two-story with a walkout basement, located in the middle of a group of eight row houses. In this subdivision, the number of row houses consisted of various quantities (e.g., 10, 8, or 7) (**See Photos 1, 2, and 3**). The structure was built in 1944 and was attached to row houses on the south side (Side Delta) and the north side (Side Bravo). The west side (front) (Side Alpha) faces toward a street. The foundation consists of a concrete block walkout basement supported by a poured concrete slab. The exterior walls were constructed of three courses of red masonry brick. The building has a flat style roof that consisted of tar over underlayment and wood sheathing supported by wood joists. An asphalt-shingled parapet was present on the face of the west side of the roof structure. Concrete block firewalls were located on both the north side and south side of the structure that abutted both exposures. The firewalls started in the basement and continued through the roof. A small cockloft was located between the 2<sup>nd</sup> floor and the roof structure.

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**Photo 1. Side Alpha of the fire building.**  
*(Photo from Google Earth Street View.)*

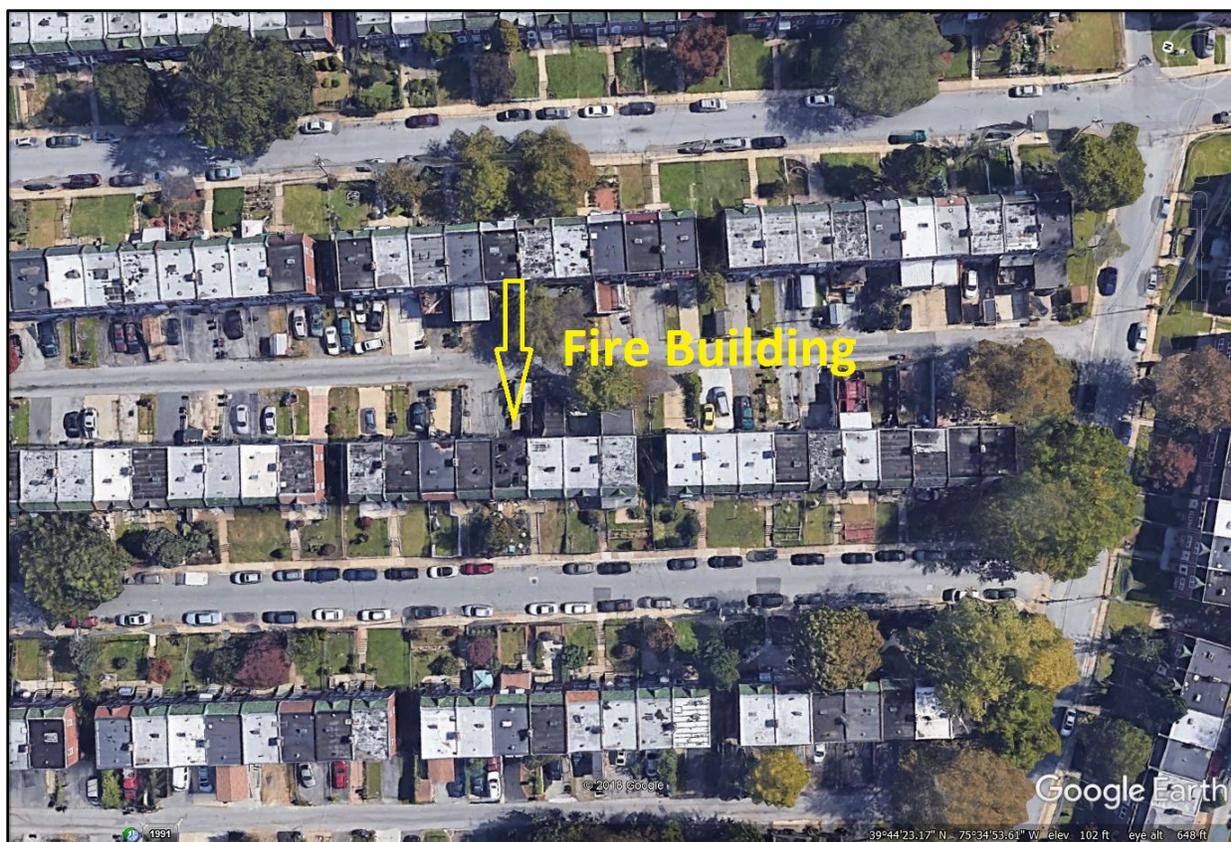


**Photo 2. Side Charlie during fireground operations.**  
*(Photo courtesy of the fire department.)*

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There were three means of ingress/egress to the structure. The main ingress/egress point was located on the front (west side – Side Alpha) of the structure consisting of a fiberglass front door with an oval decorative glass insert window, which was attached to a wood frame. An aluminum storm door was also present and affixed to the exterior wood frame. The access to the rear (east side – Side Charlie) of the structure was provided by two ingress/egress points. A large aluminum frame sliding glass door was located at the center of the rear wall and provided direct access to the main portion of the basement. *Note: The basement garage had been converted to a living space. The sliding glass door replaced the original garage doors, which pulled open.* A wood framed steel entry door with a storm door was located to the south of the sliding glass door near the southeast corner (Side Charlie) and accessed the laundry/utility room in the basement (See Diagram 1).

The interior of the structure measured approximately 1,075 square feet, consisted of a living room, dining room, and kitchen on the 1<sup>st</sup> floor. The 2<sup>nd</sup> floor consisted of three bedrooms and one full-size bathroom. The structure contained a partially finished basement. The basement originally contained a



**Photo 3. The location of the fire building with the street on Side Alpha and alley on Side Charlie.**  
*(Photo from Google Earth.)*

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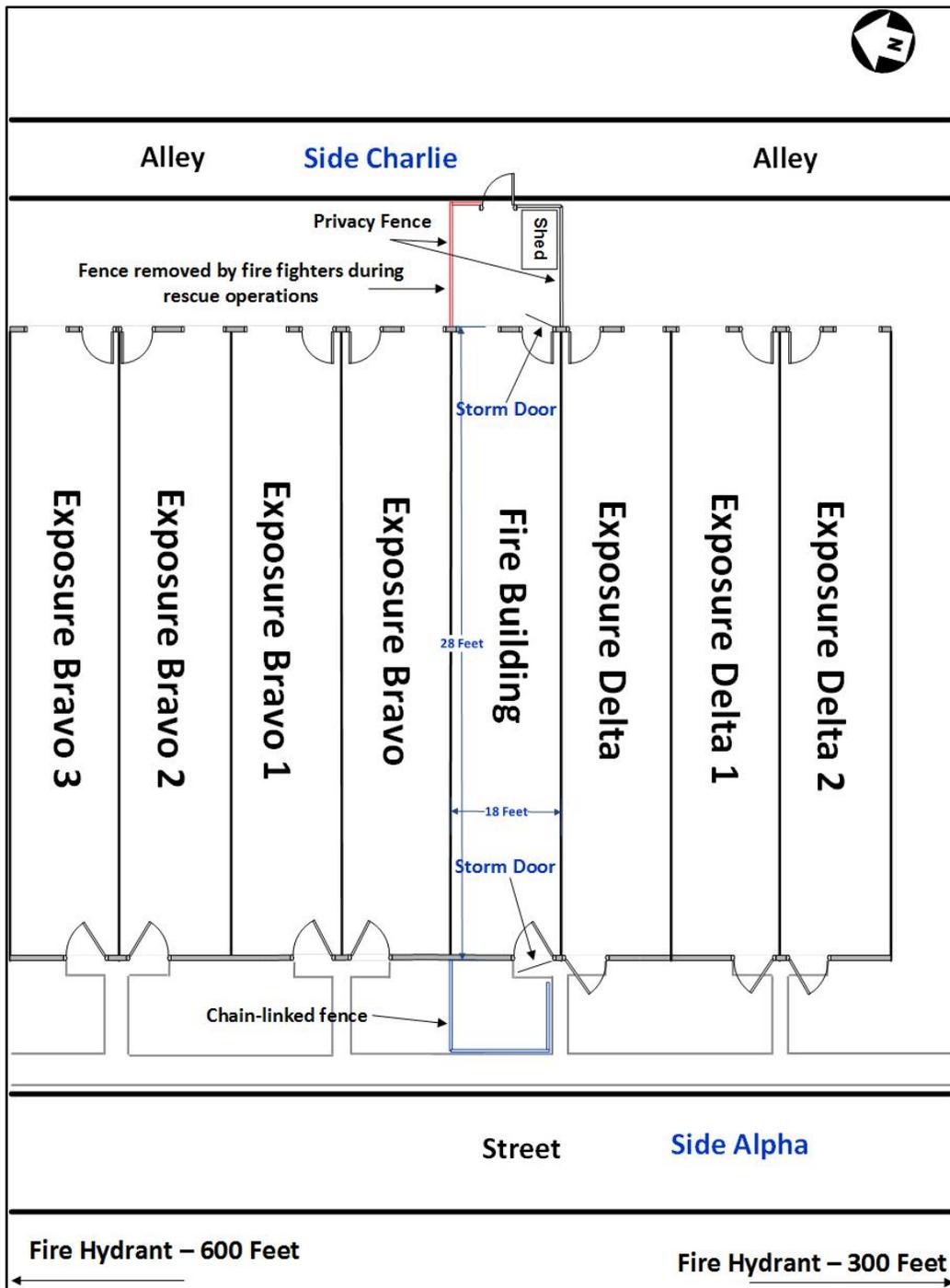


Diagram 1. The fire building and exposures. Each row house is approximately 1,075 square feet with 2 floors and a basement or garage.

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garage. The walls of the garage were removed and the basement was used for storage and a living area (See Diagrams 2, 3, and 4). *Note: One of the walls which ran from Side Bravo to Side Delta was a load bearing wall.*

The interior wall coverings consisted of a combination of gypsum board and wood paneling. The flooring on the 1<sup>st</sup> floor of the structure consisted of 12-inch x 12-inch ceramic tiles glued directly to furring strips that were nailed to 2-inch x 8-inch wood floor joists, which spanned from the Side Bravo to Side Delta walls supporting the 1<sup>st</sup> floor. The flooring on the 2<sup>nd</sup> floor of the structure consisted of wall-to-wall carpeting over wood planks. The basement floor consisted of concrete that was painted and partially covered by linoleum stick tiles. The ceiling coverings in the basement consisted of plywood material with the main portion of the ceiling coated with a plaster “popcorn” finish. *Note: Prior to the fire, there were several breaches in the plywood material exposing the floor joists to the 1<sup>st</sup> floor.* The ceiling coverings in the remainder of the house consisted of fiberboard with a plaster finish.

### **Mutual Aid**

There are 21 volunteer fire companies located in the county where this incident occurred. The city fire department (career) involved in this incident does not have a formal automatic aid agreement with any of the volunteer fire departments. The city fire department will initiate a request for mutual aid as needed. For example, when the incident commander requests a 2<sup>nd</sup> Alarm, the following occurs:

- incident commander from the city fire department requests Fireboard dispatch the remaining available companies within the city to the incident.
- the incident commander will request Fireboard dispatch county volunteer fire companies to backfill empty city fire stations.
- and, the fire department initiates a callback of off duty members to operate with volunteer fire companies backfilling stations and putting reserve apparatus in service.

If the incident goes to a 3<sup>rd</sup> Alarm, the incident commander would request through Fireboard, that volunteer fire companies respond to Staging at the incident.

The volunteer fire companies that were dispatched and utilized at this incident were Engine 16-5, Engine 17-5, and Ladder 21-7.

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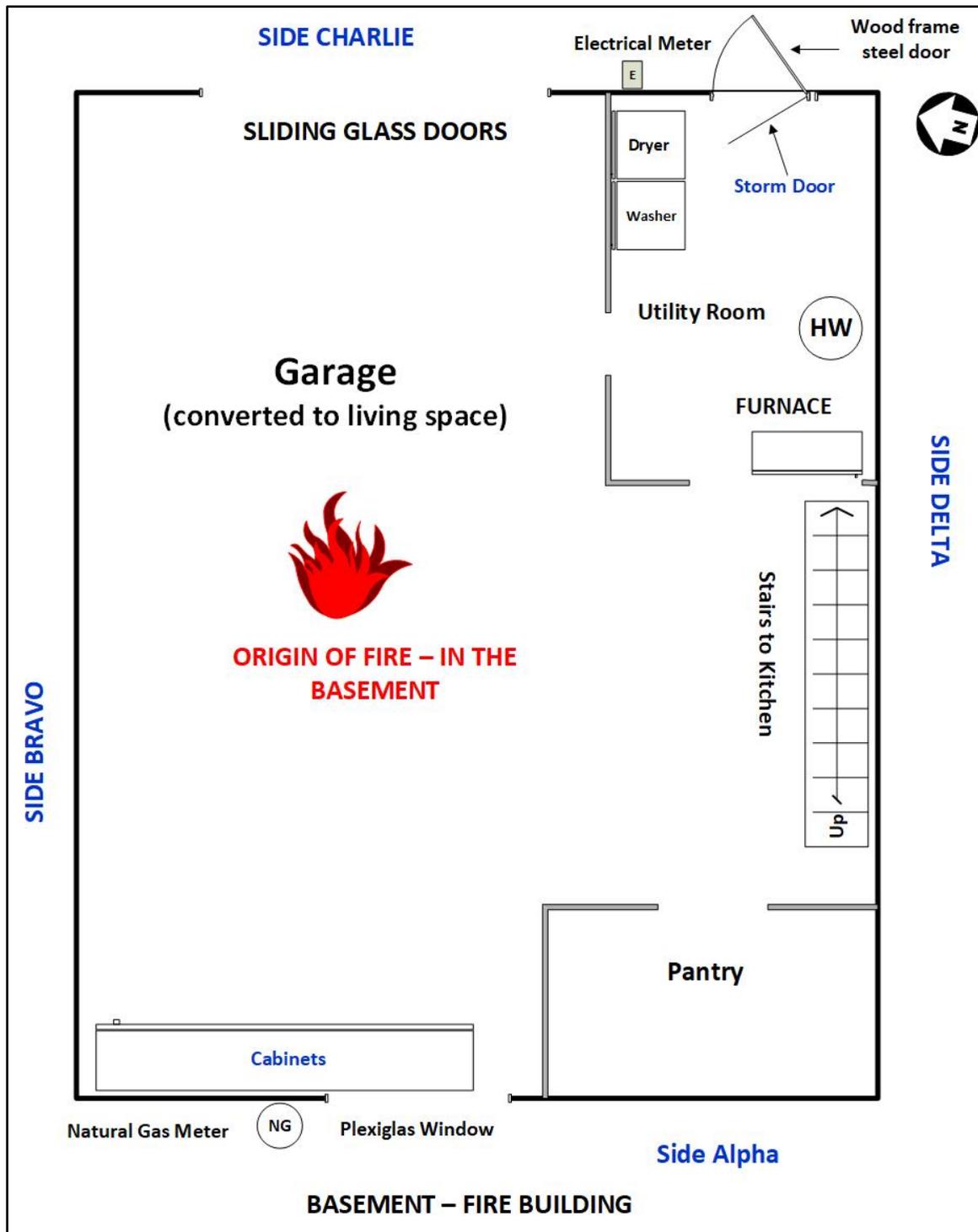


Diagram 2. The basement of the fire building.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

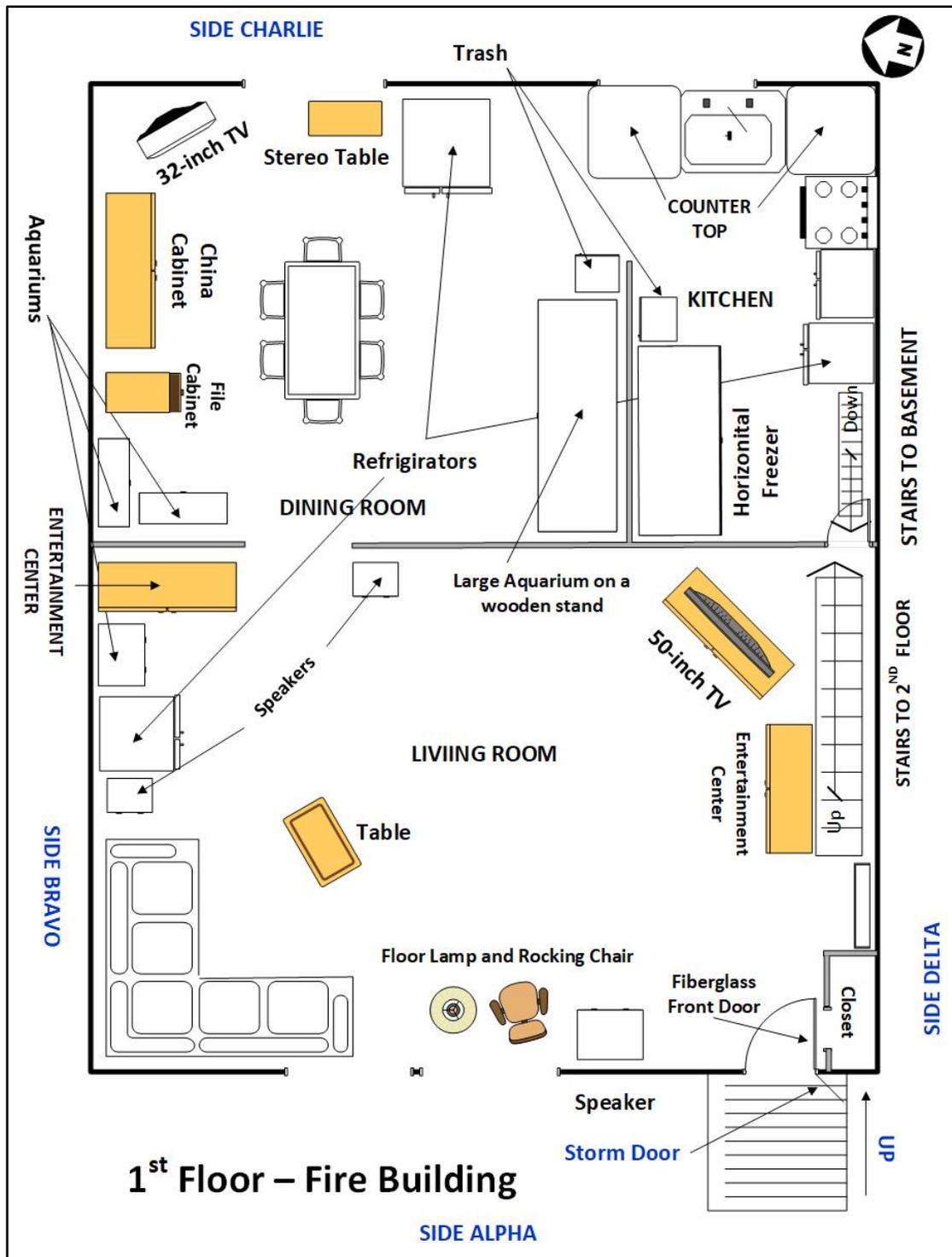


Diagram 3. The 1<sup>st</sup> floor of the fire building.

## Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

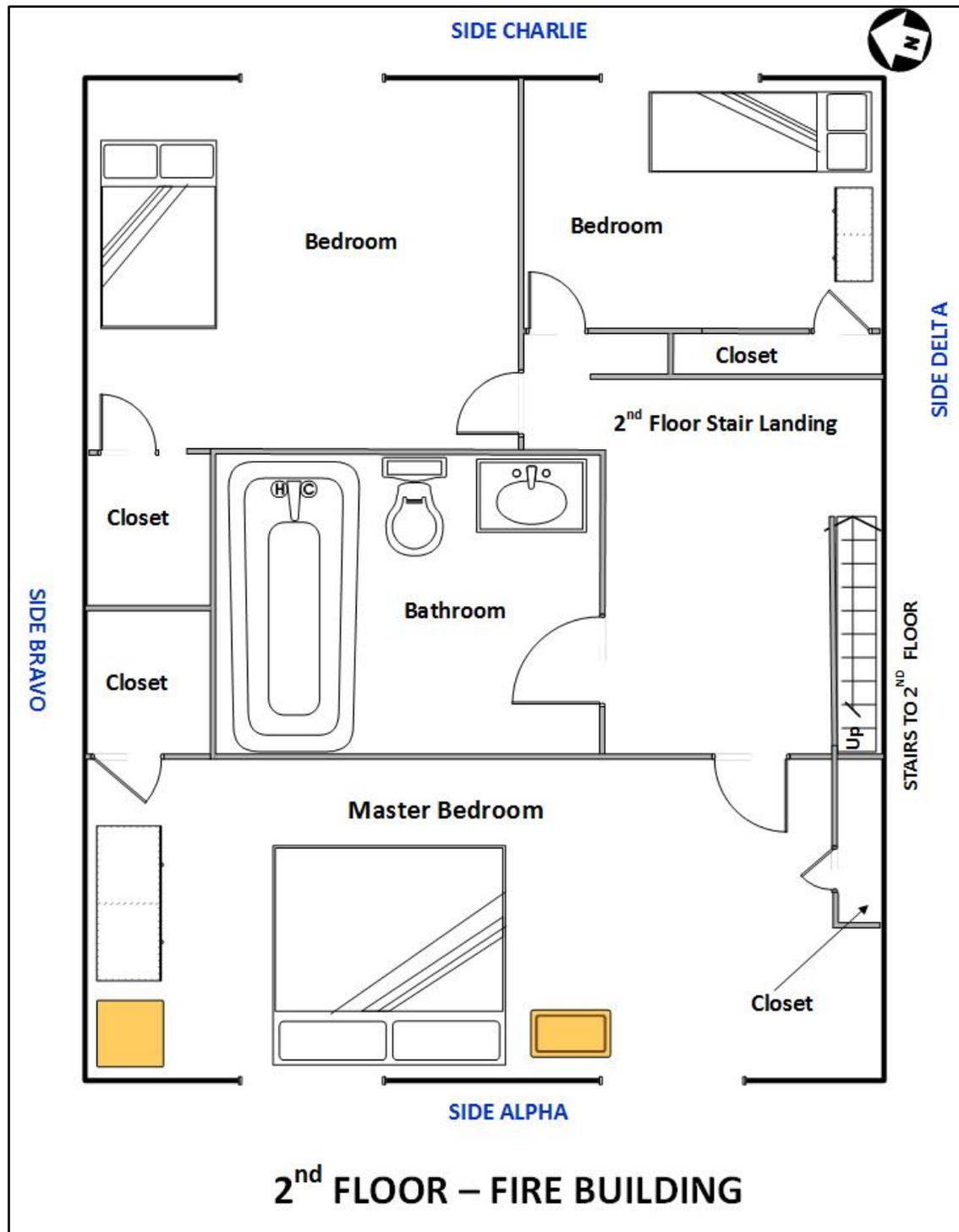


Diagram 4. The 2<sup>nd</sup> floor of the fire building.

## Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

### 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 studying the dispatch records, audio recordings, witness statements, and other available information. The timeline lists the dispatch communications and fire department response, as well as fireground communications and fireground operations. 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
<b>September 24, 2016</b>		
9-1-1 call received for a report of a residential structure fire.	02:54:38	
Fireboard dispatched a 1 <sup>st</sup> Alarm assignment for a residential structure fire with possible occupants trapped. Battalion 2, Battalion 1, Engine 1, Engine 5, Ladder 2, and Squad 4 were dispatched.	02:56:38 Hours	
Ladder 2 requested Fireboard dispatch a 4th engine. <i>Note: Per the department's SOP, the 4th due engine is assigned as the Rapid Intervention Crew (RIC).</i>	02:59:20	
	03:01:31 Hours	Ladder 2 arrived on-scene. Ladder 2 reported heavy fire showing from the rear (Side Charlie) of the structure.
	0302 Hours	Battalion 2, Battalion 1, and Engine 5 arrived on-scene.
Fireboard dispatched Skyboom 2 as the 4 <sup>th</sup> engine and as the RIC assignment.	0303 Hours	
	03:04:34 Hours	Engine 1 arrived on-scene.
	0305 Hours	Squad 4 arrived on-scene

## Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
<i>Note: 10 minutes into the incident. No water on the fire on Side Charlie.</i>	<b>03:06:10 Hours</b>	Command reported heavy fire on the 1 <sup>st</sup> floor. Two 2-inch hoselines in service. Command reported all occupants are out of the house.
	<b>0309 Hours</b>	The collapse of the 1 <sup>st</sup> floor occurred on Side Alpha. Three fire fighters had fallen into the basement.
	<b>03:10:12 Hours</b>	Command reported a Mayday and fire fighters are trapped in the basement.
Engine 16-5 (mutual aid company) self-dispatched after hearing the Mayday.	<b>03:11:56 Hours</b>	
	<b>03:12:12 Hours</b>	Command reported another Mayday. Command reported two fire fighters had fallen through the 1 <sup>st</sup> floor. The Rapid Intervention Team had been activated, which was Squad 4.  Squad 4, Team 2 was trying to make the basement from Side Charlie. Command reported contact with two fire fighters in the basement.
	<b>03:14:29 Hours</b>	Skyboom 2 arrived and parked at the entrance to the alley. The officer of Skyboom 2 and two fire fighters walked up the alley to the fire building on Side Charlie. The two fire fighters from Squad 4 were trying to get the Ladder 2 Officer out of the basement.
Squirt 3 and Ladder 1 dispatched when Command declared a Mayday. Fireboard dispatched additional BLS and ALS resources.	<b>03:14:36 Hours</b>	
<i>Note: 20 minutes into the incident. No water on the fire on Side Charlie.</i>	<b>0316 Hours</b>	

## Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

Dispatch Communications & Fire Department Response	Time	Fireground Communications & Fireground Operations
	03:17:09 Hours	Engine 16-5 arrived on-scene in the alley (Side Charlie). Skyboom 2 pulled up the alley facing Engine 16-5. Engine 16-5 stretched a 1¾-inch hoseline and started knocking down the fire on Side Charlie and moving into the basement. Skyboom 2 would not go into pump.  <i>Note: Water is on fire after 21 minutes.</i>
	03:18:02 Hours	The fire fighter from Engine 1 (Engine 1B) was pulled from the basement and removed from the structure. The fire fighter was treated on Side Alpha by EMS. Deputy 2 was on-scene and assumed Command. Deputy 2 requested a status of all on-scene resources. Deputy 2 also requested mutual aid. Battalion 2 was assigned Division Alpha.
Ladder 1 arrived on-scene in the alley and parked by the Side Bravo/Side of the row houses (See Diagram 2).	03:18:30 Hours	
Command radioed Fireboard that one fire fighter had been removed from the basement and two other fire fighters were unaccounted for at this time.	03:19:06 Hours	A second collapse of the 1 <sup>st</sup> floor into the basement on Side Charlie trapped the Ladder 2 Officer and a fire fighter from Squad 4 (Squad 4C).
Command radioed Fireboard that the 1 <sup>st</sup> floor has completely failed. Two fire fighters were still missing.	03:20:53 Hours	
Fireboard dispatched Engine 17-5 and Ladder 21-7 (mutual aid companies).	03:24:59 Hours	
	03:29:49 Hours	The fire fighter from Squad 4 (Squad 4C) was brought out of the basement. Division Charlie Supervisor requested EMS to Side Charlie.
	03:32:11 Hours	Ladder 21-7 arrived on-scene.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

<b>Dispatch Communications &amp; Fire Department Response</b>	<b>Time</b>	<b>Fireground Communications &amp; Fireground Operations</b>
	<b>0333 Hours</b>	Engine 17-5 arrived on-scene.
	<b>03:36:13 Hours</b>	Fire fighters in the basement have contact with a fire fighter from Engine 5 (Engine 5B), but they can't access the fire fighter.
	<b>03:37:41 Hours</b>	Ladder 1 on the roof reported to Command the fire is now through the roof of the structure.
Mutual Aid Medic unit B16 (basic life support) transported the fire fighter from Squad 4 (Squad 4C) to hospital. CPR was in progress.	<b>03:40:13 Hours</b>	
	<b>03:48:12 Hours</b>	The fire fighter from Engine 5 (Engine 5B) was brought out of the fire building on Side Charlie. The fire fighter was being moved to a medic unit.
	<b>03:50:05 Hours</b>	RIC (fire fighters and officers from the department as well as mutual aid fire companies) entered the basement to search for missing fire fighter. The fire fighter was possibly on Side Charlie of the basement near the doorway.
Command advised Fireboard that 1 fire fighter and possibly 1 civilian unaccounted for at this time.	<b>03:54:52 Hours</b>	
Command advised Fireboard that the roof has been vented. Still one fire fighter and possibly one civilian unaccounted for at this time.	<b>03:56:30 Hours</b>	
Command advised Fireboard that conditions of the structure are deteriorating.	<b>0421 Hours</b>	Division Charlie advised Command that crews were working around a debris pile in the basement trying to locate the missing fire fighter.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

<b>Dispatch Communications &amp; Fire Department Response</b>	<b>Time</b>	<b>Fireground Communications &amp; Fireground Operations</b>
Command advised Fireboard that all fire was knocked down.	<b>04:24:44 Hours</b>	
Command advised Fireboard that the Ladder 2 Officer was found under a debris pile in the basement.	<b>04:30:55 Hours</b>	
Command advised Fireboard that the Engine 5 fire fighter (Engine 5B) transported to the hospital.	<b>04:36:54 Hours</b>	Command conducted a PAR. Engine 1 was PAR 3. Skyboom 2, Squirt 3, and Squad 4 were PAR 4. Ladder 1 was operating on the roof and PAR.
	<b>04:58:56 Hours</b>	Command advised companies to shut down all hoselines and exit the structure.
	<b>0501 Hours</b>	The Ladder 2 Officer was located and uncovered in the debris pile. A paramedic pronounced the Ladder 2 Officer deceased. The officer was prepared for removal from the building and transport to the hospital.
Medic 5B transported the Ladder 2 Officer to the trauma center.	<b>05:08:14 Hours</b>	
Command advised Fireboard that all hotspots were knocked down and the fire was under control.	<b>05:19:52 Hours</b>	
Command advised Fireboard the following companies would remain on-scene: Engine 5, Ladder 2, Engine 16-5, and USAR 13.	<b>05:51:59 Hours</b>	

## Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

October 1, 2016	
Command to Fireboard, “Command is dissolved. All units are clear.”	1549 Hours

### Personal Protective Equipment

The NIOSH investigators inspected the personal protective equipment from the fire fighters and officers assigned to Ladder 2, Engine 1, Engine 5 (2), and Squad 4 (2) at the State Fire Marshal’s evidence facility. *Note: The fire department provides two sets of turnout gear to each member. Also, each member is assigned a portable radio.*

The turnout pants worn by Ladder 2 Officer had thermal damage to the left side. The turnout coat of the injured fire fighter from Engine 1 (Engine 1B) had thermal damage to both arms. The turnout coat of the fire fighter from Engine 5 (Engine 5B) had thermal damage to the left arm. Her turnout pants were cut off in the hospital. Also, the drag-rescue-device (DRD) was deployed. The personal protective equipment (turnout gear) was not considered a contributing factor to the fatalities in this incident. NIOSH investigators conducted no further evaluation or testing of the turnout gear.

NIOSH investigators inspected and photographed the self-contained breathing apparatus (SCBA) worn by the Ladder 2 Officer, the fire fighters from Engine 1, two fire fighters from Squad 4, and the fire fighter from Engine 5 (Engine 5B) . This process was conducted at the State Fire Marshal’s evidence facility.

Five SCBA units were shipped to the [NIOSH National Personal Protective Technology Laboratory](#) (NPPTL) in Morgantown, West Virginia, for evaluation and testing (**See Appendix One**). The entire investigation report is available on the NPPTL website.

### SCBA Internal Data Log Capabilities

NFPA 1981, *Standard for Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2007 edition, required SCBAs certified to this edition to collect and retain electronic data from the personal alert safety system (PASS). Pneumatic data log information was an option on some SCBA from various SCBA manufacturers. The SCBA involved in this incident were certified to the 2007 edition of NFPA 1981 with the exception of one SCBA, which was certified to the 2013 edition of NFPA 1981 [NFPA 2007; NFPA 2013a]. The five SCBA certified to the 2007 edition of NFPA 1981 had limited pneumatic data log capabilities. The SCBA certified to the 2013 edition had additional pneumatic data log capabilities. The Delaware State Fire Marshal’s Office secured and provided restricted access to the pneumatic data log information (**See Appendix Two**).

The SCBA used in this incident contained pneumatic data log capabilities as well as electronic PASS data log capabilities. All integrated PASS devices must meet NFPA 1981 and NFPA 1982, *Standard*

## ***Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware***

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on Personal Alert Safety Systems (PASS) [NFPA 2013a, b]. Since the 2007 edition of NFPA 1981, all integrated PASS devices have to store electronic PASS events. These include minimum PASS events such as time date stamp when activated, pre-alarm, motion alarm, user reset, and manual alarm activation [NFPA 2007].

The pneumatic events for the SCBA/PASS devices used by this fire department include:

- Document time and date on all events
- Document when the cylinder is turned on including beginning cylinder pressure
- Document intervals of at least every 30 seconds for pressure readings with a pressure resolution of a minimum of 5 liters per minute (LPM)
- A minimum of 36 hours of data collection before data points are overwritten
- Document pressure resolution of no more than 10 pound per square inch gauge (psig) increments
- Document all air cylinder milestone events (full, 75%, 50%, 33% plus or minus 2%, and end of service time indicator (EOSTI and empty) [NFPA 2013a].
- Document breathing rate. (The breathing rate is data required to be reported and stored in the SCBA. However, the breathing rate is permitted to be obtained by an external algorithm during a data log download process).

The SCBA manufacturer should provide data log software that is capable of creating and exporting a file documenting the minimum pneumatic data points. This information should be downloadable by the fire department.

SCBA manufacturers may document more than the required minimum pneumatic data points to provide more data (or finer resolution). The manufacturers should provide real-time pneumatic algorithm information such as time to an empty cylinder based on user's breathing rate. Other recorded data may be manufacturer-specific events. This information may be useful to a manufacturer or to the fire department for maintenance or training. The documented information can include evacuation alarm, evacuation confirmed, reset, pressure, and temperature (internal or external to the housing).

It is important that fire departments understand the data log capabilities and documentation based upon the manufacturer and model. There are benefits to understanding pneumatic data log capabilities when investigating reported issues or events with a particular SCBA.

### **Weather Conditions**

At 0256 hours on September 24, 2016, the following weather conditions were reported. The temperature was 68 degrees Fahrenheit (68° F), the dew point was 64.9 degrees Fahrenheit (64.9° F), the relative humidity was 90%, and the winds were calm. The sky was clear with 10 miles visibility. There had been no precipitation in the past 24 hours [Weather Underground 2016].

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

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### **Investigation**

At 0254 hours on September 24, 2016, FireBoard received a 9-1-1 call reporting a residential structure fire. At 0256 hours, FireBoard (county dispatch center) dispatched the city fire department to a report of a structure fire with possible entrapment. FireBoard dispatched Engine 1, Engine 5, Squad 4, Ladder 2, Battalion 1, and Battalion 2.

Ladder 2 was 1<sup>st</sup> due at this residential structure fire. *Note: The 1st due engine (Engine 6) was out of service due to budget constraints affecting overtime and daily staffing of companies. The fire department has to detail fire fighters throughout the city to maintain minimum staffing on a prescribed number of engine companies and ladder companies (e.g., “rolling brown outs”). Engine 6 was housed with Ladder 2. The impact of Engine 6 being out of service is unknown.* The Ladder 2 Officer provided the following size-up as Ladder 2 arrived on-scene: “Heavy fire in the rear; respond a 4<sup>th</sup> engine.” Ladder 2 stopped at the alley and could see the fire on Side Charlie. They proceeded to the front of the structure on the next street. Engine 1 responded with Battalion 2. Engine 1 arrived on-scene and laid in (from the north) from a hydrant at the nearest intersection. They parked about 30 feet behind Ladder 2. Engine 5 laid in from the opposite direction (from the south) and parked facing Ladder 2 (**See Diagram 5**). Battalion 2 arrived on-scene and parked near the intersection. Engine 5 laid out from the hydrant at this intersection. Battalion 2 walked to the front of the fire building with the accountability board. Battalion 2 talked to the owner of the residence and asked about the occupants. The owner said all occupants were out of the building.

Engine 1B stretched 300 feet of uncharged 2-inch hoseline to the front door. The stretch was difficult due to moving the hose around parked cars on the street. Upon arrival, Engine 5 stretched 200 feet of 2-inch hose to the front door. The front door was open but the storm door was closed. Smoke was pushing out under pressure. When the storm door was opened, heavy fire came out. Engine 1 and Engine 5 started flowing water on the fire. The Engine 5 Officer was on the nozzle of a 2-inch hoseline and was unaware of the location of Engine 5B. The time was approximately 0306 hours. The fire fighter from Engine 5B told the Engine 1 Officer, she was hot and moved away from the structure. The driver of Engine 1 helped the Engine 5B adjust her facepiece, protective hood, and gloves. She immediately returned to the hoseline.

Engine 1B entered the house with the hoseline and went to the left and then toward the dining room and kitchen. The Ladder 2 Officer and Ladder 2B were going to the 2<sup>nd</sup> floor to search for occupants. Engine 5B was left of Engine 1B. Engine 1B went about 10 feet into the living room when the floor became soft.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

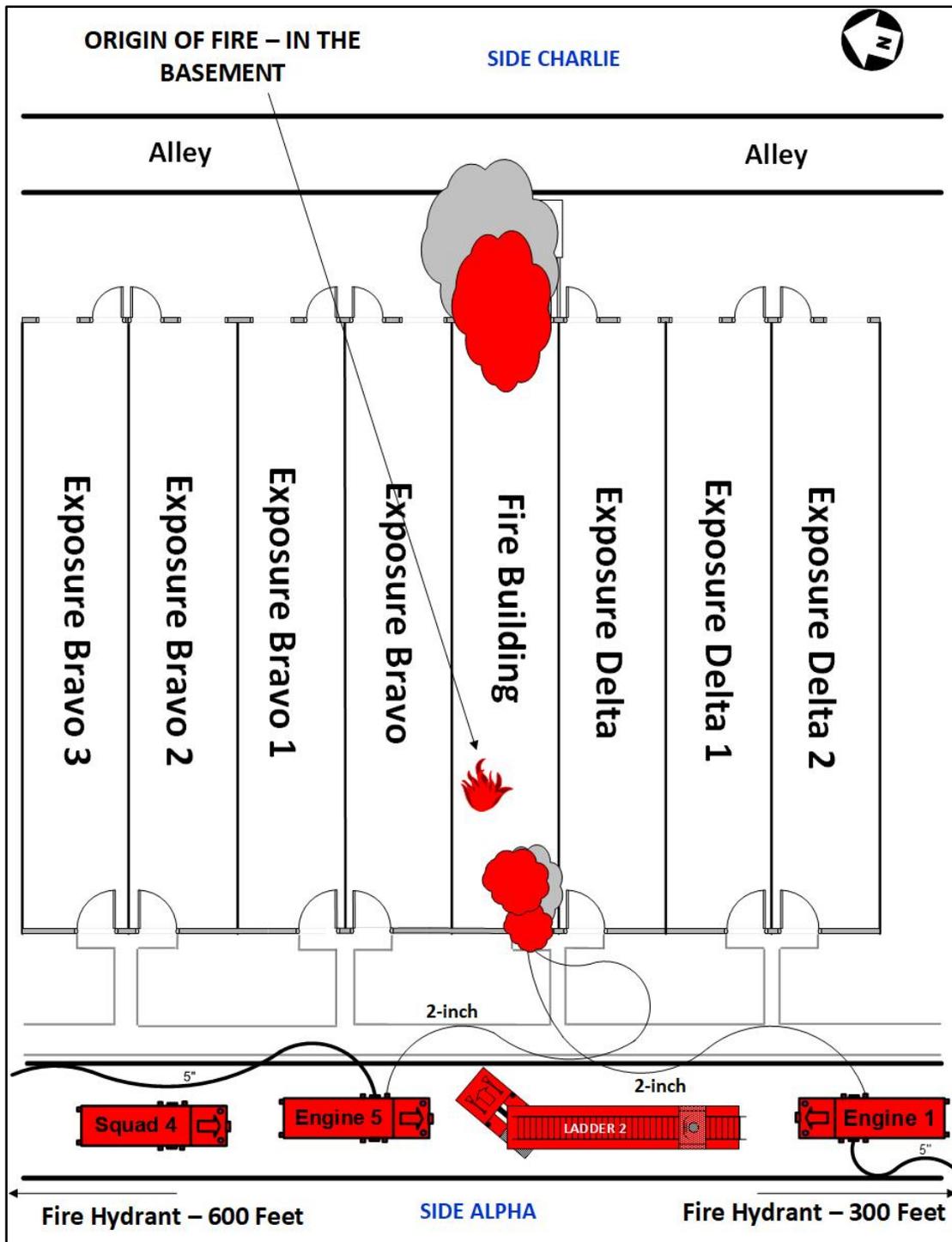


Diagram 5. The deployment of 1<sup>st</sup> Alarm companies during initial fireground operations. The time is approximately 0306 hours.

## ***Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware***

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He told the Engine 1 officer the floor was soft and to get out. The Engine 1 officer shouted for everyone to get out of the house. At this time, the following members were inside the living room: Ladder 2 Officer, Ladder 2B, Engine 5 Officer, Engine 5B, Engine 1 Officer, and Engine 1B (**See Diagram 6**). Squad 4 arrived on-scene at 0305 hours and parked behind Engine 5. Squad 4 abandoned the apparatus and split into two crews. The Squad 4 Officer, a fire fighter, and the driver of Squad 4 went toward the front door to search the 2<sup>nd</sup> floor per the orders of Command. The other two fire fighters (Squad 4C and Squad 4D) went toward Side Charlie.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

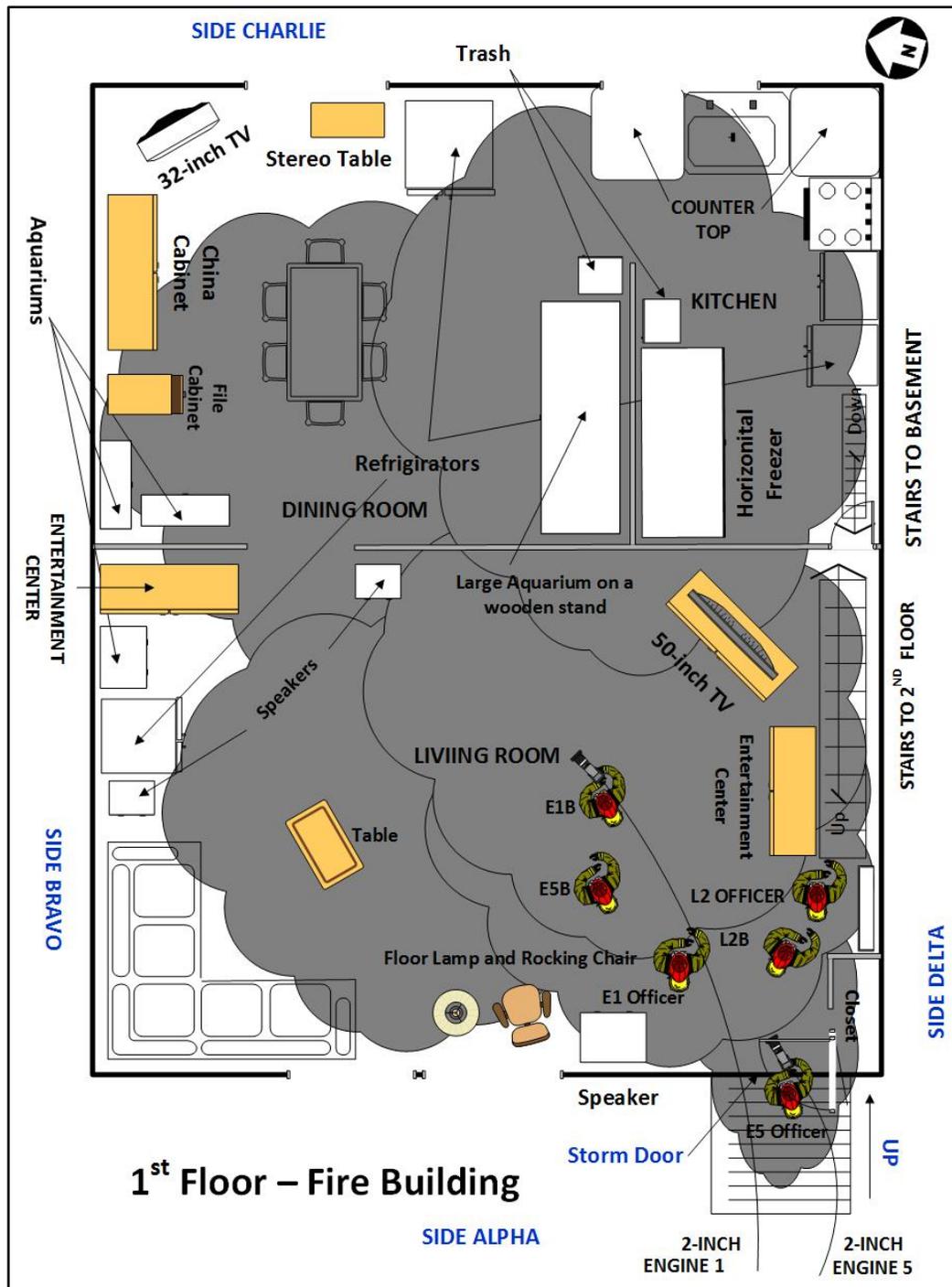


Diagram 6. Crews from Engine 1 (E1), Engine 5 (E5), and Ladder 2 (L2) entered the 1<sup>st</sup> floor for search and fire attack. The time was approximately 0307 hours.

## ***Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware***

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At approximately 0309 hours, the collapse of the 1<sup>st</sup> floor into the basement occurred. The officer of Engine 5 and Ladder 2B struggled to get out the front door. The fire fighter from Engine 1 fell backwards into the basement. The Engine 1 officer grabbed the fire fighter from Engine 1, but the fire fighter let go so he would not pull the Engine 1 officer into the basement. The fire fighter from Engine 1 saw the fire fighter from Engine 5 (Engine 5B) fall into the basement (**See Diagram 7**). When the fire fighter from Engine 1 (Engine 1B) landed in the basement, he was closer to the Side Alpha/Side Bravo corner. The Ladder 2 Officer fell toward the Side Alpha/Side Delta corner. The lieutenant then started to crawl toward Side Charlie of the basement. Engine 1B searched and found Engine 5B.

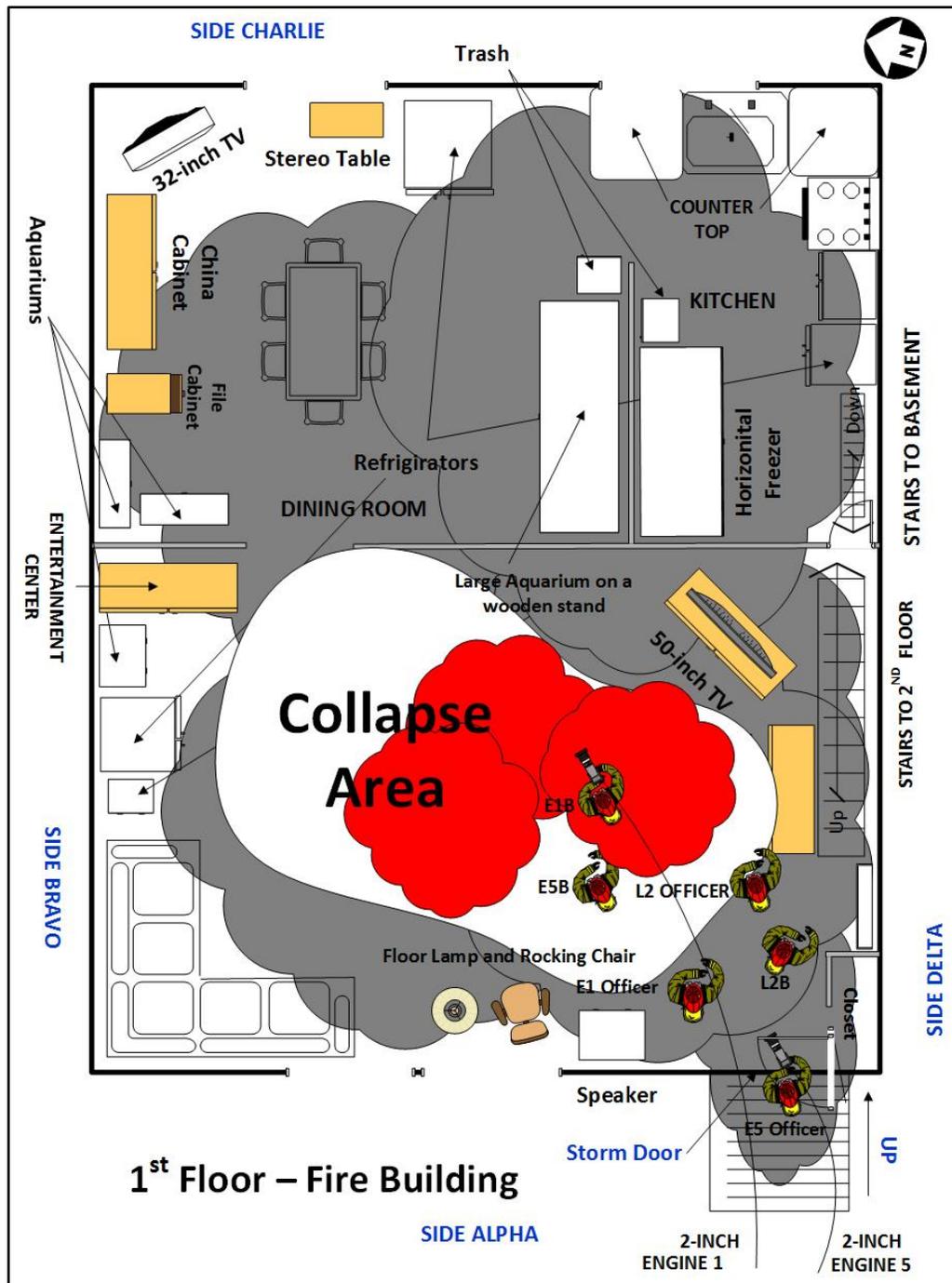
The Engine 1 Officer got outside and met Battalion 2. He asked Battalion 2 to transmit a Mayday due to the collapse of the living room floor. Battalion 2 transmitted the Mayday to FireBoard, stating, “Mayday; fire fighters are trapped on the 1<sup>st</sup> floor.” The time was approximately 0310 hours. Fire was blowing out of the doorway and the 1<sup>st</sup> floor windows. The Engine 1 Officer also transmitted a Mayday. At 0312 hours, Command advised that a fire fighter from Engine 1 (Engine 1B) and the fire fighter from Engine 5 (Engine 5B) had fallen through the 1<sup>st</sup> floor into the basement.

At approximately 0313 hours, all crews were still operating on Side Alpha. Three fire fighters were in the basement: Engine 1B, Engine 5B, and the Ladder 2 Officer. Once the collapse of the 1<sup>st</sup> floor occurred, fire was blowing out of the 1<sup>st</sup> floor and the basement windows. Command had to deal with locating and rescuing the fire fighters in the basement, controlling the fire, maintaining resource status, and requesting extra resources. The time was approximately 0313 hours. The following resources were on-scene at this time: Engine 1, Engine 5, Ladder 2, Squad 4, Battalion 2, and Battalion 1.

Engine 16-5 from a volunteer fire company, approximately 1 mile from the incident, self-dispatched after hearing the Mayday. Ladder 1 was enroute and Squirt 3 was being dispatched. At 0314 hours, Skyboom 2 arrived at the entrance to the alley (south of the fire building and on Side Charlie). The Skyboom 2 Officer and two fire fighters walked up the alley to the fire building. The driver of Skyboom 2 eventually drove Skyboom 2 up the alley and parked near the fire building. Skyboom 2 did not lay a supply line down the alley.

After the collapse, Command assigned Squad 4, as a rapid intervention crew (RIC) to locate the missing fire fighters. The Squad 4 Officer and two fire fighters (Squad 4A and Squad 4B) went in the front door with a 2-inch hoseline. The fire fighter from Ladder 2 (Ladder 2B) had a 2-inch hoseline spraying water in the basement window on Side Alpha. The Engine 1 Officer and a fire fighter from Engine (Engine 5C) entered Exposure Delta. They worked their way through the structure to the basement and out to the alley. Two fire fighters from Squad 4 (Squad 4C and Squad 4D) went to Side Charlie, which had heavy fire showing. At this time, no water had been put on the fire from Side Charlie. The two fire fighters from Squad 4 entered the basement of Exposure Bravo and searched the structure. They found the structure clear and returned to Side Charlie. The driver and the tillerman put Ladder 2’s aerial ladder to the roof. Both fire fighters were assigned to vent the roof. The tillerman cut a hole in the roof and heavy smoke and fire came out, plus the tar roof was bubbling. Also, they took out the skylight. Then both fire fighters left the roof.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware



**Diagram 7. The 1<sup>st</sup> floor collapse occurred approximately three minutes after the arrival of the 1<sup>st</sup> Alarm Assignment. Three fire fighters (L2 Officer, Engine 1B, and Engine 5B) fell into the basement. The time was approximately 0309 hours.**

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

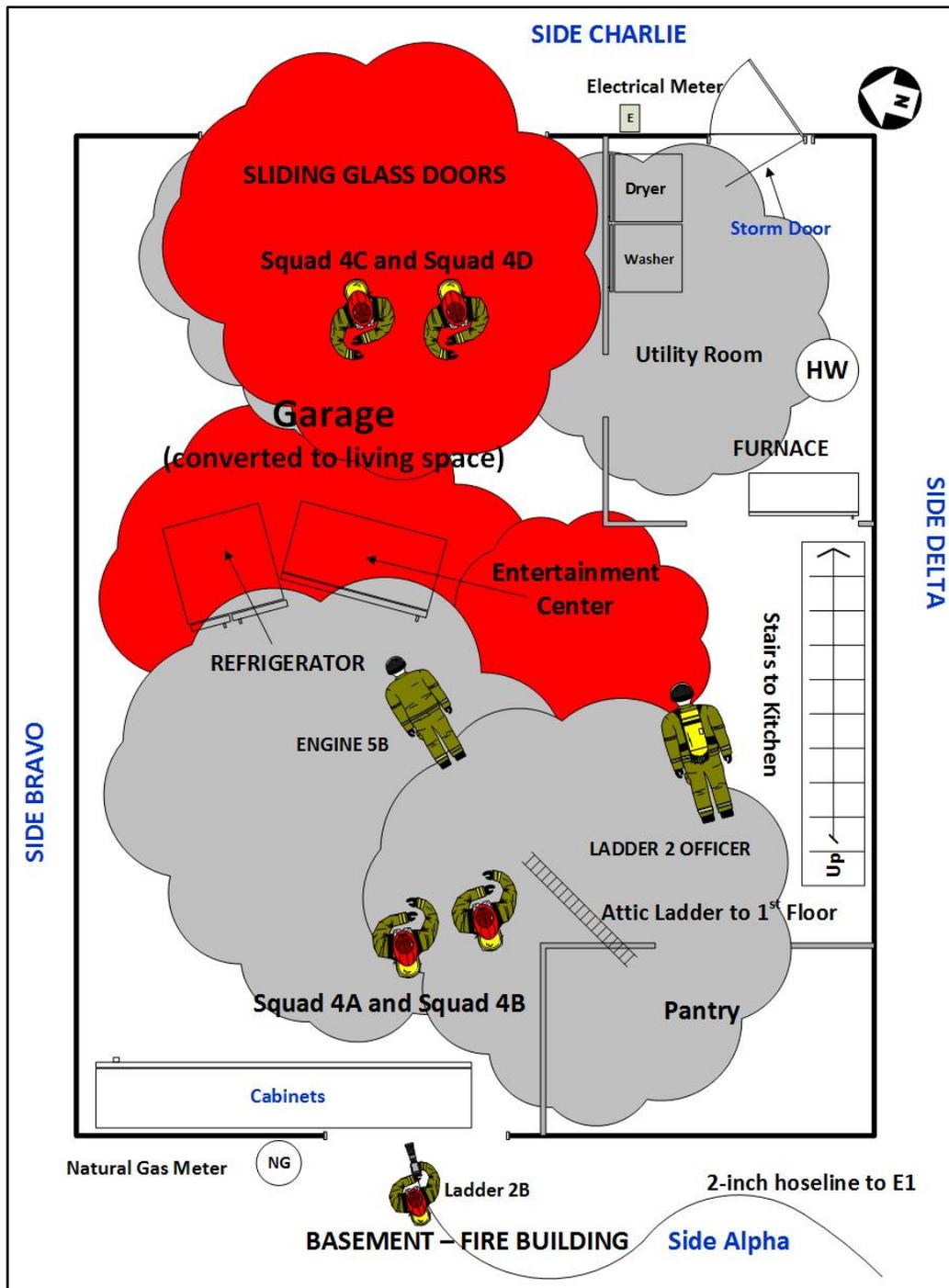
Squad 4 entered the 1<sup>st</sup> floor and one fire fighter started flowing water in the basement to knock down the fire. Someone from Squad 4 requested an attic ladder. An attic ladder was brought into the 1<sup>st</sup> floor and placed in the opening. The driver from Squad 4 (Squad 4A) went down the attic ladder into the basement. The fire fighter found the Engine 1B and talked to him. The fire fighter from Squad 4 helped Engine 1B to the attic ladder. Squad 4A climbed up the attic ladder and then pulled Engine 1B out of the basement to the 1<sup>st</sup> floor. An off-duty fire fighter arrived on-scene. He went to the front door and he assisted Engine 1B off the porch and down to the main sidewalk. The fire fighter was turned over to county EMS personnel. The driver of Engine 1 assisted with getting Engine 1B to the sidewalk. The time was approximately 0318 hours. Deputy 2 arrived on-scene as Engine 1B was being brought out Side Alpha. Deputy 2 assumed Command after a face-to-face with the incident commander (Battalion 2). Deputy 2 requested a status of units and also requested mutual aid from FireBoard.

The off-duty fire fighter then put on his PPE and took an SCBA off Engine 5, talked to Command, and then entered the 1<sup>st</sup> floor. He was trying to get into the basement. He called for another attic ladder, which took time to get. The Engine 5 Officer was flowing water into the basement from the 1<sup>st</sup> floor. Once he had an attic ladder, the off-duty fire fighter went into the basement trying to locate the Engine 5B. He made contact with Engine 5B. Engine 5B was screaming she was trapped. There was quite a bit of debris on top of her. The off-duty fire fighter worked to get the debris off her. Engine 1C climbed down into the basement. The off-duty fire fighter got a knife from Engine 1C and cut the SCBA straps. *Note: Engine 5B was found without her helmet, SCBA facepiece, and protective hood.* The off-duty fire fighter noticed that Engine 5B was pinned under a refrigerator that had fallen from the 1<sup>st</sup> floor. He was able to move the refrigerator enough to free Engine 5B.

A second fire fighter from Squad 4 went down the attic ladder into the basement. The off-duty fire fighter told the Squad 4 fire fighter that he was out of air and had to get out. The off-duty fire fighter got Engine 5B to the bottom of the attic ladder, sitting up. The fire fighter from Squad 4 that was in the basement did not have contact with Engine 5B. She was with Engine 1C, who then left the basement due to being out of air. Another fire fighter from Squad 4 immediately entered the basement via the attic ladder. Both fire fighters from Squad 4 couldn't find Engine 5B because she had moved further into the basement towards Side Charlie (**See Diagram 8**).

The Engine 1 Officer and Engine 5C entered Exposure Delta trying to get to Side Charlie. The time was approximately 0314 hours. The two fire fighters worked their way to Side Charlie by going through the kitchen, down the interior steps to the basement, and outside to Side Charlie. As the Engine 1 Officer got into the alley, the chauffeur had pulled Skyboom 2 up the alley. Skyboom 2 did not lay a supply line up the alley. Once Skyboom 2 was parked in the alley, fire fighters from Skyboom 2 were stretching a 2-inch hoseline to Side Charlie. Heavy fire was blowing out of all three floors of the fire building on Side Charlie. Skyboom 2 was not able to go into "pump" due to the maxi-brake not being set. At this point, no water has been put on the fire on Side Charlie. The time was approximately 0317 hours.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware



**Diagram 8.** The fire fighter from Engine 1 had been rescued from the basement. Fire fighters were trying to locate the fire fighter from Engine 5 and the officer from Ladder 2 in the basement. The time was approximately 0320 hours.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

Team 2 of Squad 4 (Squad 4C and Squad 4D) went into the basement through the doorway on Side Charlie. They could hear the Ladder 2 Officer calling for help. Squad 4C remembered seeing the refrigerator lying on the basement floor. He entered the utility room and saw the basement stairs located near Side Alpha. He found the Ladder 2 Officer who said, “My back is broken, I can’t move my legs.” The Ladder 2 Officer was still on air. Squad 4D entered the mudroom. They grabbed Ladder 2 Officer’s SCBA harness and were pulling him through the utility room towards Side Charlie. Squad 4D fell backwards and the Ladder 2 Officer landed on him. Squad 4C helped get the officer off the fire fighter. They continued pulling the Ladder 2 Officer toward Side Charlie. Battalion 1 (Division Charlie) was standing in the basement saying get down, get low. Squad 4D stated he remembered seeing the 1<sup>st</sup> floor on fire when he went into the basement. The conditions in the basement were deteriorating from the fire. Engine 5C entered the basement and met the two fire fighters from Squad 4. He was helping pull the Ladder 2 Officer out of the building. The 2<sup>nd</sup> floor collapsed onto the 1<sup>st</sup> floor, which collapsed into the basement. The collapse caused the refrigerators to fall into the basement and on top of Squad 4C and the Ladder 2 Officer. The collapse pushed Engine 5C toward the doorway of the building. He grabbed Squad 4D and pulled him completely out of the basement. Engine 5C got Squad 4D to Side Alpha for medical treatment. The time was approximately 0320 hours.

Engine 16-5 pulled down the alley toward Skyboom 2. Once the apparatus was parked, the officer of Engine 1 ordered Engine 16-5 to stretch a hoseline to the doorway and knock down the active fire. Engine 16-5 stretched a 2-inch hoseline and worked on knocking down the fire in the basement. Engine 16-5 ran out of water while a 5-inch supply line was being hand-stretched to the hydrant approximately 700 feet away. Once a water supply was established, the hoseline was charged again. A chief from Company 17 took down the man door in the garage. *Note: The chief from Company 17 responded in a chief’s vehicle and arrived on-scene prior to Engine 17-5 arriving on-scene.* There was a filing cabinet behind the door. The power meter was burning on the exterior wall. An Engine 16-5 fire fighter with the hoseline went inside with the chief from Company 17, Engine 5C, and the Engine 1 Officer. The fire fighter with the hoseline was knocking down the fire in the basement (**See Diagram 9**). The other fire fighters were crawling across the debris pile from the collapse looking for the missing fire fighters. One of the fire fighters saw the reflective trim from turnout pants in the debris pile. *Note: Based upon the interviews with all the fire fighters in the basement at this time, fire fighters located Squad 4C by seeing the reflective trim on this turnout pants. None of the fire fighters can remember if Squad 4C’s PASS alarm was sounding, though the data logger indicated the PASS was in alarm.*

The fire fighters started digging and found the Squad 4C. The fire fighter was face down on his left side and wearing everything but his helmet. The fire fighters got Squad 4C to the alley. Members of the fire department removed his turnout gear and started CPR. At 0329 hours, the Division Charlie Supervisor requested EMS to Side Charlie for CPR in progress on Squad 4C.

# Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware

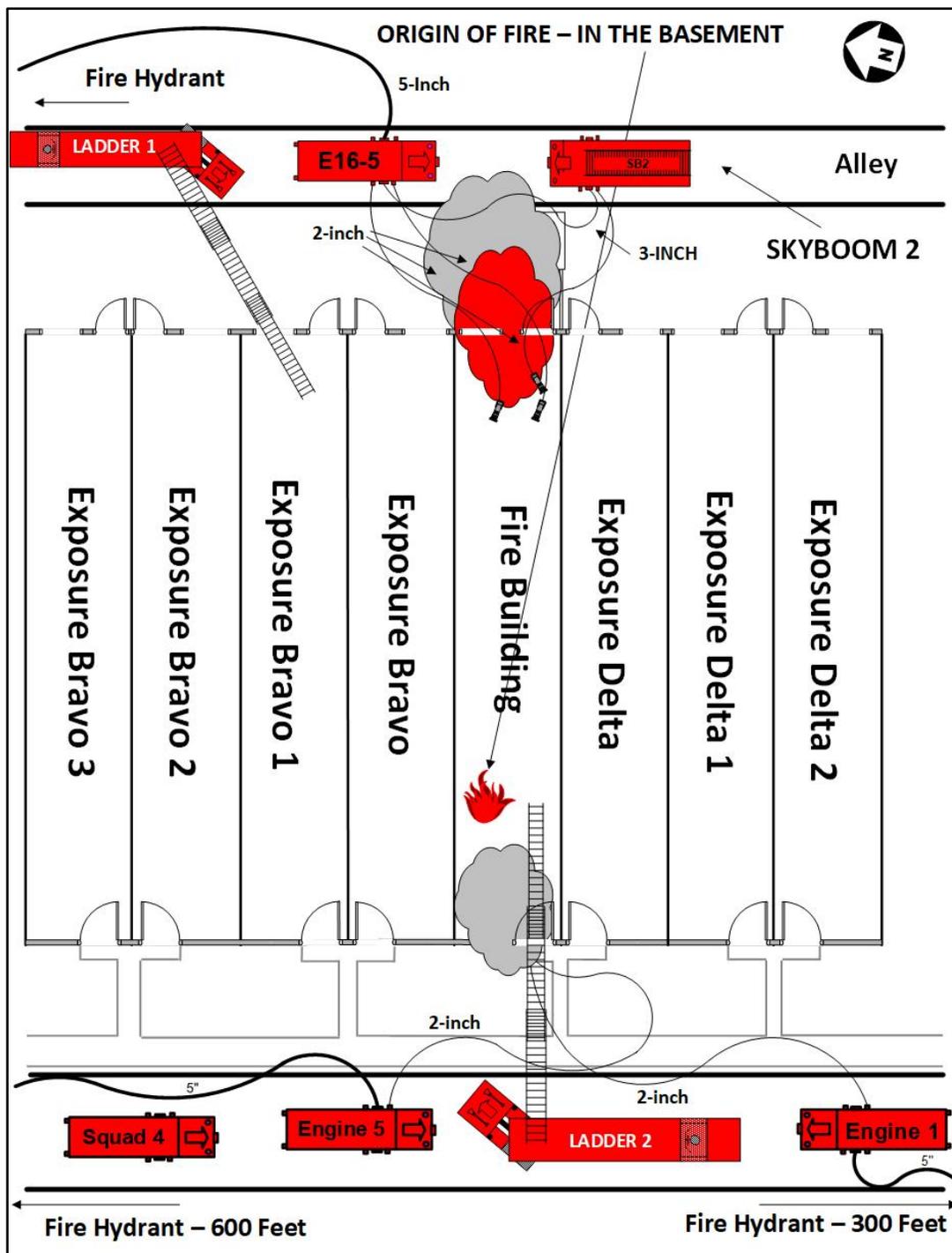


Diagram 9. The apparatus placement during operations from Side Alpha, Side Charlie, and the roof. The time is approximately 0329 hours.

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After Squad 4C was removed from the structure, the Engine 1 Officer and three fire fighters from Ladder 21-7 entered the basement from Side Charlie. They crawled over the debris pile, which was 3 – 4 feet high and moved toward the middle of the basement. There was heavy smoke and moderate heat in the basement. As the fire fighters were moving toward the middle of the basement, they encountered a refrigerator and filing cabinet. They heard Engine 5B calling for help while they tried to locate her. The time was approximately 0336 hours. The Engine 1 Officer ordered two fire fighters to climb over the refrigerator to try and find Engine 5B. The two fire fighters from Ladder 21-7 found Engine 5B kneeling on the floor with no SCBA, helmet, protective hood, or gloves. A fire fighter from Ladder 21-7 was on top of the refrigerator and the other two fire fighters were with Engine 5B. They pulled and lifted her up and over the refrigerator. The four fire fighters were able to carry Engine 5B to a stretcher in the alley. The time was approximately 0348 hours. Engine 5B was conscious and talking to the fire fighters and EMS personnel. Engine 5B was taken by a medic unit to a landing zone approximately half-mile from the incident. She was airlifted to a local trauma center.

A rapid intervention crew was formed using fire fighters from Skyboom 2, the Engine 1 Officer, and Engine 17-5 to locate the Ladder 2 Officer in the basement. The collapse of the 1<sup>st</sup> floor and 2<sup>nd</sup> floor covered most of the basement from Side Bravo to Side Delta with debris, which was 3 – 4 feet in height. They started removing the debris and then heard a PASS alarm. The Engine 1 Officer thought the Ladder 2 Officer was more toward Side Alpha. The fire fighters started digging and found a pant leg. The recovery process was started. At 0430 hours, Command notified Fireboard that the Ladder 2 Officer had been located in the debris pile. Crews were in the process of removing the lieutenant. Crews finally uncovered and prepared the Ladder 2 Officer for removal from the structure. A paramedic pronounced the Ladder 2 Officer deceased in the basement. The Ladder 2 Officer was covered with an American flag, removed from the structure, and transported to the trauma center at 0508 hours.

At 0519 hours, Command advised Fireboard that the fire was under control. At 0551, Command was developing an incident action plan for demobilizing companies and resources. The county urban search and rescue (USAR) resources that had been dispatched, were now on-scene. Command was developing an incident action plan for reinforcing the 1<sup>st</sup> floor and 2<sup>nd</sup> floor of the structure. This process was being put in place to allow fire investigators access to all floors of the structure. The investigation process would be completed on October 1, 2016, at 1549 hours when Command was dissolved and all units were back in service.

*Note: The fire was ruled arson by fire investigators. A female occupant was charged with arson.*

### **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:

- Sliding glass door open on Side Charlie

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- Lack of scene size-up and risk assessment
- Lack of incident management and Command Safety
- Lack of an incident action plan
- Inappropriate fireground tactics for below grade fire
- Lack of company/crew integrity
- Lack of personnel accountability system
- Lack of rapid intervention crew(s)
- Ineffective fireground communications
- Lack of professional development for fire officers and fire fighters.

### **Cause of Death**

The cause of death for the 41-year-old lieutenant and a 51-year-old senior fire fighter was asphyxiation and thermal burns. The manner of death was ruled a homicide by the county medical examiner in the state of Delaware. The cause of death of the 48-year-old female fire fighter was complications of thermal burns from being injured in an arson fire. The manner of death was ruled a homicide by the county medical examiner in the Commonwealth of Pennsylvania.

### **Recommendations**

***Recommendation #1: As part of the strategy and incident action plan, the incident commander should ensure a detailed scene size-up and risk assessment occurs during initial fireground operations, including the deployment of resources to Side Charlie. Scene size-up and risk assessment should occur throughout the incident.***

Discussion: The strategy and incident action plan (tactics) of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. The priority is to get fire department resources to Side Charlie as quickly as possible. However, unless an obvious life safety issue exists (e.g., visible victims requiring immediate assistance), interior firefighting operations should not commence until a report from Side Charlie is received. If physical barriers make the 360-degree size-up impractical for the 1<sup>st</sup> 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 1<sup>st</sup> Alarm. Even if a 360-degree size-up was conducted, resources should be assigned to Side Charlie. Resources could be any unit—engine, truck, medic unit, or chief—preferably an engine company with a hoseline [Fire and Rescue Departments of Northern Virginia 2013]. 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 1<sup>st</sup> priority, followed by incident stabilization (2<sup>nd</sup> priority) and then property conservation (3<sup>rd</sup> priority). The ability to ensure for the safety of fire fighters 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. The incident commander should use the following risk management principles:

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- Activities that present a significant risk to the safety of fire fighters 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 fire fighters, and the actions shall be taken to reduce or avoid these risks.
- No risk to the safety of fire fighters 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 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 standard operating procedure (SOP) to implement.
- If there were 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.
- 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 [Modern Fire Behavior 2014; TSFRS 2014]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

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

The International Association of Fire Chief (IAFC) has developed a set of [Rules of Engagement for Structural Firefighting](#) that, when applied to fireground operations, will improve risk assessment and safety for firefighters. The Rules of Engagement also serve as a best-practice model procedure for fire departments to adopt in their own SOPs. The Rules of Engagement can also serve as an excellent training document. The Rules of Engagement integrate several nationally recognized safety-related programs and principles. They include risk-assessment principles from NFPA Standards 1500 and 1561. The Rules of Engagement also align well with the concepts in the IAFF's [Fire Ground Survival Program](#). Additionally, the development process also included review of lessons learned from

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numerous firefighter fatality investigations conducted by NIOSH's [Fire Fighter Fatality Investigation and Prevention Program](#).

The Rules of Engagement recognize that those at most risk are the firefighters and company officers operating in the hazard zone and so integrate them into the risk-assessment and decision-making process. The Rules of Engagement allow them fully to say no to unsafe conditions or practices and report such situations, without penalty, through a structured process.

Because the development process involved so many national fire service organizations and broad public comment to achieve consensus, along with an increasing number of organizations and individual fire departments that are formally adopting the Rules of Engagement, they have now evolved to the point of being considered a standard of practice for the fire service [IAFC 2012].

### **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. You are required to 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.

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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].

The fire service has recently been introduced to (and 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 1<sup>st</sup> 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 2015b].

The acronym *SLICE-RS* is not designed to replace the well-known *RECEO-VS* method that was developed by Chief Lloyd Layman 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 2015b].

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 10**).

*S-RECEO-VS* is:

- **Size** up or estimate of the situation
- **Rescue**
- **Exposures**
- **Confinement**
- **Extinguishment**
- **Overhaul**
- **Ventilation**
- **Salvage** [Layman 1953].

The rescue and salvage operations are self-explanatory—if anything can be saved, save it. These two actions are always active, right from sizing up to extinguishing. The identification of the flow path is

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**Diagram 10. Lloyd Layman's "Basic Division of Firefighting Tactics"**

critical during initial fireground operations and communicated to the incident commander. In addition, this issue should be part of every after-action review of an incident.

Establishing a continuous and uninterrupted water supply is vital and one of the most critical elements of fireground operations. This should be done before or in conjunction with committing crews to interior operations. To ensure a water supply is secured, many fire departments require, per standard operating procedure (SOP), that the 2<sup>nd</sup> due engine company and 4<sup>th</sup> due engine company should secure a water supply for the 1<sup>st</sup> due engine company and 3<sup>rd</sup> due engine company [Fire and Rescue Departments of Northern Virginia 2013].

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

- Life hazard (must be given 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].

At this incident, as the Ladder 2 Officer was arriving on-scene, he radioed Fireboard that heavy fire was showing from Side Charlie and requested a 4<sup>th</sup> engine company respond. Ladder 2 proceeded to Side Alpha of the fire building, as did Engine 1 and Engine 5. Squad 4 arrived on-scene and went to

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Side Alpha of the fire building. No companies were deployed to Side Charlie until Skyboom 2 arrived in the alley. Skyboom 2 did not lay a supply line. Engine 16-5 arrived on-scene and pulled into the alleyway facing Skyboom 2. Skyboom 2 would not go into “pump” due to the maxi-brake not being set. Engine 16-5 was the first company to get water on the fire, which was 21 minutes after dispatch. Also, fire fighters from Engine 16-5 had to hand-jack a 5-inch supply line approximately 700 feet.

***Recommendation #2: Fire departments should develop and implement a standard operating procedure/guideline for tactical operations involving below grade fires.***

Discussion: One of the most dangerous and most difficult fire locations in a structure for a fire fighter is below-grade. Below-grade fires can include basements, cellars, and sub-cellars.

Recognizing a below grade fire is essential to ensuring the proper strategy and tactical objectives are developed for the incident. 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; and requires adequate staffing for hoseline placement, operation, and ventilation; and fire fighters may be working over the fire [NIOSH 2018]. Additionally, the increased risk to fire fighters is due to:

- Limited entry and egress into a basement
- Working above the fire
- Weakened floor joists and rafters
- Being caught in the fire’s exhaust portion of the flow path
- Unknown fire loading
- Ventilation concerns
- Utility panels and meters plus connections
- Hanging wires
- Furniture and appliances.

The important factors to remember include:

- access - how easily can you get water in; make an attack via a window or a walk-out door.
- ventilation – no ventilation to the below grade area, no flashover. Potential ventilation via windows or doors connected to the below grade compartments enable rapid changes in fire growth, create uni-directional exhaust flows in the stairwell(s) and allow for an increased burning rate of a wood floor assembly, which increases floor collapse potential and reduces safe operating time on the floor above.
- ventilation of the below grade space is the key factor in fire fighter line of duty deaths including the Pang Fire (Seattle, WA); the Cherry Road Fire (Washington, DC); the Squirrelsnest Lane Fire, Colerain, OH; the Berkley Way Fire, San Francisco, CA; and the Pater Road Fire, Hamilton, OH. [Madrzykowski D, and Weinschenk C 2018].

Key factors in recognizing a below-grade fire are:

- fire or smoke venting from a cellar window, smoke pushing from the chimney (especially during warmer weather).

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- heavy smoke with no visible fire on the 1<sup>st</sup> floor.
- floorboards may not be hot. Look for smoke around the edges of the baseboard or HVAC duct.
- smoke from attic windows or louvered 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 must stretch enough hoseline to reach the upper floors. Intermediate floors must be checked for fire before a hoseline is committed to the top floor because floor construction can isolate the fire. 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 post-flashover basement fires, even after starting to lose the structural integrity of the floor supports the following:

- may not generate high heat conditions on the floor above.
- may not provide clear information on the level of hazard to a thermal imager.
- may hold up to a strike from a tool during sounding but may not be able to carry the weight of a fire fighter or fire fighters [Kerber et al. 2012; Madrzykowski and Kent 2011].

Standard operating procedures must consider numerous factors that affect fire-fighting operations. This will ensure essential strategic-, tactical-, and task-level functions are performed by the incident commander, division/group supervisors, company officers, and fire fighters. Additionally, this process compliments the defined knowledge, skills, abilities, competencies, and fireground experience to assist:

- The incident commander to plan and implement an effective strategy and incident action plan.
- Division/group supervisors to formulate and follow tactics.
- Company officers to successfully carry out assigned tasks.
- Fire fighters to effectively perform their duties and functions [FDNY 2013].

A fire department's standard operating procedure 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.

The strategy and tactics of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. The priority is to get a fire department unit to Side Charlie of the structure. However, unless an obvious life safety issue exists (e.g., visible victims requiring immediate assistance), interior firefighting operations should not commence until a report from Side Charlie is received. If physical barriers make the 360-degree size-up impractical for the first

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arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta may be delegated to another engine company on the 1<sup>st</sup> Alarm. Even if a 360-degree can be conducted, the 2<sup>nd</sup> due engine company or 3<sup>rd</sup> due engine company and the 2<sup>nd</sup> due truck company should be assigned to Side Charlie [Fire and Rescue Departments of Northern Virginia 2013].

Below grade fires are one of the most challenging situations fire fighters encounter. As with all fires, a risk assessment and an occupant survivability profile should be conducted to evaluate what is at risk, lives or 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 standard operating procedures based on recommendations from post incident analysis reports.

At this incident, the fire department did not have a standard operating procedure or guideline for fighting below grade fires. Based upon the interviews conducted during this investigation, the procedure for any fire attack in a structure was through the front door on Side Alpha. The fire department was familiar with the construction and design of the row houses in this area of the city. There had been other structure fires in this neighborhood.

***Recommendation #3: Fire departments should ensure that the incident commander develops and communicates the strategy and incident action plan (tactics) during the initial stages of the incident. The incident action plan should be updated when benchmarks are met/not met.***

Discussion: Fireground operations are very dynamic and fast-paced. An incident commander must determine a strategy and then develop the incident action plan (IAP) to ensure that the proper actions take control of the incident. The incident commander must 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), and then 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].

At this incident, the Ladder 2 Officer provided an initial scene size-up indicating heavy fire showing from Side Charlie. The original IAP did not include the assigning of initial resources to Side Charlie. All resources operated from Side Alpha. Initially the first arriving companies did not realize the fire was in the basement until they were operating on the 1<sup>st</sup> floor prior to the collapse.

To ensure a standard outcome of each incident, the incident commander should match the standard conditions to standard actions. This is the core of the incident command system and is the basis for all operations. Standard conditions are identified as the incident’s ***current*** critical factors:

- Identify the incident’s critical factors before taking any action.
- Initial and ongoing size-up of the incident’s critical factors must produce the information that becomes the basis for the current incident strategy and IAP.

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- Current, accurate, and relevant information provides the foundation for effective initial and ongoing action.
- The goal of this systematic evaluation process continually produces standard, safe, well-managed incident outcomes [MABAS 2017].

The IAP should match the defined strategy established by an incident commander for a particular incident. The defined strategy describes 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 then followed by the tactical objectives. At each incident, the incident commander should start with a standard placement-oriented operational plan that develops a strong, dependable beginning for command and control of the incident. While developing the strategic goal for the incident is the first component, the incident commander needs to produce detailed tactical objectives that can be assigned to responding companies. This is the purpose of the IAP [Brunacini 2002; Fire and Rescue Departments of Northern Virginia 2013].

The initial incident commander, most often, is a company officer who arrives on-scene prior to a command officer. The company officer should provide a detailed size-up, which is communicated to all responding resources including the dispatch center. The company officer assumes command and makes a decision regarding 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].

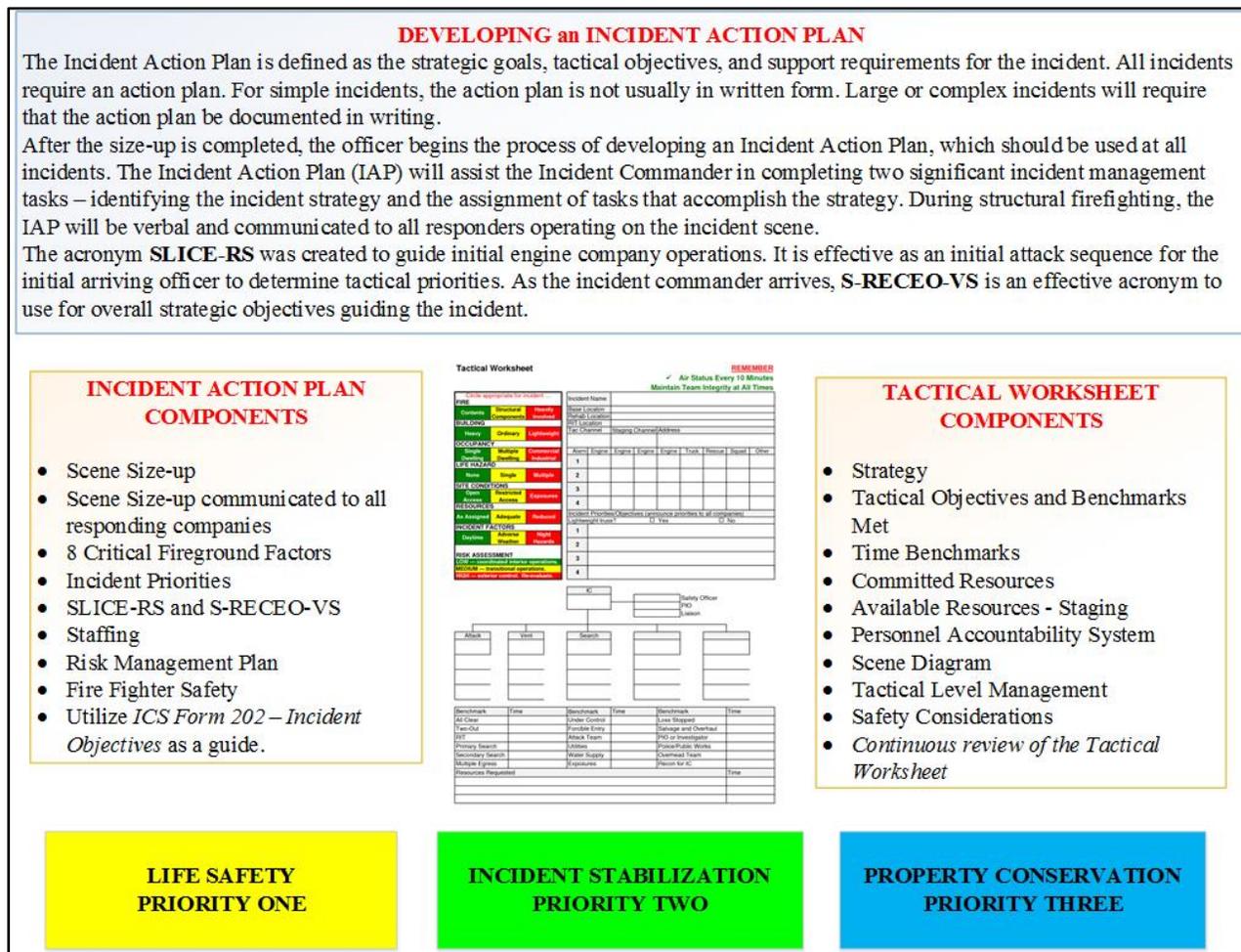
The IAP can be as simple as a verbal transmission to all units assigned to an incident. Once an officer assumes command, the overall strategy – either offensive or defensive is communicated. Command can make specific assignments to arriving companies along with tactical objectives such as search, rescue, 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 incident commander 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 that reflects the overall incident strategy, tactics, risk management, and member safety that are developed by an incident commander. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* [NFPA 2014] requires the following regarding an incident action plan:

- 5.3.12.1 The incident commander shall be responsible for developing and/or approving an incident action plan (IAP).
- 5.3.12.2 This IAP shall be communicated to all staged and assigned members at an incident.

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- 5.3.20 The incident commander shall be responsible for reviewing, evaluating, and revising the IAP and overall strategy of the incident (See Diagram 11).



**Diagram 11. 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.)*

The following are guidelines for developing an IAP for offensive and defensive operations.

### 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 for entering the structure (hazard zone) to attempt to control the incident hazards. An offensive IAP is based on the standard offensive tactical priorities.

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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 [MABAS 2017].

### **Defensive Incident Action Planning**

A defensive situation is where the incident problem has evolved to the point that lives and property are no longer savable and offensive tactics are no longer effective or safe. The entire defensive strategy is based on protecting fire fighters.

#### ***Fire fighter safety is the Number 1 defensive priority.***

Defensive strategy tactical priorities and their corresponding completion benchmarks:

- Define the hazard zone and keep fire fighters 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 must conduct defensive operations from outside the hazard area. Command must 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 campaign operations, Command will coordinate the rotation of crews for rest and rehydration.

A basic defensive IAP includes the following tasks:

- 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 [MABAS 2017].

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

- Fire fighter safety
- Consider changing operational modes – go defensive
- Does the current strategy match 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”
- Corrective actions to the current conditions (Fire Control, All Clear, Loss Stopped) [MABAS 2017].

At this incident, the Ladder 2 Officer never formally assumed Command. Battalion 2 arrived on-scene, parked his vehicle, and walked to Side Alpha of the fire building. He carried the accountability board and hooked the board to the fence in front of the fire building. By the time, Battalion 2 arrived in front of the fire building, Engine 1, Engine 5, and Ladder 2 were inside on the 1<sup>st</sup> floor of the fire building. Command advised Fireboard at 0306 hours that two hoselines were operating on the 1<sup>st</sup> floor and that all occupants were out of the building. The collapse of the 1<sup>st</sup> floor occurred at 0309 hours. At this time, no resources were on Side Charlie. There was no structured incident action plan announced for this incident by Command.

***Recommendation #4: Fire departments need to ensure that critical incident benchmarks are communicated to the incident commander throughout the incident.***

Discussion: The size-up of interior conditions is just as important as exterior size-up. The incident commander monitors exterior conditions while the company officers monitor interior conditions and communicate these conditions to the incident commander as soon as possible. Knowing the location and the size of the fire inside the building lays the foundation for all subsequent operations. Interior conditions could change the incident commander’s initial strategy [Klaene and Sanders 2007]. Also, when operating inside the structure, company officers should communicate to the incident commander when making initial entry, while searching and clearing areas, during fire attack, while progressing between floors, and when exiting the structure.

Proper size-up and risk-versus-gain analysis require that the incident commander gather a number of key pieces of information and be kept informed of the constantly changing conditions on the fireground. The incident commander must develop and utilize a system that captures pertinent incident information to allow continuous situational evaluation, effective decision-making, and development of an incident management structure. Decisions can be no better than the information on which they are

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based. The incident commander must use an evaluation system that considers and accounts for changing fireground conditions in order to stay ahead of the fire. If this is not done, the incident action plan will be out of sequence with the phase of the fire. The incident commander will be constantly surprised by changing conditions [Brunacini 2002; NIOSH 2010; Smith 2002; TSFRS 2013].

Interior size-up is just as important as exterior size-up. Since the incident commander is located at the command post (outside the hazard zone), the interior conditions should be communicated by interior crews as soon as possible to the incident commander. Interior conditions could change the incident commander's strategy. Interior crews can aid the incident commander in this process by providing reports of the interior conditions as soon as they enter the fire building and by providing regular updates, especially when benchmarks are met (e.g., "primary search complete is all clear" and "the fire has been knocked down").

Fire Chief Alan Brunacini stated that critical fireground factors, including interior and exterior conditions, are among the many items that the incident commander must consider when evaluating tactical situations. These items provide a checklist of the major issues involved in size-up, decision-making, initiating operations, and review and revision. The incident commander deals with these critical factors through a systematic management process that creates a rapid, overall evaluation; sorts out the critical factors in priority order; and then seeks out more information about each factor [Brunacini 2002].

An incident commander should train and prepare through practice to engage in conscious information management. 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. The incident commander should develop the habit of using the critical factors in their order of importance as the basis for making the specific assignments that make up the incident action plan. The incident commander should develop a standard information system and use effective techniques to keep informed at the incident. The incident commander can never assume the action-oriented responder engaged in operational activities will stop what they are doing so they can feed the incident commander with a continuous supply of top-grade, objective information. It is the incident commander's responsibility to do whatever is required to stay effectively informed [NIOSH 2010].

For all members operating at an incident scene, in addition to general discipline on the fireground, radio discipline is essential. All members on the fireground should use the thought process of (and be trained on) "is my transmission necessary" as a part of fireground behavior. All 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, as opposed to transmissions that add little to the incident action plan.

At this incident, the collapse of the 1<sup>st</sup> floor occurred within 3 minutes of the initial fire attack on Side Alpha. Radio communications became quickly overwhelmed on the fireground. There was minimal

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radio traffic from the initial crews conducting fire attack until the collapse occurred. The collapse quickly impacted the initial tactics plus the fire on Side Charlie created problems for fire fighters trying to get into the basement to rescue the three fire fighters. Command did not know the actual number of fire fighters that had fallen into the basement or their location. Command was not aware of fireground operations on Side Charlie.

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

***Recommendation #5: Fire departments should integrate current fire behavior research findings developed by the National Institute of Standards and Technology (NIST) and Underwriter’s Laboratories (UL) into operational practices by developing standard operating procedures, conducting live fire training, and revising fireground tactics.***

Discussion: The National Institute of Standards and Technology (NIST) and Underwriters Laboratories (UL) 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 will enable fire fighters to better predict and react to 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 [UL FSRI 2012].

The NIST and UL experiments evaluated individual and combinations of methods for strategically ventilating and isolating fires to prevent flashover—or at least delay it. 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.

Traditionally, fire suppression operations were conducted from the interior of the structure as a means to reduce water damage and limit fire damage to structures. These operations must be coordinated with the ventilation operations. Previous research and examinations of line-of-duty deaths have shown that ventilation events occurring with fire fighters in the structure prior to suppression have led to tragic results [NIOSH 2012, 2013a,b]. One method of eliminating the possibilities of this occurrence would be a transitional attack. 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 the fire fighters entering the building. The major

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concern with this type of operation is the potential harm that 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 [Kerber et al. 2012]. Therefore, 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 provide [the potential for longer occupant exposures to IDLH conditions and therefore increased potential for further injury or death [Zevotek, Stakes, and Willi 2017].

Also the following are challenges from basement fires and tactical considerations from a recent study conducted by ISFSI and UL Fire Fighter Safety Research Institute (FSRI) on [Understanding and Fighting Basement Fires](#) [Madrzykowski D, and Weinschenk C. 2018]. Many fire fighters 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 fire fighters. This risk stems from unexpected floor collapse and high heat. Prior research also indicated the tools that fire fighters have traditionally used to determine the structural integrity of the floor offer little value with lightweight construction [Madrzykowski and Weinschenk 2018].

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 ISFSI/UL FSRI study went beyond earlier research by increasing the size of the basement and incorporating three different ventilation and access conditions to the basement. 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 that coordinate ventilation with suppression. In all experiments, the basement fire were ventilation limited. Additional ventilation without suppression was shown in 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.

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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 action made entry conditions into a basement with active burning possible for a fully protected firefighter. Effective water application also supported search operations and reduced the threat from heat and toxic gases for any trapped occupants [Madrzykowski and Weinschenk 2018].

Based upon the NIST and UL research, the following fireground operations should be considered for implementation.

- **Size-Up**

Size-up must occur at every fire. Consideration must be given to the resources available and situational conditions, such as weather, fire location, size of the fire and building, and the construction features. Ensure a 360-degree size-up is conducted whenever possible. A tactical plan for each fire must be developed, communicated, and implemented.

- **Ventilation**

Fire departments should manage and control the openings to the structure to limit fire growth and spread and to control the flow path of inlet air and fire gases during tactical operations. All ventilation must be coordinated with suppression activities. Uncontrolled ventilation allows additional oxygen into the structure, which may result in a rapid increase in the fire development and increased risk to fire fighters due to increased heat-release rates within the flow path.

- **Firefighting Operations**

Given the fuel-rich environment that the fire service operates in today, 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 and ventilation openings controlled during fire fighter Mayday incidents [UL FSRI 2012].

This information is presented to educate the fire service and to ensure that fire departments consider a change in fireground tactics based upon the current research conducted by NIST and UL. Much of this research has been directed toward developing a better understanding of the characteristics of modern fire behavior. This modern research provides members of the fire service with the information and 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. 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

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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. Operations conducted in the flow path, between where the fire is and where the fire will travel, places fire fighters at significant risk due to the increased flow of fire, heat, and smoke toward their positions. This risk is true for natural-ventilation cases with or without wind. In cases with the potential for wind to affect the heat release rate and the movement of the fire, it is important to keep the wind at your back and to attack the fire from the upwind side [FDNY 2013; UL FSRI 2012].

Fire fighters must 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 incident commander and company officers must be notified immediately when any of these conditions are observed. **The communication of this critical information to the incident commander and company officers operating inside the building must be acknowledged.**

At this incident, the initial size-up reported heavy fire on Side Charlie by the 1<sup>st</sup> arriving company. No companies were directed to Side Charlie until Skyboom 2 and Engine 16-5 arrived on-scene and pulled into the alley. Twenty-one minutes elapsed from the time of dispatch until water was put on the fire on Side Charlie. A complete 360-degree size-up was never done of this incident. All 1<sup>st</sup> Alarm companies went to Side Alpha and made entry into the fire building on Side Alpha.

***Recommendation #6: Fire departments should ensure adequate staffing and deployment of resources based on the community’s risk assessment.***

Discussion: Fire departments need to ensure not only adequate staffing, but also consider the deployment strategy to ensure adequate resources are on-scene to conduct fire suppression operations for the likely hazards in their jurisdiction. The deployment model should have allowances for mutual aid for large fires and maintaining adequate coverage for smaller incidents in their jurisdiction in cooperation with neighboring departments.

Many cities struggle with staffing and deployment challenges. However, NFPA and best practices have suggested a minimum of 17 fire fighters (3 engines, a ladder, and a battalion chief with an incident command technician (ICT)) for a single-family residential structure fire. This deployment model example may or may not meet some fire departments’ needs. Rapid intervention teams and rehabilitation also need to be taken into consideration in the deployment model.

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* contains requirements for minimum staffing of career fire departments [NFPA 2016]. NFPA 1710 states the following: “On-duty fire suppression personnel shall be comprised of the numbers necessary

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for fire-fighting performance relative to the expected fire-fighting conditions. These numbers shall be determined through task analyses that take the following factors into consideration:

- life hazard to the populace protected.
- provisions of safe and effective fire-fighting performance conditions for the fire fighters.
- potential property loss.
- nature, configuration, hazards, and internal protection of the properties involved.
- types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene” [NFPA 2016].

NFPA 1710 states that both engine companies and truck companies shall be staffed with a minimum of four on-duty personnel. The standard also states that companies shall be staffed with a minimum of five or six on-duty members in jurisdictions with tactical hazards, high-hazard occupancies, high-incident frequencies, geographical restrictions, or other pertinent factors identified by the authority having jurisdiction.

Staffing studies have concluded that four-person crews were more effective versus three-person crews once a water supply from an external source is established [NFPA 2016]. Such additional tasks that may be accomplished by a four-person crew include:

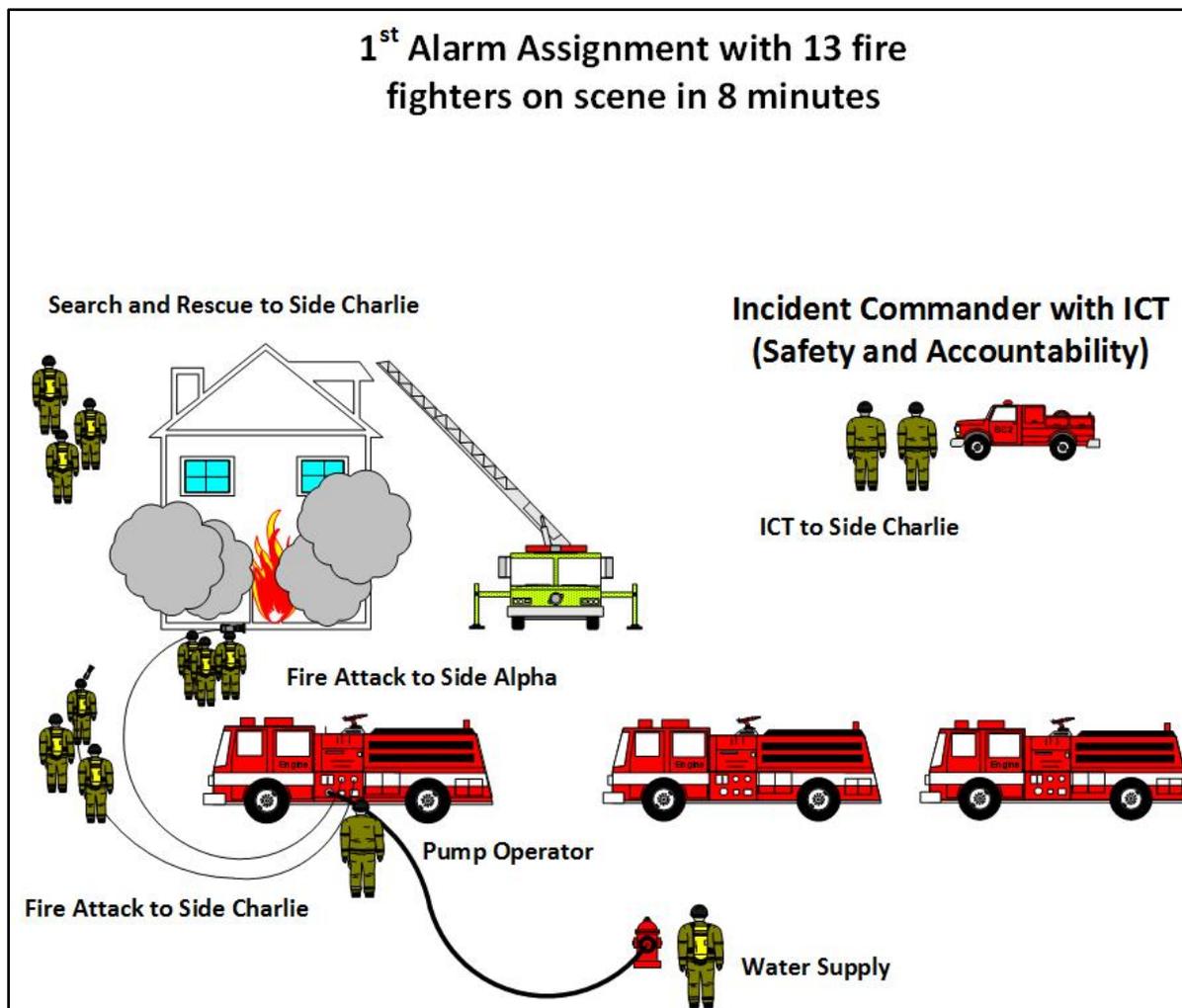
- two-person interior search and rescue with no hand-held back-up line
- two-person interior structural fire-fighting with no rescue component and no hand-held back-up line
- limited roof-level ventilation operations
- laddering operations
- salvage operations.

Four-person crews, depending on the circumstances, may also be capable of completing the following:

- use of 2½-inch hoseline
- establishment of a water supply from a static source
- establishment of a second point of entry and approach to the fire location in the structure
- preparing for search and rescue for person(s) in need of rescue.

NFPA 1710 sets a standard for delivering a full first-alarm assignment to lower-risk occupancies (e.g., single-family dwelling). This requires a minimum of 15 fire fighters to be on the scene of a structure fire within 8 minutes. Using the specified minimum staffing level of four members per engine company and ladder company, this would require four companies (e.g., three engine companies and one truck company) plus a battalion chief and staff assistant/incident command technician (**See Diagram 12**). In this incident, the fire department operated with 13 fire fighters during the initial stages of the incident. The diagram describes the suggested deployment of the 13 fire fighters in order to follow the incident priorities of life safety, incident stabilization, and then property conservation.

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**Diagram 12. This is a sample deployment model of 13 fire fighters operating on the strategic, tactical, and task level during initial fireground operations**

The requirements for moderate risk occupancies (typically multifamily residential and small commercial buildings) are based on performing the same basic functions that are listed for low-risk occupancies, however, the scale of the required operation demands additional resources. NFPA 1710 does not specify minimum requirements, leaving it up to the individual fire department to make this determination. Staffing studies have determined that a minimum of 20 fire fighters should be included in the first alarm assignment for moderate-risk occupancies. This combined force would require a total of five companies plus a battalion chief, incident command technician, and a safety officer [NIST 2013].

The requirements for higher-risk occupancies are also based on performing the same basic functions on a larger scale. These occupancies would be classified as apartment buildings, hotels, and similar structures over two stories in height; schools; hospitals; nursing homes; and larger commercial

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buildings. Staffing studies have determined that a minimum of 29 fire fighters should be deployed on the first alarm assignment for a high-risk occupancy. This combined force would require a total of six companies plus two battalion chiefs with incident command technicians and an incident safety officer [NIST 2013].

Many communities are struggling to provide or maintain adequate staffing. However, deployment studies have determined that certain occupancies require more personnel to effectively fight a fire and stop the spread of fire. Once an incident expands in size or complexity, a properly staffed and equipped rapid intervention crew (RIC) or team (RIT) should be immediately available to respond to rescue incidents. This formal RIC is beyond the initial RIC considerations of “2 In/2 Out”. It is a much more capable and equipped crew or team.

If the available staffing and deployment are insufficient for the situation encountered, the risk assessment should steer the initial strategy toward a defensive posture until additional resources arrive. During this time, the fire will continue to grow and have negative impacts on the structural integrity of the building, making an offensive attack much less desirable and certainly more dangerous. If the initial firefighting forces and deployment ability don’t match the conditions, the incident commander should consider a defensive strategy.

At this incident, the initial dispatch was for three engine companies, one ladder company, and two battalion chiefs. All of these resources responded and parked on Side Alpha. All fire fighters went to front entrance on Side Alpha. Two fire fighters from Squad 4 went to Side Charlie, but without a hoseline and made entry at 0312 hours. Skyboom 2 was the first apparatus to Side Charlie at 0314 hours, which was 18 minutes after the initial dispatch.

***Recommendation #7: Fire departments should ensure that once Command is established at an incident, the incident commander maintains control of situation status, resource status, and fireground communications and ensures the completion of the tactical objectives.***

Discussion: Fireground standard operating procedures (SOPs) define the strategic goals and tactical objectives for the coordinated deployment of departmental resources for specific incidents and occupancies. SOPs are based on factors not limited to but 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 hazard.

The first arriving resource will establish command of an incident. The initial scene size-up is communicated to the initial responding units with or without a command officer on the scene. The intent is to maximize efficiencies while minimizing confusion and duplication of effort. The strategy and tactics for an incident are dictated by the size-up, initial risk assessment, and situational report from the first arriving officer. 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

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delegated to another fire department resource. The priority is to get a fire department unit to Side Charlie of the structure. However, unless an obvious life-safety issue exists (e.g., visible victims requiring immediate assistance), interior fire-fighting operations should not commence until a report from Side Charlie is received. A radio report of conditions, including those on Side Charlie, should be transmitted over the assigned tactical channel to the incident commander and the dispatch center.

The incident commander develops and communicates a strategy and tactical objectives based upon scene size-up and the risk assessment. This is a process that must be made in a short period of time involving a dynamic and fluid situation. Most importantly, the strategy and tactics should include an observation and/or report from all sides of the structure, especially Side Charlie. The goal of effective fireground procedures is to increase the safety of the fire fighters, eliminate confusion, and prevent the loss of life [Fire and Rescue Departments of Northern Virginia 2013; NIOSH 2015]. This will ensure a strong command structure is developed and essential strategic-, tactical-, and task-level functions are performed by the incident commander, division/group supervisors, company officers, and fire fighters.

**Strategic Level.** This organizational level is designed around the incident commander and incident advisory team operating in the command mode. The strategic level involves the activities necessary for overall operational control, considering critical fireground factors and the risk management plan in establishing objectives, determining the strategy and developing an IAP, continuous review of the strategy, setting priorities, and allocating resources.

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 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 incident commander. They are assigned by the incident commander and are supervised directly at the site of the assigned activity in order to meet the operational objectives given to them by the incident commander.

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 incident commander’s IAP,
- Implement a risk management plan in the division,
- Complete tactical priorities in the division,
- Ensure positions always match conditions in the division,

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- 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,
- Manage recycle & rehab within the division [MABAS 2017].

**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].

Additionally, this process compliments the defined knowledge, skills, abilities, competencies, and fireground experience to assist:

- The incident commander in how to plan and implement an effective strategy and IAP,
- Division/group supervisors to formulate and follow tactics and maintain accountability of assigned resources.
- Company officers to successfully carry out assigned tasks,
- Individual members to effectively perform their duties [FDNY 2011; FIRESCOPE 2015].

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

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

- Life hazard (must be given first priority),
- Problems with water supply and water application,
- Volume and extent of fire, requiring large caliber streams,
- Location of the fire, if inaccessible for hand-line 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, the intensity, and the duration of the fire [ISFSI 2013].

At this incident, an incident action plan was not announced by the 1<sup>st</sup> due company officer or the 1<sup>st</sup> due battalion chief prior to beginning fireground operations. There were conflicting reports of occupants still inside the building. Also, no resources were initially deployed to Side Charlie. The purpose of the Incident Command System (ICS) is to provide for a systematic development of a

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complete, functional command organization designed to allow for single use, which increases the effectiveness of command and fire fighter safety. ICS provides an organized method to apply goals and objectives to structure fire incidents. This system helps to provide fireground safety and accountability. The organization builds from the ground up, with the management of all major functions initially being the responsibility of one or just a few persons. Functional units are designed to handle the most important incident activities. As the incident grows in size and/or complexity, functional unit management is assigned to additional individuals in order 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 are followed closely; therefore, the organizational structure is not larger than required. It is imperative that the incident commander operate from a vehicle away from the hazard zone. The incident commander must operate in an area that is conducive to effectively manage and control an incident.

***Recommendation #8: Fire departments should ensure that the Incident Commander establishes a stationary command post for effective incident management, which includes the use of a tactical worksheet, effective fireground communications, and a personnel accountability system.***

Discussion: When a command officer (e.g., battalion chief, district chief, deputy chief) arrives on scene, he/she should automatically assume a standard stationary, exterior, and remote command position and immediately assume “Command” and begin functioning as the incident commander. Command officers generally establish and continue command and control functions inside their vehicles or at the rear of the vehicle, which has a command board and/or a tactical worksheet.

NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety*, 5.3.1 states, “The incident commander shall have overall authority for management of the incident.” The incident commander must establish and maintain a command post outside of the structure in order to assign companies, delegate functions, and continually evaluate the risk versus gain of continued firefighting efforts [NFPA 2014].

In establishing a command post, the Incident Commander shall ensure the following:

- The command post is located in or tied to a vehicle to establish presence and visibility.
- The command post includes radio capability to monitor and communicate with assigned tactical, command, and designated emergency traffic channels for that incident.
- The location of the command post is communicated to the communications center.
- The Incident Commander, or his/her designee, is always present at the command post.
- The command post should be located in the incident cold zone [NFPA 2014].

In order to effectively command an incident, incident commanders must be in the most advantageous position possible. The best position is a fixed, visible, and accessible location at the command post. This can be accomplished by utilizing the incident commander’s staff vehicle, a designated command vehicle, or fire apparatus. An acceptable alternative is utilizing the rear area of a sport utility vehicle or pick-up truck type vehicle. This method will provide the incident commander with an area that is quiet

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and free of distractions from which to command an incident. It is also vital for the incident commander to be able to hear all radio transmissions, especially from those operating on-scene. The best way to accomplish this is through the use of a radio communication headset. This will enable the incident commander to be in the best position possible to hear critical radio transmissions. The incident command post also should be visible and recognizable. This can be accomplished by displaying a colored light, flag, banner, or other symbol to mark the location. Where special command post vehicles are used, such vehicles are usually marked with distinctive identification to make the command post recognizable [NFPA 2014].

The use of a tactical worksheet can assist the incident commander with tracking various task assignments on the fireground. The tactical worksheet identifies critical incident information in a fill-in format and allows for the tracking of initial alarm assignments plus additional alarms, division/group assignments, and tactical/functional considerations. It is intended that this form would be used by the incident commander as early in the incident as possible [NFPA 2014]. It can be used along with pre-plan information and other relevant data to integrate information management, fire evaluation, and decision-making. The tactical worksheet should record unit status and benchmark times and include a diagram of the fireground, occupancy information, activities checklist(s), and other relevant information. The tactical worksheet can also help the incident commander in continually conducting a situation evaluation and maintaining personnel accountability [NFPA 2014]. The tactical worksheet is a vital resource because it helps the incident commander organize fireground operations. The tactical worksheet provides reminders, prompts, and a convenient workspace for tracking companies and apparatus. It allows the incident commander to slow down during an incident and record vital information that may help make future operational decisions [NFPA 2014].

The advantages of using a tactical worksheet are that the tactical worksheet:

- Includes a location to quickly note individual assignments.
- Provides prompts for the incident commander, such as time, air management and personnel accountability reports.
- Provides tactical benchmarks, such as “water on the fire,” “primary search complete,” “fire under control,” and “loss stopped.”
- Documents the command structure—strategic, tactical, and task.
- Facilitates consistent, organized information.
- Documents assignments and responsibilities.
- Expedites passing of Command or support for the incident commander.
- Provides resource status [NFPA 2014].

The tactical worksheet is also an excellent tool when the transfer of command must occur. On the fireground, the officer taking over command can quickly check the worksheet and obtain a clear understanding of the initial deployment of resources, the need for additional apparatus and equipment, and the status of units in the staging area.

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Fire departments should have a communications standard operating procedure (SOP) coupled with an effective training program. These procedures include the use of clear text (specifically, no 10 codes, or other terms that may be unfamiliar to other responders), a separate radio channel for Dispatch, and a separate tactical channel to be used during the incident [NFPA 2014]. When a division or group is implemented, a fire department should provide a dispatch channel, a command channel, and a tactical channel. A fire department should provide the necessary number of radio channels with multiple tactical channels, depending on the type of incident and the complexity of the incident. The fire department should have procedures for the announcement of emergency conditions, using the term “emergency traffic” as a designation to clear radio traffic”. Emergency traffic should be declared by the Incident Commander, tactical level management unit, or member who identifies a high risk situation on the fireground (e.g. power lines down, signs of impending collapse) and should be used to alert members that the Incident Commander is ordering the evacuation of the building [NFPA 2014]. The term “Mayday” should be reserved for only those situations where a fire fighter or fire fighters is/are in trouble or facing a life threatening emergency.

Another element that is essential to the success of the personnel accountability system is effective fireground or incident scene communications. The function of resource accountability should be assigned to a member, such as a chief’s aide, who is responsible for maintaining the location and status of all assigned resources at an incident. This is separate from the role of the incident commander. The incident commander is responsible for the overall command and control of the incident. Due to the importance of responder safety, this function should be assigned to an accountability officer or resource status officer. A number of members could function in this role including an incident command technician, chief officer, apparatus driver/operator, or other responder. There are many means of accounting for resources. Components can include tactical worksheets, command boards, apparatus riding lists, company responder boards, passport system, and electronic bar-coding systems, depending on whether equipment or personnel are being tracked. These components can be used in conjunction with one another to facilitate the tracking of responders by both location and function. The components of any resource accountability system should be modular and expand with the size and complexity of the incident [NFPA 2014].

Fire departments should ensure a stationary command post is established at working incidents or any time that “Command” is established. This process includes establishing proper radio communication, initiating the tactical worksheet, and starting the personnel accountability system. The next step for the Incident Commander would be to focus on the development of the strategy and the Incident Action Plan (IAP) (tactics) which is then communicated to all companies and other personnel operating on the incident scene. Most importantly the communications and personnel accountability process would be initiated from the beginning of the incident.

***It is imperative that the Incident Commander establish a stationary command post outside the hazard zone for effective incident management, which includes the use of a tactical worksheet, effective fireground communications, and a personnel accountability system.***

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***Recommendation #9: 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 the incident commander with the necessary resources on how to use, follow, and incorporate safety into the incident management system at all incidents. 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 the incident commander must 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].

A vital command function involves the incident commander using the initial scene size-up, consideration 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. 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 in use at any one time [MABAS 2017].

An offensive strategy means that personnel are actively and directly attempting to correct the identified problem. This might mean that they are doing CPR on the pulseless patient or directing water streams into the burning structure. A defensive strategy is where the incident commander decides the best course of action is to contain the problem. Examples can be fire fighters might build containment around a leak or spill or only put water on the fire building and threatened exposures outside the hazard zone. Any change of strategy must be the result of deliberate defensible thought and must be communicated.

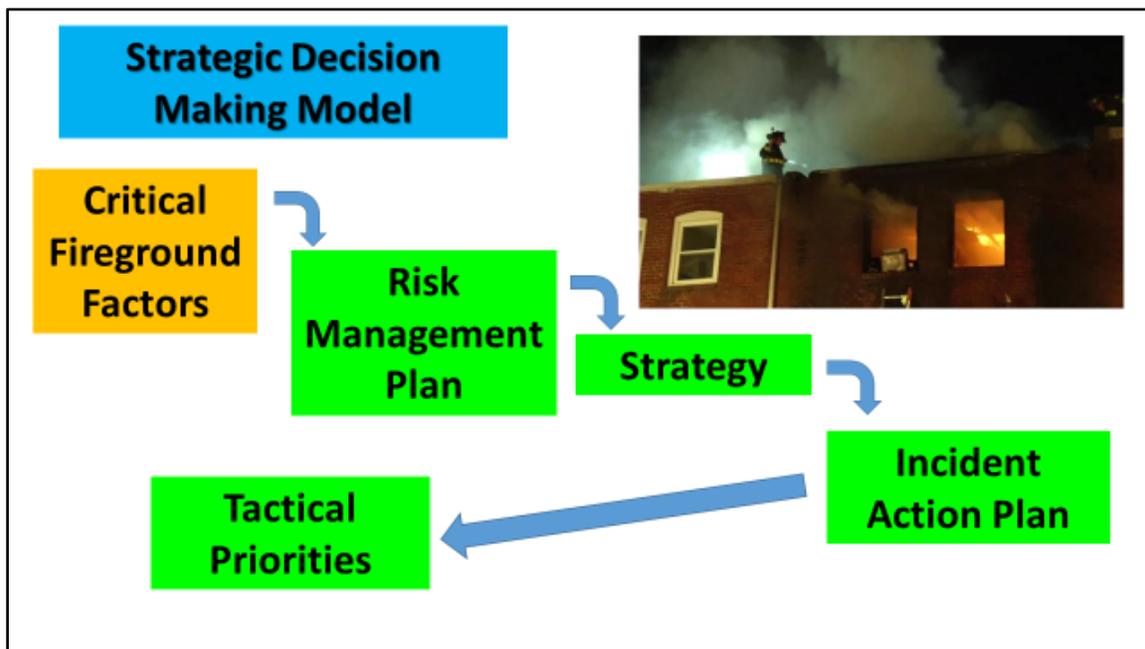
The two separate strategies create a simple, *understandable* plan that describes in basic terms how close the emergency responders will get to the incident's hazards. The incident's overall strategic decision is based on the incident's critical factors weighed against the risk management plan (See **Diagram 13**). Declaring the incident strategy up front, as part of the initial radio report will:

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- Announce to everybody the overall incident strategy.
- Eliminate any question on where fire fighters will be operating on the incident scene inside the structure [MABAS 2017].

Offensive and defensive strategies should not be combined.

Once the overall incident strategy has been determined and the incident action plan developed, the incident commander 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 incident commander 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 incident action plan must be short and simple. A complicated incident action plan tends to break down during this critical time. Generally, the incident commander tries to achieve the same basic objectives from one incident to the next. Tactical priorities offer a regular set of tools on which the incident commander can utilize for tactical activities in order to develop a standard approach to solving incident problems. With this standard approach, the incident commander can manage the basic work sequence at every incident, in the same manner.



**Diagram 13.** 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 MABAS Division 201[MABAS 2017].)

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At this incident, the 1<sup>st</sup> arriving officer never formally assumed Command of the incident. Based upon his size-up and risk assessment, the Ladder 2 Officer decided to operate in the fast-attack mode based upon the reports of possible victims in the structure. This mode is applied when quick, immediate action can prevent life loss or injury. These situations require immediate action to stabilize the incident and require the company officer's direct involvement in the attack. In this mode, the company officer accompanies the crew to provide the appropriate level of supervision. Command may be passed to the next arriving officer, upon their arrival. Command shall not be passed to an officer who is not on-scene. Where fast intervention is critical, use of a portable radio will permit the company officer's involvement in the attack without neglecting incident commander's responsibilities. The fast-attack mode can only be used for a rescue attempt or when 2-in and 2-out is established. The fast-attack mode should not last more than a few minutes.

Dispatch centers should contact the incident commander every 10–15 minutes on the assigned fireground tactical channel with elapsed-time reminders. These 10–15 minute notifications reminders serve as cues for the incident commander to re-evaluate conditions, restate the current strategy, and consider the length of time fire fighters have been operating in the hazard zone. The incident commander develops the strategy and the incident action plan based on the initial size-up of the incident's critical factors. These critical factors are very dynamic. Incident operations are either getting better or they are getting worse, but they never stay the same. The incident conditions drive the strategy, the incident action plan, and the risk-management plan [MABAS 2017; NFPA 2014].

Assigned resources are fire fighters who have been entered into the accountability system and assigned work tasks on an incident. The system is designed to ensure that fire fighters do not become lost or missing in the hazard zone. An integral part of the personnel accountability system is to make sure that all assigned resources working in the hazard zone are initially accounted for based upon the system that a fire department uses for accountability (e.g., PASSPORT System). Periodically throughout the incident, a personnel accountability report is conducted to ensure that all assigned resources are accounted for by the accountability officer or resource status officer.

The accountability officer should also request a personnel accountability report from each division or group supervisor whenever there is a change in conditions that could cause unsafe operation such as an "emergency traffic" announcement to "all companies evacuate the building." When a tactical-level management component supervisor is requested to conduct a personnel accountability report, this supervisor is responsible for reporting on the accountability of all companies or members working within their area of responsibility [NFPA 2014]. With a strategic mode change, a personnel accountability report should occur to ensure that all assigned resources are accounted for and are out of the hazard zone. Defensive operations should not start until the personnel accountability report is completed and all members are accounted for by the accountability officer.

The eight functions of command serve as the foundation for addressing command safety issues. The incident commander must follow each of these functions in order without skipping or missing any function. Automatically connecting and integrating safety with command becomes a simple and

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essential way that the incident management system protects assigned resources at an incident. These functions serve as a practical performance foundation for how the incident commander completes their responsibility as the strategic-level incident manager and the overall incident safety manager [Brunacini and Brunacini N.2004].

***Recommendation #10: Fire departments should review their personnel accountability system standard operating procedure/guideline. The resource status function should account for all resources throughout an incident.***

Discussion: A personnel accountability system is a system that 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.

An integral part of the accountability system is to make sure that the fire fighters who are assigned and operating in the hazard zone are accounted for, starting with the initial operations through the entire incident. Also, a process should be in place to periodically check to make sure 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 incident commander to initiate a personnel accountability system that includes the functional and geographical assignments at the beginning of operations until the termination of the incident. NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety*, states in Paragraph 8.12.4, “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
- 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)
  - Be able to identify where all members are in the hazard zone (where)
  - Be able to identify the conditions in the hazard zone (conditions)
  - Be able to identify what actions are being taken in the hazard zone (actions)
  - Be able to identify paths of access and egress in and out of the hazard zone (exits)
  - Be able to identify and assign rapid intervention crew(s) (RIC).
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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 the incident escalates, resource status would be placed under the Planning Section. This function is separate from the role of the incident commander. The incident commander 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. A number of positions could function in this role including an 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 2015]. A properly initiated and enforced personnel accountability system enhances fire fighter 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 organized on-scene roll call in which each supervisor reports the status of their crew when requested by the incident commander [NFPA 2014]. **The PAR should be conducted every 15–20 minutes or when benchmarks are met.**

In order for the personnel accountability system to properly function, the process should include a standard operating procedure that defines each function's responsibility and the necessary hardware required to ensure this process is successful on the fireground. Also a training component—both classroom and practical—should be conducted to ensure this process functions properly during emergency incidents.

At this incident, the 1<sup>st</sup> due battalion chief brought the department's accountability board to the scene from the battalion vehicle. The accountability board was hung on a fence on Side Alpha of the structure to maintain accountability of resources. There was no accountability officer or resource status until Car 1's aide or staff assistant was appointed as accountability and safety officer at approximately 0325 hours. Throughout the incident, Command was not completely aware of what resources from what agencies were in the structure conducting firefighting operations.

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***Recommendation #11: Fire departments should develop and implement a standard operating procedure/guideline on the deployment and use of rapid intervention crew(s).***

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

The RIC function should be incorporated into the department's incident management system and the personnel accountability system [NFPA 2014]. The needs of critical fireground operations and staffing should be continuously evaluated in regards to fire fighter safety. Resource assignments should be made with the goal of having the RIC function in place at all times. When the incident commander needs additional resources, the consideration of deploying the rapid intervention team 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/FAST should be considered by the incident commander during fireground operations:

- The RIC should not be used for fire-fighting operations.
- 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 assigned by a superior officer to other than RIC duties, the RIC unit officer should remind such officer of RIC designation [Toledo Fire & Rescue Department 2012; TSFRS 2014].
- When the incident commander orders the RIC to work, the incident commander should immediately assign another on-scene company to stand by as the RIC. **At a minimum, the incident commander should request an additional alarm and designate a company or companies to function as RIC.** The remainder of the companies should report to staging. If no units are available, the incident commander should assign at least two members to act as a rapid intervention team 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].

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 rapid intervention team. Based upon the complexity, magnitude, configuration of the structure or geographical layout of the incident, the incident commander may deploy additional RIC/FAST by location or function [NFPA 2014].

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Upon arrival or upon appointment, the RIC officer should confer with the incident commander. The RIC officer should establish an area to stage the rapid intervention team and the necessary RIC equipment. The RIC equipment should include:

- Tool staging tarp
- Rescue SCBA (RIC Pack)
- Forcible entry tools such as a Halligan bar or other pry tool
- Stokes basket
- 150-foot rope for search and rescue
- Wire cutters
- Rebar cutter
- Saws
- Thermal imager
- Emergency strobe lights
- Life-saving rope/life belt
- Elevator keys for buildings with elevators [FDNY 2011; LAFD 2001; TSFRS 2014].

It is important to stage all necessary RIC equipment in an expedient manner. The RIC officer, accompanied by one member of the RIC/FAST, should perform an incident scene survey while the remaining RIC members assemble the RIC equipment. If the size of the structure negates a 360-degree survey of the building, this fact should be relayed to the incident commander as soon as possible. This should be a benchmark for Command to designate another RIC/FAST in order to effectively cover all sides of the building.

During this survey, the RIC officer and members should look for ways in and out of the structure, including window configuration, fire escapes, and construction features. The RIC officer should note the feasibility for placement of ground ladders for rescue or escape purposes. The RIC officer should be responsible for setting up and securing a suitable secondary egress for interior crews. This may include laddering multiple sides of the structure. Once the RIC has determined the need for an egress ladder, the window glass should be removed. This should only be done after conferring with Command that the removal of the window will not affect fire-fighting operations. Once approved by Command, the egress ladder should be placed at the window. The location of the egress ladder(s) shall be announced over the radio by the RIC officer [Toledo Fire & Rescue Department 2012].

After the above tasks are completed, the RIC officer should inform Command that a 360-degree survey is complete and the RIC is ready to intervene, if necessary. Once the incident scene survey has been completed and the RIC equipment is in place, the entire RIC should be located in an area immediately accessible to the building in order for rapid deployment plus maintaining radio contact with Command. The RIC officer should brief all members of the RIC as to the results of his/her incident scene survey. The RIC should operate as one unit. Additional crews may be added to or in support of the team as necessary. When more than one company is added as part of the rapid intervention team, a rescue group should be formed with a rescue group supervisor [Toledo Fire & Rescue Department 2012]. Another consideration for Command is to request the response of an advanced life support (ALS)

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engine company or truck company as a component of the RIC Group. The members of the ALS company are trained to operate in an IDLH atmosphere and can function as part of the RIC, plus they can provide advanced life support to affected fire fighters [FDNY 2011].

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

To ensure that fire fighters 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].

At this incident, the deployment of resources on the 1<sup>st</sup> Alarm assignment allowed for rapid intervention crew (RIC) operations to be conducted on low-risk occupancies such as residential structures. The department's SOP defined the 4<sup>th</sup> due engine as RIC, which would have been Skyboom 2. When Squad 4 arrived on-scene, both teams of Squad 4 were assigned to search. When the collapse of the 1<sup>st</sup> floor occurred, both teams of Squad 4 immediately started operations to locate the fire fighters in the basement on Side Alpha and Side Charlie. The two fire fighters (Team 2) from Squad 4 who entered Side Charlie did not have a hoseline or other RIC equipment. There were no additional resources on-scene to designate as another RIC team. When Skyboom 2 arrived on scene, they were ordered by Division Charlie to get a hoseline in operation on Side Charlie. Additional rapid intervention crew operations were not initiated until after the arrival of mutual aid companies.

***Recommendation #12: Fire departments should ensure that all fire fighters and fire officers are trained in managing a Mayday.***

Discussion: The ability of a fire fighter to call a Mayday is a complicated behavior that includes the affective, cognitive, and psychomotor domains of learning and performance. Any delay in calling a Mayday reduces the chance of survival and increases the risk to other fire fighters trying to rescue the downed fire fighter.

Fire fighters should be 100% confident in their competency to declare a Mayday for themselves. Fire departments should ensure that any personnel who enter an IDLH environment meet the department standards for Mayday competency throughout their active duty service. A rapid intervention crew (RIC) will typically not be activated until a Mayday is declared. Any delay in calling the Mayday reduces the window of survivability and also increases the risk to the RIC [NFPA 2018a].

The National Fire Academy has a course addressing the fire fighter Mayday Doctrine, *Q133 Fire Fighter Safety: Calling the Mayday*, which is a 2-hour program covering the cognitive and affective learning domain of the fire fighter Mayday Doctrine. As with any training, practical training should

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supplement this classroom training. The important factor is to ensure fire departments understand the true magnitude of a Mayday. The issues that surface from a fire fighter calling a Mayday include effective incident management, proper fireground and radio communications plus dispatcher support, adequate resources (staffing), tools and equipment, and emergency medical services support [NIOSH 2011].

The rescue of a lost, missing, trapped, or injured fire fighter is time sensitive. A very narrow window of survivability exists for a fire fighter who is out of air or trapped in a hazardous environment. Fire fighters must not delay in communicating a Mayday ensuring the Incident Commander is notified.

The Incident Commander will be required to revise the strategy and incident action plan (tactics) to incorporate a priority rescue. This will impact fireground communications as well. Once a Mayday condition is broadcasted on the radio, using distinctive emergency traffic alert tones, the incident commander and/or dispatch center is responsible for taking action to clear the radio channel and to determine the member's location, situation, and resources needed to remedy the situation. In the event of a Mayday, a rescue group supervisor will take responsibility of the resolution of the Mayday. It will be necessary for the incident commander to support the rescue group supervisor with appropriate and adequate resources to manage the Mayday at the same time reinforcing the surrounding groups and division to continue the incident mitigation. Projecting resource requirements for the rescue group operations has the potential to increase the survivability of a Mayday situation.

The incident commander should ensure that firefighting operations are continued in conjunction with the rescue operations especially in the area of the Mayday. The incident commander should assign this responsibility to a division or group supervisor. This ensures that adequate resources are available to hold or extinguish the fire while the rescue operations are being conducted [MABAS 2017]. The two most important rescue tasks that must occur during a Mayday are protecting the downed fire fighter from fire, and getting air to the downed firefighter. The incident commander has the responsibility for ensuring this two tasks are assigned and happening.

Responsibilities of the Rescue Group include:

- Responding to the Mayday from the inside out
- Manage communications with the down fire fighter. The Incident Commander will be required to revise the strategy and Incident Action Plan (tactics) to incorporate a priority rescue. This will impact fireground communications as well. The Incident Command should declare the use of “emergency traffic only” until the situation is resolved. Once a “Mayday” condition is broadcasted on the radio, using distinctive emergency traffic alert tones, the Incident Commander and/or dispatch center is responsible for taking action to clear the radio channel and to determine the member's location, situation, and resources needed to remedy the situation.
- Manage the search and rescue efforts for the down firefighter if necessary
- Increase and maintain resources assigned to the rescue group.
- Manage the logistical support as well.

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- Improve survivability and tenability
- Improve ventilation
- Increase exterior access for the Rescue Group
- Utilize the RIC bag and request additional RIC bags if necessary
- Recognize and support the help order of a Mayday
- Crews from and “on-deck” position or staged outside of the rescue group as a tactical reserve
- Additional resources requested from the Incident Commander
- Crews from other groups or divisions
- Requesting additional staged resources
- Communications with surrounding divisions and groups.

When a Mayday occurs, this effects the strategic, tactical, and task levels. Each level plays a critical role in the successful outcome of a Mayday [MABAS 2017].

### **Mayday Operational Procedures (Task, Tactical, & Strategic Levels)**

#### ***Task/Company/Fire fighter level Mayday responsibilities***

- Firefighter or interior Unit having the mayday must: Call for a mayday as soon as you realize you cannot safely exit the hazard zone
- Declare a Mayday (3 times) to ensure priority radio traffic, un-key the microphone and wait for command to acknowledge the Mayday; HOWEVER, if circumstances do not permit, DO NOT un-key the microphone - relay your Mayday immediately after you call Mayday (3 times)
- Give a CAN (conditions, actions, and needs) report that includes:
  - Who - your identity – Unit, Unit riding position, or entire name
  - What – caused the condition(s) of the mayday – what you were assigned
  - Where - identify your current location/surroundings or your last known location
  - NEEDS – the needs that will help resolve the Mayday (critical)
- Calm down and begin your self-help / self-rescue techniques
- Conserve your air
- Activate your PASS alarm if appropriate
- Maintain radio contact with the IC or the Division Supervisor as required [MABAS 2017].

Other Companies operating in the hazard zone during a Mayday must:

- Maintain radio silence
- Transmit Mayday announcements, Priority traffic and status reports ONLY
- Be prepared to assist with the rescue if you are able to do so
- Interior crews that are actively addressing fire control when a Mayday occurs should continue with their fire control efforts [MABAS 2017].

#### ***Tactical level Mayday responsibilities (if in place)***

A Division Supervisor that is in place at the entry point when a Mayday occurs in their Division must perform the following:

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- Take strong control of entry point
- Resource assessment in the Division
- Request resources
- Support the fire fight when necessary
- Consider the critical factors in the Division
- Develop the Division's rescue IAP
- DO NOT flood the interior with resource
- Organize, properly equip, and brief On Deck units before deployment *Note: "On Deck" is defined as a forward staging position located just outside the immediate hazard zone, safely distanced from the entrance of a tactical position/ Division/Group Supervisor. On Deck crews will be supervised either by the Division/Group Supervisor or the Company Officer and they will remain On Deck until assigned by the IC or Sector Officer.*
- Provide clear, realistic objectives to the rescue teams
- Implement, react to, and reinforce the rescue efforts as required in the Division [MABAS 2017].

### ***Strategic level Mayday responsibilities***

When a Mayday is declared on the fireground, the incident commander must:

- Confirm the critical factors – the risk management plan – and the overall strategy
- Take *STRONG* control of the communications process
- Follow the Mayday communication algorithm
- Change the IAP to high priority rescue effort
- A *NO PARs* policy will take effect
- Assign officers into divisions if not already assigned
- Coordinate and support the rescue efforts with the divisions as required
- Expand the command organization and verify with dispatch that the next alarm level and EMS strike team have been dispatched
- Support the fire fight when necessary
- Establish a Treatment Group
- Consider the medical and technical requirements for the rescue [MABAS 2017].

If there are division supervisors in place when a Mayday is declared on the incident, once the IC has completed the Mayday communication algorithm, their next action should be to push control of the rescue operation down to the division supervisor where the mayday is occurring. The division supervisor is in the best position to manage the rescue activities that need to take place in the division to resolve the Mayday. The IC is then in the best position to coordinate and support the rescue, firefighting, and treatment efforts with the other divisions and companies as required by the incident's critical factors.

If there are no tactical level division supervisors in place when a Mayday is declared on the incident scene, the IC should continue to manage the entire tactical rescue efforts required to resolve the Mayday after completing the Mayday communication procedure.

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On Deck companies must use great discipline when there is no division supervisor in place during a Mayday. On Deck crews, must properly equip themselves, have a rescue plan, and be ordered into the hazard zone by the IC before making entry.

The IC should assign division responsibilities as soon as possible into the event (when none are in place when the Mayday is declared). This could be a subsequent arriving chief officer, safety officer, or a company officer that will operate at the entry point of the division. Once assigned, quickly brief the division supervisor on the details of the mayday and have them continue to manage the Mayday directly in their assigned division.

In this incident, a collapse of the 1<sup>st</sup> floor into the basement occurred at 0309 hours immediately followed by a Mayday. Squad 4, which was operating with an officer and four fire fighters were assigned as the rapid intervention crew. The officer and two fire fighters from Squad 4 went to Side Alpha. The other two fire fighters from Squad 4 went to Side Charlie. No other resources were formally assigned as RIC until after the arrival of additional resources.

***Recommendation #13: Fire departments should provide a checklist for the incident commander regarding procedures in the event of a Mayday.***

Discussion: When a Mayday is transmitted for whatever reason, the incident commander has a very narrow window of opportunity to locate the lost, trapped, or injured member(s). The incident commander must restructure the strategy and incident action plan (tactics) to include a priority rescue [NFPA 2014].

Some departments have adopted the term “LUNAR”—location, unit assigned, name, assistance needed, and resources needed—to gain additional information in identifying a fire fighter who is in trouble and in need of assistance. The incident commander, division/group supervisors, company officers, and fire fighters need to understand the seriousness of the situation. It is important to have the available resources on-scene and to have a plan established prior to the Mayday [Brunacini and Brunacini 2004; NFPA 2014].

A checklist is provided in “**Appendix Three: Incident Commander’s Tactical Worksheet for Mayday.**” This checklist can assist the incident commander to ensure the necessary steps are taken to clear the Mayday as quickly and safely possible. This checklist serves as a guide and can be tailored to any fire department’s Mayday procedures. The intent of the checklist is to provide the incident commander with the essential actions to be taken in the event of Mayday. This format allows the incident commander to follow a structured worksheet. This process is too important to operate from memory and risk missing a vital step that could jeopardize the outcome of the rescue of a fire fighter who is missing, trapped, or injured.

At this incident, when the Mayday occurred, the incident commander quickly called for additional resources. Due to issues with radio communications and the urgency to locate the missing fire fighters,

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the incident commander was quickly overwhelmed. The intent of this Mayday worksheet, like the tactical worksheet, is to assist the incident commander during a very difficult and stressful time on the fireground.

***Recommendation #14: Fire departments should ensure that their radio communication system is capable of providing adequate coverage based upon the demands of an incident and complies with NFPA 1561, Standard on Emergency Services Incident Management System and Command Safety.***

Discussion: Effective fireground radio communication is an important tool to ensure proper command and control of an incident plus fire fighter safety and health. The radio system must be dependable, consistent, and functional to ensure that effective communications are maintained, especially during emergency incidents. Fire departments should have a “communications” standard operating procedure that outlines the communication procedures for fireground operations. Fire departments should ensure that the department’s communications division and communication center and/dispatch center are part of this process. Another important aspect of this process is an effective education and training program for all members of the department.

Radio frequency usually refers to the radio frequency of the assigned channel. A radio channel is defined as the width of the channel depending on the type of transmissions and the tolerance for the frequency of emission. A radio channel is normally allocated for radio transmission in a specified type of service or by a specified transmitter. Fire departments should ensure that an adequate number of radio channels are available. Multiple radio channels are necessary at large-scale or complex incidents, such as a commercial structure fire, mass-casualty incident, hazardous materials incident, or special operations incident [FIREScope 2015; NFPA 2014].

NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety*, Paragraph 6.1.2, requires, “The communications system shall have the capacity to provide one dispatch radio channel and a separate tactical radio channel for initial use at the incident.” Paragraph 6.1.3 states, “When a division or group has been implemented, the communications system shall have the capacity to provide a dispatch radio channel, a command radio channel, and a tactical radio channel.” Fire departments should preplan for not only large-scale or complex incidents, but also for the ability to handle daily operations. Standard operating procedures, radio equipment (e.g., mobile radios, portable radios), other hardware (e.g., mobile data terminals, laptop computers, CAD system), and dispatch and communications protocols should be in place to ensure that these additional channels are available when needed [NFPA 2014].

Every fire fighter and company officer should take responsibility to ensure radios are properly used. Ensuring appropriate radio use involves taking personal responsibility (e.g., to have your portable radio, to have the portable radio turned on and on the correct channel). A company officer’s responsibility is to ensure that all members of the crew comply with these requirements. Portable radios should be designed and positioned to allow a fire fighter to monitor and transmit a clear message [IAFF 2010; Varone 2003].

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A fire department should provide the necessary number of radio channels relating to complex or large-scale incidents needing multiple tactical channels. NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety* states in Paragraph 6.1.4, “The communications system shall provide reserve capacity for complex or multiple incidents.” This would require fire departments to preplan radio channel usage for all incident levels based upon the needs of an emergency incident including large-scale or complex incidents [NFPA 2014].

When a fire department responds to an incident, the incident commander should forecast for the incident to determine if there is potential for being a complex or long-term operations that may require additional resources, including demands on the communications system. As incidents increase in size, the communication system has to keep up with the demands of the incident. The incident commander must be able to communicate with company officers and division/group supervisors [FIREScope 2015]. Before communications become an issue, the incident commander must consider options for alleviating excessive radio traffic. Several options are:

- Assign non-fireground resources (e.g., Staging, Rehab) to a separate tactical channel or talk-group channel.
- Designate a Command Channel, which is a radio channel designated by the fire department to provide for communications between the incident commander and the division/group supervisors or branch directors during an emergency incident.
- For incidents involving large geographical areas, designate a tactical channel or talk-group for each division [NFPA 2014].

NFPA 1561, Paragraph 6.2.2 states, “Clear text/plain language shall be used for radio communications.” The intent of the use of clear text/plain language for radio communications is to reduce confusion at incidents, particularly where different agencies work together [NFPA 2014].

At this incident, the fire department is dispatched on Tac Channel "A" and fireground operations are also conducted on Tac Channel "A". The department does have 3 additional Tac Channels available. The radio communications became quickly overwhelmed with excessive radio traffic due to the floor collapse. The most important issue is to always have fireground operations moved to one of the available tactical channels and off the dispatch channel. When the Mayday occurred, one of the first actions of Command is to request emergency traffic from the dispatcher to control the amount of radio traffic. Nonessential operations should be moved to another tactical channel. Another option would be to put Division Alpha and Division Charlie on a separate tactical channel. Command should designate a “Command Channel,” which is a radio channel designated by the fire department to provide for communications between the incident commander and the division/group supervisors.

***Recommendation #15: Fire departments should ensure that a communication standard operating procedure is in place for dispatchers to support fireground operations and the incident commander.***

Discussion: Effective fireground radio communication is an important tool to ensure fireground command and control as well as helping to enhance fire fighter safety and health. The radio system

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must be dependable, consistent, and functional to ensure that effective communications are maintained, especially during emergency incidents. Fire departments should have a “Communications” standard operating procedure (SOP) that outlines the communication procedures for fireground operations. This SOP should be periodically reviewed and updated. Fire departments should ensure that the Communication or Dispatch Center is part of this revision process. Another important aspect of this process is an effective education and training program for all members of the department and the dispatchers [Kunadharaju K, Smith TD, DeJoy DM. 2010].

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* provides basic requirements for fireground communications in Chapter 6, “Communications and Information Management”. The chapter addresses the key components for effective fireground communications, such as the requirements for a dispatch radio channel, a command radio channel, and a tactical radio channel; use of plain text for transmitting strategic modes of operation and situational reports; emergency traffic including a Mayday; and dispatcher support [NFPA 2014].

One of the consistent factors, defined in line-of-duty death investigation reports, is the incident commander can be overwhelmed with fireground radio communications. This is especially true if the incident commander has to monitor the dispatch channel and the fireground tactical channel. Fire departments need to ensure that the fireground radio communication system is designed and operated to take this issue into account. Among the reasons an incident commander may miss messages include being engaged in face-to-face communications, operating the command board and tactical worksheet, reviewing or preparing incident documentation, ambient noise conditions, radios accidentally being turned down, radio failure, simultaneous transmissions on separate channels, or simply being distracted with other tasks [NFPA 2014; Varone 2003].

There are several ways to ensure that the incident commander can effectively manage fireground communications. The best solution is to have a trained dispatcher monitoring the fireground radio channel. Dispatchers should meet the requirements of NFPA 1061, *Professional Qualifications for Public Safety Telecommunications Personnel* [NFPA 2018b]. The dispatcher is in a secure environment, isolated from fireground distractions and noise. The dispatcher should have access to playback technology with the ability to listen to hard-to-understand messages. The dispatcher should also have access to "identifier" information, which identifies the portable radio making the transmission. Like any other aspect of the fire service, all personnel need to be properly trained before being assigned to a critical task. In the world of fireground operations today, effective radio communications are critical, and the dispatcher is one of the most critical components in the radio communications systems. Proper training of a dispatcher involves more than teaching which buttons to push and how to figure out what companies to send where. Dispatchers need a thorough understanding of the incident management system, fireground strategy and tactics, and firefighting vernacular. Most important is to define the dispatcher’s role during emergency operations with such responsibilities as fireground benchmarks, notifying the incident commander of lapsed time intervals for a personnel accountability report, emergency traffic, a Mayday, roll calls, or building evacuations. Dispatchers

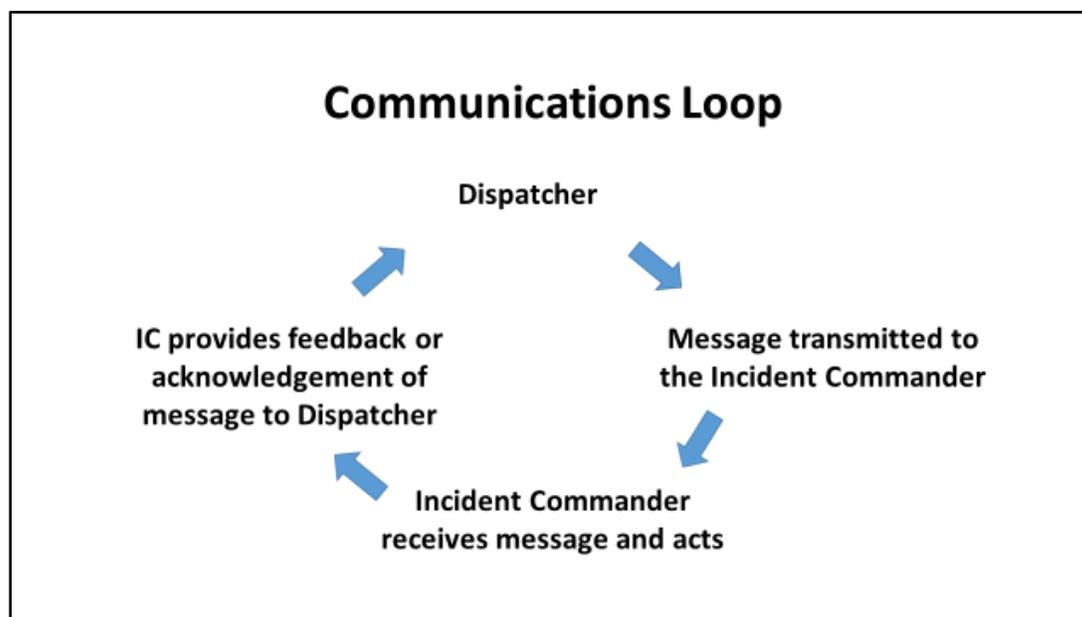
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should understand the critical role they play in the incident management system [NFPA 2014; Varone 2003].

Another important function for the dispatcher is to communicate with the incident commander about critical incident benchmarks. One responsibility of the dispatcher is to ensure that a personnel accountability report is conducted every 10–15 minutes during the incident. The dispatcher should prompt the incident commander every 10–15 minutes to conduct a personnel accountability report. Other responsibilities are to ensure that the incident commander communicates critical fireground benchmarks during the incident, such as a complete scene size-up with declared strategy, water is on the fire, a primary search is completed with outcome, command is being transferred, a Mayday has occurred and a request has been made for additional tactical channels and emergency traffic, fire is knocked down, and fire is out. This is not an all-inclusive list, but an idea of critical fireground benchmarks [NFPA 2014]. The job of dispatching should not be assigned to a new fire fighter or to a police dispatcher who does not have adequate training in fireground radio communications. Numerous line-of-duty death reports are of incidents in which the dispatcher had information that a fire fighter was in distress yet failed to act on that information [NFPA 2014]. Effective communication involves a thorough understanding of the message. The sender (dispatcher) transmits a clear message and the receiver (incident commander) must acknowledge the transmission so the sender (dispatcher) knows that the transmission was understood. This process would work the same way if the incident commander transmits a message to the dispatcher (**See Diagram 14**).



**Diagram 14. Communications loop between the dispatcher and the incident commander.**

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Dispatching is not a job that should be left to just one person who may be called away from monitoring the fireground radio to field telephone calls or dispatch runs. Dispatchers who monitor a fireground radio channel must be able to put 100% of their concentration into listening for missed messages and providing support to resources on-scene. Ideally, one dispatcher should be assigned to each fireground channel in use [Varone 2003]. Many fire departments assign a tactical radio operator or dispatcher to the assigned fireground tactical channel. This dispatcher is assigned the incident until Command clears the tactical channel.

Another solution is to provide the incident commander with a staff assistant or incident command technician. A battalion chief or district chief must monitor and comprehend radio traffic while enroute to the incident and then on-scene. Additionally, a battalion chief or district chief must address deployment issues, develop a strategy for the incident based upon communications from the first arriving resource, and develop an incident action plan for the incident. An incident command technician or staff aide can assist the battalion chief or district chief with processing information without distraction. Once on-scene, the staff assistant or staff aide can maintain fireground communications with the dispatcher. For fire departments that do not have a staff assistant or staff aide, another officer or fire fighter can be designated to function in this position [NFPA 2014].

Every fire fighter and company officer should take responsibility to ensure their portable radio is turned on and on the correct channel. A company officer's responsibility is to ensure that all members of the crew comply with these requirements [IAFF 2010].

At this incident, once the collapse occurred, the radio communications were out of balance both on the fireground and dispatch center. In order to ensure that proper communications is maintained, a tactical radio operator (TRO) could have been assigned to this incident. The TRO is assigned to an incident with no other responsibilities but to provide the necessary support and needs of the incident commander. Dispatchers need a thorough understanding of the incident management system, fireground strategy and tactics, and fire-fighting vernacular. Most important is to define the dispatcher's role during emergency operations with such responsibilities as fireground benchmarks, notifying the incident commander of lapsed time intervals for a personnel accountability report, emergency traffic, a Mayday, roll calls, or building evacuations. Dispatchers should understand the critical role they play in the incident management system.

It is essential that a fire department have a comprehensive standard operating procedure/guideline that clearly defines the dispatcher's role as well as the incident commander's for fireground communications.

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***Recommendation #16: 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 2015c]. The physical and mental condition of personnel should be monitored as part of the overall assessment. This ensures a fire fighter’s health does not deteriorate to the point it affects the safety of other fire fighters or endangers the safety and integrity of the operation. An incident commander 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 incident commander should establish rehabilitation operations when emergency operations pose a safety or health risk to fire fighters 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 2015c, 2018a, 2014].

Incident scene rehabilitation (“Rehab”) is a term often used for the care given to fire fighters 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 incident commander should establish more than one rehabilitation area. The site should be a sufficient distance from the effects of the operation where members can safely remove their personal protective equipment and can be afforded physical and mental rest [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:

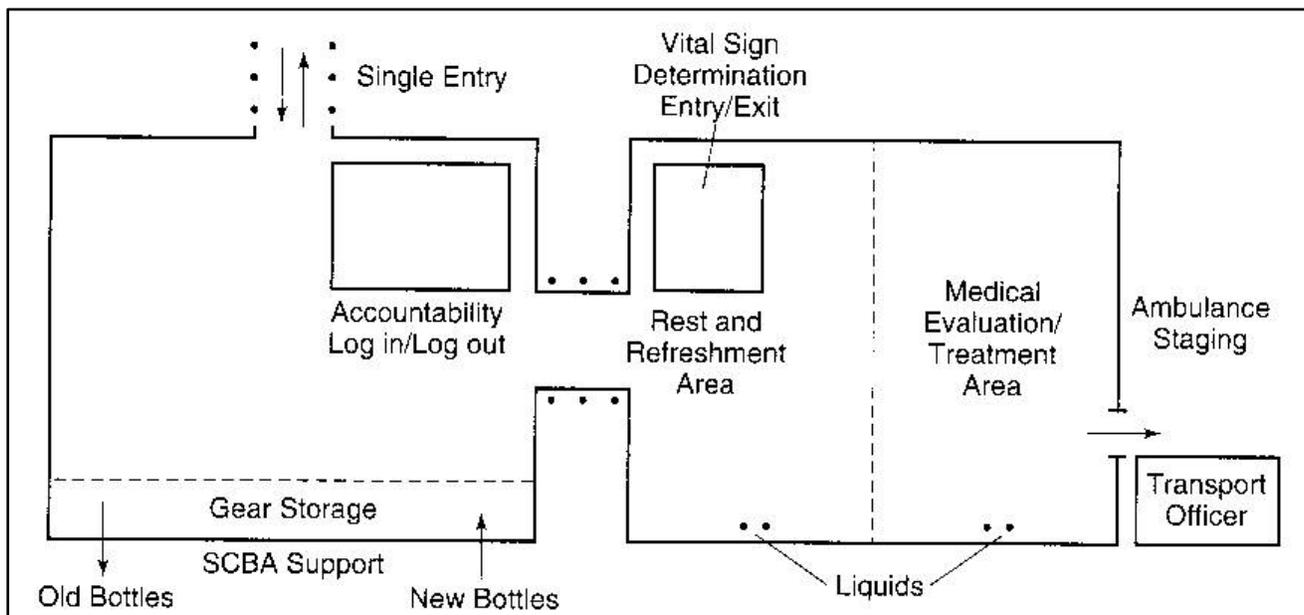
- Should be in a location that will provide physical rest by allowing the body to recuperate from the demands and hazards of the emergency or training evolution.
- Should be far enough away from the scene that personnel may safely remove their turnout gear and SCBA and be afforded physical and mental 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.

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- 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 15).

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: soup, broth, or stew in hot/cold cups
- 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].



**Diagram 15.** An example of how a “Rehab” area can be organized. There are many ways to establish an effective “Rehab” area.

At this incident, no formal rehab process was established. It is essential at any working fireground incident to have a rehab area. By establishing a rehab group, this will insure for the health and safety fire fighters during the incident. Also, a medical treatment area should be established so fire fighters

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are immediately treated and transported if necessary. Add the mental stress of this incident; this supports the need for a formal rehab process during fireground operations that would continue into the investigation phase.

***Recommendation #17: Fire departments should ensure that all members engaged in emergency operations receive annual proficiency training and evaluation on fireground operations.***

Discussion: In order to ensure for the proficiency and competency of fire department members, fire departments should conduct annual skills evaluation to verify minimum professional qualifications. This annual evaluation should address the qualifications specific to the member's assignment and job description. This process should be structured in a manner that skills are evaluated on a recurring cycle with the goal of preventing skills and abilities degradation and ensuring for the safety of members. Proficiency evaluation and training provides an opportunity to ensure that all fire officers and fire fighters are competent in the knowledge, skills, and abilities in fireground operations. This process should include annual live fire training.

NFPA 1500, *Standard for a Fire Department Occupational Safety, Health, and Welfare 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. This ensures members are trained and competencies are maintained in order to effectively, efficiently, and safely execute all responsibilities [NFPA 2018a]. 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 2018a].

The primary goal of all training, education, and professional development programs is the reduction of occupational injuries, illnesses, and fatalities. As members progress through various job duties and responsibilities, the department should ensure the introduction of necessary knowledge, skills, and abilities to members who are new in their job titles as well as ongoing development of existing skills [NFPA 2018a].

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 performance during initial fireground operations [NFPA 2015b]. Proficiency training for fireground operations and emergency incidents should be conducted annually. This training should include, but not be limited to, 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 rapid intervention teams, and Mayday operations.

At the time of this incident, the department was not conducting annual proficiency training for fireground operations.

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***Recommendation #18: Fire departments should provide battalion chiefs with a staff assistant or incident command technician to manage communications, resource status, and information management.***

Discussion: A chief's aide, staff assistant, or incident command technician is a position designed to assist an incident commander with various operational duties during emergency incidents. The staff assistant can be an essential element for effective command and control of an incident. At an emergency incident, the staff assistant can assist with key functions such as managing the tactical worksheet; maintaining personnel accountability of all members operating at the incident (resource status and deployment location); monitoring radio communications on the dispatch, command, and fireground channels; control information flow by computer, fax, or telephone; and, access reference material and pre-incident plans. The personnel accountability system is a vital component of the fire fighter safety process. The system is designed to account and track personnel as they perform their fireground tasks. In the event of an emergency or Mayday, the personnel accountability system must be able to provide the rapid accounting of all responders at the incident. This is one of the staff assistant's essential responsibilities. Another important function is the role of a driver in addition to their role as part of the command team. Command officers are required to respond quickly to emergency incidents. In their response, they have to be fully aware of all traffic conditions, construction detours, traffic signals, and other conditions. More importantly, the command officer must also monitor and comprehend radio traffic to assess which companies are responding, develop a strategy for the incident based upon input from first arriving officers, and develop and communicate an incident action plan that defines the strategy of the incident. A staff assistant can drive while the battalion chief or chief officer is processing information without distraction and complete the necessary tasks enroute to the scene [NFPA 2014].

The fire department involved in this incident assigned a staff assistant to the fire chief. The staff assistant performs administrative duties, drives the fire chief's vehicle, and assists on the fireground with communications and accountability as necessary. However, battalion chiefs were not assigned staff assistants. Thus, the battalion chief is responsible for the operation of their vehicle during emergency responses, in addition to collecting and analyzing information about the incident from a number of sources. Departments should consider a staff assistant or incident command technician to be an individual who has the experience and authority to conduct the required tasks. Other potential roles for the staff assistant include assisting with the initial size-up, completing a 360-degree size-up, coordinating progress reports from group/division officers, and many others. The staff assistant or incident command technician position can be used as a training position to help facilitate officer development, especially for officers preparing to soon become battalion chiefs/incident commanders. There are non-emergency functions for the staff assistant that are vital to the daily operations of the department. Some jurisdictions assign a staff assistant to command officers to perform daily administration functions (such as position staffing and leave management).

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At this incident, the department did not have the position of staff assistant or incident command technician for battalion chiefs. This position is essential for successful fireground incident management and command safety.

***Recommendation #19: Fire departments should develop and implement a professional development plan to ensure for career enhancement plus maintaining knowledge, skills, abilities, and competencies for emergency response.***

*Discussion:* The primary goal of all training, education, and professional development programs is the reduction of occupational injuries, illnesses, and fatalities. As members progress through various duties and responsibilities, the department should ensure the introduction of the necessary knowledge, skills, and abilities to members who are new in their position, as well as ongoing development of existing skills. In order to build a successful training plan, it is critical to develop the plan in a systematic and functional manner. Training occurs in the fire service to improve the skills of fire fighters as well as the overall response capabilities of the department while meeting national standards. Therefore, it is critical to build a structured plan that meets all these criteria [Clark 2017].

Each fire department should develop an annual training plan that will be a combination of minimum company standards, special operations training, and opportunity training. This process should consist of fire suppression, EMS, hazardous materials, technical rescue, water rescue, and various fire fighter safety topics. The annual training plan should serve as the training calendar for the given year but is also the basis for multi-year planning. Classes should be rotated on a minimum three-year basis to ensure a variety of opportunities are offered. Classes such as Instructor I and II, Fire Officer I and II, National Fire Academy classes, and others will be offered on a rotating basis. Live fire training evolutions should be conducted at least once every year. All training should be delivered in varying formats. Classroom presentations, quick drills, practical evolutions, or web-based training should be utilized throughout the course of the year [Springfield Fire Department 2014].

When developing a formal training plan, the first step is to evaluate and build upon existing training standards, such as NFPA professional qualifications standards. Each fire department is structured differently in order to meet the needs of their community. Therefore, training plans must be designed based on services provided by a fire department and the department's mission statement. NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, Chapter 4, "Fire Department Administration," states in paragraph 4.1.2, "The fire department shall prepare and maintain written policies and standard operating procedures that document the organizational structure, membership, roles and responsibilities, expected functions, and training requirements including the following [NFPA2018a]:

- The types of standard evolutions that are expected to be performed and the evolutions that must be performed simultaneously or in sequence for different types of situations
- The minimum number of members who are required to perform each function or evolution and the manner in which the function is to be performed

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- The number and types of apparatus and the number of personnel that will be dispatched to different types of incidents
- The procedures that will be employed to initiate and manage operations at the scene of an emergency.

These programs should include information to ensure that members are trained prior to performing individual duties, as well as ongoing professional development to ensure competency. The training plan continues to serve as a comprehensive all-hazards approach that meets or exceeds federal, state, and local regulations as well as the needs of fire department personnel. This approach allows the department to maintain operational and response capabilities to the customers they serve. The plan is designed to be specific yet allows for flexibility in the event of training that is made available or as departmental needs dictate. The plan includes a detailed calendar for the year, which will allow the company officers and command staff to balance other duties and priorities throughout the course of the year [Maness 2013].

Training programs should include but not be limited to the following:

- Community risk reduction (fire prevention, public education, investigation, etc.)
- Safety, health, and wellness
- Fire suppression
- Emergency medical
- Human resources (leadership, supervision, interpersonal dynamics, equal employment opportunity, etc.)
- Incident management system
- Hazardous materials
- Technical rescue
- Information systems and computer technology
- Position-specific development (fire fighter, company officer, chief officer, tele-communicator, investigator, inspector, driver/operator, etc.) [NFPA 2018a].

NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, Chapter 5, “Training, Education and Professional Development,” states in paragraph 5.1.9, “As a duty function, members shall be responsible to maintain proficiency in their skills and knowledge, and to avail themselves of the professional development provided to the members through department training and education programs” [NFPA 2018a].

Finally, the responsibility of the fire service is to save lives, stabilize incidents, and conserve property. This is accomplished through effective and structured training prior to an emergency response. A well-developed annual training plan will ensure continuity across a fire department and will maintain and improve knowledge, skills, and abilities in all members. All members must take it upon themselves to continually improve and train new fire service members so the department can respond effectively to any emergency incident.

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At this incident, the fire department did not have a formal annual training plan for fire fighters and fire officers. The fire department had a captain responsible for conducting the recruit training program, but no professional development for fire fighters and fire officers. The department does have annual training requirements for specialized training such a trench rescue, technical rescue, and shipboard firefighting.

### **References**

- Brunacini AV [2002]. *Fire command*. Quincy, MA: National Fire Protection Association.
- Brunacini AV, Brunacini N [2004] *Command safety*. Phoenix, AZ: Across the Street Publications.
- Clark M [2017]. [Building a fire department annual training plan from the ground up](#). Charles Town, WV: American Military University, *In Public Safety*, May 8.
- 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. In: Firefighting procedures. Vol. 1. New York, NY: Fire Department of New York.
- Fire and Rescue Departments of Northern Virginia [2013]. Engine company operations. Fire and Rescue Departments of Northern Virginia, Firefighting and emergency operations manual. 2<sup>nd</sup> ed. Fairfax County, VA: Fire and Rescue Departments of Northern Virginia.
- FIRESCOPE [2015]. [Incident command system for structure fire operations, ICS 500](#). Riverside, CA; FIRESCOPE. <http://firescope.org/>.
- Harms, T. [2010]. [Using tactical worksheets, tactical worksheets help maintain control at the scene](#). FireRescue Magazine. April 2010. <http://www.firefighternation.com/index.php?q=article/using-tactical-worksheets>. Date accessed: June 2018.
- IAFC [2012]. [Rules of Engagement for Structural Firefighting](#). Fairfax, VA, International Association of Fire Chiefs.
- IAFF [2010]. [IAFF Fire Ground Survival Training Program](#). Washington, DC: International Association of Fire Fighters.
- ISFSI [2013]. International Society of Fire Service Instructors position statement—[Fire dynamic research in tactical operations](#). Press release, October 30, 2013.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

Klaene B, Sanders R [2007]. *Structural firefighting strategy and tactics*. 2<sup>nd</sup> ed. Sudbury, MA: Jones & Bartlett Learning.

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.

Kunadharaju K, Smith TD, DeJoy DM [2010]. [Line-of-duty deaths among U.S. firefighters: an analysis of fatality investigations](#). Athens, GA: University of Georgia, College of Public Health, Workplace Health Group, <https://www.ncbi.nlm.nih.gov/pubmed/21376916>.

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

LAFD [2001]. [Rapid intervention company, fireground safety, and incident accountability](#). Los Angeles, CA: Los Angeles Fire Department.

MABAS [2017]. [MABAS Division 201 operations manual](#). Version 1.1. Mishawaka, IN: Mutual Aid Box Alarm System.

Madrzykowski D, Kent J [2011]. [Examination of the thermal conditions of a wood floor assembly above a compartment fire](#)<sup>+</sup>. Gaithersburg, MD: National Institute of Standards and Technology, NIST Technical Note 1709.

Madrzykowski D, and Weinschenk C [2018]. [Understanding and Fighting Basement Fires](#), Underwriters Laboratory, Fire Fighter Safety Research Institute, Columbia, MD.

Maness B [2013]. [Developing an annual training program](#), Carolina Fire Rescue EMS Journal, April 21, 2013.

Modern Fire Behavior [2014]. [SLICE-RS](#). [ModernFireBehavior.com](#).

NFPA [2007]. NFPA 1981, *Standard on open-circuit self-contained breathing apparatus (SCBA) for emergency services*. Quincy, MA: National Fire Protection Association.

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

NFPA [2013b]. NFPA 1982, *Standard on personnel alert safety system*. 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.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

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

NFPA [2015b]. NFPA 1410, *Standard on training for emergency scene operations*. Quincy, MA: National Fire Protection Association.

NFPA [2015c]. NFPA 1584, *Standard on the rehabilitation process for members during emergency operations and training exercises*. Quincy, MA: National Fire Protection Association.

NFPA [2016]. 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 [2018a]. NFPA 1500, *Standard on fire department occupational safety, health, and wellness program*. Quincy, MA: National Fire Protection Association.

NFPA [2018b]. NFPA 1061, *Standard for public safety telecommunications personnel professional qualifications*. Quincy, MA: National Fire Protection Association.

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.

NIOSH [2011]. [A Career Captain Dies and 9 Fire Fighters injured in a Multistory Medical Building Fire—North Carolina](#). Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2011-18.

NIOSH [2012]. [Volunteer fire fighter caught in a rapid-fire event during unprotected search, dies after facepiece lens melts—Maryland](#). 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.

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.

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.

## **Arson Fire Kills Three Fire Fighters and Injures Four Fire Fighters due to a Floor Collapse in a Row House—Delaware**

NIOSH [2015]. [4 career fire fighters killed and 16 fire fighters injured at commercial structure fire—Texas](#). Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2013-16.

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 (NIOSH), Publication No. 2018-154, <http://www.cdc.gov/niosh/docs/wp-solutions/2018-154/>.

NIST [2013]. [Report on high-rise fireground field experiments](#). By Averill JD, Moore-Merrell L, Ranellone Jr. RT, Weinschenk CG, Taylor N, Goldstein R, Santos R, Wissoker D, Notarianni K, Butler KM. Gaithersburg, MD: National Institute of Standards and Technology.

OSHA [1998]. [Respiratory protection](#). Final rule. Fed Reg 63(5):1218-AA05 (to be codified at 29 CFR 1910.1926).

Smith JP [2002]. *Strategic and tactical considerations on the fireground*. Upper Saddle River, NJ: Prentice Hall.

Springfield Fire Department [2014]. [Annual training plan 2014](#). City of Springfield, MO: Springfield Fire Department.

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

TSFRS [2013]. [Initial fireground assessment standard operating procedure, section 3. Response to alarms, subsection 3.00.01](#). Township of Spring, PA: Township of Spring Fire & Rescue.

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

UL FSRI [2012]. [Governor's Island Experiments](#). Underwriters Laboratory, Fire Fighter Safety Research Institute, Columbia, MD. <https://ulfirefightersafety.org/resources.html#training/scientific-research-for-the-development-of-more-effective-tactics-governors-island-experiments>

USFA [2008]. [Emergency incident rehabilitation manual for firefighters and other emergency responders](#). Washington, DC: U.S. Department of Homeland Security, U.S. Fire Administration, [https://www.usfa.fema.gov/downloads/pdf/publications/fa\\_314.pdf](https://www.usfa.fema.gov/downloads/pdf/publications/fa_314.pdf).

Varone JC [2003]. [Firefighter safety and radio communication](#). Fire Engineering 156(3).

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Weather Underground [2016]. [Weather history for KILG, Saturday, September 24](#). Atlanta, GA: The Weather Channel Interactive, Inc.

Zevotek, R, Stakes K, and Willi J [2017]. [Impact of Fire Attack Utilizing Interior and Exterior Streams on Firefighter Safety and Occupant Survival: Full Scale Experiments](#), Underwriter's Laboratory, Fire Fighter Safety Research Institute, Columbia, MD.

### **Investigator Information**

This incident was investigated by Murrey E. Loflin, Investigator, Matt Bowyer, General Engineer, and Tim Merinar, Safety Engineer, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, West Virginia. An expert technical review was provided by Joseph Fleming, Deputy Chief with the Boston Fire Department and Dennis Rubin, Chief of the Upper Merion, PA Fire & EMS Department. The NFPA Public Fire Protection Division provided a technical review of this investigation report.

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### **Additional Information**

#### **National Institute for Standards and Technology (NIST) and Underwriters Laboratories (UL)**

These two agencies provide information including training videos showing the findings from NIST and UL research conducted in cooperation with the Fire Department of New York on Governor’s Island in 2012. <https://ulfirefightersafety.org/resources.html#training/scientific-research-for-the-development-of-more-effective-tactics-governors-island-experiments>

#### **Underwriters Laboratory (UL), Fire Fighter Safety Research Institute (FSRI)**

UL FSRI Director Steve Kerber, Fire Protection Engineer Dan Madrzykowski and Los Angeles County Fire Department Chief of Training Derek Alkonis team up to present a 7-part video lecture series titled “NIST and UL Research on Fire Behavior & Fireground Tactics.” The presentations were filmed at the 2013 IAFF Redmond Symposium and the slides and videos have been integrated into the presentations for a better learning experience. Part 4: Case Studies is most relevant to this investigation. <https://ulfirefightersafety.org/posts/nist-and-ul-release-a-video-lecture-series.html>

Information on completed studies involving ventilation, suppression, structural collapse and below grade fires can be found at the [UL Firefighter Safety and Research Institute](https://ulfirefightersafety.org) website at <https://ulfirefightersafety.org>

#### **International Association of Fire Fighters (IAFF) Fire Ground Survival Program**

The purpose of the [IAFF Fire Ground Survival Program](#) is to ensure that training for Mayday prevention and Mayday operations is consistent among all fire fighters, company officers, and chief officers. Fire fighters 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 fire fighter fatality investigations conducted by the National Institute for Occupational Safety and Health (NIOSH) and has been developed by a committee of subject matter experts from the IAFF, the International Association of Fire Chiefs (IAFC), and NIOSH.

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

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

The chapter on Command Safety clearly defines the requirements for the incident commander to meet, including establishing a fixed command post, personnel accountability, the use of staff aides, rapid

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intervention crews, and the appointment of a safety officer and assistant safety officer(s)(as needed), plus the expectations and authority of the safety officer. Annexes cover *Functional Assignments for High-Rise Building Incidents*, *Development of Subordinate Officers or Implementing a More Efficient Management System*, *Incident Management for the Fire Service on Type V or Type IV Incidents*, and *Structural Fire-Fighting—Risk Assessment and Operational Expectation*.

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

### **Disclaimer**

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

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

#### **NIOSH Task Number 21198**

*Note:* [Full report](https://www.cdc.gov/niosh/npptl/ppe-fireservice/completedrpts.html) is at <https://www.cdc.gov/niosh/npptl/ppe-fireservice/completedrpts.html>

#### **Background**

As part of the *National Institute for Occupational Safety and Health (NIOSH), Fire Fighter Fatality Investigation and Prevention Program (FFFIPP)*, the National Personal Protective Technology Laboratory (NPPTL) agreed to inspect and evaluate six self-contained breathing apparatus (SCBA) unit identified as five MSA Model Firehawk® M7, 4500 psi, 45 minute units and one MSA Model G1, 4500 psi, 45 minute unit.

This SCBA status investigation was assigned NIOSH Task Number 21198. The NIOSH Fire Fighter Fatality Investigation and Prevention Program and the Fire Department were advised that NIOSH NPPTL would provide a written report of the inspection and any applicable test results.

The SCBA units were delivered by NIOSH FFFIPP investigators, who were assigned to investigate the incident which occurred in Delaware on September 24, 2016. The NIOSH FFFIPP investigators delivered the SCBA to Lab H1513 for secure storage at the NIOSH facility in Morgantown, West Virginia on October 25, 2016.

From February 10 - 22, 2017, NPPTL employees Jeremy Gouzd and Angie Andrews inspected the SCBA units. The SCBA units remained in secure storage in Lab H1513 throughout the entire inspection and testing process.

#### **SCBA Inspection**

The inspection process was initiated by Jeremy Gouzd and Angie Andrews once the SCBA units were delivered by NIOSH FFFIPP investigators. They delivered the units to Lab H1513 in the NIOSH facility in Morgantown, West Virginia on October 25, 2016. The SCBAs were identified as the Fire Department's SCBAs, which were visually examined, component by component, in the condition received to determine the conformance of the unit to the NIOSH-approved configuration. The units were identified as five MSA Model Firehawk® M7, 4500 psi, 45 minute units and one MSA Model G1, 4500 psi, 45 minute unit; with NIOSH Approval Numbers TC-13F-0798CBRN, TC13F-549CBRN, TC-13F0770CBRN, and TC-13F-302.

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### **SCBA Testing Summary and Conclusions**

The SCBA units inspected and evaluated by NPPTL were identified as five MSA Model Firehawk® M7, 4500 psi, 45 minute units and one MSA Model G1, 4500 psi, 45 minute unit, with NIOSH Approval Numbers TC-13F-0798CBRN, TC13F-549CBRN, TC-13F0770CBRN, and TC-13F-302. The corresponding facepieces and cylinders were provided with all units.

**Unit #12**, TC-13F-0798CBRN 45 minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was empty with the valve closed and the MMR bypass was found in the open position. Overall condition of this unit was fair with normal wear and tear. This unit met the requirements of the NIOSH Positive Pressure Test, as the unit did maintain a positive pressure for the 45 minute minimum duration of the unit. The unit passed all of the other NIOSH tests as well as the NFPA airflow test.

**Unit #13**, TC-13F-549CBRN 45 minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was still pressurized to 1500 psi with the valve closed and the MMR bypass was found in the closed position. Overall condition of this unit was fair with normal wear and tear. There was some heat damage found on the straps as well as some melted debris found on the unit. This unit met the requirements of the NIOSH Positive Pressure Test, as the unit did maintain a positive pressure for the 45 minute minimum duration of the unit. The unit passed all of the other NIOSH tests as well as the NFPA airflow test.

**Unit #14**, TC-13F-0770CBRN 45 minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was empty with the valve closed and the MMR bypass was found in the closed position. Unit had severe heat damage and melting of parts. Melted debris had to be removed from around unit to conduct evaluation. Lens showed severe heat damage with a protruding bubble with a hole in it. Gauges on both the PASS device and cylinder were unreadable due to heat damage. Overall condition was poor and in an unusable condition. This unit did not meet the requirements of all six NIOSH SCBA certification tests. The unit failed the NIOSH Positive Pressure Test (Standard Test Procedure Number 120, 42 CFR Part 84 Reference: Subpart H, 84.70 (a)(2)(ii)), the NIOSH Gas Flow Test (Standard Test Procedure Number 123, 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c)), the NIOSH Remaining Service Life Indicator Test (Standard Test Procedure Number 124, 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)), and NFPA Airflow Performance Test - NFPA 1981 (1997 Edition) Reference: Chapter 5, Performance Requirements, Sec. 5-1.1.

**Unit #18**, TC-13F-549CBRN, 45 minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was empty with the valve closed and the MMR bypass was found in the closed position. Overall condition of this unit was fair to poor with severe heat damage found on the straps as well as some melted debris found on the unit. Left shoulder strap and waist belt were cut. The back frame also showed signs of damage with a cracked left railing.

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This heat damage would cause the unit to be unusable. This units PASS and electronics did not function. This unit did not meet the requirements of all six NIOSH SCBA certification tests. The unit failed the NIOSH Positive Pressure Test (Standard Test Procedure Number 120, 42 CFR Part 84 Reference: Subpart H, 84.70 (a)(2)(ii)), the NIOSH Gas Flow Test (Standard Test Procedure Number 123, 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c)), the NIOSH Remaining Service Life Indicator Test (Standard Test Procedure Number 124, 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)), and NFPA Airflow Performance Test - NFPA 1981 (1997 Edition) Reference: Chapter 5, Performance Requirements, Sec. 5-1.1.

**Unit #19**, TC-13F-549CBRN 45 minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was still pressurized to 2000 psi with the valve closed and the MMR bypass was found in the closed position. Overall condition of this unit was fair with normal wear and tear. There was some heat damage found on the straps as well as some melted debris found on the unit. This unit met the requirements of the NIOSH Positive Pressure Test, as the unit did maintain a positive pressure for the 45 minute minimum duration of the unit. The unit passed all of the other NIOSH tests as well as the NFPA airflow test.

**Unit #Unknown**, TC-13F-302 45minute, 4500 psi, was delivered in a black trash bag with an attached corresponding cylinder and facepiece. As received the cylinder was still pressurized to 3500 psi with the valve closed and the MMR bypass was found in the closed position. This unit MSA Firehawk® M7, NFPA 1981, 2002 edition was upgraded to NFPA 2007, TC-13F-302. Overall condition of this unit was fair with normal wear and tear and some heat dye sublimation on straps. This unit did not meet the requirements of all six NIOSH SCBA certification tests. The unit failed the NIOSH Positive Pressure Test (Standard Test Procedure Number 120, 42 CFR Part 84 Reference: Subpart H, 84.70 (a)(2)(ii)). The unit passed the NFPA airflow test.

In light of the information obtained during this investigation, NIOSH NPPTL has proposed no further action on its part at this time. No evidence was identified to suggest that the SCBA units inspected and evaluated contributed to the fire fighter fatalities. NIOSH determined that there was no need for corrective action with regards to the approval holder or users of SCBAs manufactured under the approval numbers granted to these products.

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### Appendix Two SCBA Data Log Information

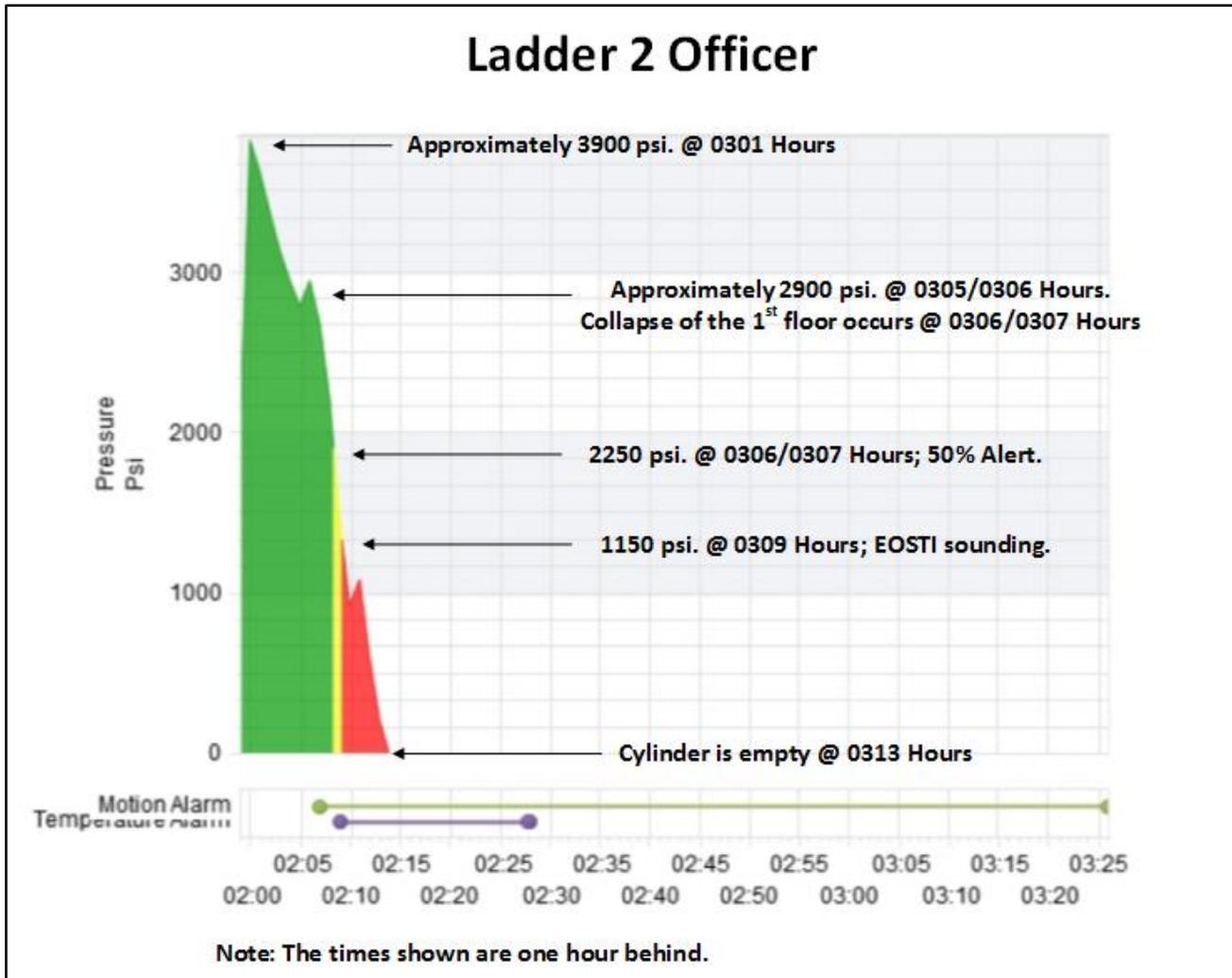


**Diagram 16. The SCBA data log information for Squad 4C.**

PASS Alarm Motion: Activated at 0322 hours; reset attempt logged at 0322, however PASS remained in alarm.

**Breathing Air Rate Estimate Average:** Approximately 160 liters per minute over an 11-minute period. The period between 0311 hours and 0319 hours, the air consumption rate was 50% of the volume used in 8 minutes; the remaining 50% of the volume was exhausted in the following 4 minutes which could indicate a significant air loss.

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**Diagram 17. The SCBA data log information from the Ladder 2 Officer. Note: The time on data log is 1 hour behind but corresponds to events that occurred.**

The PASS Internal Temperature Alarm: activated at 0310 hours and went off at 0328 hours.

Breathing Rate Estimate: all volume of air was exhausted in 12 minutes. The breathing rate was in excess of 130 liters per minute, which can indicate a significant air loss event

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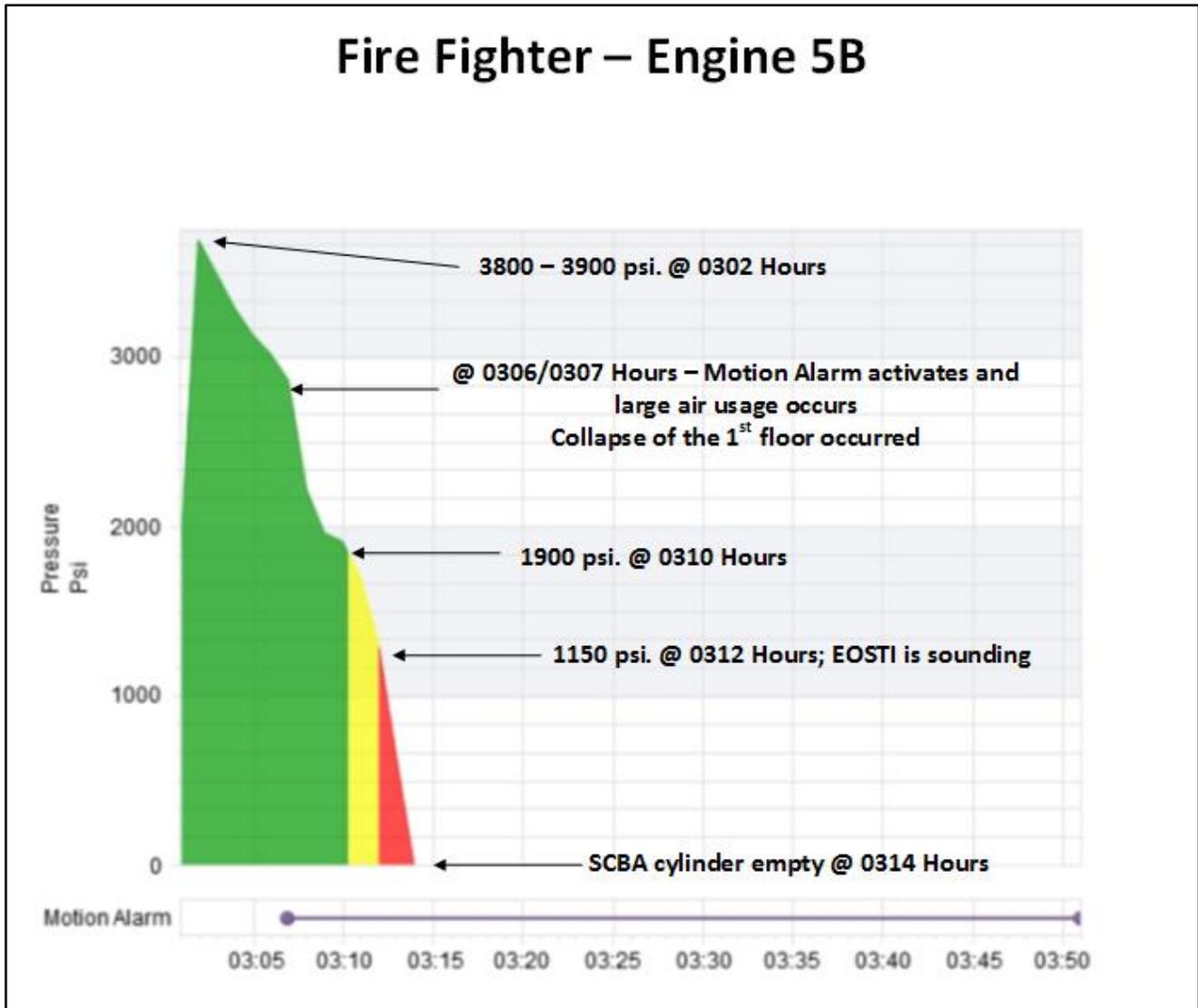


Diagram 18. The SCBA data log information from the fire fighter from Engine 5B.

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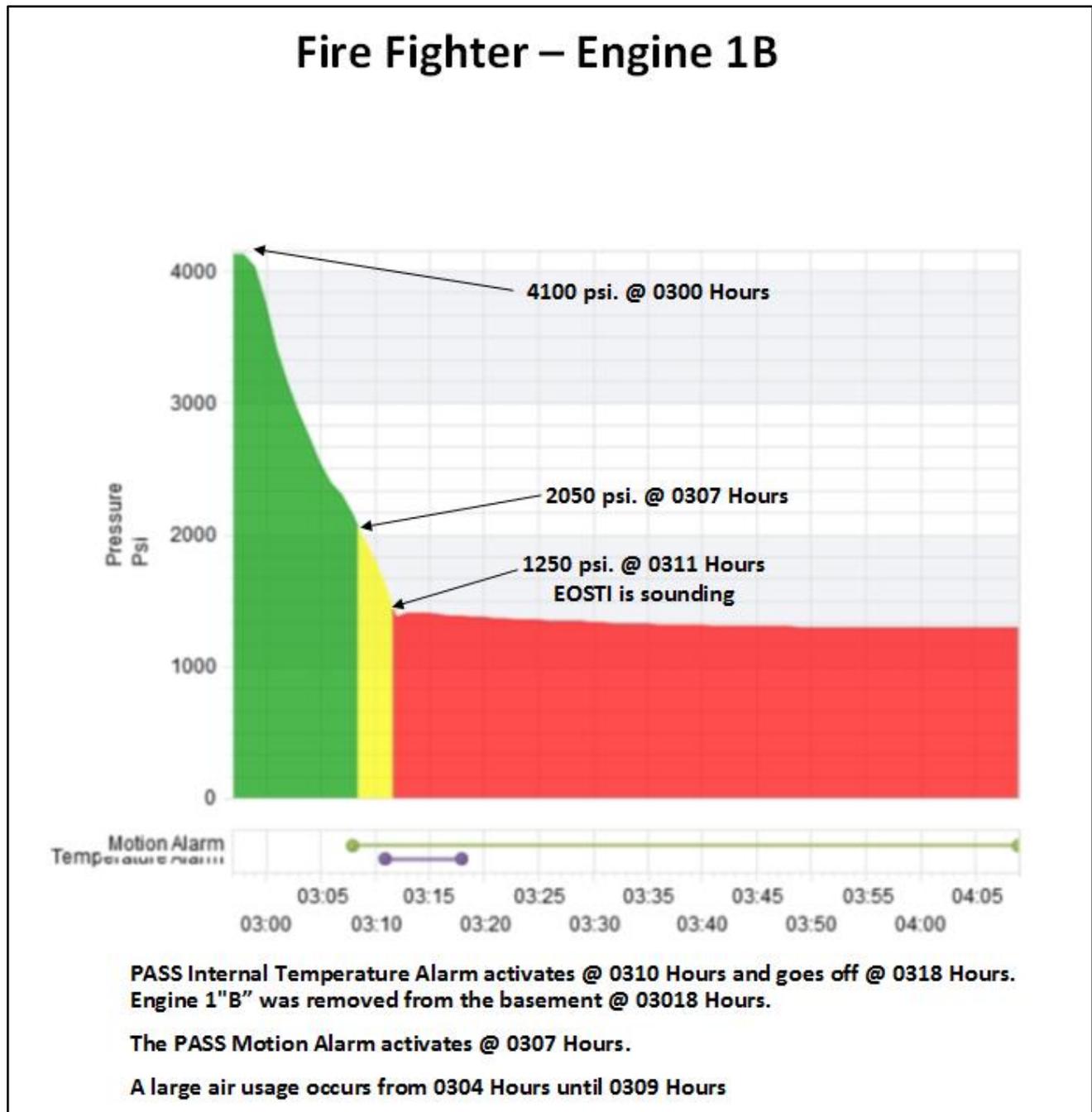


Diagram 19. The SCBA data log information from the fire fighter from Engine 1B.



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	ORIGINAL TACTICAL / MAYDAY CHANNEL	VRS CHANNELS	ALTERNATE TACTICAL CHANNEL	COMMAND / ANNOUNCEMENT CHANNEL	NOTES:
Talk Group 1	03	04 & 08	05	06	
Talk Group 2	07	08 & 04	09	010	
Talk Group 3	A3	A4 & A8	A5	A6	
Talk Group 4	A7	A8 & A4	A9	A10	
Talk Group 5	B3	B4 & B8	B5	B6	
Talk Group 6	B7	B8 & B4	B9	B10	

EMERGENCY IDENTIFIER SIGNALS						
<ul style="list-style-type: none"> <li>1<sup>st</sup> Digit = Type Of Unit</li> </ul>						
1	Engine Company	6	EMS Supervisor			
2	Truck Company	7	Medic Unit			
3	BFC	8	Ambulance			
4	Haz-Mat Unit	9	Fire Boat			
5	Rescue Squad	0	Fire Ops/SOD Cached Radios			
0800 Fire Ops radios 0900 SOD events						
<ul style="list-style-type: none"> <li>2<sup>nd</sup> &amp; 3<sup>rd</sup> Digits = Company Number</li> </ul>						
<ul style="list-style-type: none"> <li>4<sup>th</sup> Digit = Riding Position On Apparatus</li> </ul>						
	ENGINE	TRUCK	BFC	HAZ MAT	SQUAD	EMS
1	OIC	OIC	BFC P1	OIC	OIC	OIC/ACIC
2	Line	Bar	BFC P2	Entry 1	Team A	ACA
3	Layout	Hook	BFC P3	Entry 2	Team B	
4	Driver	Driver	BFC P4	Research	Team B	
5		Tillerman	BFC P5	Driver	Driver	
6			BFC P6 (Aide)		Spare 1	
7					Spare 2	

**Diagram 20. An example of a Mayday Tactical Worksheet  
(Courtesy of the District of Columbia Fire and EMS Department)**