Career Fire Fighter Dies From an Out-of-air Emergency in an Apartment Building Fire—Connecticut

Executive Summary

On October 7, 2014, a 48-year-old male career fire fighter died while conducting interior fire-fighting operations in a two-story residential apartment fire. At 1830 hours, Engine 16 was dispatched to a structure fire reported with smoke showing. The lieutenant from Engine 16 conducted a scene size-up and reported heavy fire showing from the second floor on Side Bravo. The lieutenant and right jumpseat fire fighter made entry into the front door with a 1¾-inch hoseline and started up the stairs to the second-floor apartment. The Ladder 4 crew went by them, went to the top of the stairs, and forced the door to the apartment. The Engine 16 crew entered the apartment, and the lieutenant had the hoseline charged. The apartment was hot with zero visibility.

Sides Alpha and Bravo of the fire building (*NIOSH photo.*)

The lieutenant had his fire fighter pencil the ceiling. Minutes later, the fire fighter's vibra-alert activated, and the lieutenant told him to exit the building. The lieutenant started to exit the apartment but couldn't find the fire fighter behind him. The lieutenant continued to search for the Engine 16 fire fighter and stated that he called a Mayday, but it was not acknowledged by Command. He then tried to radio the fire fighter. A fire fighter from Ladder 4 vented the picture window on Side Alpha of the second-floor apartment. The heat conditions increased in the apartment. Two fire fighters from Tactical Unit 1 were in the living room of the apartment, and due to the heat conditions, they got separated. One of the fire fighters from Tactical Unit 1 had been hit by a hose stream and momentarily lost consciousness, eventually causing him to fall out the Side Alpha picture window. He was transported to the hospital with burns and lacerations. The Engine 16 lieutenant came out of the building and the Engine 16 fire fighter was still not located. Command activated the rapid intervention crew and ordered Engine 5 and Tactical Unit 1 into the apartment. Engine 5 made entry to the apartment and heard a PASS alarm going off to the right of the door. The Engine 16 fire fighter was found lying on his right side near the door with his foot caught in a piece of furniture. The Engine 5 crew brought the fire fighter out of the building, and he was transported to the hospital but pronounced

dead upon arrival. The Engine 16 lieutenant sustained injuries but was treated and released. The Tactical Unit 1 fire fighter who had fallen out the window remained in the hospital for 23 days.

Contributing Factors

- *Fireground tactics*
- *Crew integrity*
- *Personnel accountability*
- *Air management*
- *Mayday procedures*
- *Fireground communications*
- *Ventilation*
- *Personal protective equipment use*
- *Live fire training*
- *Unsprinklered occupancy*

Key Recommendations

- *Fire departments should ensure that risk assessments are conducted prior to initial operations and throughout the incident and that the strategy and tactics match the assessment.*
- *Fire departments should ensure that crew integrity is properly maintained by voice or radio contact when operating in an immediately dangerous to life or health (IDLH) atmosphere.*
- *Fire departments should ensure that fire fighters and officers are properly trained in air management including out-of-air emergencies.*
- *Fire departments should use a personnel accountability system that accounts for all resources assigned to an incident.*
- *Fire departments should ensure that incident commanders incorporate the principles of command safety into the incident management system.*
- *Fire departments should ensure fire fighters are properly trained in Mayday procedures.*
- *Fire departments should provide the incident commander with a Mayday tactical checklist for use in the event of a Mayday.*

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Introduction

On October 7, 2014, a 48-year-old male career fire fighter died while conducting interior operations in a two-story residential apartment. On October 9, 2014, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On October 14–24, 2014, a general engineer, an occupational safety and health specialist, and an investigator from the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Connecticut to investigate this incident. The NIOSH FFFIPP investigators met with members of the career fire department, International Association of Fire Fighters local union, Connecticut State Police, Connecticut Division of Occupational Safety and Health, and the city dispatch center. NIOSH FFFIPP investigators interviewed the incident commander and fire fighters who were on-scene at the time of the incident. The NIOSH FFFIPP investigators visited the incident site, took photographs, and collected and reviewed training records, standard operating procedures, and medical records. The self-contained breathing apparatus (SCBA) from the Engine 16 fire fighter (Engine 16B) and Tactical Unit 1 fire fighter were evaluated by the NIOSH National Personal Protective Technology Laboratory.

Fire Department

The career fire department involved in this incident serves a city with a population of over 125,000 and has a total area of 17.38 square miles. The fire department employs 395 personnel and averages about 23,053 response calls annually. The fire department is subdivided into two main fields of operation: Emergency Services and Support Services. The Support Services is comprised of the Fire Administration staff and the Employee Assistance Program. Under command of the Support Services Division are the Fire Marshal’s Office, Equipment Maintenance Division, Fire Alarm Communications Technology Division, Fire Training Division, and Special Events Unit.

The Emergency Services Division is comprised of 12 fire stations, which are divided into 2 districts. Each district is commanded by a district chief. Each shift is commanded by a deputy fire chief. The apparatus fleet consists of 11 engines, 5 ladders, 1 tactical unit (Heavy Rescue), and numerous special, support, and reserve units. All front-line apparatus are staffed with a minimum crew of three fire fighters and an officer (captain or lieutenant). The fire department uses the following designations for riding assignments on the fire apparatus: Officer is “A,” right jumpseat is “B,” left jumpseat is “C,” and the engineer operator is “D.”

Emergency medical service is provided by two separate ambulance companies. Each ambulance company is assigned a response area within one of the two districts in the city.

Training and Experience

The fire department involved in this incident requires potential candidates for employment as a fire fighter to have a high school diploma or GED and a valid state driver's license and to successfully pass a background check and an entry-level civil service test.

Once selected as a candidate, the initial step is to attend the 16-week recruit training program at the department's fire academy. The curriculum covers all of the National Fire Protection Association's (NFPA) qualifications for NFPA 1001 *Standard on Fire Fighter Professional Qualifications.* This includes Fire Fighter I, Fire Fighter II, Hazardous Materials Awareness, Hazardous Materials Operations, and emergency medical care [NFPA 2013a].

Upon completion of recruit school, the fire chief assigns the recruit to a station where they become a probationary fire fighter for 1 year. Upon completion of probation, the fire fighter trainee becomes a fire fighter. After 5 years of experience, a fire fighter can take the lieutenant test. A fire fighter can test for an apparatus operator after 3 years in-grade. After being promoted to the lieutenant rank, the officer can test for the next rank of captain, district chief, and deputy chief after 3 years in-grade.

The department's training academy has a full complement of staff. However, due to budgetary constraints, the staff is not authorized overtime and the facilities are in need of repairs. The training academy has a burn building, but it hasn't been used for years and is currently condemned. Also, the fire academy adjoins the police academy with an operational firing range. No fire fighter training can take place outside when the firing range is in use due to rounds ricocheting onto the training grounds.

Table 1. Summarizes the documented training of the Engine 16 right jumpseat fire fighter (Engine 16B), the Engine 16 lieutenant (Engine 16A), and the incident commander (District Chief 2).

Fire Fighter	Training Courses	Years Experience
Fire Fighter B (Engine 16B)	Basic Fire Fighting (Fire Fighter I, Fire Fighter II), Introduction to the Incident Command System (IS-100), ICS for Single Resources and Initial Action Incidents (IS-200), Rail Safety for Emergency Responders, various fire-fighting procedures, and various other administrative and technical courses.	6
Lieutenant (Engine 16A)	Basic Fire Fighting (Fire Fighter I, Fire Fighter II), Pump Operator, Introduction to the Incident Command System (IS-100), ICS for Single Resources and Initial Action Incidents (IS-200), National Incident Management System (NIMS) An	19

	Introduction (IS-700.a), and various other administrative and technical courses.	
District Chief 2 (Incident Commander)	Basic Fire Fighting (Fire Fighter I, Fire Fighter II), Introduction to the Incident Command System (IS-100), ICS for Single Resources and Initial Action Incidents (IS-200), National Incident Management System (NIMS) An Introduction (IS-700.a), and various other administrative and technical courses.	26

Note: All fire fighters must complete training equivalent to the NFPA 1001 Standard for Fire Fighter Professional Qualifications, Fire Fighter I and Fire Fighter II [NFPA 2013a].

Structure

The two-story apartment building was built in 1953 and constructed of a wood frame on a poured concrete basement foundation (see Photos 1–4). The two-story structure consisted of 2,016 square feet of total living space between the two apartments. Each floor consisted of five rooms that included two bedrooms, a living room, a kitchen, and a bathroom. The exterior was covered with vinyl siding, and the pitched roof was covered with asphalt shingles. The structure had a front entrance with two doors: the one on the left opened to an interior stairway to the second floor, and the one on the right to the first-floor apartment. At the top of the stairway was a door with a dead bolt and a second door to the right with a normal entry knob. There was a rear entrance to both floors via a covered porch with stairs to the second floor. The structure had an unoccupied third apartment in the finished basement with an exterior entrance in the rear (Side Charlie) of the structure. The building's utilities were electric and natural gas heating.

Photo 1. Side Alpha—street view of the duplex. Engine 16 and Ladder 4 made entry into the building through the left doorway.
(*NIOSH photo.*)

Photo 2. Side Bravo—street view of the duplex. Origin of fire near the Bravo/Charlie corner on the second floor.
(*NIOSH photo.*)

Photo 3. Side Charlie of the structure. An unoccupied apartment was in the basement. The entrance to the basement apartment is on the Bravo/Charlie corner.
(*NIOSH photo.*)

Photo 4. Side Delta of the structure. A rear entrance leads to the first- and second-floor apartments on the Delta/Charlie corner
(*NIOSH photo.*)

Equipment and Personnel

On October 7, 2014, the dispatch center transmitted an alarm for a structure fire with smoke showing. The initial units dispatched included Engine 16, Engine 14, Engine 7, Ladder 4, Ladder 3, Tactical Unit 1, and District 2. Upon arrival, Engine 16 advised this was a working fire. This upgraded the alarm to a working-fire dispatch, which added another district chief and two engines. Table 2 identifies the apparatus and staff dispatched on the first-alarm assignment and the working-fire assignment, along with their approximate dispatch times and on-scene arrival times rounded to the nearest minute.

Table 2. First-alarm and working fire equipment and personnel dispatched.

Resource Designation	Staffing	Dispatched (rounded to minute)	On-scene (rounded to minute)
Engine 16	lieutenant, engine operator, and 2 fire fighters	1830 hrs	1832 hrs
Ladder 4	lieutenant, engine operator, and 2 fire fighters	1830 hrs	1834 hrs
Engine 14	lieutenant, engine operator, and 2 fire fighters	1830 hrs	1834 hrs
District Chief 2 (Incident Commander)	district chief and chief's aide	1830 hrs	1834 hrs
Ladder 3	lieutenant, engine operator, and 2 fire fighters	1830 hrs	1836 hrs
Tactical Unit 1	lieutenant, and 4 fire fighters	1830 hrs	1837 hrs
Engine 7	lieutenant, engine operator, and 2 fire fighters	1830 hrs	1838 hrs
Engine 5	lieutenant, engine operator, and 2 fire fighters	1832 hrs	1840 hrs
District Chief 1	district chief and chief's aide	1835 hrs	1840 hrs
Engine 2	lieutenant, engine operator, and 2 fire fighters	1835 hrs	1840 hrs

Timeline

An approximate timeline summarizing the significant events of the incident is listed below. The times are approximate and were obtained by studying available dispatch records, photos, run sheets, witness statements, and fire department records. The times are rounded to the nearest minute. The timeline is not intended, nor should it be used, as a formal record of events.

- **1830 Hours**
  Engine 16, Engine 14, Engine 7, Tactical Unit 1, Ladder 4, Ladder 3, and District 2 are dispatched to a structure fire with smoke showing.

- **1832 Hours**
  Engine 5 is dispatched as the rapid intervention team (RIT); Engine 16 arrives on-scene and assumes command.

- **1833 Hours**
  District Chief 2 is en route and on the air; Engine 16 reports a 2½-story wood frame with heavy smoke showing. Engine 16 advises this would be a "working fire."

- **1834 Hours**
  District Chief 2 advises the dispatch center that Engine 16 said this would be a working fire; Ladder 4, Engine 14, and District Chief 2 arrive on-scene.

- **1835 Hours**
  District Chief 1 and Engine 2 are dispatched to a working fire.

- **1836 Hours**
  Ladder 3 arrives on-scene; Engine 14 at hydrant.

- **1837 Hours**
  Tactical Unit 1 arrives on-scene; Engine 14 brings hoseline around to Side Charlie.

- **1838 Hours**
  Engine 7 arrives on-scene. Engine 16 enters the stairwell to second floor with Ladder 4.

- **1839 Hours**
  Engine 5, District Chief 1, and Engine 2 arrive on-scene; District Chief 1 assigned as Safety Officer; Engine 14 and Ladder 3 make entry on second floor rear with a charged 1¾-inch hoseline.

- **1840 Hours**
  Engine 16 makes entry to second-floor apartment with a charged 1¾-inch hoseline.

- **1842 Hours**
  Engine 14 puts water on fire from exterior of Side Charlie.

- **1844 Hours**
  Command requests reports from Engine 16 and Engine 14. Replies are inaudible.

- **1845 Hours**
  Engine 16 calls a Mayday but is not acknowledged by Command or any other personnel.

- **1846 Hours**
  Command orders evacuation of the structure and requests medic unit.

- **1847 Hours**
  Command requests a status of injuries and a PAR. Ladder 3 requests tone for all companies out of the building.

- **1849 Hours**
  Engine 16A tries to radio Engine 16B; Engine 14 has PAR.

- **1850 Hours**
  Engine 16A tries to radio Engine 16B; Engine 7 charges their hoseline on Side Bravo.

- **1851 Hours**
  Engine 16A tries to radio Engine 16B.

- **1852 Hours**
  Command requests second alarm.

- **1853 Hours**
  Command orders Ladder 4 to open up the roof. Command contacts Engine 16A, who is changing his SCBA cylinder, and asks where Engine 16B is located. Engine 16A states they are on the second floor in the room on the right; Command activates the RIT (Engine 5 and Tactical Unit 1).

- **1854 Hours**
  Engine 5 hears PASS device going off to the right and locates Engine 16B.

- **1855 Hours**
  RIT crew moves Engine 16B down the stairway.

- **1857 Hours**
  Engine 7 knocks down the fire in the Bravo/Charlie corner, second-floor bedroom.

- **1900 Hours**
  Medic unit en route to hospital.

- **1909 Hours**
  Engine 2 and Ladder 5 crews complete the extinguishment of the fire on the second floor.

Personal Protective Equipment

The Engine 16B fire fighter was wearing a work station uniform, turnout coat and pants, gloves, boots, helmet, self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS), and a portable radio.

Engine 16B's and Tactical Unit 1's SCBAs were evaluated by the NIOSH National Personal Protective Technology Laboratory and a summary report is enclosed as Appendix I. The evaluation showed that Engine 16B's SCBA failed the Remaining Service Life Indicator Test, in which the secondary bell failed to operate within the parameters but passed all other NIOSH tests. Tactical Unit 1's SCBA did not meet the requirements for the 30-minute minimum duration test but passed all other NIOSH tests. The full report is available upon request.

Weather Conditions

According to data from the Weather Underground, the sky conditions were clear with 10-mile visibility. The temperature was 92 degrees F. Dew point was 73 degrees F. Relative humidity was 78%. Wind speed was 8.1 miles per hour and wind direction was south. Barometric pressure was 29.99 [NOAA 2015].

Investigation

On October 7, 2014, a 48-year-old male career fire fighter died while conducting interior operations in a two-story residential apartment. At 1830 hours, Engine 16**,** Engine 14, Engine 7, Ladder 4, Ladder 3, Tactical Unit 1, and District 2 were dispatched to a structure fire with smoke showing. Upon confirmation of a working fire, Engine 5, Engine 2 and District 1 were added to the alarm. The Engine 16 lieutenant (Engine 16A) observed heavy smoke in the air from a block and half away. Engine 16 laid into the fire from a hydrant approximately a block and half away from the fire building. A fire fighter (left jump seat) from Engine 16 (Engine 16C) was the hydrant man and made the connection and waited for the order to charge the supply line. Engine 16 pulled past the building to allow space for Ladder 4. A fire fighter from Engine 16 (Engine 16B) pulled a 1¾-inch hoseline while Engine 16A radioed heavy fire was showing on Side Bravo. At approximately 1834 hours, Ladder 4, Engine 14, and the chief from District 2 (District Chief 2) arrived on-scene. District Chief 2 assumed command while Engine 14 laid in from a hydrant two blocks away. Ladder 4 forced the first-floor door to the second-floor apartment. Engine 16A and Engine 16B made entry into the stairwell and started up the stairs to the second-floor apartment. The crew from Ladder 4 went by Engine 16 and went to the top of the stairs. In near zero visibility, Ladder 4 felt a dead bolt on the door at the top of the stairs in front of them but no door knob, then felt a locked door knob on a door to their right, which Ladder 4 forced open. The Engine 14 crew had a back-up 1¾-inch line out front and were redirected by Command to go to the rear (Side Charlie) and make entry up the stairs. The crew from Engine 7 replaced Engine 14 in the front to back up Engine 16. At approximately 1839 hours, Engine 14, with the help of Ladder 3, made entry on the second-floor rear with a charged 1¾-inch hoseline. Engine 5, District Chief 1, and Engine 2 arrived on-scene. Command assigned District Chief 1 as the Safety Officer, Engine 5 as RIT, and Engine 2 as rehab.

Upon entry, Engine 16A reported the apartment was hot with zero visibility. At approximately 1840 hours, Engine 16A had the line charged and had Engine 16B pencil the ceiling. Ladder 4 also reported the second-floor apartment was hot with zero visibility and began a right-hand search on their knees.

Minutes later, Ladder 3 reported to Command that Engine 14 was hitting the fire from Side Charlie. Engine 16C had gone to the rear with Engine 14. About this time, the Engine 16B's vibra-alert sounded and the lieutenant told him to exit. Tactical Unit 1 had made entry from the rear stairwell to the second-floor apartment. They passed Ladder 3 and Engine 14 in the kitchen area. Tactical Unit1 began pulling ceiling in the living room looking for fire.

A fire fighter from Ladder 4 vented the picture window on Side Alpha of the second-floor apartment. The Ladder 4 lieutenant reported a rapid increase in heat in the apartment and ordered his crew out. Engine 16A headed for the door but lost contact with Engine 16B. Engine 16A found the hoseline with the nozzle shut off near the door. Due to the extreme heat in the room, Engine 16A opened up the nozzle to cool down the room. Three members of Tactical Unit 1's crew who were in the living room near the kitchen pulling ceiling, were struck by a hose stream coming from somewhere near Side Alpha of the living room. The crew became separated. One member of Tactical Unit 1 exited out the rear stairwell through the kitchen. The other two fire fighters reported being hit in the face and chest and momentarily became disorientated. One member made it to the kitchen and located the lieutenant and a fire fighter who had also been hit by a hose stream. Engine 14's hoseline had become loose but they were able to secure it. All the fire fighters who were hit with the hose stream had their helmets knocked off and SCBA facepieces dislodged. An Engine 14 fire fighter became disorientated and confused having been hit twice with the hose stream. He needed assistance exiting the structure.

The third fire fighter from Tactical Unit 1 had taken a direct hit to the face; he lost his helmet, his facepiece was dislodged, and he was knocked down by the hose stream. He stated he was unconscious for a brief period of time. He was unable to locate his helmet and facepiece and stated that his head and eyes were burning from the extreme heat in the apartment. He used his wet gloves to try to cool his head and face. He was unable to locate any fire fighters or use his radio. He ended up at the Side Alpha picture window that Ladder 4 had previously vented. Fire fighters on the ground noticed him at the window and tried to communicate to him that they were getting a ground ladder. At approximately 1846 hours, he lost consciousness and tumbled out the window to the ground. Command ordered everyone out of the structure and requested a medical unit. The EMS crew arrived and he was transported to the hospital. *Note: The Tactical Unit 1 member sustained burns to his head, ears, neck, shoulder, and wrist; he was hospitalized in a burn unit for approximately 23 days.*

Engine 16A continued the search for Engine 16B until his vibra-alert activated. Engine 16A stated that he called a Mayday, but it was not acknowledged; he also tried to radio Engine 16B. Engine 16A crawled out of the apartment with no air left in his cylinder and exited the structure. Upon his exit, Engine 16A had noticed that a fire fighter was being attended to on the ground on Side Alpha. On several occasions, Command tried to contact Engine 16A with no response. For several minutes, the lieutenant tried to locate Engine 16B with no success. At approximately 1856 hours, the lieutenant notified Command that he couldn't find his fire fighter. Immediately, Command tried to radio Engine 16B but got no response.

At approximately 1858 hours, Command activated the rapid intervention crew, which sent Engine 5 and Tactical Unit 1 into the apartment. Engine 5 made entry into the second-floor apartment. The Engine 5 officer looked at his thermal imager and the screen was white, but he heard a PASS alarm going off to the right of the door. Engine 16B was found lying on his right side near the door. The crew grabbed Engine 16B but he appeared to be caught on something. Engine 16B's lower right leg and foot were entangled in a piece of wrought iron furniture (see Diagram 1). The RIC crew untangled him and carried him down the stairs to EMS waiting outside. Engine 16B's SCBA was intact and properly donned on his face but the air cylinder was empty. At approximately 1900 hours, EMS started CPR on Engine 16B. Engine 16B was transported to the hospital but pronounced dead upon arrival. Engine 16B did not appear to have sustained any burns or other life-threatening injuries.

At approximately 1909 hours, Engine 2 and Ladder 5 crews knocked down the fire in the bedroom on the Bravo/Charlie corner.

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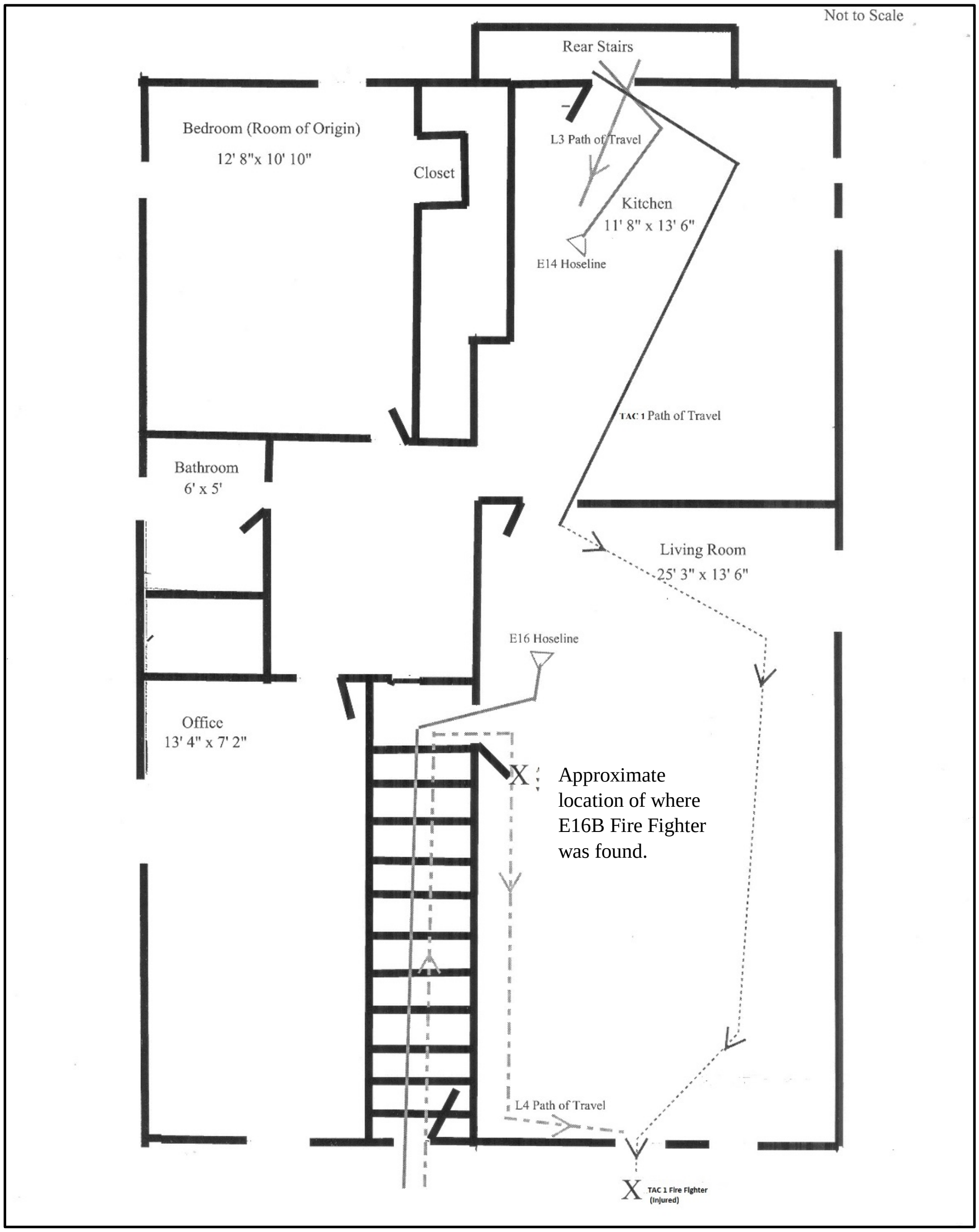

Diagram. Floor plan of second floor, path of attack crews, and location of fire fighters found.
(*Diagram courtesy of the fire department.*)

Fire Behavior

The origin and cause of the fire is still under investigation by the Connecticut State Police's Fire and Explosion Investigation Unit. By all accounts, the fire originated on the second floor, in the bedroom on the Bravo/Charlie corner of the fire structure.

Indicators of significant fire behavior

- Smoke on Bravo/Charlie corner upon arrival
- Fire showing on Side Bravo
- Heat and heavy, black smoke throughout the second floor
- Fire self-vents out two windows on Bravo/Charlie corner and extended up the exterior wall
- Heavy fire at Bravo/Charlie corner on second floor and attic
- No vertical ventilation at this time
- Heat and heavy, black smoke continue to fill second floor
- Side Alpha window removed, creating a flow path for the fire
- Fire knocked down approximately 41 minutes after arrival

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 led to the fatalities:

- Fireground tactics
- Crew integrity
- Personnel accountability
- Air management
- Mayday procedures
- Fireground communications
- Ventilation
- Personal protective equipment use
- Live fire training
- Unsprinklered occupancy

Cause of Death

According to the chief medical examiner's report, the cause of death of the fire fighter was lack of breathing gas. The report listed cardiac hypertrophy as a contributing factor.

Recommendations

Recommendation #1: Fire departments should ensure that risk assessments are conducted prior to initial operations and throughout the incident and that the strategy and tactics match the assessment.

Discussion: Occupancies define the space inside the class of building. Construction types/classes of construction define how the building is constructed with either combustible or noncombustible materials. Occupancies exist inside the constructed building. Standard operation procedures (SOPs) 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, 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 [NFPA 2014].
- Division/group supervisors to formulate and follow tactics.
- Company officers to successfully carry out assigned tasks.
- The individual members to effectively perform their duties [ULFSRI and FirefightersCloseCall.com, no date].

At any incident, life safety is always the first priority, followed by incident stabilization and then property conservation. Ensuring 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 actions and conditions. The following risk management principles should be utilized by the incident commander:

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

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 the rear of the structure (Side Charlie). 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. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta may be delegated to another engine company on the first alarm. Even if a 360-degree size-up can be conducted, the second-due engine company or third-due engine company and the second-due truck company should be assigned to Side Charlie.

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, the number of stories, type of occupancy, and location of fire. This lays the foundation for additional reports and serves as notification to responding units as to the type of SOP to implement.
- If there were critical building description information through the critical incident dispatch system (CIDS) for the address, then this information would aid in implementing or adjusting SOPs. CIDS could contain information that would necessitate alternative action to fulfill operational goals.
- Building features—e.g., number of stories (particularly if there is a difference between Sides Alpha and Charlie.
- Basement access and type.
- Other life or safety hazards.

The incident commander must conduct an initial and ongoing situational assessment of the incident [NFPA 2014]. 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 [Township of Spring Fire Rescue 2013; ULFSRI and FirefightersCloseCall.com, no date]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

Stretching and operating hoselines is the primary function of an engine company. All members must realize the importance of an initial charged hoseline stretched at a structural fire. The majority of structural fires are controlled and extinguished by this initial line. The **first line** is placed between the fire and any persons endangered by it. This is accomplished by stretching the hoseline via the primary means of egress, usually the main stairway. This tactic:

- Provides a base for confining and controlling the fire.
- Allows occupants to evacuate via the stairs.
- Allows fire fighters to proceed above the fire for search operations [FDNY 2013].

In most cases, the first line is stretched via the interior stairs to the location of the fire. The purpose of this line is to protect the primary means of egress for occupants evacuating the building and to confine and extinguish the fire. Prior to opening the door to the fire area for advancement of the line, the engine company officer **must** ensure that no fire fighters will be exposed in the hallway or on the stairs above as the fire attack is initiated. This can be done via portable radio or in person [FDNY 2013].

When the fire attack is being initiated, the engine company officer shall announce via portable radio to Command that “water is on the fire.” This is a significant incident benchmark being met. If the engine company officer can't get water or there is a delay of getting water on the fire, this must be communicated to Command as well [Brunacini 2002].

All members must be alert to fireground communications concerning hoseline placement and the commencement of fire-fighting operations so that crews can avoid opposing hoselines and getting hit with high-pressure water and debris.

At any fire, there are tasks that need to occur regardless of the occupancy: initial on-scene report upon arrival; initial risk assessment; situational report; water supply; deployment of handlines and back-up handlines; search and rescue, ventilation, and rapid intervention crews; ground and aerial ladder placement; fire attack and extinguishment; and salvage and overhaul. Over the past few years, fire fighters have adopted an acronym that details the steps to take when confronted with a fire: *SLICERS*.

- **S**ize up all scenes.
- **L**ocate the fire.
- **I**dentify and control the flow path (if possible).
- **C**ool the heated space from a safe location.
- **E**xtinguish the fire.
- **R**escue and **S**alvage are actions of opportunity that may occur at any time [ULFSRI and FirefightersCloseCall.com, no date].

The "flow path" of a fire is the movement of a fire determined by incoming and outgoing vents for air, since air is what allows a fire to burn. Identifying and controlling the flow path is about knowing where the air comes from and where it's headed. The importance of identifying and using flow path information cannot be underestimated. The identification of flow path is an item that should find its way into every after-action review. While trying to locate the fire, cooling the heated space from a safe location while ensuring for the safety of the fire fighters is important. Once the fire is under control, the fire can be completely extinguished.

The rescue and salvage operations are self-explanatory—if anything can be saved, save it as long as fire fighters are not placed at risk. These two actions are always active, right from sizing up to extinguishment.

Procedures developed for fireground operations should be flexible enough to allow the change in the incident action plan 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 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 and the intensity and duration of the fire [Brunacini 2002].

At this incident, the exterior fire on the Bravo/Charlie corner was not controlled by knocking down what fire could be reached due to the limited access to that area prior to sending in interior attack crews. The interior attack crews weren't able to get water on the fire in a timely manner due to several obstacles, and horizontal ventilation took place causing a flow path that affected interior crews. Perhaps a second interior attack crew to back up the first line at the top of the stairs in the door way could have seen Engine 16's crew and assisted them in evacuating.

Recommendation #2: Fire departments should ensure that crew integrity is properly maintained by voice or radio contact when operating in an immediately dangerous to life and health (IDLH) atmosphere.

Discussion: When an engine company enters a structure, the members must remain in contact by visual (eye-to-eye contact), verbal (radio or face-to-face), or direct (touch) contact. NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program*, 8.5.5, states, "Crew members operating in a hazardous area shall be in communication with each other through visual, audible, or physical means or safety guide rope, in order to coordinate their activities," and 8.5.4 states, "Members operating in hazardous areas at emergency incidents shall operate in crews of two or more" [Gagliano et al. 2008]. Additionally, NFPA 1500, 8.5.6, states, "Crew members shall be in proximity to each other to provide assistance in case of an emergency" [NFPA 2013c].

The International Association of Fire Chiefs, Safety, Health, and Survival Section has redefined the *Rules of Engagement for Structural Firefighting*. One of its objectives is to ensure that fire fighters always enter a burning building as a team of two or more members and no fire fighter is allowed to be alone at any time while entering, operating in, or exiting a building. A critical element for fire fighter survival is crew integrity. Crew integrity means fire fighters stay together as a team of two or more. They must enter a structure together and remain together at all times while in the interior, and all members come out together. Crew integrity starts with the company officer ensuring that all members of the company understand their riding assignment, have the proper PPE, and have the proper tools and equipment. Upon arrival at the incident, the company is given a task to perform by the incident commander. The company officer communicates to the members of the company what their assignment is and how they will accomplish their assignment. To ensure that crew integrity is maintained, all the members of a company should enter a hazardous environment together and leave together. If one member has to leave, the whole company leaves [IAFC 2009].

It is the responsibility of every fire fighter to stay connected with crew members at all times. All fire fighters must maintain the unity of command by operating at all times under the direction of the incident commander, division/group supervisor, or their company officer. The ultimate responsibility for crew integrity and ensuring no members get separated or lost rests with the company officer. While operating in a hazard zone they must maintain constant contact with their assigned members by visual observation, voice, or touch. They must ensure they stay together as a company or crew. If any of these elements are not adhered to, crew integrity is lost and fire fighters are placed at risk.

NFPA 1500, 8.4.4–8.4.6 states:

- The incident commander shall maintain an awareness of the location and function of all companies or crews at the scene of the incident. This can be accomplished using a tactical worksheet/accountability board.
- Officers assigned the responsibility for a specific tactical-level management component at an incident shall directly supervise and account for the companies and/or crews operating in their specific area of responsibility.
- Company officers shall maintain an ongoing awareness of the location and condition of all company members [NFPA 2013c].

If a fire fighter becomes separated and cannot immediately get reconnected with his/her crew, the fire fighter should attempt to communicate via portable radio with the company officer. If the fire fighter and officer do not rejoin after three radio attempts or they are not rejoined within 1 minute, a Mayday should be declared. If conditions are rapidly deteriorating, the Mayday must be declared immediately. As part of a Mayday declaration, the fire fighter must next activate the radio's emergency alert button (where provided), followed by manually turning on the PASS alarm. Similarly, if the company officer or other company member(s) recognize they have a separated member, they should immediately attempt to locate the member by using their radio or by voice. If contact is not established after three attempts or within 1 minute, a Mayday should be declared immediately [IAFC 2009].

In this incident, the Engine 16 fire fighter (Engine 16B) became separated from his lieutenant after his low-air alarm went off and his lieutenant said to exit. The lieutenant searched and tried to contact his fire fighter. He then called a Mayday that went unheard. Also, the Engine 16 fire fighter (Engine 16C) went to the rear with Engine 14.

Recommendation #3: Fire departments should ensure that fire fighters and officers are properly trained in air management including out-of-air emergencies.

Discussion: Chief Bobby Halton, retired chief and editor in chief of *Fire Engineering* notes: "If you run out of air in a working fire today, you are in mortal danger. There is no good air at the floor anymore, no effective filtering methods, no matter what others may say to the contrary" [Gagliano et al. 2008]. The only protection for fire fighters in the toxic smoke environments in today's fires is the air that they carry on their backs. Like SCUBA divers, fire fighters must manage their air effectively and leave enough reserve air to exit in case of unforeseen occurrences while inside a structure fire. Fire fighters must manage their air so that they leave the immediately dangerous to life and health (IDLH) atmosphere before the low-air alarm activates. This leaves an adequate emergency air reserve and removes the noise of the low-air alarm from the fireground [Gagliano et al. 2008].

Air management is a program that the fire service can use to ensure that fire fighters have enough breathing air to complete their primary mission and allow enough reserve air for the fire fighter to escape an unforeseen emergency. Fire departments and fire fighters need to recognize that the smoke in modern construction is an IDLH atmosphere and manage their air along with their work periods so the fire fighters exit the IDLH atmosphere with their reserve air intact. NFPA 1404 *Standard for Fire*

Service Respiratory Protection Training states that fire fighters should exit from an IDLH atmosphere before the consumption of reserve air supply begins, and a low-air alarm is notification that the individual is consuming the reserve air supply and that immediate action is required by the individual and the fire-fighting team [NFPA 2013b].

Fire fighters and command officers need to recognize and communicate their air status and use air management on the fireground. Air management happens at the individual fire fighter level, the crew level, and the command level. Fire fighters need to ensure their air supply is adequate (full cylinder) at the start of the shift and need to monitor their air usage during an event. They must be able to recognize the 50% HUD light flash and then communicate that information to his/her crew members. Fire fighters need to understand principles of air management, such as the need to exit the IDLH atmosphere before they go into their emergency reserve air and their end-of-service-time indicator (EOSTI) alarms. If they are not out of the IDLH atmosphere and go into their emergency reserve air, they need to immediately communicate with their crew and Command as this can now be considered an emergency. Fire fighters should not wait until their EOSTI alarms or they are out of air to communicate.

Fire-fighting crews need to understand and communicate their air supply status among the crews so they can plan accordingly to notify Command of the need to exit and still have their reserve/emergency air available. One method is to have the first person on a crew who reaches their 50% (flashing yellow light on HUD) notify the crew leader and he/she can then estimate the amount of work period left so they can leave the structure (or IDLH atmosphere) before the person with the least amount of air goes into their emergency reserve air.

Command needs to understand air management at the command level. This means that someone at the command post is monitoring not only accountability of the crews, but how long they have been working (estimating air supply usage) and checking on air status through PAR checks and then rotating crews with enough time to ensure that crews exit the IDLH atmosphere with their emergency reserve air intact.

Too often fire fighters may not pay attention to their air usage and remaining air until they get into their emergency reserve air and their EOSTI sounds or vibrates. This can be due to a number of reasons, including lack of familiarity with a new SCBA (with heads-up display [HUD]) or a different model or a lack of training. Another reason may be the old culture of waiting to take an action based on the old "low-air alarm." Fire fighters in the past didn't have HUDs and relied on the "low-air alarm" to warn them of their low air status. It was very difficult if not impossible in some fire-fighting incidents to read the over-the-shoulder gauge. With the addition of HUDs or heads-up displays, fire fighters now have the ability to know their approximate air supply status by reading the lights in their facepiece. The four lights in the facepiece start in the illuminated and green position and then turn off as the air supply decreases. Once the SCBA air supply reaches approximately 50%, the light begins to flash. Some change color to yellow when below 50% then change to red in the EOSTI mode. This is designed to alert the fire fighter to take an action that would ensure they have enough escape time to exit the building with their reserve air intact. Once the air supply reaches the EOSTI level, the SCBA will provide another signal (bell, whistle, and/or vibration signal) that alerts the user they are nearing the end of the usable air in the cylinder. On pre-2013 edition SCBAs, this level was approximately 25% (+/-2), but on the 2013 and newer editions SCBAs, this EOSTI level was increased to 33%.

Repetitive skills training with a SCBA is vital for the safety of fire fighters working inside an IDLH atmosphere. SCBA skills training is an ongoing process that should be performed regularly to ensure that fire fighters "know their SCBA." The benefits of repetitive skills training with a SCBA are an increased comfort and competency level, decreased anxiety, lower air consumption, increased awareness of the user's air level (noticing and using the HUD), and an automatic muscle memory response for the vital function controls, such as the don/doff buttons, main air valve, emergency bypass operating valve, and auxiliary air connections (i.e., rapid intervention crew/universal air connection [RIC/UAC] connection and the buddy breather connection). Repetitive skills training also provide the user with an increased ability to operate these functions and controls in a high-anxiety moment or an emergency. Many times, using these skills will be necessary with gloved hands, limited vision, and reduced ability to hear commands from others. Performed in conditions that are non-IDLH, repetitive skills training helps build the fire fighters' muscle memory so their hands will be able to activate the controls with gloves on and the operation will be a conditioned or second-nature response in case of an emergency [NIOSH 2011, 2012].

The first step in overcoming an SCBA out-of-air emergency is complete familiarization with your specific SCBA and your breathing air requirements and usage. Fire fighters need to understand that many SCBA out-of-air emergencies are caused by fire fighters not recognizing the remaining air supply relative to the mission and then another event occurs, such as becoming separated from their crew or hoseline and becoming lost. There are other events that can challenge a fire fighter’s ability to overcome an out-of-air emergency, such as facepiece becoming dislodged, hose entanglement, vomiting in a facepiece, or mechanical issues with the SCBA. A fire fighter’s ability to overcome these events is directly related to their repetitive muscle memory skill, which is only achieved through training and experience with their current SCBA.

One helpful hint for departments to understand is that fire fighters need sufficient “cockpit time” with their particular model SCBA so they can operate in fire environments without undue concentration on their SCBA. If a fire fighter has limited experience with a particular SCBA, whether it is because they are a new fire fighter or an experienced fire fighter with a new SCBA model or manufacturer, they may be concentrating so much on using their SCBA that they miss fire environment signs such as fire growth, smoke behavior, orientation of the room, other crew members actions, and other conditions that require attention. This undue concentration on using the SCBA may even be subtle, and when faced with a condition that needs a trained muscle memory response, such as activating the bypass or checking the cylinder wheel, the fire fighter may not have the automatic response necessary to overcome the initial event. In addition, increased anxiety further complicates the steps to overcome the situation. Many uncontrolled SCBA out-of-air emergencies can be overcome by repetitive skills training.

In this incident, the fire fighter's low-air alarm was going off and his officer told him to exit, but he became separated and ran out of air. During the interview process, investigators were informed that cylinders would often be allowed to go down to 3,800 psi before filling to 4,500 psi, since the stations did not have a cascade system to fill them in-house. It is possible that the fire fighter entered the structure with only 84% of his cylinder air. The fire fighter was found with his mask on and out of air. The medical examiner's cause of death was lack of breathing gas. It is unknown why the fire fighter did not remove his mask and follow the hoseline to the door.

NIOSH investigators have identified air management as a contributing factor on many investigations of fire fighter line-of-duty deaths. Fire departments need to ensure that training on air management occurs at all levels of the command structure [NIOSH 2011, 2012].

Recommendation #4: Fire departments should use a personnel accountability system that accounts for all resources assigned to an incident.

Discussion: The personnel accountability system was designed and is operated to ensure that fire fighters do not become lost or missing in the hazard zone. The system tracks fire fighters by location and function. 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 and throughout the entire incident. Also, a process must be in place to periodically check to make sure that all members operating in the hazard zone are accounted for.

A personnel accountability system readily identifies both the location and function of all members operating at an incident scene [Bachrach and Egstrom 1987; Corbin 2000]. 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.

One of the most important functions of command safety is for the incident commander to initiate an accountability system that includes the functional and geographical assignments at the beginning of operations and until the termination of the incident. It is very important for the first on-scene resource to initiate an accountability system. This initial system allows the passing or transfer of information to the next officer who assumes command upon his/her arrival [Bachrach and Egstrom 1987].

A functional personnel accountability system requires the following:

- Development and implementation of a departmental standard operating procedure.
- Necessary components and hardware.
- Training all members on the operation of the system.
- Strict enforcement during emergency incidents.

Some methods and tools for resource accountability are:

- Tactical worksheets
- Command boards

- Apparatus riding lists
- Company responding boards
- Electronic bar-coding systems
- Accountability tags or keys (e.g., PASSPORT System) [Bachrach and Egstrom 1987]

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 on the implemented accountability system [NFPA 2014]. 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 on-going tracking and accountability of members [Bastain 2003]. 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 [Bachrach and Egstrom 1987]. The PAR should be conducted every 15–20 minutes or when benchmarks are met.

In order for the personnel accountability system to function, it must include a standard operating procedure that defines each function's responsibility in making this process successful on the fireground. Also a training component—both classroom and practical—should occur to ensure this process operates properly during emergency incidents.

In this incident, accountability was not established until late on the fireground.

Recommendation #5: Fire departments should ensure that incident commanders incorporate the principles of command safety into the incident management system.

Discussion: The principles of command safety 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 (retired). Command safety defines 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 and a close connection between the safety officer and the incident commander. The eight functions of command are:

- Assumption/confirmation/positioning
- Situation evaluation, which includes risk management

- Communications
- Deployment
- Strategy/incident action planning
- Organization
- Review/revision
- Transfer/continuation/termination [Clark 2008; NFPA 2013d]

A major objective of the incident management system is to establish and support an incident commander. The incident commander will direct the geographical and functional needs of the entire incident on the task, tactical, and strategic levels. Issues develop for the incident commander when these three standard levels are not in place, operating, and effectively connected. One of the most important components is to ensure the incident commander operates on the strategic level from the very beginning of the incident and stays on the strategic level as long as fire fighters are operating in an immediately dangerous to life and health (IDLH) environment [Clark 2008; NFPA 2013d]. The incident commander uses the incident management system as the basic foundation for managing the strategic-level safety function. Command safety ensures the highest level of safety for fire department members operating at emergency incidents. The incident commander completes the operational and safety responsibility to the fire fighters by performing the eight command functions. These functions serve as a very practical performance foundation for how the incident commander completes their responsibility as the strategic-level incident manager and the overall incident safety manager [Corbin 2000].

At this incident, several elements of command safety, such as communications, incident action planning, and risk management, needed to be further evaluated and updated.

Recommendation #6: Fire departments should ensure that fire fighters are properly trained in Mayday procedures.

Discussion: It is essential to train fire fighters to recognize when they are in trouble, know how to call for help, and understand how incident commanders and others must react to a responder in trouble [Jakubowski and Morton 2001].

One of the most difficult situations a fire fighter can face is when they realize they need to declare a Mayday. Recognizing that they are (or about to be) in a life-threatening situation is the first step in improving the fire fighters' chances to survive a Mayday event. Many fire departments don't have a simple procedure for what to say when a fire fighter gets into trouble—i.e., a critical situation where communications must be clear [Jakubowski and Morton 2001]. A Mayday declaration is such an infrequent event in any fire fighter's career that they need to frequently train in how to recognize the need for a Mayday, how to declare the Mayday, and what steps to take to improve their chances for survival.

Fire fighters must understand that when they are faced with a life-threatening emergency, there is a very narrow window of survivability, and any delay in egress and/or transmission of a Mayday message reduces the chance for a successful rescue. Knowledge and skill training on preventing a Mayday situation or how to call a Mayday should be mastered before a fire fighter engages in fireground activities or other immediately dangerous to life and health (IDLH) environments.

Fire fighter training programs should include training on such topics as air management, crew integrity, reading smoke, fire dynamics and behavior, entanglement hazards, building construction, signs of pending structural collapse, and familiarity with a self-contained breathing apparatus (SCBA), a radio, and personal protective equipment (PPE).

A fire fighter's knowledge, skill, and ability to declare a Mayday must be at the mastery level of performance. This performance level should be maintained throughout their career through training offered more frequently then annually [IAFF 2010; Sendelbach 2003].

Fire fighters need to also understand that their PPE and SCBA do not provide unlimited protection. Fire fighters should be trained to stay low when advancing into a fire as extreme temperature differences may occur between the ceiling and floor. When confronted with an emergency situation, the best action to take may be immediate egress from the building or to a place of safe refuge (e.g., behind a closed door in an uninvolved compartment, in a staging area on a lower floor) and manually activating the PASS device. A charged hoseline should always be available for a tactical withdrawal while continuing water application or as a lifeline to be followed to egress the building. Conditions can become untenable in a matter of seconds.

Presently there are no Mayday standards for fire fighters to be trained on, and most states do not have Mayday standards. Mayday rules and training are not included in the job performance requirements in NFPA Fire Fighter 1 or 2 standards. It is up to each authority having jurisdiction to develop rules and performance standards for a fire fighter to call a Mayday. Fire departments should ensure that any personnel who may enter an IDLH environment meet the standards for Mayday competency for the authority having jurisdiction [IAFF 2010; Clark 2008].

The National Fire Academy has two courses addressing the fire fighter Mayday Doctrine, Q133 Firefighter Safety: Calling the Mayday, which is a 2-hour program covering the cognitive and affective learning domain of the fire fighter Mayday Doctrine, and H134 Calling the Mayday: Hands-on Training, which is an 8-hour course that covers the psychomotor learning domain of the fire fighter Mayday Doctrine. These courses are based on the military methodology used to develop and teach fighter pilots ejection doctrine. A training CD is available to fire departments free of charge from the U.S. Fire Administration Publications office [Clark 2005; USFA 2006]. Also, the International Association of Fire Fighters (IAFF) Fire Ground Survival Program is another resource fire departments can use and was developed to ensure that training for Mayday prevention and Mayday operations are consistent between all fire fighters, company officers, and chief officers [IAFF 2010].

Any Mayday communication must contain the location of the fire fighter in as much detail as possible and, at a minimum, should include the division (floor) and quadrant. When in IDLH environments, fire fighters must know their location at all times to effectively be able to give their location in the event of a Mayday. Once in distress, fire fighters must immediately declare a Mayday. The following example uses LUNAR (Location, Unit, Name, Assignment/Air, Resources needed) as a prompt: "Mayday, Mayday, Mayday, Division 1 Quadrant C, Engine 71, Smith, search/out of air/vomited, can't find exit." When in trouble, a fire fighter's first action must be to declare the Mayday as accurately as possible. Once the incident commander and rapid intervention team (RIT) know the fire fighter's location, the fire fighter can then try to fix the problem, such as clearing the nose cup, while the RIT is en route for rescue [USFA 2006].

A fire fighter who is breathing carbon monoxide (CO) quickly loses cognitive ability to communicate correctly and can unknowingly move away from an exit, other fire fighters, or safety before becoming unconscious. Without the accurate location of a downed fire fighter, the speed at which the RIT can find them is diminished, and the window of survivability closes quickly because of lack of oxygen and high CO concentrations in an IDLH environment [Clark 2005, 2008].

Fire fighters also need to understand the psychological and physiological effects of the extreme level of stress encountered when they run low on air; become trapped during rapid fire progression; or become lost, disoriented; or injured. Most fire training curricula do not include discussion of the psychological and physiological effects of extreme stress, such as encountered in an imminently life-threatening situation, nor do they address key survival skills necessary for effective response. Understanding the psychology and physiology involved is an essential step in developing appropriate responses to life-threatening situations. Reaction to the extreme stress of a life-threatening situation, such as being trapped, can result in sensory distortions and decreased cognitive processing capability [Grossman and Christensen 2008].

Fire fighters should never hesitate to declare a Mayday. There is a very narrow window of survivability in a burning, highly toxic building. Any delay declaring a Mayday reduces the chance for a successful rescue [Clark 2005]. In the book *Stress and Performance in Diving*, the author notes that while all training is important,

> We know that under conditions of stress, particularly when rapid problem-solving is crucial, over-learning responses is essential. The properly trained individual should have learned coping behavior so well that responses become virtually automatic requiring less stop and think performance [Bachrach and Egstrom 1987].

The word Mayday is easily recognizable and is an action word that can start the process of a rescue. The use of other words to declare an emergency situation should be discouraged because it is not as recognizable as an immediate action word that will start a rescue process. During this incident, the fireground radio traffic was busy and many different communications were taking place. A Mayday message transmitted over the radio much earlier in the event may have gotten the attention of command officers and other fire fighters when a rescue attempt might have had a better chance of locating the fire fighter.

In this incident, the fire fighter never called a Mayday and never activated his emergency button (emergency buttons were inoperable) or PASS device. His officer called a Mayday that went unacknowledged and a second one that was not recorded on the radio transmission log.

Recommendation #7: Fire departments should provide the incident commander with a Mayday tactical checklist for use 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 [Bachrach and Egstrom 1987].

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 [Bachrach and Egstrom 1987; Corbin 2000].

A checklist is provided in **Appendix Two,** "**Incident Commander's Tactical Worksheet for Mayday,"** which can assist the incident commander in the necessary steps for clearing 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 checklist 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.

At this incident, when the Mayday occurred, the incident commander quickly called for additional resources and conducted a personnel accountability report to determine if any companies were lost or missing. Due to the influx of resources, trying to determine the location of companies and identifying crews that were missing, 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 operations.

Recommendation #8: Fire departments should develop and implement a fireground communication standard operating procedure that includes a communication protocol and specifies equipment and capacity of the communication system.

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 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. Fire departments should ensure that the communications division and communication 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 signal 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 [NFPA 2014; FIRESCOPE 2012]. A fire department should provide the necessary number of radio channels for 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].

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, mobile data terminals, laptop computers), other hardware (e.g., 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 both taking personal responsibility to have your portable radio turned on and to 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 carried in a position that allows a fire fighter to monitor and transmit a clear message [IAFF 2010; Varone 2003].

A fire department's SOP on communications should address issues on what to do if your Mayday transmission is not acknowledged, such as activating your emergency button. If there is a complete radio failure, the fire fighter should evacuate the building as a matter of safety. In this incident, a Mayday was not acknowledged and the emergency button was not functionally activated by the fire department.

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 operation 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 2012]. 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 [NFPA 2014].
- For incidents involving large geographical areas, designate a tactical channel or talk-group for each division.

Communications between the incident commander and tactical-level management units and/or company officers is essential for successful fireground operations. Communication during the fire attack may be difficult at times due to the noise created by the hose stream striking walls, ceilings, and furnishings. However, the engine company officer must monitor the portable radio for critical information that may affect the engine company. This includes ventilation delays, water supply difficulties, collapse potential, and Mayday and/or "urgent" transmissions. The engine company officer can provide the incident commander with vital information that may affect how the fire operation is handled. Messages such as those listed below should be transmitted to the incident commander, other units, or individual members on the scene:

- "Start a 1¾-inch line to the second floor."
- "Start water."
- "We have two rooms knocked down; making progress."
- "Main body of fire has been extinguished."
- "Increase/decrease pressure."
- "We need a back-up line to the second floor" [Brunacini 2002].

In this incident, there were several breakdowns in communication, including transmissions not being understood, a Mayday not acknowledged, and transmissions not getting through.

Recommendation #9: 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 procedures 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 new materials and construction on fire. The fire research experiments were conducted in cooperation with the Fire Department of New York, Chicago Fire Department, Spartanburg, South Carolina Fire and Rescue, and other agencies. The live burn tests were aimed at quantifying emerging theories about how fires are different today, largely due to new building construction and the composition of home furnishings and products. In the past, these products were mainly composed of natural materials, such as wood and cotton, but now contain large quantities of petroleum-based products and synthetic materials that burn faster and hotter and generate large volumes of fuel-rich smoke. Where a fire in a room once took approximately 20 minutes to "flashover"—igniting all the contents—this can happen with today's furnishings in as little as 4 to 5 minutes [NIST 2013; ULFSRI and FirefightersCloseCall.com, no date].

In addition, modern living spaces tend to be more open, less compartmentalized and are better insulated than homes built years ago. As a result, interior residential fires can generate an oxygen-depleted, fuel-rich environment within minutes. This fire condition of hot, fuel-rich smoke is highly reactive to the introduction of oxygen. Introducing oxygen to this environment by opening a door or venting a window may result in a rapid transition to flashover. These same conditions can occur in commercial structures as seen in the Charleston, South Carolina, Sofa Super Store fire [NIOSH 2009a].

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 of reducing water damage and limiting 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 [Brunacini 2002; FDNY 2013; NIOSH 2009a]. One means of eliminating the possibilities of this occurrence would be a transitional attack, in which 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 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 [NIST 2013].

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.

- **Fire-fighting 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 ensure that during fire fighter Mayday incidents, water is provided on the fire as soon as possible and ventilation openings are controlled [FDNY 2013].

This information is presented to educate the fire service and to ensure that fire departments consider a change in fireground tactics based upon the current research presented by NIST and UL. Much of this research has been directed toward developing a better understanding of the characteristics of the modern fire. This modern research provides members of the fire service with the information and knowledge needed to modify essential fire-fighting tactics. While fire-fighting will never be without risk, this research represents a vital contribution to overall efforts to reduce risks and to save lives.

At this incident, coordinated vertical ventilation was not conducted on the second floor in a timely manner.

Recommendation #10: Fire departments should review standard operating procedures regarding the use and operation of thermal imagers.

Discussion: Another valuable tool that enhances situational awareness is the thermal imager. The thermal imager provides a technology with potential to enhance fire fighter safety and improve the ability to perform tasks such as size-up, search and rescue, fire attack, and ventilation. Thermal imagers should be used in a timely manner. Fire fighters should be properly trained in the use of a thermal imager and be aware of their limitations [SAFE-IR 2013; NIOSH 2009b].

The application of thermal imaging on the fireground may help fire departments accomplish their primary mission, which is saving lives. This mission can be accomplished in many ways. First and foremost, in near zero visibility conditions, primary searches may be completed quickly and with an added degree of safety. The use of thermal imaging technology may also be invaluable when fire fighters are confronted with larger floor areas or unusual floor plans [SAFE-IR 2013]. Thermal imagers may provide a method for fire fighters to track and locate other fire fighters in very limited visibility conditions. This can enhance fire fighter accountability before an issue arises [SAFE-IR 2013]. While the use of a thermal imager is important, research by Underwriters Laboratories has shown that there are significant limitations in the ability of these devices to detect temperature differences behind structural materials, such as the exterior finish of a building or outside compartment linings (i.e., walls, ceilings, and floors) [NIOSH 2009b]. The most common misconception about temperature measurement using a thermal imager is that it estimates air temperatures. Thermal imagers do not read air temperatures; they read surface temperatures. Although occasionally a thermal imager may show superheated or cryogenic gases, in general, thermal imagers do not "see" or measure gases. Fire fighters should not be lulled into a mistaken sense of security because the temperature measurement on the thermal imager seems relatively low or has not reached its scale maximum [Corbin 2000].

At a structure fire, the thermal imager may help identify the location of the fire or the extent of fire involvement prior to fire fighters being deployed into a structure. Knowing the location of the fire may help fire fighters determine the best approach to the fire. The thermal imager may provide additional information for a crew making the fire attack that they would not previously have had due to poor visibility and building construction features. Using this information, fire fighters may be able to locate the fire more quickly and may also ensure that the water application is effective. From a ventilation perspective, fire fighters can use the thermal imager to identify areas of heat accumulation, possible ventilation points, and significant building construction features. This helps ensure proper and effective ventilation that successfully removes smoke and heat from a building [SAFE-IR 2013; Bastain 2003].

Per department protocol, the first arriving officer provides a temperature reading as they enter the structure as part of the initial size-up. The thermal imager does not provide an accurate assessment of the total room temperature. In all reality, the temperature readings and color variations that a thermal imager provides are best suited to establish differences of an area being entered, rather than the true atmospheric temperature [SAFE-IR 2013; Bastain 2003].

Additional information is provided in Appendix Three. The intent of this recommendation and the appendix material is to ensure that the fire service clearly understands the concept, use, and limitations of thermal imagers.

In this incident, Engine 16’s thermal imager was out of service. Engine 5 did use a thermal imager when they were searching for the missing fire fighter.

Recommendation #11: Fire departments should ensure that proper use of structural fire-fighting protective hoods is enforced.

Discussion: NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* contains the general recommendations for fire fighter protective clothing and protective equipment [NFPA 2013c]. Chapter 7.1.1 specifies that “the fire department shall provide each member with protective clothing and protective equipment that is designed to provide protection from the hazards to which the member is likely to be exposed and is suitable for the tasks that the member is expected to perform.” Chapter 7.1.2 states, “Protective clothing and protective equipment shall be used whenever the member is exposed or potentially exposed to the hazards for which it is provided.” Chapter 7.2.1 states, “Members who engage in or are exposed to the hazards of structural fire fighting shall be provided with and shall use a protective ensemble that shall meet the applicable requirements of NFPA

Career Fire Fighter Dies From an Out-of-air Emergency in an Apartment Building Fire—Connecticut

1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*" [NFPA 2013d].

NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* states: "The fire department shall provide each member with protective clothing and protective equipment that is designed to provide protection from the hazards to which the member is likely to be exposed and is suitable for the tasks that the member is expected to perform. … Protective clothing and protective equipment shall be used whenever a member is exposed or potentially exposed to the hazards for which the protective clothing (and equipment) is provided" [NFPA 2013c].

NFPA 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* has established minimum requirements for structural fire-fighting protective ensembles and ensemble elements designed to provide fire-fighting personnel limited protection from thermal, physical, environmental, and bloodborne pathogen hazards encountered during structural fire-fighting operations [NFPA 2013d]. These requirements will assist in protecting fire fighters, but only if they wear the protective ensembles as recommended by the manufacturer.

In this incident, the fire department did not require fire fighters to wear hoods. The fire department has recently changed their policy and now requires fire fighters to wear hoods. A number of fire fighters were hit by a hose stream and had their helmets knocked off. Also, numerous fire fighters were not using their chin straps on their helmets. Proper use of the helmet requires using the chin strap.

Recommendation #12: Municipalities should ensure that an ambulance is dispatched on every working fire.

Discussion: History has shown and numerous NIOSH fatality reports have documented how routine fires can change in minutes and cause critical injuries. When this occurs, seconds count and having an ambulance (preferably advance life support capability) on-scene can make a significant difference in the outcome for the patient. When it is confirmed that there is a working fire, an ambulance should be dispatched along with the additional fire service resources as a general practice.

In this incident, ambulance service was provided by two ambulance companies that cover the city by a north and south divider, and an ambulance was not called until it was needed. However, if an ambulance had been present, it is believed that the outcome may not have changed.

Recommendation #13: Municipalities, building owners, and authorities having jurisdiction should consider requiring sprinkler systems be installed in mixed occupancy structures.

Discussion: Fire development beyond the incipient stage is one of the greatest hazards that fire fighters are exposed to. This exposure and risk to fire fighters can be dramatically reduced when fires are controlled or extinguished by automatic sprinkler systems. NFPA statistics show that most fires in sprinklered buildings are controlled prior to fire department arrival by the activation of one or two sprinkler heads. The presence of automatic fire sprinklers also reduces the exposure risk to fire fighters in rescue situations by allowing the safe egress of building occupants before the fire department arrives on-scene. Finally, by controlling fire development, the exposure to hazards such as building collapse and overhaul operations are greatly reduced, if not eliminated.

In this incident, the structure was not equipped with a sprinkler system.

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Investigator Information

This incident was investigated by Matt E. Bowyer, General Engineer, Stephen Miles, Occupational Safety and Health Specialist, and Murrey Loflin, Investigator, 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 John J. Salka, Jr., Battalion Chief (ret.), FDNY, and Fire Command Training Instructor. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

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Appendix I

Self-Contained Breathing Apparatus

National Personal Protective Technology Laboratory
Technology Evaluation Branch

Disclaimer

Investigator Information
The SCBA inspection and this report were written by Thomas D. Pouchot, General Engineer, the Technology Evaluation Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Bruceton, Pennsylvania.

The purpose of Respirator Status Investigations is to determine the conformance of each respirator to the NIOSH approval requirements found in Title 42, *Code of Federal Regulations*, Part 84. A number of performance tests are selected from the complete list of Part 84 requirements and each respirator is tested in its "**as received**" condition to determine its conformance to those performance requirements. Each respirator is also inspected to determine its conformance to the quality assurance documentation on file at NIOSH.

In order to gain additional information about its overall performance, each respirator may also be subjected to other recognized test parameters, such as National Fire Protection Association (NFPA) consensus standards. While the test results give an indication of the respirator's conformance to the NFPA approval requirements, NIOSH does not actively correlate the test results from its NFPA test equipment with those of certification organizations which list NFPA-compliant products. Thus, the NFPA test results are provided for information purposes only. Selected tests are conducted only after it has been determined that each respirator is in a condition that is safe to be pressurized, handled, and tested.

Respirators whose condition has deteriorated to the point where the health and safety of NIOSH personnel and/or property is at risk will not be tested.

Status Investigation Report of One Self-Contained Breathing Apparatus Submitted By the NIOSH Division of Safety Research NIOSH Task Number 19908

The National Institute for Occupational Safety and Health (NIOSH) has concluded its investigation conducted under NIOSH Task Number TN-19908. This investigation consisted of the inspection of two Scott Health and Safety AirPak 4.5, 30 minute, 4500 psig, Self Contained Breathing Apparatus (SCBA). The SCBAs in question were packaged inside a paper bag and shipped inside a plastic shipping box and were delivered to the NIOSH facility in Morgantown, WV, on October, 28, 2014. The SCBA units were then transported to Building 20 in Pittsburgh for inspection and stored under lock until the time of the evaluations on November 21, 2014.

SCBA Inspection:

An initial general inspection of the SCBA units was conducted on November 18, 2014. The units were identified as the Scott Health and Safety AirPak 4.5 model. In addition, Scott Health and Safety performed a downloading of the data logger present on one of the SCBA units, with NIOSH personnel present, on November 25, 2014. The other SCBA did not have a data logger.

A complete visual inspection of both SCBA units was conducted on November 18, 2014. The units were examined, component by component in the condition received, to determine conformance to the NIOSH-approved configuration. The visual inspection process was photographed.

Both SCBA units exhibited some signs of wear and tear; and the units were covered lightly with general soot and grime. The cylinder valve as received on the unit was in the closed position. The cylinder gauge could be read and indicated that there was no air remaining in either cylinder. The cylinder valve hand-wheels on both units could be turned.

The regulator and facepiece mating and sealing area on both of the units were relatively clean. The units had only slight scratches on the lenses. Visibility through the facepiece lens of both units was good as the condition of the lenses was fair. The facepiece head harness webbing on the both units was in fair condition with only a slight amount of dirt. The PASS on both units functioned. The NFPA SCBA approval label on Unit #1 and Unit #2 were present and readable.

Personal Alert Safety System (PASS) Device

The Personal Alert Safety System (PASS) device on both Units #1 and Unit #2 were operable and functional. The PASS devices were activated and appeared to function normally. However, the units were not tested against the specific performance requirements of NFPA 1982, *Standard on Personal Alert Safety Systems, (PASS),* 2007 Edition. Because NIOSH does not certify PASS devices, no further evaluation was performed.

SCBA Compressed Air Cylinder Contents

During the inspection, it was noted that the compressed air cylinders of both units were empty.

SCBA Testing

The purpose of the testing was to determine the SCBA conformance to the approval performance requirements of Title 42, *Code of Federal Regulations*, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the SCBA conformance to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, 1997 Edition.

NIOSH SCBA Certification Tests (in accordance with the performance requirements of 42 CFR 84):

1. Positive Pressure Test [§ 84.70(a)(2)(ii)]
2. Rated Service Time Test (duration) [§ 84.95]
3. Static Pressure Test [§ 84.91(d)]
4. Gas Flow Test [§ 84.93]
5. Exhalation Resistance Test [§ 84.91(c)]
6. Remaining Service Life Indicator Test (low-air alarm) [§ 84.83(f)]

National Fire Protection Association (NFPA) Tests (in accordance with NFPA 1981, 1997 (Edition):

7. Air Flow Performance Test [Chapter 5, 5-1.1]

The testing of both units was conducted on November 21, 2014. SCBA Unit #1 failed the remaining service life indicator test, secondary alarm. Unit #2 failed the positive pressure test and the rated service time test.

Appendix II of the Status Investigation Report contains complete NIOSH and NFPA test reports for both SCBA Units. Tables One through Four summarize the NIOSH and NFPA test results.

Summary and Conclusions

Two SCBA units were submitted to NIOSH National Personal Protective Technology Laboratory (NPPTL) by the NIOSH Division of Safety Research (DSR) for the Connecticut Fire Department for evaluation. The SCBA units were delivered to NIOSH on October 28, 2014 and extensively inspected on November, 18, 2014. Both units were identified as a Scott Health and Safety model AirPak 4.5, 4500 psi, 30-minute, SCBA (NIOSH approval numbers, TC-13F-0076, Unit #1 and TC-13F-0076CBRN, Unit #2). Scott Health and Safety performed a downloading of the Unit #2 data logger on November 25, 2014. The units suffered very slight amounts of damage but exhibited other signs of wear and tear and the units were slightly covered with general dirt. The cylinder valves, as received, on Unit #1 and Unit #2 were in the closed position. The cylinder gauges showed no pressure. The cylinder valve hand-wheels could be turned on both units. The regulator and facepiece mating and sealing area on both units were relatively clean. The units had only slight scratches on the lenses. Visibility through the facepiece lenses of Units #1 and #2 were good to fair with the lenses having slight scratches. The facepiece head harness webbing on both units were in fair condition and were slightly dirty with some fraying at the connection points. The NFPA approval label on Unit #1 and Unit #2 were present and readable after some dirt was wiped away. The personal alert safety system (PASS) on both units functioned.

The air cylinder on Unit #1 had a manufactured date of 01/04. Under the applicable DOT exemption, the air cylinder is required to be hydro tested every 5 years. For the air cylinder on Unit #1, a retest date before the last day of 01/09 is required. The retest label was readable on Unit #1 with a retest date of 4/13; therefore, the cylinder was within the hydro certification when last used. The cylinder on Unit #1 was in fair to good condition with surface scratches and gouge repairs present on the outer coating. There was no air remaining in the cylinder. Although the cylinder was within the hydro testing requirements, it was determined that it may not be safe to pressurize. Another cylinder and facepiece was requested from the Fire Department. The SCBA Unit #1 was tested as it was received as no other maintenance or repair work was performed on the unit at any time.

The air cylinder on Unit #2 had a manufactured date of 01/04. Under the applicable DOT exemption, the air cylinder is required to be hydro tested every 5 years. For the air cylinder on Unit #2, a retest date before the last day of 01/09 is required. The retest label was not present on Unit #2 and could not be pressurized safely. The cylinder on Unit #2 was in fair to good condition with surface scratches and gouge repairs present on the outer coating. There was no air remaining in the cylinder. Another cylinder and facepiece was requested from the Fire Department. The SCBA Unit #2 was tested as it was received as no other maintenance or repair work was performed on the unit at any time.

Unit #1 failed the Remaining Service Life Indicator Test. The secondary bell failed to operate within the parameters. SCBA Unit #1 did meet the requirements of the NIOSH Positive Pressure Test, as the unit did maintain a positive pressure for the 30 minute minimum duration of the unit. The unit passed all of the other NIOSH tests.

SCBA Unit #2 did not meet the requirements of the NIOSH Positive Pressure Test, as the unit did not maintain positive pressure throughout the 30 minute minimum duration of the unit. The unit passed all of the other NIOSH tests.

In light of the information obtained during this investigation, NIOSH has proposed no further action on its part at this time. The SCBA units were returned to the Fire Department.

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

From the information obtained during this investigation, NIOSH proposes no further action on its part at this time. The investigation under task number TN-19908 will be considered closed.

Appendix II
Incident Commander's Tactical Worksheet for Mayday

INCIDENT COMMANDER'S TACTICAL WORKSHEET FOR "MAYDAY"

- ☐ **MAYDAY - MAYDAY - MAYDAY Message is Transmitted;**
- ☐ **Announce *EMERGENCY RADIO TRAFFIC* only;**
- ☐ **Acknowledge Company/Member transmitting the Mayday – Obtain LUNAR information:**

LOCATION ______________________________
UNIT ______________________________
NAME ______________________________
ASSIGMENT AND AIR SUPPLY ____________________
RESOURCES NEEDED________________________

- ☐ **If no answer after two attempts conduct a PAR of all operating companies on the fire ground to isolate company/member;**
- ☐ **Deploy RIC to reported or last known location/assignment;**
- ☐ **Request an additional alarm;**
- ☐ **Request an additional TAC channel for fire operations TAC___**
- ☐ **Assure that companies not assigned to the rescue or near the rescue change to the new fire operations channel and conduct a PAR;**
- ☐ **Maintain fire-fighting positions. Withdraw only if necessary;**
- ☐ **Establish a Rescue Group with a Safety Officer;**
- ☐ **Review the Building Pre-Plan if available;**
- ☐ **Establish a Backup RIC to replace the deployed RIC;**
- ☐ **Establish a forward staging area for the Rescue Group and provide support with adequate staffing and equipment;**
- ☐ **Request additional EMS Resources/ALS Ambulances;**
- ☐ **Request Specialized Resources if needed – Technical Rescue;**
- ☐ **Conduct a PAR if an emergency evacuation is ordered (due to structural stability or fire conditions);**
- ☐ **Conduct a PAR after the rescue operation is completed;**
- ☐ **Announce the end of the Mayday;**

Appendix III
Use and Operations of Thermal Imagers

The temperature measurement feature on fire service thermal imagers should not be used for interior structural firefighting.
Use of this feature *MAY CAUSE ERRORS IN JUDGEMENT WHICH MAY RESULT IN SERIOUS INJURY OR DEATH.*

Fire service thermal imagers may be equipped with a temperature measurement feature.

Utilizing either a bar indicator or digital readout or both this feature displays the approximate surface temperature of a targeted surface.

The temperature measurement feature is a non-contact solid surface temperature measurement device that is not accurate.

Different materials or the same materials with different composition, surface textures, color and polish will not register temperature readings in the same way resulting in variations in the temperature readings.

Several factors including but not limited to:
- how much heat
- the material being measured and its ability to absorb or reflect heat (emissivity)
- the objects temperature
- the distance from the object being measured as well as
- the angle at which the object is being viewed
- the cleanliness of the lens as a result of steam or smoke;
- the object does not fully fill the center target area then a false reading may be obtained

Users must be aware and understand that the temperature measurement feature in a thermal imager will NOT provide atmospheric or air temperature readings.

Additionally the thermal imaging camera cannot see through walls.
- When attempting to view a source of heat behind a wall or above a ceiling the heat source will not be evident if it does not heat the wall itself. Consideration must be given to the thickness of the wall or ceiling as well as any additional layers of materials that may exist and further insulate or mask the true magnitude of the heat source.

All of these factors may individually or collectively greatly affect the accuracy of the temperature measurement feature during interior structural firefighting situations.

Because interior structural firefighting is a rapidly changing dynamic environment with many unknown and uncontrolled variables the temperature measurement feature on thermal imagers should not be utilized or relied upon by fire fighters to make tactical interior structural fire-fighting decisions.