Lieutenant and Fire Fighter Die and 13 Fire Fighters injured in a Wind-driven Fire in a Brownstone—Massachusetts

Executive Summary

On March 26, 2014, a 43-year-old male career fire lieutenant and a 33-year-old fire fighter died during fire-fighting operations in an occupied multifamily residential structure (brownstone). Engine 33 was the first-due engine company assigned to Box 1579. Engine 33 arrived on scene and reported: "We have a four-story with smoke showing from the first floor. Engine 33 is stretching a 1¾-inch hoseline in the front doorway." The lieutenant and the fire fighter stretched the 1¾-inch hoseline up the front steps (uncharged), through the front door, and into the front hallway. When the lieutenant was informed the fire and a possible victim were in the basement, Engine 33 took the hoseline down the steps. The Engine 33 pump operator charged the line, but the line lost its water due to the rapidly deteriorating fire conditions which compromised the hose. Engine 7 arrived on scene and stretched a 2 ½-inch hoseline as a back-up line to Engine 33. Engine 7 stretched their line in the front door following Engine 33's hoseline. Engine 22 was on-scene and was preparing to stretch a hoseline into the basement apartment underneath the front steps. The crew from Engine 7 was moving their hoseline towards the stairwell leading to the basement, when conditions changed drastically. Fire and heat came up the steps from the basement. This was due to a maintenance worker leaving the rear door of the attached shed open while investigating the smoke detector activation. The conditions became untenable for the fire fighters from Engine 7. They moved out of the building to the landing of the front steps. Also, the interior door at the top of the basement stairs was open, the front exterior doors were left open by an occupant fleeing the fire, and a rear basement door or window failed. Once the rear door or window burned through, this created an unrestricted flow path from the basement to the first floor plus the floors above, thereby triggering a rapid progression of fire conditions. This trapped the officer and fire fighter from Engine 33 in the basement. The fire, heat, and smoke through the basement and first floor created untenable conditions on both floors. Due to the intense heat and fire conditions, the 1¾-inch attack hose burned through. Command then ordered the building to be evacuated. Approximately 1 minute later, the Engine 33 lieutenant called Command and said they were running out of water. The dispatcher replied, "OK Engine 33, we are going to get you water." Command immediately called a

A view of fireground from Side Charlie. The fire started near the one-story shed (located against the fence) and extended into hallway on the basement of the structure.
(Photo courtesy of the fire department)

second alarm for Box 1579. Several companies tried to make entry into Side Alpha from both the basement and the first floor of the structure, but were pushed back by heavy fire and smoke. Crews pushed through the Side Bravo exposure to initiate fire attack on Side Charlie. Crews took a 2½-inch hoseline into the basement apartment on Side Charlie. Approximately 15 minutes later, crews located the fire fighter from Engine 33 in the kitchen area of this apartment. The fire fighter was removed from the apartment and immediately taken to an ambulance for transport to the hospital. The fire fighter from Engine 33 was pronounced dead at the hospital. After the fire fighter was removed, conditions changed and the structure became fully involved. Crews were removed from the structure and the strategy was changed to defensive operations. Once the fire was completely knocked down and conditions allowed fire fighters to safely re-enter the structure, a search was made for the lieutenant of Engine 33. The lieutenant was found at the bottom of the stairs near the entrance to Apartment #10 in the basement. The lieutenant was pronounced dead at the scene.

Contributing Factors

- *Delayed notification to the fire department*
- *Uncontrolled ventilation by a civilian*
- *Occupied residential building with immediate life safety concerns*
- *Staffing*
- *Scene size-up*
- *Lack of fire hydrants on Side Charlie (a private street)*
- *Lack of training regarding wind-driven fires*
- *Unrestricted flow path of the fire*
- *Lack of fire sprinkler system*

Key Recommendations

Fire departments should define fireground strategy and tactics for an occupancy that are based upon the organization's standard operating procedures. As part of the incident action plan, the incident commander should ensure a detailed scene size-up and risk assessment occurs during initial fireground operations, including the deployment of resources to Side Charlie. Scene size-up and risk assessment should occur throughout the incident.

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Introduction

On March 26, 2014, a 43-year-old career fire lieutenant and a 33-year-old fire fighter died during fire-fighting operations in a multifamily residential structure (brownstone). On April 4, 2014, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On April 8, an investigator and safety engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Massachusetts to meet with the fire commissioner, senior staff, International Association of Fire Fighters (IAFF), and the IAFF local president to develop a plan for the investigation process. On April 10, 2014, a general engineer and two occupational health and safety specialists traveled to Massachusetts to join the investigator to begin the investigation process. During this segment of the investigation, the NIOSH Fire Fighter Fatality Investigation Team met with the fire commissioner, the chief of operations, a safety chief, the president of the IAFF local, superintendent of the Fire Alarm Office, and the county's assistant district attorney assigned to this incident. The Fire Fighter Fatality Investigation Team inspected and photographed the turnout gear and self-contained breathing apparatus (SCBA) from the lieutenant and fire fighter. The team departed on April 16, 2014.

On May 3, 2014, the same members of the NIOSH Fire Fighter Fatality Investigation Team returned to Massachusetts to complete the field investigation. Two subject matter experts joined the NIOSH Fire Fighter Fatality Investigation Team during this segment of the investigation. The Fire Fighter Fatality Investigation Team toured the incident scene, photographed the interior and exterior of the structure, and interviewed investigators with the fire investigation unit and members of the fire training division. The NIOSH Fire Fighter Fatality Investigation Team conducted interviews with fire department officers and fire fighters who operated at Box 1579 on March 26, the superintendent of the fire alarm office, the superintendent of the fire department's fleet division, and members of the city's Inspectional Services Department (Building Officials Office). A closing meeting was held on May 9, 2014, with the fire commissioner and senior staff, the president and members of the IAFF local, the subject matter experts, and the NIOSH Fire Fighter Fatality Investigation Team.

Fire Department

This career fire department has 35 stations with 1,606 members of which 1,467 are uniformed members. The department protects a population of approximately 646,000 within an area of about 48 square miles.

The fire department consists of the following members:

- 1 fire commissioner and chief of department
- 2 chiefs of operations

2 deputy fire commissioners
14 deputy chiefs
51 district chiefs (battalion chiefs)
1 fire alarm superintendent
1 assistant fire alarm superintendent
75 captains
219 lieutenants
1,092 firefighters
92 civilian personnel
56 fire alarm personnel

The rank structure for the fire department is as follows: fire commissioner/chief of the department, chief of operations, deputy fire commissioner, deputy chief, district chief, captain, lieutenant, senior fire fighter, fire fighter, and probationary fire fighter.

The fire department consists of nine divisions: Fire Suppression; Fire Prevention; Training; Special Operations; Office of Field Services; Information Technology; Personnel; Safety, Health, and Wellness; Fire Alarm Office.

Fire Suppression: The services provided include fire-fighting, medical evaluation, vehicle extrication, hazardous material response, confined space rescue, structural collapse rescue, trench collapse rescue, and more. The department operates engine companies, ladder companies, and rescue companies, each providing distinctly separate services at a fire or other emergency.

The fire department operates 33 engine companies, 20 ladder companies, 2 tower ladder companies, 2 heavy rescue companies, 9 district chiefs (battalion chiefs) (Car 1, Car 3, Car 4, Car 6, Car 7, Car 8, Car 9, Car 11, Car 12), 2 deputy chiefs (C6 [Division 1] and C7 [Division 2]), 1 marine unit, 1 fire brigade, 2 tunnel/confined space units, 2 brush units, 1 hazardous materials unit, 1 mobile air supply unit, 1 rehab unit, 1 mobile command unit, 1 mobile decontamination unit, and 1 hydrant thawing unit. The district chief and deputy chiefs are each staffed with an incident command technician (ICT). Division 1 has District 1, District 3, District 4, District 6, and District 11. Division 2 has District 7, District 8, District 9, and District 12.

All fire stations are under the supervision of a captain (station captain) and are divided into four working groups (shifts). Three of the four working groups are under the supervision of a lieutenant.

All companies are staffed with a minimum of one officer and three fire fighters per shift. The riding assignments for each engine company, ladder company, and rescue company are as follows:

Engine Company

Engine xx Officer	(Right front seat)
Engine xx Pump	(Left front seat)
Engine xx Pipe	(Right rear seat)

Engine xx Hydrant	(Left rear seat)	
Engine xx Loop	(Rear seat, as staffing allows)	
Ladder Company		
Ladder xx Officer	(Right front seat)	
Ladder xx Open-up Man	(Left rear seat)	(Halligan and Maul)
Ladder xx Rake	(Right rear seat)	
Ladder xx Chauffeur/Roof man	(Left front seat)	
Ladder xx Vent	(Rear seat, as staffing allows)	
Rescue Company		
Rescue x Officer	(Right front seat)	
Rescue x Chauffeur, Alpha	(Left front seat)	
Rescue x Bravo	(Right rear seat)	
Rescue x Charlie	(Rear middle seat)	
Rescue x Delta	(Left rear seat)	

Members assigned to the Fire Suppression Division work a 24-hour shift (0800–0800), followed by 48 hours off, then 24 hours on duty, and followed by 96 hours off.

In 2014, the fire department responded to 75,176 emergency incidents. The fire department responded to:

- 5,704 fire incidents
- 33,624 rescue/EMS incidents
- 3,303 hazardous incidents—no fire
- 11,001 service calls
- 7,122 good intent calls
- 14,139 false alarms and false calls
- 283 miscellaneous calls

Fire Prevention: This division is responsible for maintaining records, granting permits, conducting public education, inspecting buildings, and conducting fire investigations. The Fire Marshal's Office consists of the following:

- 3 fire protection engineers
- 1 plans reviewer (engineer)
- 1 chemist
- 45 uniformed fire inspectors
- 20 civilian personnel
- 25 uniformed fire investigators (Fire Investigation Unit)

Training: This division provides recruit training, company in-service training, live fire training, and professional development for all members of the department. Also, the division conducts research to improve techniques and equipment, evaluating new tools before their implementation. The Emergency Medical Services and the Safety Operations Unit are also within this division.

Special Operations: The Special Operations Division of the fire department is tasked with duties concerning hazardous materials, technical rescue, and marine operations. These duties include developing and delivering training and creating operational plans and standard operating procedures for the three functions with Special Operations.

Office of Field Services: The department's Office of Field Services provides for the planning and logistical needs for the fire department. This includes acting as a liaison with outside agencies, monitoring the hazardous building list, coordinating the local emergency planning committee (LEPC), managing special projects, and planning for special events.

Information Technology: This division supports staff within the fire department operations (e.g., computer-aided dispatch), operational support (e.g., training and fire prevention records), and administrative support (e.g., payroll and personnel). The Information Technology Division reports to a chief of operations.

Personnel: This division includes the Administration Section, Selection Unit, Medical Office, Personnel Assignments of Officer's Section, and the Employees Assistant Program. The division keeps the records of each fire fighter; communicates with other departments, unions, and agencies; and hears grievances, disciplinary hearings, and appeals.

Safety, Health, and Wellness: The functions of this division, established in 2014, are to monitor and research current safety procedures and policies and to promote solutions when problems are discovered. The overall goal is the reduction of fire fighter injuries and illnesses on the fireground and in training and chronic occupational health issues. The Safety, Health, and Wellness Division is also tasked with writing and revising the department's standard operating procedures. This is to promote greater safety and fireground effectiveness, injury and illness prevention, and improvements in training practices and fireground operations. This division also investigates department injuries and motor vehicle accidents.

Fire Alarm Office: The Fire Alarm Office (FAO) serves as the dispatch center and base of communications for the department. The FAO enters all calls for service from any source into the computer-aided dispatch system to initiate the proper response, deploy resources, and expedite all alarms in accordance with standard operating procedures. The FAO also reads, adjusts, and maintains fire alarm circuits and recorders. Also, FAO staff repairs and adjusts equipment in the dispatch center as needed. All FAO operators are versed in the department's fireground standard operating procedure with a special emphasis on fireground safety.

Training and Experience

The Commonwealth of Massachusetts has no mandatory minimum requirements to become a fire fighter. For cities and towns that have adopted the Commonwealth of Massachusetts civil service system, a candidate must pass the state's fire fighter civil service written examination and successfully complete the Candidate Physical Ability Test. The Commonwealth of Massachusetts Civil Service

Commission administers the fire fighter written examination and physical agility exam for the municipality. The applicants are ranked and then given to the city's human resources division. The municipality conducts the following:

- Background check
- Drug screen
- Medical examination, which meets the requirements of NFPA 1582 *Standard on Comprehensive Occupational Medical Program for Fire Departments* (1997 edition) [NFPA 1997]
- Physiological exam
- City residency requirements check

Once a candidate is hired by this fire department, the candidate is required to attend a 20-week recruit school at the department's training academy. Five weeks of the academy training consists of the National Registry of Emergency Medical Technician—Emergency Medical Technician course. Upon completion of the recruit school, the recruit fire fighter will have completed more than 745 hours of instruction and will be certified (ProBoard Certification) per NFPA 1001 *Standard for Fire Fighter Professional Qualifications* [NFPA 2013c] to the level of Fire Fighter I and Fire Fighter II and per NFPA 472 *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents* [NFPA 2013b] to the level of Hazardous Materials—Awareness Responder and Operational Responder. The recruit fire fighter becomes a probationary fire fighter and then completes a probationary period of 32 weeks. Upon the successful completion of the probationary period, the individual becomes a fire fighter.

The officer of Engine 33 was hired by the department on December 8, 2004. He completed recruit school in April 2005 and was assigned to Ladder 15 as a probationary fire fighter. He successfully completed his probation and was assigned as a fire fighter to Ladder 15. He was promoted to lieutenant on April 3, 2012. His current assignment was a lieutenant on Engine 33. His qualifications included NFPA 1001, Fire Fighter I and II; Hazardous Materials Awareness level and Operations level per NFPA 472; Massachusetts EMT/Basic; and a ProBoard-certified Hazardous Materials Technician per NFPA 472. Other training included Radio Communications; Driver/Operator Training; Mayday procedures; EMS continuing education units; hazardous materials refresher training and certifications; weekly in-service training on standard operating procedures and EMS protocols pursuant to department General Orders; and the fire department fire college.

The fire fighter from Engine 33 was hired by the department on November 5, 2007. He completed recruit school in March 2008 and was assigned to Ladder 2 as a probationary fire fighter. He successfully completed his probation and was assigned as a fire fighter to Ladder 2. His current assignment was as a fire fighter to Ladder 15. He was detailed to Engine 33 on March 26, 2014. His qualifications included NFPA 1001, Fire Fighter I and II—ProBoard certification; Hazardous Materials Awareness level and Operations level per NFPA 472—ProBoard certification; and Massachusetts EMT/Basic. Other training included IAFF Emergency Response to Terrorism Course—Operations; Hazardous Materials Training—CBRNE, Response to Radiological Incidents; Air/Gas Monitoring, Chlorine Training, and Highway Tanker Emergencies; and EMS continuing education units.

Equipment and Personnel

All 9-1-1 calls are answered by the city's police dispatch center. If the 9-1-1 call is for a fire or a medical emergency, the call is then routed to the fire department's Fire Alarm Office (FAO). In the event of a structure fire, the FAO assigns the appropriate number and type of companies to the incident. All incidents are assigned a box number based upon the location of street boxes, which are also used as a method of transmitting alarms to the FAO. The fire department communicated information from an incident to the Fire Alarm Office by a street box, which was done primarily before the radio system came into existence. The fire department still has telegraph alarm boxes located on street corners throughout the city and in various businesses and occupancies.

Types of Alarms for Structure Fires

Still Alarm. Usually any emergency call received by telephone at the Fire Alarm Office or verbal notification by a citizen at a fire station. Under certain conditions the FAO may treat a box alarm as a still alarm.

Still Alarm Assignment: 1 engine, 1 ladder

Box Alarm

First Alarm Assignment: 4 engines (1 engine for rapid intervention team [RIT]), 2 ladders, 1 rescue, 1 district chief

Downtown First Alarm Assignment: 4 engines (1 for RIT), 2 ladders, 1 tower ladder, 1 rescue, 1 district chief, and 1 division chief

High-rise Fire Response First Alarm Assignment: 4 engines (1 for RIT), 2 ladders, 1 rescue, 3 district chiefs (1 for operations, 1 for evacuation, 1 for accountability), 1 division chief, safety chief, air supply unit

Full Box Alarm/Confirmed Fire with RIT and Rehab Assignment: 1 ladder (RIT), 1 tower ladder, 1 district chief (RIT), safety chief, rehab unit

Second Alarm

Second Alarm Assignment: an additional 3 engines, 1 ladder, 2 district chiefs (1 for accountability), 1 division chief, air supply unit, fire investigation unit, and 1 public information officer

Third Alarm

Third Alarm Assignment: an additional 2 engines, 1 ladder, special unit, and field/tactical communications unit

Fourth Alarm

Fourth Alarm Assignment: an additional 2 engines

Fifth Alarm

Fifth Alarm Assignment: an additional 2 engines and 1 ladder

Sixth Alarm

Sixth Alarm Assignment: an additional 2 engines

Seventh Alarm

Seventh Alarm Assignment: an additional 2 engines and 1 ladder

Eighth Alarm

Eighth Alarm Assignment: an additional 2 engines

Ninth Alarm

Ninth Alarm Assignment: an additional 2 engines

Total apparatus on scene: 21 engine companies, 7 ladder companies, 1 tower ladder, 1 heavy rescue company, 6 chiefs (1 deputy/5 district), 1 special unit, 1 rehabilitation unit, and 1 air supply unit.

Types of Alarms for Specific Incidents

Motor Vehicle Accident

Motor Vehicle Accident Assignment: 1 engine, 1 ladder

Motor Vehicle Accident (Pin or Entrapment)

Motor Vehicle Accident (Pin or Entrapment) Assignment: 1 engine, 1 ladder, 1 district chief, 1 rescue

Vehicle Fire

Vehicle Fire Assignment: 1 engine

EMS Response

EMS Response Assignment: 1 company only (either an engine, ladder, rescue, or tower ladder company)

HazMat Level 0

HazMat Level 0 Assignment: 1 engine, 1 ladder

HazMat Level 1 (Upgrade)

HazMat Level 1 Assignment: 1 district chief, special unit, 1 HazMat inspector, 1 engine (HazMat), 1 ladder (HazMat), safety chief (H1)

HazMat Level 2 (Upgrade)

HazMat Level 2 Assignment: 1 district chief, HazMat unit, fireground rehab/mass casualty unit, field/communication tactical unit, 1 police department environmental safety group unit

HazMat Level 3 (Upgrade)

HazMat Level 3 Assignment: 2 engines (decontamination), 1 division chief, 1 public information officer, 1 fire investigation unit, fire department photography unit

Fireground Communications

Department's Fire Alarm Office

The department operates a dispatch and communication center (Fire Alarm Office), which started operation on December 27, 1925. All fire alarm circuits, along with radio and telephone communications, are controlled from the Fire Alarm Office (FAO). The radio shop for the fire department is located at the FAO. Personnel designated to maintain the street boxes and circuits are assigned to the FAO.

All 9-1-1 calls are answered by the 9-1-1 police dispatcher. Requests for fire and EMS responses are routed to the FAO, which only dispatches fire department resources. The fire department still has telegraph alarm boxes located on street corners throughout the city and in various businesses and occupancies.

The department's communication system consists of ultra-high-frequency (UHF) radios:

- 5 channels
- 42 receiver sites
- 4 simulcast sites
- 5 portable radios assigned to each fire apparatus
- 312 high-rise sites in the city with repeater systems

The portable radios can be used (on the fireground) with the repeater or line of site; a computer automatically selects the appropriate mode of operation. The district chiefs and deputy chiefs have repeaters in their vehicles, which boost the signal from 5 watts to 100 watts.

The staffing for the FAO is 1 superintendent, 1 assistant superintendent, and 32 dispatchers. The FAO staffs each shift (4 shifts) with 7 dispatchers with a minimum staffing of 5 dispatchers. The dispatchers work a 24-hour shift (0800–0800), followed by 48 hours off, then 24 hours on duty, and followed by 96 hours off. Each shift works with the same operational staff as members of the Fire Suppression Division, so dispatchers are familiar with the shift's deputy chiefs and district chiefs.

The FAO dispatches an average of 250–275 incidents per day. Each incident is assigned a box number based upon the street boxes located throughout the city. When an incident occurs, a dispatcher is assigned to that incident and maintains communications on the dispatch and tactical channel(s) from the beginning of the incident until the incident is terminated. If the incident goes to a fifth alarm, an additional dispatcher is called back, plus the superintendent and assistant superintendent respond to the FAO.

Role of the Dispatcher during a Mayday

Dispatchers should be the voice of calm during a Mayday. This takes practice. Dispatchers should train in performing their responsibilities so when a Mayday is called, they react instinctively and without delay. A dispatch center/communications center supports fire fighter safety best when adequately staffed. In addition to the call taker and dispatcher, at least one other dispatcher should monitor the fire ground tactical channel during working incidents. In some cases, units on the fire ground *DID NOT* hear the Mayday, but dispatchers and fire department resources did. In order to ensure fire fighter survivability, the tactical channel should be monitored at all times during working incidents. Dispatchers should also be authorized to immediately contact Command upon hearing any Mayday or emergency traffic communications. This confirms that Command has heard the message and is taking action. The same applies if the dispatcher received an emergency activation from a fire fighter's portable radio. Command should be notified and take action to confirm whether the message is an emergency or an accidental activation.

If the fire department's radios are equipped with channels from other fire departments, the dispatcher should immediately advise these departments of the Mayday situation. Fire fighters have accidentally selected the wrong frequency, and contacted another fire department on their radio. These agencies should be advised that if they hear communications from the distressed fire fighter. This agency's dispatch center should maintain contact with them. *DO NOT* change frequencies. The other agency should immediately advise the department's dispatcher of the contact, followed by a notification to Command. Command or other designated officer should go to that tactical channel and communicate directly with the distressed fire fighter. *DO NOT* ask the fire fighter to change channels. The fire fighter may not be able to do so, or even worse, end up on another channel [IAFF 2010].

The FAO plays an integral role in the department's daily fireground operations. The FAO had a positive impact on the Mayday operation at Box 1579 on March 26, 2014. Upon transmission of the Mayday, the FAO immediately confirmed that the incident commander was aware of the Mayday transmission. Also, FAO dispatchers transmitted the alert tome and ordered radio silence, confirmed the Mayday fire fighter's location, maintained contact with the Mayday fire fighter, assigned a tactical channel for non-RIT operations, confirmed additional alarms with Command, dispatched additional RIT resources, dispatched additional technical rescue resources, ordered advanced life support from the city's emergency medical services, and assisted in conducting a personnel accountability report with Command.

Timeline

This timeline is provided to set out, to the extent possible, the sequence of events according to recorded radio transmissions. Times are approximate and were obtained from review of the dispatch records, witness interviews, and other available information. NIOSH investigators have attempted to include the potential radio transmissions. This timeline is not intended, nor should it be used, as a formal record of events.

Incident and Fireground Communications	Time	Response and Fireground Operations
March 26, 2014		
9-1-1 call reported building filled with smoke.	**1441 Hours**	

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Incident and Fireground Communications	Time	Response and Fireground Operations
Alert tone announcement for the transmission of Box 1579 by Fire Alarm Office (FAO): "Engine 33, Engine 7, Engine 22, Ladder 24, Ladder 26, Rescue 1 [R01], and District 4 [Car 4] dispatched for structure fire for Box 1579; Channel 2 is the fireground channel."	**1442 Hours**	
	1445 Hours	Engine 33 (E33) reported on scene and assumed command; Command advised smoke showing from the first floor. The E33 officer and E33 Pipeman (right jumpseat) stretched a 1¾-inch hoseline (uncharged) up the front steps and into the first floor.
For "smoke showing," FAO dispatched District 3 (Car 3), Engine 37, Tower Ladder 3 (TL3), and Ladder 18 as RIT. Also dispatched were H1 (safety officer) and W25 (mobile air unit).	**1446 Hours**	Car 4 arrived on scene and assumed command for Box 1579. An unknown unit radioed that occupants were trapped on the fourth floor.
H1 (safety officer) enroute.	**1447 Hours**	Rescue 1 arrived on scene.

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Incident and Fireground Communications	Time	Response and Fireground Operations
Per the orders of Command, transmit a second alarm for Box 1579.	**1448 Hours**	Car 3, E7, E22, E37, H1, L18, L24, L26, and TL3 arrived on scene. Command reported, "We have a four-story brick residential; the fire is in the basement; the occupants of the fourth floor have self-evacuated off the fire escape." E33's 1¾-inch hoseline is charged and going down the stairs to the basement. ***Note:*** *Due to a rapid progression of fire conditions, E33 hoseline is burned through and loses pressure. The officer of E33 is unaware this has occurred. The water never reaches the nozzle.* E7 backed up E33 with a 2½-inch hoseline into the first floor. Conditions rapidly change due to a rapid progression of fire conditions and E7 was forced out to the front stoop.
FAO transmitted Box 2-1579. Engine 4, Engine 17, Engine 10, Ladder 17, Rescue 2, C6 (Division 1 Deputy Chief), District 7 (Car 7) (Accountability), and District 9 (Car 9) are dispatched for Box 2-1579.	**14:49:09 Hours**	
	14:49:12 Hours	E33 officer called Engine 33 to have the hoseline charged.
	14:49:22 Hours	Command radioed FAO and advised, "Emergency Traffic…everyone off the first floor, everyone off the first floor."
	14:49:31 Hours	FAO advised all companies operating at Box 2-1579 to "get out of the first floor."
	14:49:45 Hours	E33 declares a Mayday. "Mayday E33, Mayday E33."
FAO radioed, "E33 has a Mayday on Fireground Channel 2 in the basement; E33 has a Mayday on Fireground Channel 2 in the basement. OK Car 4?"	**14:49:57 Hours**	

Incident and Fireground Communications	Time	Response and Fireground Operations
FAO transmitted again, "E33 has a Mayday on Fireground Channel 2 in the basement. OK Car 4?"	1450 Hours	Command acknowledged the message.
Command to FAO, "I want all members out of the building, all members out of the building immediately."	14:50:17 Hours	
FAO transmitted this message on Channel 1, Fireground Channel 2, and Fireground Channel 3.	14:50:26 Hours	
	14:50:38 Hours	FAO transmitted on Fireground Channel 2 to E33 to charge the 1¾-inch hoseline going to the crew of E33 in the basement.
	14:50:43 Hours	Ladder 26 called FAO. "Tell Command, we need a line to the back [of the building – Side Charlie]; We have fire showing on the first floor. There is a shed attached to the basement level in the rear. Have companies come around to the street in the rear. The companies can attack the fire from Side Charlie."
	1451 Hours	The officer of E33 asked for the line to be charged.
FAO transmitted the following message on Channel 1, Fireground Channel 2, and Fireground Channel 3: "All companies operating at Box 1579, switch to Fireground Channel 3. Fireground Channel 2 is the Mayday Channel. All companies operating at Box 1579, use Fireground Channel 3. Fireground Channel 2 is the Mayday Channel."	14:51:07 Hours	
	14:51:42 Hours	The officer of E33 radioed, "33, we need water now, charge 33's pipe."

Incident and Fireground Communications	Time	Response and Fireground Operations
Command to FAO, "Give me a third alarm. Have the second-alarm companies report to the rear."	**14:51:45 Hours**	
	14:52:02 Hours	E33 officer radioed FAO, "Both of us are trapped in the basement towards the front of the building. We got water, but the hoseline is burnt through. You have got to charge our line."
FOA to Command, "E33 is trapped in the basement. They are trying to head to the front of the building. They need water."	**14:52:34 Hours**	
	14:52:50 Hours	Command acknowledged the message.
	14:52:53 Hours	FAO to E33 officer, "They are trying to get you water."
	14:52:59 Hours	The officer of E33 radioed, "We are on the stairway and it's getting hot down here."
	14:53:30 Hours	The chauffeur of E33 radioed, "I am running out of water, I am running out of water." ***Note:*** *E33 was operating off water from the booster tank which 750 gallons. A supply line for E33 had not been established at this time.*
FAO to Command, "E33 is in the basement heading toward the front of the building. I will verify."	**14:53:36 Hours**	
	14:53:58 Hours	
FAO transmitted Box 3-1579; Engine 29, Engine 42, and Ladder 15 are dispatched for Box 3-1579.	**1454 Hours**	

Incident and Fireground Communications	Time	Response and Fireground Operations
	14:54:31 Hours	E33 officer radioed, "We are in the basement towards the front of the building."
	14:55:20 Hours	E33 officer radioed FAO, "It's getting hot down here. Getting hotter."
	14:55:35 Hours	FAO to E33 officer, "OK 33, they are going to get you water."
	14:56:43 Hours	FAO to E33 officer, "E33, they are coming to get you."
Command to FAO, "We have companies in the front of the basement now. Tell E33's officer if he can find a way out, to get out."	14:56:56 Hours	
	14:57:24 Hours	The last radio transmission from E33 officer. He radioed, "Need a line in the basement, right away; a big line."
FAO to Command, "L26 officer reports they need a line in the rear and E33 is still calling for water."	14:57:43 Hours	
	14:57:51 Hours	L26 to FAO, "Tell Command we need a line on the backside of the building. We have heavy fire on Side Charlie."
"Per the orders of Command, transmit a fourth alarm for Box 1579." FAO transmitted: "A fourth alarm has been struck for Box 1579. The fireground channel is Channel 3. Stay off Channel 2, it is the Mayday Channel."	14:58:51 Hours	

Incident and Fireground Communications	Time	Response and Fireground Operations
"Division 1 Deputy Chief (C6) on scene." FAO transmits: "C6 is assuming Command of Box 1579. On the orders of the Deputy Chief, he is requesting a fourth and fifth alarm for Box 1579. Have the fourth and fifth alarm companies respond to the rear of the building (Side Charlie)."	**14:59:07 Hours**	
Engine 5 and Engine 3 are dispatched for Box 4-1579. ***Engine 28, Engine 55, and Ladder 14, and C1 (Commissioner) are dispatched for Box 5-1579.***	**14:59:22 Hours**	
	15:00:21 Hours	Car 4 to Command, "We have heavy fire in the rear; we are trying to get water back here."
Command to FAO, "Have the third-alarm ladder companies go to the front of the building (Side Alpha) with 35's and the first-due engines on the fourth and fifth alarms to the rear of the fire building and run big lines into the basement."	**15:00:29 Hours**	
FAO radioed to third-alarm ladder companies respond to the front of the building and fourth-alarm engine companies respond to the rear.	**15:01:00 Hours**	
Command to FAO, "We have companies trying to advance into the basement now."	**15:03:48 Hours**	
	1504 Hours	C7 (Division 2 Deputy Chief) on scene. C7 assigned as Division Charlie.

Incident and Fireground Communications	Time	Response and Fireground Operations
	15:06: 18 Hours	C7 to Command, "We have 3 big lines going in the rear moving towards the front of the building."
	15:07:18 Hours	C7 to Command, "Have a couple of ambulances come to Side Charlie in case we pull these guys out the rear door."
	15:07:35 Hours	C7 to Command, "Companies are making progress. They are 20 to 25 feet inside the basement and they keep going."
"Per the orders of Command strike the sixth alarm and seventh alarm for Box 1579."	**15:08:16 Hours**	
	15:08:59 Hours	Rescue 1 to FAO, "Have all members reset their PASS devices. We have multiple PASS devices going off."
FAO transmitted the following message on Channels 1, 2, and 3: "All companies reset PASS devices due to multiple PASS devices in alarm."	**15:09:35 Hours**	
FAO dispatched Engine 30 for Box 6-1579. ***FAO dispatched Engine 8, Engine 21, and Ladder 4 for Box 7-1579.***	**15:09:46 Hours**	
Command to FAO, "Urgent, Urgent, I want everybody out of the building, everybody out of the building."	**15:10:14 Hours**	A rapid progression of fire conditions occurs in the structure.

Incident and Fireground Communications	Time	Response and Fireground Operations
FAO transmitted the following message on Channels 1, 2, and 3. “Per the orders of Command, All companies operating at the seventh alarm for Box 1579, get out of the building, all companies out of the building.”	**15:10:28 Hours**	
	15:11:11 Hours	Command to all companies on Fireground Channel 3, “Everybody out the building.”
FAO transmitted the following message on Channels 1, 2, and 3. “Per the orders of Command, All companies operating at the seventh alarm for Box 1579, get out of the building, all companies out of the building.”	**15:11:31 Hours**	
“Per the orders of Command strike the eighth alarm and ninth alarm for Box 1579.” “Have these companies report to Command in front of the building.”	**15:13:00 Hours**	
FAO dispatched Engine 49 and Engine 24 for Box 8-1579.	**15:13:37 Hours**	
FAO dispatched Engine 39, Engine 14, and Tower Ladder 10 (TL10) for Box 9-1579.	**15:13:52 Hours**	
	15:15:34 Hours	C7 to Command, “Do we still have members missing?”
C1 to FAO, “Yes, there is still a member unaccounted for in the basement.”	**15:16:38 Hours**	
C7 to FAO, “Companies are going back in.”	**15:16:48 Hours**	
C1 to FAO: “Negative. No companies are going in anywhere. Stay out and away from the building.”	**15:17:03 Hours**	

Incident and Fireground Communications	Time	Response and Fireground Operations
	15:17:11 Hours	C7 to C1: "We are aware of the collapse potential. We can see in front of us. We can hear a PASS device inside the building."
C1 to FAO: "We can't put anybody in there at the front door or back door. That OK? Other than that, stay out of the building."	**15:18:09 Hours**	
C7 to FAO, "I copy the message."	**15:18:30 Hours**	
C7 to FAO, "Tell C1 I am pulling companies back out again."	**15:19:07 Hours**	
	15:19:30 Hours	***C7 to Command, "We are getting the guy [fire fighter from E33] out now. Get EMS to the rear [Side Charlie]."***
FAO to C1, "Tower Ladder 3 just brought a member [fire fighter from E33] out the rear of the building."	**15:20:59 Hours**	
	15:21:37 Hours	C7 to Command, "Are there still members inside?"
C1 to FAO: "We are doing an accountability check right now. We are looking into that right now."	**15:21:52 Hours**	
C7 to FAO, "Can you ask Command if all the members of E33 are accounted for at this time?"	**15:23:56 Hours**	
FAO to C7: "Command is doing an accountability check. They are doing an accountability check right now."	**15:24:04 Hours**	
FAO dispatched Engine 32 to Box 9-1579. E32 is special called.	**1531 Hours**	

Incident and Fireground Communications	Time	Response and Fireground Operations
Command to FAO: "All first-alarm and second-alarm companies do a PAR with Accountability 7. They can do it in person or send a member. I want an accountability PAR for the first-alarm and second-alarm companies."	**15:35:21 Hours**	
Accountability 7 to FAO, "Accountability 7 is located across the street from the fire building."	**15:36:08 Hours**	
FAO transmitted the following message: "Engines 37, 33, 22, 3, 4, and 39, L15, L17, L26, and TL3 report your PAR to Accountability 7 who is located across the street from the fire building."	**15:37:18 Hours**	
	15:40:09 Hours	C7 to Command: "We are going to defensive operations in the rear. I am getting members away from the building."
	15:40:27 Hours	Command to C7: "The fire is through the roof. I am sure you are aware that we are trying to get ladder pipes flowing and Blitz guns in operation on adjacent roofs to try and knock down the fire."
Command to FAO, "I want all lines shut down. I want all exterior lines shut down." FAO repeats this message on Fireground Channel 2 and Fireground Channel 3.	**15:50:18 Hours**	
	15:51:14 Hours	Command to C7: "Give me a report. It seems that heavy fire is through the roof and coming from the rear forward. Is that accurate?"
	15:51:32 Hours	C7 to Command, "Yes, I really can't see the fire from the ground, but we know there is heavy fire on the roof in the rear."

Incident and Fireground Communications	**Time**	**Response and Fireground Operations**
Accountability 7 to FAO, "Can you list the third-alarm companies?" FAO replied, "Engine 10, Engine 17, and Ladder 18 for the third alarm at Box 1579."	**15:54:15 Hours**	
	15:57:34 Hours	C7 to Command: "The heavy fire in the rear on the third floor and fourth floor has been knocked down by the deck guns. We still have heavy fire on the second floor. We are going to hit that with the Blitz guns. I have set up collapse zones in the rear." Command acknowledged report.
FAO to Accountability 7, "All members accounted for?"	**1605 Hours**	
FAO dispatched Engine 51 to Box 9-1579. E51 is special called**.**	**1614 Hours**	
	1624 Hours	C7 to Command, "We have everyone back 1½ times the height of the building." Command acknowledged.
Command to FAO: "I want all heavy stream appliances and exterior lines shut down. I want all exterior lines shut down." FAO transmitted the message on Fireground Channel 3.	**1629 Hours**	
FAO dispatched Engine 16 to Box 9-1579. E16 was special called.	**1633 Hours**	
FAO dispatched HazMat 1 to Box 9-1579. HazMat 1 was special called.	**1635 Hours**	
"Per the orders of Command, respond a structural engineer and the medical examiner to the fire building."	**1706 Hours**	
FAO dispatched Ladder 16 to Box 9-1579. L16 is special called.	**1744 Hours**	

Incident and Fireground Communications	Time	Response and Fireground Operations
	1848 Hours	Crews from R01 and R02 located the lieutenant of E33 near the bottom of the stairs near the rear basement apartment.
	1911 Hours	The officer of Engine 33 was removed from the building and placed in an ambulance for transport to the hospital.
Command to FAO: "Place this fire under control. I am requesting 1 district chief, two engines and 1 ladder for "Fire Detail." ***FAO dispatched Engine 2, Engine 41, Ladder 19, and District 11 (Car 11) to Box 9-1579 as Fire Detail.***	2125 Hours	
March 27, 2014		
Command to FAO, "I am transmitting an "All out" for Box 9-1579."	0743 Hours	

Building Construction and History

The structure involved in this incident was called a "brownstone." Brownstone is the common name for a variety of brown, red, and pink sandstone widely used as building materials from the mid-1800s until the early 1900s [New York Landmarks Conservancy 2003]. *Note: In the city involved in this incident, the bottom or ground floor is called the basement. The floor entered by the front steps is called the first floor. The bottom or ground floor identified as basement is different from most basements as there is access from the front and rear of the structure and access by interior stairs; more than half of the basement was above street level.*

The layout of the interior apartments of the fire building (**See Photo 1**) were numbered as follows:

- Basement: the basement (e.g., partially below grade) had two apartments, Apartment #9 in the front (Side Alpha) and Apartment #10 in the rear (Side Charlie).
- First Floor: the first floor was previously two separate apartments but had been combined into a single apartment identified as Apartment #1 at the time of the fire.
- Second Floor: the apartment on the second floor has a similar floor plan as Apartment #1 and was numbered as Apartment #3.

- Third Floor: the third floor was made up of two apartments, Apartment #5 in the front (Side Alpha) and Apartment #6 in the rear (Side Charlie).
- Fourth Floor: the fourth floor was made up of two apartments, Apartment #7 in the front (Side Alpha) and Apartment #8 in the rear (Side Charlie).
- With the exception of Apartment #1 and Apartment #3, all of the apartments only had windows facing either the front or the rear, depending on the position of the apartment.

Photo 1. The fire building is the one with the bay windows from the basement to the fourth floor. The entrance to the basement apartment is under the steps.
(*Photo source: World Wide Web.*)

Extension and Spread of Fire

In order to better understand fire growth and development during this incident, it may be useful to understand how fire generally spreads in these types of buildings. A brownstone will generally be classified as Type III (Ordinary) construction, with masonry walls and combustible (i.e., dimension lumber), interior load-bearing construction.

In addition to typical problem areas associated with Type III buildings, particular points of examination inside a brownstone could include dumbwaiter shafts, hot air ducts, and registers running throughout the building. Because of the nature of mechanical systems installed at the time of construction, these interior connected voids are much larger than would be found in today's Type III buildings. Also consider that when built, any brownstone was likely to be a single-family home. It is entirely possible that these voids were not sealed off when the building was subsequently divided into apartments.

Some brownstone buildings may have open stairs in the rear of the building, which was originally for use by servants. Their existence allows for areas of fire spread that may not be recognized or known by those unfamiliar with this type of building. Additionally, the large, open, and often wood-paneled main stairway provides a continuous combustible flue from the first floor to the ceiling of the top floor and is typically terminated at a skylight. This will allow fire to spread rapidly and cut off escape routes for the occupants. Transom windows, which may be found over the interior doors, can fail under fire conditions and allow heat and smoke into the hallway areas. This also will allow fire to spread more easily [FDNY 2009a, FDNY 2013a].

The Fire Building

The structure involved in the fire was built in 1899 with a total living space of 6,376 square feet. The structure had five floors including a basement. The lot size is 3,600 square feet. The construction is Type III (Ordinary).

When built, the structure was designed as a single-family dwelling. In 1974, the owner divided the building into apartments with one apartment each on the first floor and the second floor and with two apartments each in the basement, third floor, and fourth floor. The basement was divided into two separate apartments with separate entrances. The basement unit at the front of the building (Apartment #9) could only be entered from the exterior entrance below the stairs on Side Alpha. The basement unit at the rear of the structure (Apartment #10) could be entered from the interior stairs at the center of the common hall on the first floor and from an exterior grade-level entrance on Side Charlie (**See Diagram 1**). The main entrances to the apartments on the second through fourth floors were reached by a common interior stairwell. Secondary means of egress from apartments on the first through fourth floors were provided by exterior fire escapes.

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

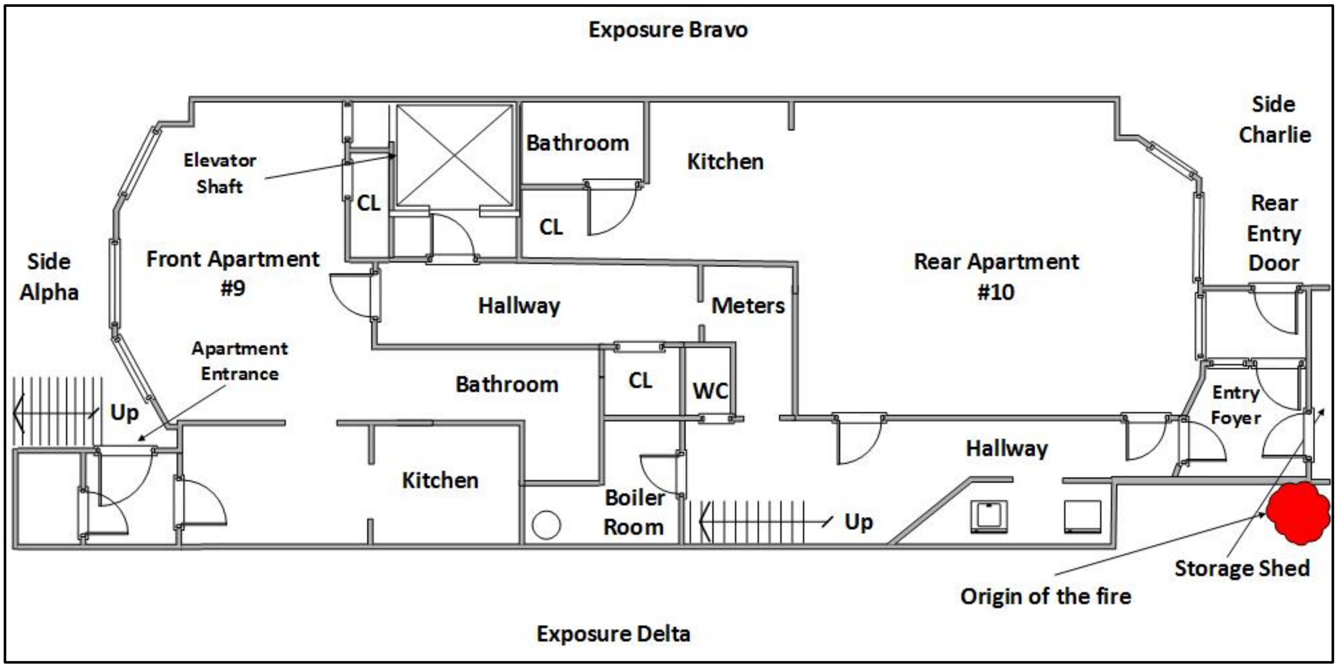

Diagram 1. The diagram of the basement of the fire building. The front apartment is #9 and the rear apartment is #10. The shed was attached to the structure on Side Charlie, behind the rear entrance doors for the rear apartment.

The first floor consisted of one apartment, which included a bedroom in the front (Side Alpha), a large living area in the rear (Side Charlie), a kitchen, a bathroom, another bedroom, and a common entry foyer, which had access to the basement (Apartment #10) and the apartments on the floors above (**See Diagram 2**). Prior to its conversion to apartments, the building had an elevator that went from the basement to the first floor. The elevator had been used to bring prepared food from the basement to the first floor when the structure was a single-family dwelling. The elevator was not in service at the time of the fire. The elevator was located on the Side Bravo wall.

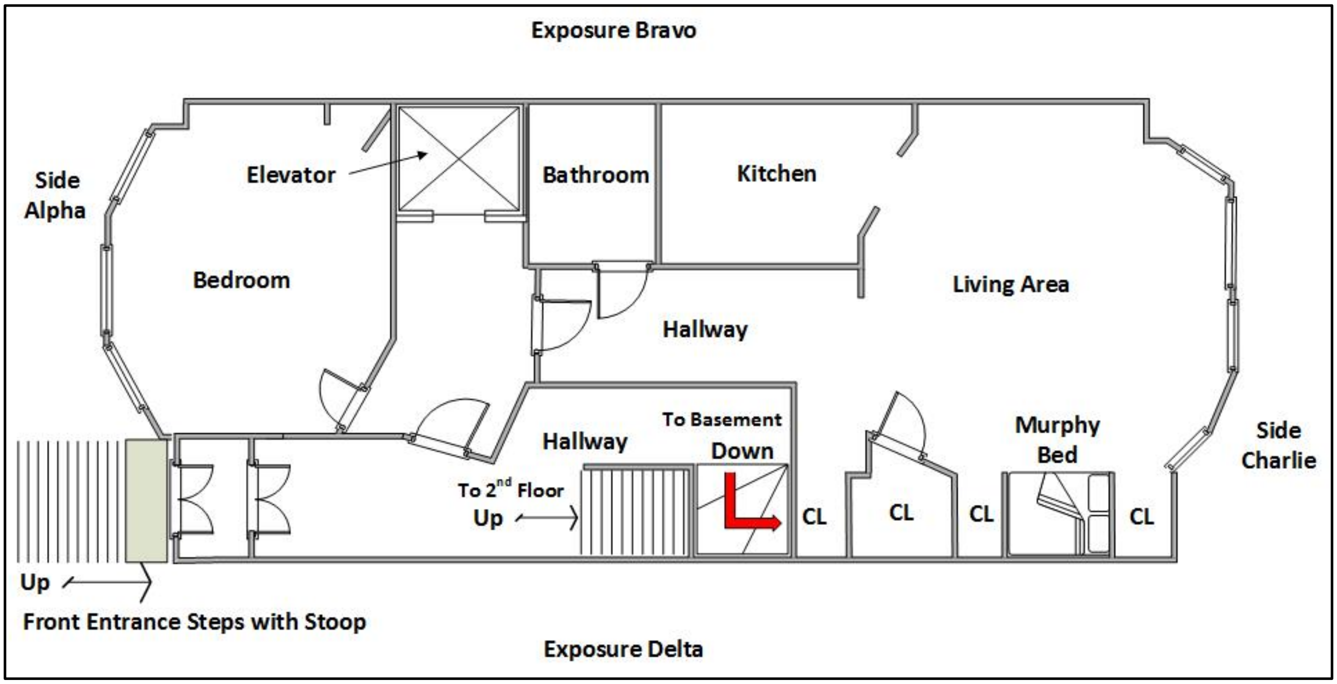

Diagram 2. The diagram of the first floor (Apartment #1) of the fire building. The stairs leading down to the basement are marked by the red arrow.

The block where the fire occurred consisted of predominately brownstone buildings. In-fill structures abutted the buildings on either side of them, just as the original structures did. Parking was allowed on the street in front of the buildings. Parking was also allowed on a private, narrow street on the Charlie side of the building. As indicated in the diagram, several buildings had garages for tenant parking (**See Diagram 3**).

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

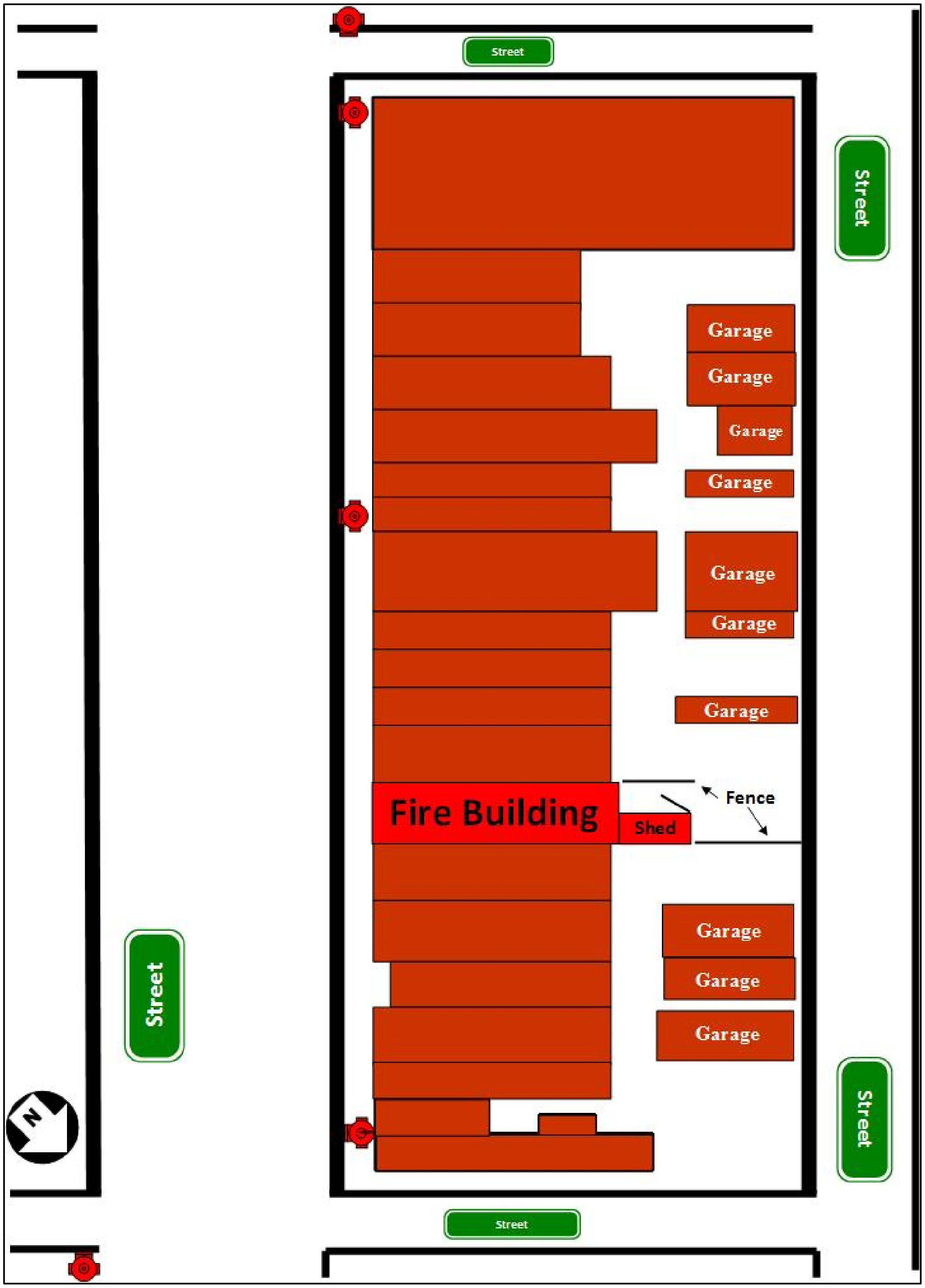

Diagram 3. The street diagram and location of the fire building.

The fire started in a shed in the rear of the structure. The shed was attached to the building by the rear entrance. The shed served as the office, storage, and work facility for the property maintenance staff of the affected building (**See Photo 2**).

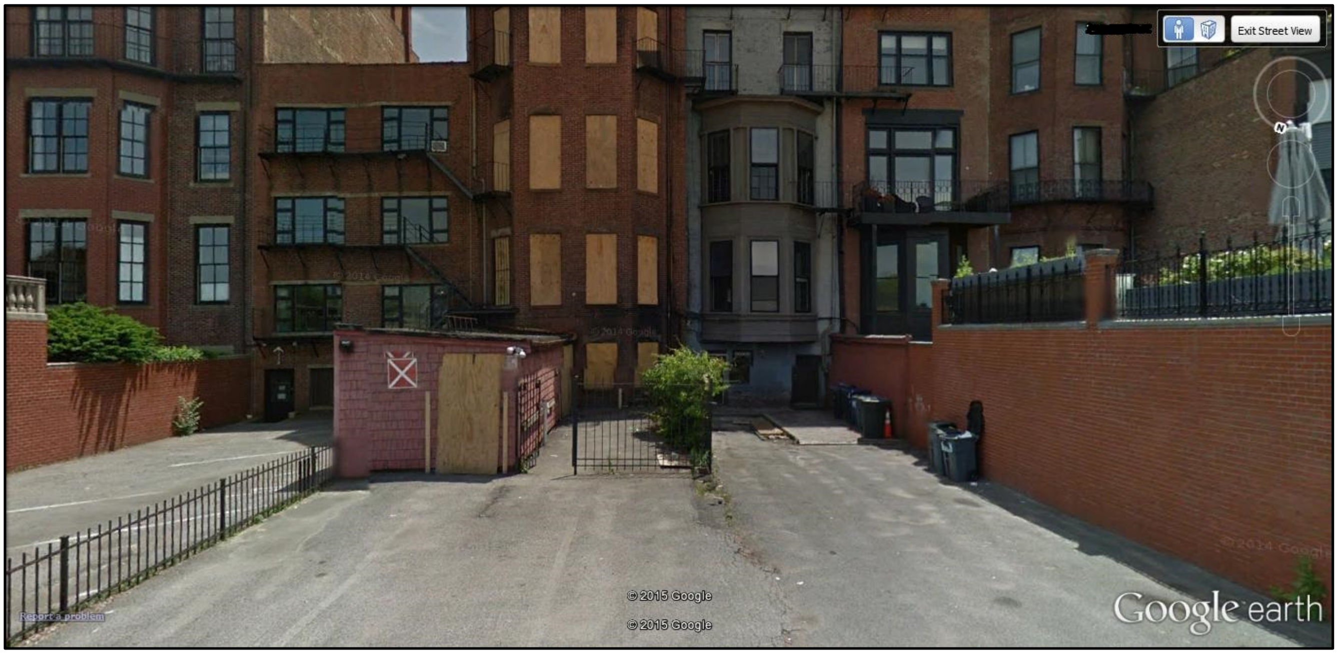

Photo 2. A view of Side Charlie and the location of the maintenance shed.
(*Photo source: Google Earth.*)

Personal Protective Equipment

At this incident, each officer and fire fighter was wearing a station/work uniform, turnout pants, turnout coat, helmet, boots, and an SCBA with integrated personal alert safety system (PASS). ***Note:*** *At the time of this incident, the department did not mandate the use of protective hoods.*

NIOSH investigators inspected and photographed each victim's personal protective equipment at the Arson Division office. The inspected SCBA and turnout gear exhibited a variety of thermal damage as the result of the exposure to the fire. Two SCBA units were shipped to the NIOSH National Personal Protection Technology Laboratory (NPPTL) in Pittsburgh, Pennsylvania, for evaluation.

On February 27, 2015, NPPTL personnel in Pittsburgh evaluated the SCBA and the summary evaluation report is included as "**Appendix One: Status Investigation Report of Two Self-contained Breathing Apparatus**."

On April 8, 2015, an independent contractor was requested to evaluate the personal protective equipment. The summary evaluation report is included as "**Appendix Two: Personal Protective Equipment Evaluation**."

Weather and Road Conditions

The weather temperature at 1454 hours was 34 degrees Fahrenheit (34° F) with a wind chill factor of 20° F. The humidity was 27% and the barometric pressure was 29.59 inches. Visibility was 10 miles and the winds were 32 miles per hour from the southeast. The winds gusted as high as 69 miles per hour during this incident. The skies were overcast and no precipitation was reported in the previous 24 hours [Weather Underground 2014].

Investigation

On March 26, 2014, at 1441 hours, the Fire Alarm Office (FAO) received a 9-1-1 call that reported a building was filling with smoke. At 1443 hours, the FAO dispatched Engine 33, Engine 7, Engine 22, Ladder 24, Ladder 26, Rescue 1, and District 4 (Car 4) for Box 1579**. *Note:*** *The first-due ladder company (Ladder 15) was out of service due to maintenance; Ladder 24 (third-due ladder company) was dispatched as the first-due ladder company. The second-due ladder company (Ladder 17) was out of service due to training; Ladder 26 (fourth-due ladder company) was dispatched as the second-due ladder company. Both Ladder 15 and Ladder 17 responded after the initial dispatch.*

Engine 33 arrived on scene at 1445 hours and parked in front of the fire building. The officer from Engine 33 advised FAO that "Engine 33 is in command and we have a four-story with smoke showing from first floor." Due to the active and dynamic situation plus the immediate life safety concerns of an occupied residential building encountered at this incident, the Engine 33 officer assumed fast-attack mode as the command mode. ***Note:*** *Fast-attack mode can also be known as fast-action mode or mobile command. This command mode is selected in situations that require immediate action to stabilize and requires the company officer's assistance and direct involvement in the attack.*

The Engine 33 lieutenant and Engine 33 (Pipeman) right jumpseat fire fighter stretched a 1¾-inch hoseline up the front steps and into the first floor. A civilian was coming down the front fire escape while Engine 33 was making their stretch. The Engine 33 chauffeur charged the 1¾-inch hoseline as Engine 33 moved down the steps to the rear basement apartment. At 1445 hours, Car 4 had arrived on scene and assumed command from the officer of Engine 33. Car 4 established command in front of Engine 33.

At 1446 hours, FAO dispatched District 3 (Car 3) and Engine 37 on the Rapid Intervention Team (RIT) assignment. At 1446 hours, FAO completed the RIT dispatch for Box 1579. FAO dispatched Tower Ladder 3 and Ladder 18. The safety officer (H1-Safety District Chief) assisted the RIT chief and RIT operations on Side Alpha. A concurrent RIT operation was ongoing on Side Charlie.

The fire fighter assigned to the left jump seat (Hydrant) of Engine 33 was preparing to pull the 4-inch supply line when a female civilian told him that someone might be in the basement apartment. The fire fighter took a halligan tool and went down the exterior steps and into the front basement apartment (Apartment #9). The fire fighter forced two doors and entered the front basement apartment. The fire fighter came out of the apartment and met with Command who was in the street. The fire fighter advised Command that the fire was in the rear basement apartment (Apartment #10) and a hoseline needed to be deployed to the basement.

Engine 7 arrived on scene at 1447 hours from the east and parked facing Engine 33 and laid a 4-inch supply line from the hydrant on the corner and then ran a 2½-inch supply line to Engine 33. Engine 33 was entering the front door as Engine 7 arrived on scene. The crew (officer and two fire fighters) from Engine 7 pulled a 2½-inch hoseline to the front steps. Engine 7 stretched a 2½-inch hoseline up the front steps following Engine 33's charged 1¾-inch hoseline. As Engine 7 moved the hoseline toward the stairs, the conditions started to change as the first floor became extremely hot. The Pipeman from Engine 7 asked the Engine 7 officer to call for water. The conditions became untenable and Engine 7 left the building. As Engine 7 pulled the 2½-inch hoseline out of the building, the hose was burned. The time was approximately 1449 hours (**See Diagram 4**).

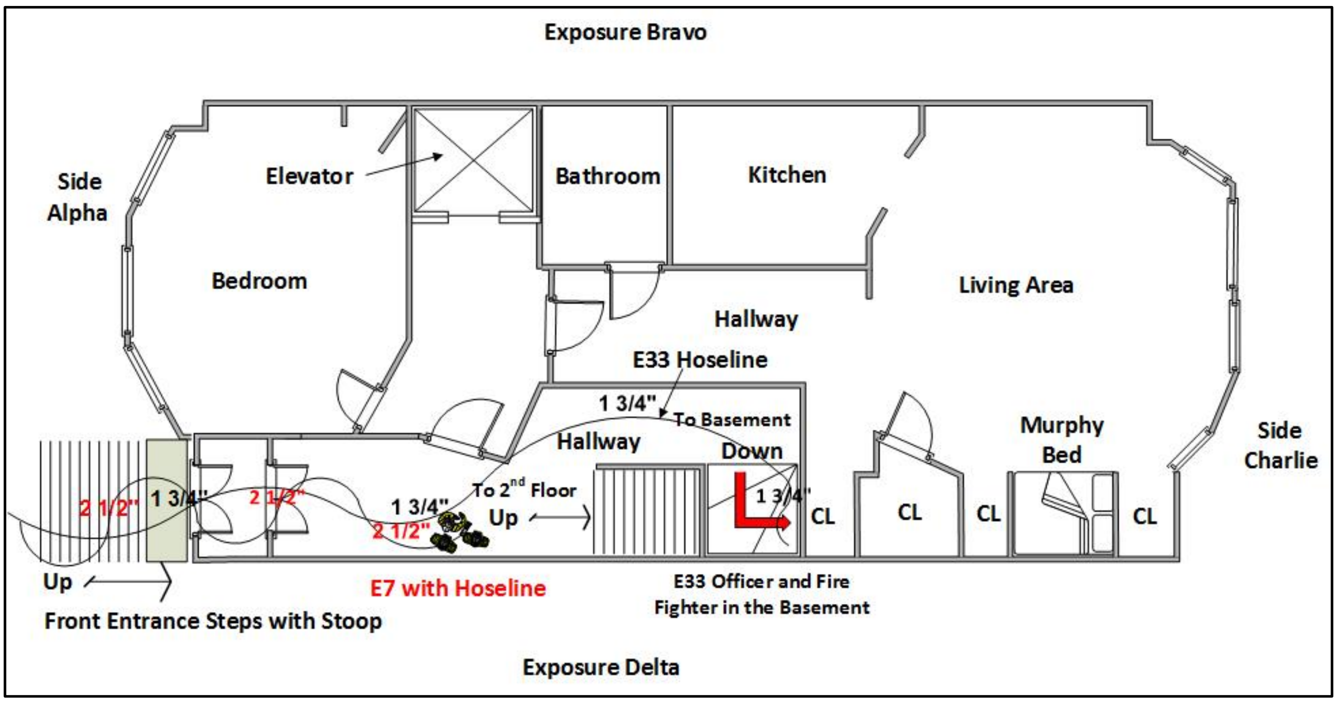

Diagram 4. The initial hoseline operations entering through the front door of the first floor. Engine 33 has taken a 1¾-inch hoseline into the basement. Engine 7 is pulling a 2½-inch hoseline into the front hallway of the first floor, moving toward the basement steps. The time is approximately 1449 hours.

Engine 22 responded to Box 1579 as the third-due engine. Engine 22 laid a 4-inch supply line from a hydrant in the previous block, arrived on scene at 1448 hours, and parked behind Engine 7. The chauffeur pulled a 200-foot 2½-inch hoseline to the front walkway of the fire building. The captain and right jump seat fire fighter from Engine 7 took the 2½-inch hose into the first floor with the "Hydrant" fire fighter from Engine 33. At the same time, Rescue 1 and Engine 37 were pulling a 1¾-inch hoseline through the front door, down the steps, and into the basement. All companies were forced out of the building at this point due to a rapid progression of fire conditions. The Engine 22 "Hydrant" fire fighter went back to Engine 22 to pull another 2½-inch hoseline when conditions changed.

Ladder 24 arrived on scene at 1448 hours and parked behind Engine 33. The captain and two fire fighters entered the first floor of the fire building. Ladder 24 crawled down the hallway to the stairs going to the second floor. The captain of Ladder 24 stated they were engulfed in black smoke and the heat increased, which forced them out of the building. Crews had to pull the captain of Ladder 24 out of the building. At the same time, the chauffeur from Ladder 24 put the aerial ladder to the roof. He went to the roof and vented the roof.

Ladder 26 arrived on scene at 1448 hours and parked on Side Charlie, directly behind the fire building. The captain of Ladder 26 observed the rear door of the maintenance shed was open and fire in the shed. The captain advised his crew not to break any windows. The captain radioed Command and asked for water on Side Charlie but was unable to reach Command due to radio traffic. He instead called FAO and advised that fire was showing on the first floor in the rear of the building. He requested an engine company on Side Charlie for water. The captain of Ladder 26 then forced his way through Exposure Bravo to get to Side Alpha (**See Diagram 5**).

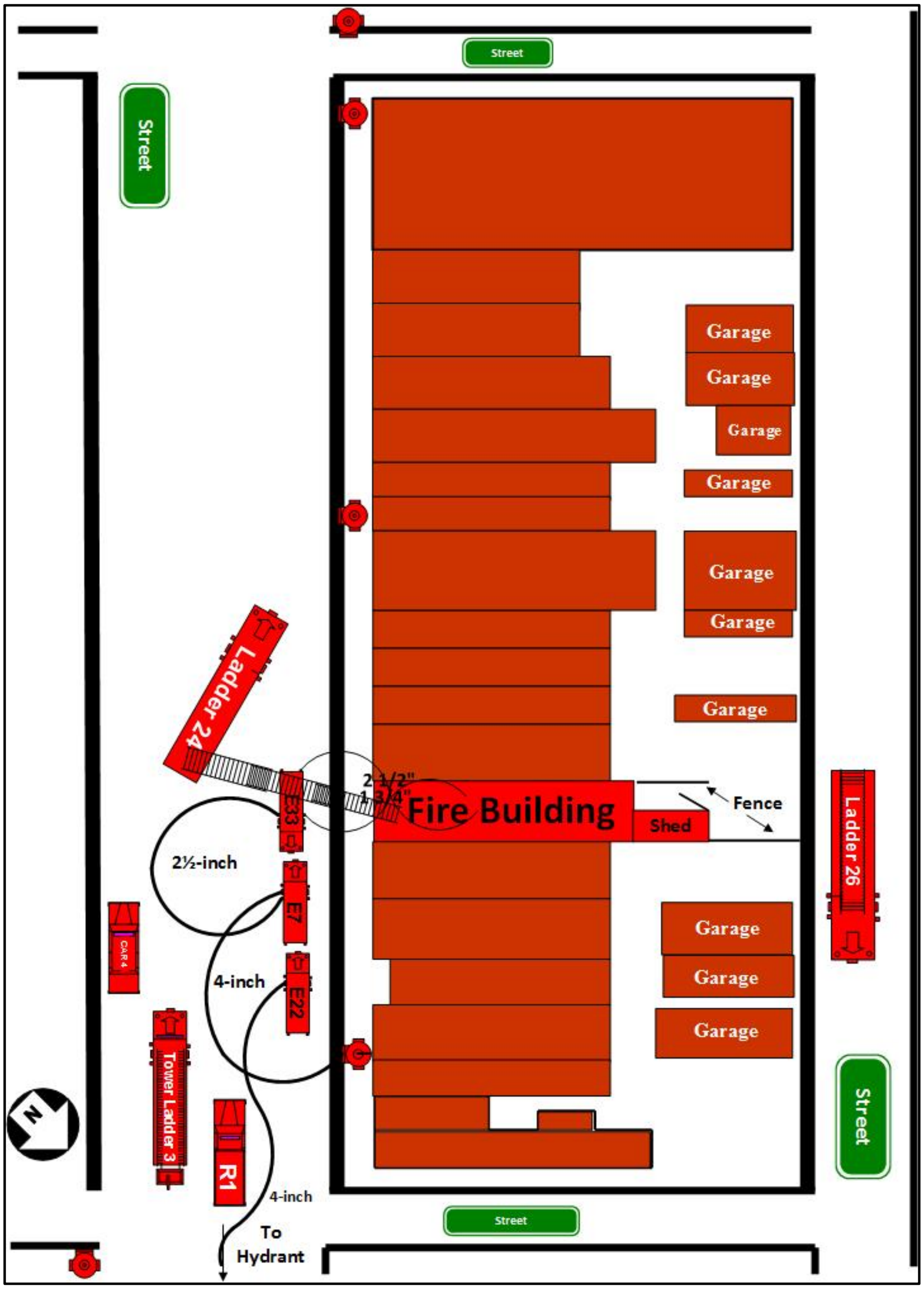

Diagram 5. The diagram of the initial engine company operations with Engine 33, Engine 7, and Engine 22 making entry into the fire building. The time is approximately 1449 hours.

The captain of Ladder 26 met with Command on Side Alpha regarding the need for water on Side Charlie. Several members of Rescue 2 pulled a 2½-inch hoseline through Exposure Bravo to Side Charlie. The captain of Ladder 26 returned to Side Charlie and entered the rear apartment through a window. He went in with crews from Ladder 17 and Rescue 2. Prior to entering the structure, a rapid progression of fire conditions occurred. Another rapid progression of fire conditions occurred while they were operating in the rear basement apartment. The time was approximately 1511 hours.

Rescue 1 arrived on scene at 1447 hours and parked at an intersection behind Tower Ladder 3. Rescue 1 was assigned to assist companies with making entry into Side Alpha. As Rescue 1 was approaching the scene, the smoke conditions changed drastically from the time of arrival. The smoke conditions changed from brown smoke to thick, black smoke. Rescue 1 entered the basement with Engine 37. Due to the tremendous heat, both companies were forced out of the basement. Rescue 1 moved to the rear (Side Charlie) of the fire building and made entry into the rear basement apartment. The time was 1511 hours.

At 1448 hours, Command ordered a second alarm for Box 1579. C6 (Division 1 Deputy Chief), District 7 (Accountability), District 9, Engine 4, Engine 17, Engine 10, Ladder 17, Ladder 15, and Rescue 2 were dispatched on the second alarm for Box 1579 (Box 2-1579). At 1449 hours, the lieutenant from Engine 33 called Engine 33 and said "charge the line." After this radio transmission, Command ordered all companies out of the building. The lieutenant radioed a Mayday at 14:49:45. The lieutenant said, "E33 has a Mayday in the basement." At 1450 hours, the dispatcher advised Engine 33 to charge the hoseline. At 1451 hours, the lieutenant from Engine 33 called and said, "We need water now; charge E33's pipe." At 14:51:07 hours, FAO moved fireground operations to Tac Channel 3. Tac Channel 2 was assigned for the Mayday. At 1452 hours, the lieutenant from Engine 33 radioed FAO and said: "Both of us are trapped in the basement toward the front of the building. We got the water but my line is burnt through. You have got to charge our line." At 1453 hours, FAO announced, per the orders of Command, a third alarm was being struck for Box 1579 (Box 3-1579). FAO dispatched Engine 29, Engine 42, and Ladder 15 for the third alarm on Box 1579. ***Note:*** *Based upon the information from interviews with fire officers, fire fighters, and fire investigators, Engine 33 stretched an 1¾-inch into the fire building, up the front stoop, and into the first floor. Engine 33 found the stairs leading to the basement and stretched the charged hoseline into the basement. A maintenance worker opened the rear door of the shed and left it open while investigating the smoke detector activation. Also, the interior door at the top of the basement stairs was open, the front exterior doors were left open by an occupant fleeing the fire, and a rear basement door or window failed. This created an unrestricted flow path from the basement to the first floor plus the floors above, thereby triggering a rapid progression of fire conditions. This trapped the officer and fire fighter from Engine 33 in the basement. The fire, heat, and smoke through the basement and first floor created untenable conditions on both floors. Due to the intense heat and fire conditions, the 1¾-inch attack hose burned through.*

At 1453, FAO advised the officer of Engine 33 that they were trying to get water to him. At 1454 hours, the lieutenant of Engine 33 repeated his message of his location in the basement. At 1455 hours, the lieutenant stated, “It is getting hot down here and getting hotter.” At 1456 hours, FAO called the lieutenant of Engine 33 and said, “They are coming to get you.” At 1457 hours, the captain from Ladder 26 made another request for water on Side Charlie. He stated, “We need a line on the backside of the building; we have heavy fire on Side Charlie.” ***The last transmission from the lieutenant of Engine 33 was at 1457 hours***. He radioed, “Need a line in the basement, right away; a big line.”

At 1459 hours, per the orders of Command, a fourth alarm was struck for Box 1579 (Box 4-1579). Engine 5 and Engine 3 were dispatched on the fourth alarm. At 14:59:07 hours, C6 assumed Command of Box 1579, and District 4 was assigned as Division Charlie. Command advised FAO to have the fourth-alarm and fifth-alarm companies respond to the rear of the building. At 14:59:22 hours, a fifth alarm was struck for Box 1579 (Box 5-1579). FAO dispatched Engine 28, Engine 55, Ladder 14, and C1 (Commissioner).

At 1500 hours, Engine 10 laid a supply line from Engine 4 to Side Charlie. The first attempt to enter the basement from the rear of the building had three 2½-inch hoselines operated by Engine 10, Engine 4, and Engine 24. Rescue 1 was attempting to locate the officer and fire fighter from Engine 33. Crews from Ladder 26, Ladder 15, Ladder 17, Tower Ladder 3, and Engine 42 were operating in the rear of the building at this time. The officer of Rescue 1 notified C7 of hearing a PASS Alarm as he exited the building. The crews were only able to get about 5–10 feet into the apartment when a rapid progression of fire conditions occurred in the basement and on the first floor. Crews exited the building, regrouped, and re-entered the basement apartment. The time was 1506 hours. The crews re-entered the building and continued the search for the missing lieutenant and fire fighter from Engine 33. Crews were operating about 20–25 feet in the rear basement apartment.

At 1509 hours, the sixth alarm and seventh alarm for Box 1579 were dispatched. Engine 30 was dispatched on Box 6-1579 and Engine 8, Engine 21, and Ladder 4 were dispatched for Box 7-1579. Another rapid progression of fire conditions occurred at the front of the building at approximately 1511 hours. Command contacted FAO and ordered all crews out of the building. This was done on all three channels. At 1511 hours, a rapid progression of fire conditions occurred at the rear of the first floor while crews were operating in the rear basement apartment (**See Photo 3**). At 1513 hours, Command ordered the eighth alarm and ninth alarm for Box 1579. Engine 49 and Engine 24 were dispatched for Box 8-1579. Engine 39, Engine 14, and Tower Ladder 10 were dispatched for Box 9-1579.

Photo 3. A rapid progression of fire conditions occurred on the first floor at approximately 1511 hours. Crews were operating on Side Charlie (upwind side) and making entry into the rear basement apartment via the windows. This photo shows the force of the rapid progression of fire conditions.
(Photo courtesy of the fire department.)

Lieutenant and Fire Fighter Die and 13 Fire Fighters injured in a Wind-driven Fire in a Brownstone—Massachusetts

Command ordered defensive operations on Side Alpha due to the severity of the fire conditions. At 1515 hours, Division Charlie (C7) contacted Command regarding whether fire fighters were still missing. C1 (Commissioner) advised that a member was unaccounted for in the basement. Crews from Engine 10, Engine 4, Engine 24, Rescue 1, Rescue 2, Ladder 17, Ladder 15, Ladder 26, Tower Ladder 3, and Engine 42 were operating on Side Charlie. Members from Rescue 2 found the fire fighter from Engine 33 in the rear basement (Apartment #10) near the kitchen. The fire fighter was covered with debris. Members of Rescue 2 moved the fire fighter from Engine 33 to the rear window (**See Diagram 6**). Crews outside picked up the fire fighter and put him on a stretcher.

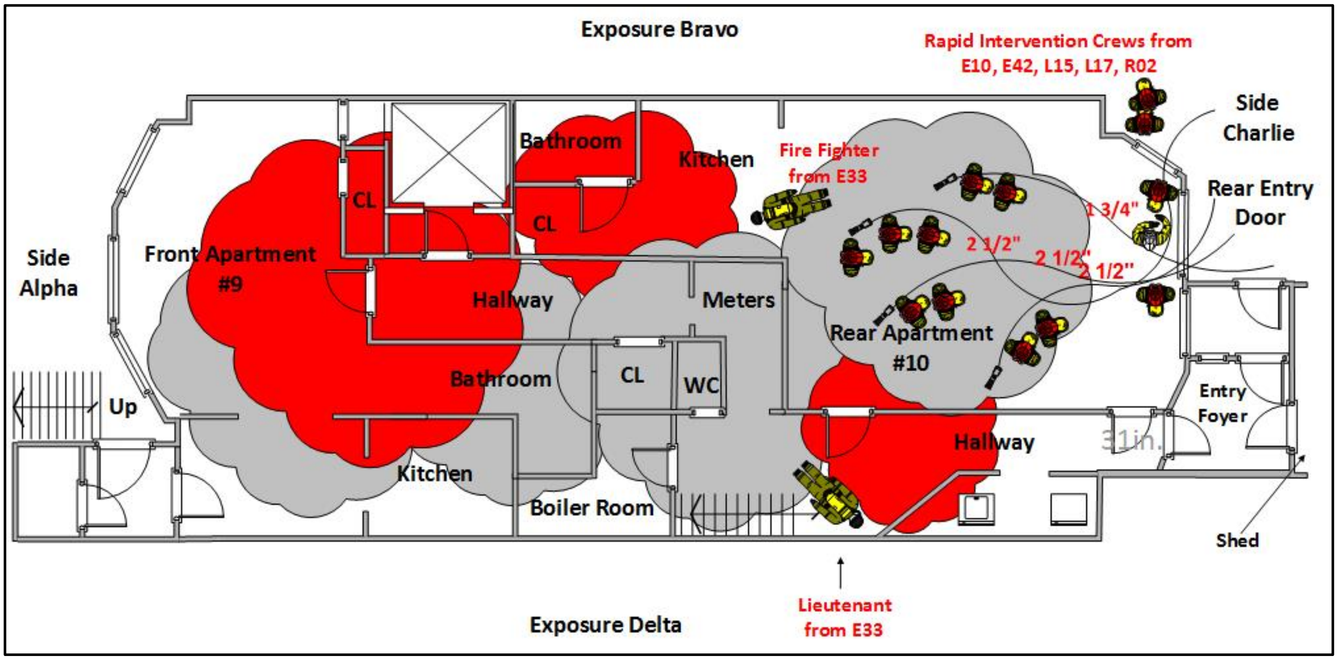

Diagram 6. Crews from Engine 10, Engine 42, Ladder 15, Ladder 17, and Rescue 2 are operating the rear basement apartment searching for the lieutenant and fire fighter from Engine 33. Rescue 2 finds the fire fighter from Engine 33 and removed him from the building. The time is 1519 hours. The lieutenant was not located until 1848 hours.

The time was 1519 hours when the fire fighter was removed from the structure. The fire fighter was taken on the stretcher to an EMS ambulance located at a cross street near Side Alpha. He was transported to the nearest trauma center. The fire fighter was pronounced dead at 1607 hours.

Shortly after the fire fighter from Engine 33 was removed from the structure, C7 allowed two companies—Engine 21 and Rescue 1—to re-enter the rear basement apartment for approximately 30–60 seconds to listen for the PASS Alarm from the Engine 33 lieutenant. When no device was heard, C7 ordered the companies out of the building due to the severely deteriorating conditions.

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

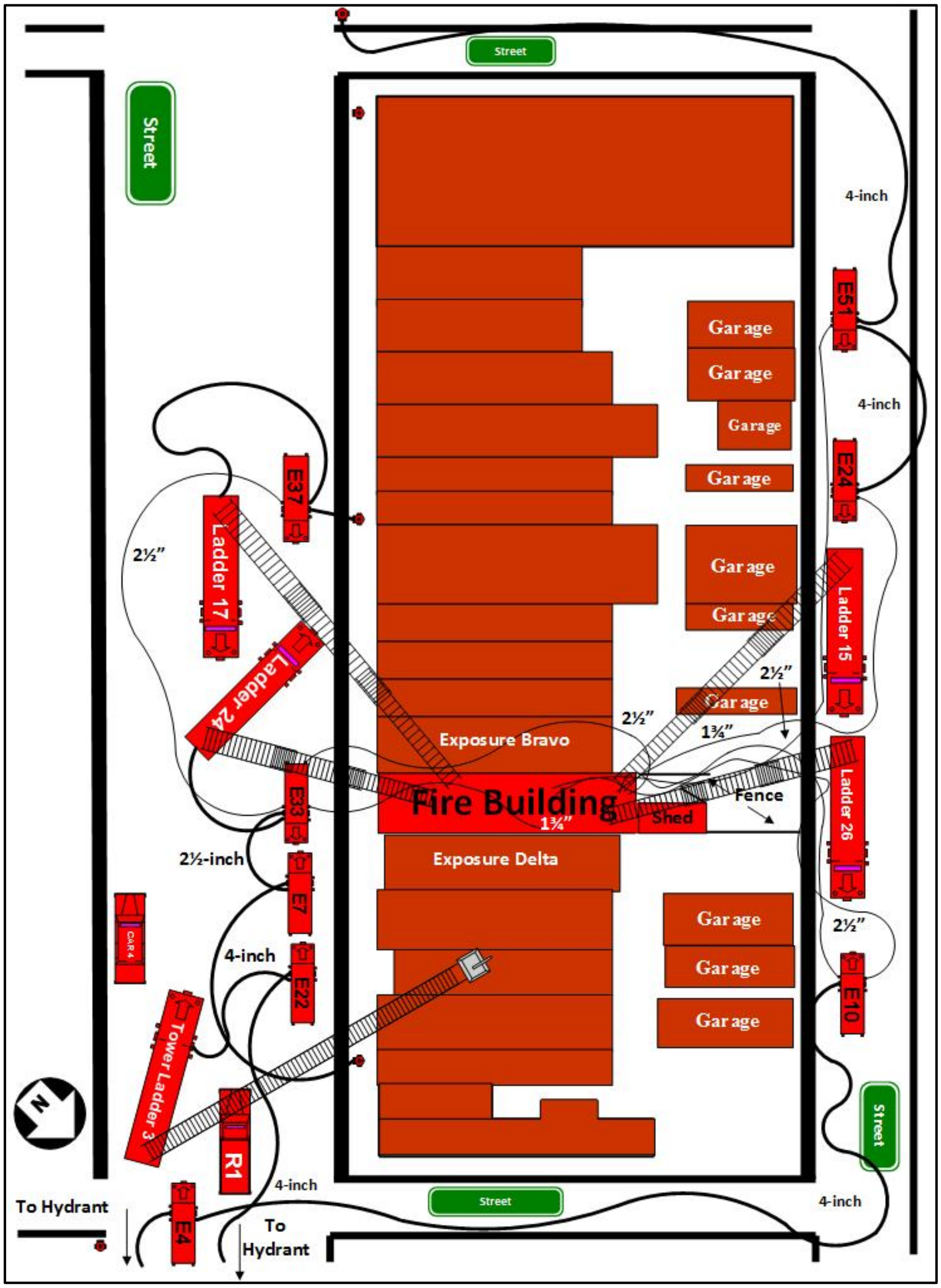

Diagram 7. Defensive operations. Ladder pipes, a tower ladder, and numerous deck guns plus hoselines are in operation. The time is approximately 1645 hours.

Lieutenant and Fire Fighter Die and 13 Fire Fighters injured in a Wind-driven Fire in a Brownstone—Massachusetts

The defensive operations continued on Side Alpha and Side Charlie until approximately 1635 hours (**See Diagram 7 and Photo 4**). At 1831 hours, a request was made for a chief inspector from the city's Inspectional Services Department, a structural engineer, and the medical examiner. At 1840 hours, a request was made for the structural engineer to report to Division Charlie. After consultation with a structural engineer, Command advised Division Charlie to attempt to locate the lieutenant from Engine 33.

Photo 4. Defensive operations on Side Alpha of the fire building. Three ladder pipes, a tower ladder, numerous deck guns, and hoselines are in operation. The time is approximately 1615 hours. (*Photo courtesy of the fire department.*)

Division Charlie (C7) tasked Rescue 1 and Rescue 2 to make another search to locate the officer of Engine 33 in the rear basement apartment. At approximately 1848 hours, members of Rescue 1 and Rescue 2 located the officer of Engine 33. He was pronounced dead at the scene. At 1911 hours, the officer was removed from the rear basement apartment and transported by an EMS ambulance to the nearest trauma center.

The fire for Box 9-1579 was declared "All Out" by Command at 0743 hours on March 27.

Fire Behavior/Wind-driven Fire

The fire was unintentionally started by welders who were installing a railing on the left side staircase at the rear entrance of Exposure Delta next to the fire building. The welders started work at approximately 1230 hours. At approximately 1439 hours, the occupant of Apartment #10 heard the building's fire alarm activate. The occupant walked out of the apartment and went up the steps and notified the occupant in Apartment #1. The occupant of Apartment #10 called 9-1-1 at 1441 hours. Another occupant telephoned the building's maintenance supervisor and advised him of the smoke in the building. The welders realized that the shed behind the fire building was on fire. They attempted to extinguish the fire with water and snow. Due to the wind, the smoke extended into the fire building.

At approximately 1445 hours, the maintenance supervisor arrived and parked on Side Charlie in the rear parking lot of the fire building. He went to the rear of the building due to fire apparatus blocking the entrance on Side Alpha. He noticed smoke coming from the shed and went to open the back exterior door going into Apartment #10. He placed his key in the door and opened the door approximately 3 inches. The maintenance supervisor stated when he opened the door, "Fire came at me." The maintenance supervisor also stated that he thought he could see fire through the window of the interior door to Apartment #10 (**See Diagram 1**). The maintenance supervisor left the door open and then moved back to the parking lot.

Engine 33 had entered the fire building through the front door and moved the hoseline to the stairwell to go down to the basement. With the rear basement doors and the front doors open, the fire had a flow path from the basement, up the stairs to the first floor and floors above. This occurred after the interior rear door or window leading into the hallway in the basement failed.

Wind has been recognized as a contributing factor to fire spread in wildland fires and large-area conflagrations. Wildland fire fighters are trained to account for the wind in their tactics. While structural fire departments have recognized the impact of wind on fires, in general, the standard operating procedures for structural fire-fighting have not changed to address the hazards created by a wind-driven fire inside a structure.

The results of the "no-wind" and "wind" fire simulations demonstrate how wind conditions can rapidly change the thermal environment from tenable to untenable for fire fighters working in a single-story residential structure fire, in a multi-family residential structure fire, and high-rise structure fire. The simulation results emphasize the importance of including wind conditions in the scene size-up before beginning and while performing fire-fighting operations and adjusting tactics based on the wind conditions [NIST 2013b].

The National Institute of Standards and Technology (NIST) has conducted research and testing on the impact of wind-driven fires and fireground operations. Adjusting fire-fighting tactics to account for wind conditions in structural fire-fighting is critical to enhancing the safety and the effectiveness of fire fighters. Studies have demonstrated that applying water from the exterior into the upwind side of the structure can have a significant impact on controlling the fire prior to beginning interior operations.

It should be made clear that in a wind-driven fire, it is most important to use the wind to your advantage and attack the fire from the upwind side of the structure, especially if the upwind side is the burned side. Interior operations need to be aware of potentially rapidly changing conditions [Fire Protection Research Foundation 2013].

The research conducted by NIST also provides potential guidance for fire fighters as a part of a scene size-up and when approaching the room of fire origin. ***Note:*** *Fire fighters should check for wind conditions in the area of the fire, look for "pulsing flames" or flames not exiting a window opening, examine smoke conditions around closed doors within the potential flow path, and maintain control of doors within the flow path. Even if flames are being forced out of adjacent windows with a high amount of energy, there could still be sufficient energy flows on the fire floor to create a hazard for fire fighters.*

The data from this research will also help to identify fire-fighting tactics to improve standard operating procedures for the fire service to enhance fire fighter safety, improve fireground operations, and to encourage the use of wind control devices. If the demonstrated technologies continue to prove effective in the field trials and pilot programs, the next step may be to examine the need for standards and standardized test methods to define a minimum level of acceptable performance of these devices [NIST 2013a].

Flow Path and Fire Control

"A flow path is composed of at least one inlet opening, one exhaust opening, and the connecting volume between the openings. The direction of the flow is determined by difference in pressure. Heat and smoke in a high pressure area will flow through openings toward areas of lower pressure." Based on varying building designs and the available ventilation openings (doors, windows, etc.), several flow paths can exist within a structure. Any operation conducted in the exhaust portion of the flow path will place members at significant risk due to the increased flow of fire, heat, and smoke toward their position [FDNY 2013a; NIST 2013a].

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

Due to the doors on Side Charlie being left open or failing, the interior door at the top of the basement stairs being left open, and the front doors on Side Alpha being left open by an occupant fleeing the fire, an unrestricted flow path was created from the basement to the first floor and floors above. The fire hose that Engine 33 deployed was impacted by the fire and heat generated by the flow path.

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

Fire Origin and Cause

The fire was ruled accidental by the county's district attorney. According to fire investigators, employees from a welding company accidentally started a fire in the maintenance shed in the rear of the fire building. The welding company employees were installing pre-fabricated wrought-iron railings in the rear of the Delta Exposure building. It was the opinion of the Fire Investigation Unit that the area of origin of this fire was the rear of the fire building, outside the shed wall facing the rear Delta Exposure. The cause of the fire was a heat source too close to combustible material, with combustion accelerated by high winds.

Contributing Factors

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

- Delayed notification to the fire department
- Uncontrolled ventilation by a civilian
- Occupied residential building with immediate life safety concerns
- Staffing
- Scene size-up
- Lack of fire hydrants on Side Charlie (a private street)
- Lack of training regarding wind-driven fires
- Unrestricted flow path of the fire
- Lack of fire sprinkler system

Cause of Death

The medical examiner listed the manner of death of the lieutenant and fire fighter from Engine 33 as accidental. The cause of death for the lieutenant was smoke inhalation and thermal injuries. The cause of death for the fire fighter was smoke inhalation and thermal injuries as well as blunt force trauma to the abdomen.

Recommendations

Recommendation #1: Fire departments should define fireground strategy and tactics for an occupancy that are based upon the organization's standard operating procedures. As part of the incident action plan, the incident commander should ensure a detailed scene size-up and risk assessment occurs during initial fireground operations including the deployment of resources to Side Charlie. Scene size-up and risk assessment should occur throughout the incident.

Discussion: Fireground standard operating procedures (SOPs) define the initial strategy and tactics for a coordinated deployment of departmental resources for specific incidents and occupancies. SOPs are based on factors not limited to but including department staffing; deployment capabilities; knowledge and skill levels; apparatus, tools, and equipment; building information including height, area, construction class, and type of occupancy; and potential life hazards. The first arriving resource will assume command and control of the incident. This ensures initial responding units understand the strategy and the operational goals and can deploy tactics at incidents with or without a chief officer on the scene. The intent is to maximize efficiencies while minimizing confusion and duplication of effort.

The incident commander develops a strategy and tactics based upon scene size-up and the risk assessment, including the factors listed above. This is a process that must be made in a short period of time involving a dynamic and fluid situation. Most importantly the strategy and tactics should include an observation and/or report from all sides of the structure, especially Side Charlie. The goal of effective fireground procedures is to increase the safety of the members, eliminate confusion, and prevent the loss of life [NIOSH 2015].

Occupancies define the space inside the class of building. Construction types/classes of construction define how the building is constructed with either combustible or non-combustible materials. Occupancies exist inside the constructed building. Fire departments must consider numerous factors that affect operations when developing these SOPs. This will ensure essential strategic-, tactical-, and task-level functions are performed by the incident commander, division/group supervisors, company officers, and fire fighters. Additionally, this process compliments the defined knowledge, skills, abilities, competencies, and fireground experience to assist:

- The incident commander to plan and implement an effective strategy and Incident Action Plan.
- Division/group supervisors to formulate and follow tactics.
- Company officers to successfully carry out assigned tasks.
- Individual members to effectively perform their duties [FDNY 2009a; FDNY 2009b; FIRESCOPE 1994].

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

At any incident, life safety is always the first priority, followed by incident stabilization (second priority) and then property conservation (third priority). Ensuring for the safety of fire fighters is a continuous process throughout the incident. A sound risk management plan ensures that the risks are evaluated and matched with the actions and conditions. The following risk management principles shall be use by the incident commander:

- Activities that present a significant risk to the safety of fire fighters shall be limited to situations that have the potential to save endangered lives.
- Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of fire fighters, and the actions shall be taken to reduce or avoid these risks.
- No risk to the safety of fire fighters shall be acceptable where there is no possibility to save lives or property [Brunacini 2002; NFPA 2014a].

The strategy and tactics of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta may be delegated to another fire department resource. The priority is to get a fire department resource 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. 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 information:

- 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 tactics 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 said operational goals.
- Building features (e.g., number of stories), particularly if there is a difference between Side Alpha and Side Charlie.
- Basement access and type.
- Any other life or safety hazards.

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

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

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

In this incident, the initial on-scene size-up and evaluation was made by Engine 33 as the first-alarm companies arrived on scene on Side Alpha. The officer of Engine 33, based upon life safety issues and smoke showing, made the decision to initiate an offensive attack (fast attack). The first fire department unit on Side Charlie was Ladder 26, which was after interior fire-fighting operations had started. It is essential that during the initial stages of an incident, at least one company (preferably an engine company) is designated to Side Charlie of a structure, even if a 360-degree walk-around is conducted. This ensures that Command has a complete initial assessment of the fireground and a continuous risk assessment and situational report from Side Charlie.

Recommendation #2: Fire departments should ensure that once command is established at an incident, the incident commander maintains control of situation status, resource status, and communications, plus ensures the completion of the tactical objectives.

Discussion: Based upon the design of the Incident Command System, the standard assumption of command establishes the organizational authority to perform the command functions starting at the very beginning of the incident. When the first officer arrives on scene, this officer has the responsibility to evaluate incident conditions, develop an incident action plan, determine how to progress toward the completion of the tactical objectives, address any safety consideration, deploy and assign operating companies, and determine if there is a need for additional resources [Brunacini 2002].

It is the responsibility of the incident commander to develop an organizational structure, using standard operating procedures, to effectively manage the incident scene. The development of the organizational structure should begin with deployment of the first arriving fire department unit and continue through a number of phases, depending on the size and complexity of the incident. The command structure must develop at a pace that stays ahead of the tactical deployment of personnel and resources. In order for the incident commander to manage the incident, they must first be able to direct, control, and track the position and function of all operating companies. Building a command structure is the best support mechanism the incident commander can use to achieve a balance between managing personnel and the needs of the incident [NFPA 2014a].

The eight basic functions of command define standard activities that are performed by the incident commander to achieve the tactical objectives. The responsibilities of an incident commander include the following:

- The first arriving fire department resource has responsibility for the incident and assumes command of the incident.
- The incident commander conducts an initial and on-going situational assessment of the incident.
- The incident commander establishes an effective communications plan.
- The incident commander develops the incident objectives from the situational assessment and forms appropriate strategy and tactics.
- The incident commander deploys available resources and requests additional resources based upon the needs of the incident.
- The incident commander develops an incident organization for the management of the incident.

- The incident commander reviews, evaluates, and revises the strategy and tactics based upon the needs of the incident.
- The incident commander provides for the continuity, transfer, or termination of command [Brunacini 2002].

As command is transferred, so is the responsibility for these functions. The first six functions must be addressed immediately from the initial assumption of command [Brunacini 2002].

At most incidents the initial incident commander will be a company officer. The company officer of the first arriving unit shall formally establish command and give an arrival report. The company officer should remain in command until properly relieved by a member of higher rank who is on scene.

The initial incident commander remains in command until command is transferred, the incident is stabilized, or command is terminated. The first arriving fire department unit initiates the command process by giving an initial radio report. A standard initial radio report (arrival report) includes the following:

- Location of the incident.
- Location of the command post.
- Title of the incident.
- Brief report (e.g., building size, construction type, and occupancy).

Other information that must be transmitted to the dispatcher and on the tactical channel are the following:

- Obvious problem/conditions
  - Nothing showing (indicates checking or investigating)
  - Smoke showing (amount and location)
  - Fire showing (amount and location)
  - Working fire
  - Fully involved
- Actions taken
  - Assuming command
  - Laying a line, attacking with …, and so forth
  - Declaration of strategy—offensive or defensive
- Command confirmation with name
- Follow-up radio report
  - Any immediate safety concerns
  - Accountability started (announce the initial accountability location)
  - Disposition of resources (situational status)
- Define initial rapid intervention crew (IRIC) [FIRESCOPE 1994; NFPA 2014a]

The following is an example of an arrival report:

> "Engine 9 is on scene at 945 Saratoga Street and Engine 9 is assuming Saratoga Command. We have fire showing from floor #2 on Side Alpha of an occupied, three-story, wood frame dwelling, which is approximately 20 feet by 30 feet. This is a working fire. Engine 9 did not lay in, Engine 19 lay a line for us. This is an offensive fire and E9 is in the fast-attack mode. E9 is attacking the fire with a 1¾-inch hoseline. Command has established accountability at E9 and IRIC has been established."

Once the location of command has been established (e.g., Saratoga Command), the incident commander may announce that he/she is resorting to "fast-attack mode" and proceeding to the incident location with his/her company. By announcing that he/she is resorting to "fast-attack mode" the incident command retains command of the incident. Fast-attack mode is employed only in the initial stages of an incident. The initial incident commander determines which type of command mode is more appropriate based upon the specifics of the incident. The three modes of command create a standard method of getting the role of command functional during the initial stages of an incident. The three command modes are:

- Nothing Showing (Investigation) Mode
- Fast-Attack Mode
- Command Mode [FIRESCOPE 1994, Brunacini 2002]

Where fast intervention is critical, utilization of the portable radio will permit the company officer's involvement in the attack without neglecting the responsibilities of the incident commander. The fast attack mode should not last more than a few minutes and will end with one of the following:

- The situation is stabilized.
- The situation is not stabilized and the company officer must withdraw to the exterior and establish an incident command post.
- Command is transferred to another higher ranking officer (e.g., battalion chief, district chief). When a chief officer is assuming command, the chief officer may opt to return the company officer to his/her crew, or assign him/her to a subordinate position [Brunacini 2002].

When operating in the fast-attack mode, communication is a critical issue. Though this function only operates in a short period of time (e.g., 3–5 minutes), a lot can occur during this time frame. Fireground communications is an essential element to ensure for effective command and control. The officer (Command) must maintain communications with the dispatcher plus first-alarm companies. Hopefully, this can be done on one radio channel—preferably a tactical channel. This allows the immediate access to the dispatcher to provide an update of the incident. Also, this allows Command to communicate directions to other company officers to ensure that tactical objectives are being met. The communication component allows the officer to maintain situational status (what is the incident doing) as well as resource status (what are the assigned companies doing).

All this information gathering is essential, especially when the battalion chief or district chief arrives on scene and the transfer of command must occur. When the transfer of command occurs, the optimum scenario is a face-to-face exchange of information. In this situation, the company officer has the responsibility to provide an update of:

- Incident conditions.
- The incident action plan.
- The status of tactical objectives.
- Any safety consideration.
- Deployment and assignment of operating companies (situational status).
- Personnel accountability (resource status) [Brunacini 2002; NFPA 2014a].

If the arrival of the battalion chief or district chief is more than a few minutes, the second-due resource may need to assume command in a standard position (outside the hazard zone) monitoring communications, updating, reviewing, and reinforcing the initial size-up, backing-up the initial attack, and verifying the safety, welfare, and accountability of crews.

At this incident, the officer of Engine 33 gave his scene size-up and assumed command of the incident at 1445 hours. Car 4 (District 4) arrived on scene 40 seconds later and assumed command of the incident. There was no communications from the officer of Engine 33 to Car 4 during the transfer of command. The next resources didn't arrive on scene until 1448 hours. The next communications from the officer of Engine 33 was at 1449 hours when he called Engine 33 to charge the hoseline. The Mayday was called 45 seconds later.

Recommendation #3: Fire departments should develop and implement standard operating procedures, training programs, and tactics for wind-driven fires.

Discussion: Based on the analysis of this fire incident and results from current research and field studies, adjusting fire-fighting tactics to account for wind conditions in structural fire-fighting is critical to enhancing the safety and the effectiveness of fire fighters. A wind-driven fire may be one of the most dangerous operations fire fighters will encounter. The term "wind-driven" fire is used to describe a fire in which the wind has the potential to, or is already causing, a dramatic and sudden increase in fire, heat, and smoke conditions. Experienced fire officers and fire fighters who have survived wind-driven fires have all described the following:

- Upon arrival, conditions appeared to be routine.
- Within seconds, fire, heat, and smoke conditions changed without warning "from routine to life threatening."
- An operating 2½-inch hoseline flowing from the downwind position or into the exhaust portion of the flow had little or no effect on the incredible heat being produced; flowing water into the intake or inlet side of the flow path is very effective.
- Directly attacking these fires with one or even two 2½-inch hoselines proved ineffective and ultimately led to fire fighters incurring serious injuries [FDNY 2013a].

When responding to a reported structure fire, an overriding consideration concerning size-up must be wind conditions and its potential effect on the fire. The key to successfully operating at wind-impacted fires in a structure depends on recognizing the wind-impacted fire conditions that may change a seemingly routine fire into a "blowtorching" fire. "Blowtorching" is the appropriate description of what will occur when fire conditions are impacted by wind conditions.

The impact of the wind will be affected by the size of the window opening, the fuel load, and the stage of the fire when the window failed. **When wind-impacted fire conditions exist in a structure, the incident commander should notify the dispatcher so this information can be relayed to all responding units. Also, the incident commander needs to make an announcement on the tactical channel as well.** Once the contributing factors are identified, steps can be taken to minimize the hazards to fire fighters [FDNY 2013a].

Fire departments should develop standard operating procedures for incidents with high-wind conditions ad for areas where high-wind conditions are likely. It is important that fire officers and fire fighters develop an understanding of how wind conditions influence fire behavior and impact fireground tactics that may be necessary under wind-driven conditions. Wind conditions can have a major influence on structural fire behavior. When wind speeds exceed 10 mph (16 km/hr.) the incident commander, division/group supervisors, company officers, and fire fighters should use caution and take wind direction and speed into account when selecting a strategy and developing tactics. The National Institute of Standards and Technology (NIST) has determined that wind speeds as low as 10 mph (16 km/hr.) are sufficient to create wind-driven fire conditions if the flow path is uncontrolled [NIST 2013a]. NIST, in a recent study on wind-driven fires in structures, has shown that wind speeds as low as 10 mph can turn a routine "room and contents fire" into a floor to ceiling fire storm or "blowtorch effect," generating untenable conditions for fire fighters, even outside of the room of origin. Temperatures in excess of 600 ºC (1100 ºF) and total heat fluxes in excess of 70 kW/m² were measured at 4 feet above the floor along the flow path between the fire room and the downwind exit vent. These conditions were attained within 30 seconds of the flow path being formed by an open vent on the upwind side of the structure and an open vent on the downwind side of the structure [NIST 2013a].

Fire departments are encouraged to develop and implement a standard operating procedure addressing such issues as obtaining the wind speed and direction, considering the possible fuel load associated with a particular occupancy, determining proper strategy and tactics for fireground operations, consideration of ventilation, and establishing possible scenarios associated with the wind speed based upon risk assessment. Under wind-driven conditions, an exterior attack from the upwind side of the fire may be necessary to reduce fire intensity to the extent that fire fighters can gain access to the involved compartments [Fire Protection Research Foundation 2013].

The strategy and tactics of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Charlie may be delegated to another fire department unit. 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 [Fire and Rescue Departments of Northern Virginia 2013].

In simulations and in previous full-scale experiments, it has been demonstrated that wind can increase the thermal hazards of a structure fire [Fire Protection Research Foundation 2013; ISFSI 2013]. Therefore, wind must be considered as part of the initial size-up of the fire conditions and must be monitored and reported throughout the fire incident. It is critical for fire fighters to not be in the exhaust portion of the fire flow path. The directional nature of the fire gas flow path results in higher temperatures than the area adjacent to the flow path or upwind of the fire. The flow path can be controlled by limiting ventilation. Previous studies demonstrated that applying water from the exterior into the upwind side of the structure can have a significant impact on controlling the fire prior to beginning interior operations [Fire Protection Research Foundation 2013; ISFSI 2013].

Current fire control training guides state, "Whenever possible, approach and attack the fire from the unburned side to keep it from spreading throughout the structure." It should be made clear that in a wind-driven fire, it is most important to use the wind to your advantage and attack the fire from the upwind side of the structure, especially if the upwind side is the burned side. The unexpected ventilation from a broken window can suddenly change the interior thermal conditions. Interior operations must be aware of potentially rapidly changing conditions.

A fire department should incorporate the following into their training and education component on wind-impacted fires:

- Ensure that an adequate initial size-up and risk assessment of the incident scene is conducted before beginning interior fire-fighting operations.
- Ensure that fire fighters, company officers, division/group supervisors, and the incident commander have a sound understanding of fire behavior and the ability to recognize indicators of fire development and the potential for extreme fire behavior (such as smoke [color, velocity, and density], visible fire, and heat).
- Ensure that fire fighters and company officers are trained to recognize the potential impact of windy conditions on fire behavior and implement appropriate tactics to mitigate the potential hazards of wind-driven fire.
- Ensure the incident commander's strategy considers high-wind conditions, if present.
- Ensure that fire fighters understand the influence of ventilation on fire behavior and effectively apply ventilation and fire control tactics in a coordinated manner.
- Ensure that fire fighters and officers understand the capabilities and limitations of thermal imagers.
- Ensure a thermal imager is used as part of the size-up process.
- Ensure that fire fighters are trained to check for fire in overhead voids upon entry and as charged hoselines are advanced.
- Develop, implement, and enforce a comprehensive Mayday standard operating procedure and train and educate fire fighters to ensure they understand the process and know how to initiate a Mayday.
- Ensure fire fighters are trained in fireground survival procedures.
- Ensure all fire fighters on the fire ground are equipped with radios capable of communicating with the incident commander and the dispatch center [FDNY 2013b].

At this incident, the wind was blowing against the fire building on Side Charlie. Due to the doors on Side Charlie being left open or failing, the interior doors at the top of the basement steps being left open, and the front doors on Side Alpha being left open by an occupant fleeing the fire, an unrestricted flow path was created from the basement to the first floor and the floors above. This allowed the fire to spread from Side Charlie to Side Alpha. One of the key issues was the captain of Ladder 26 recognized the conditions of a wind-driven fire and ordered no windows to be broken on Side Charlie.

Recommendation #4: Fire departments should ensure adequate staffing for deployment to urban incidents involving high hazard occupancies and concentrated population.

Discussion: Interdependent and coordinated activities of all fire-fighting personnel deployed are required to meet these priority objectives. A number of tasks are related to each of the priorities, and these tasks (e.g., stretching a hoseline to the fire, ventilation, search and rescue) can be conducted simultaneously, which is the most efficient manner, or consecutively (one after the other), which delays some task(s) thereby allowing risk escalation to occur. A number of resources, such as the International Association of Fire Fighters, the National Fire Protection Association, and National Institute of Standards and Technology, can assist policy makers and fire service leaders in planning for adequate resource deployment in their community to ensure that fire fighter intervention in a risk event occurs in a timely and coordinated manner to limit risk escalation and negative outcomes.

NFPA 1710 *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* contains recommended guidelines for minimum staffing of career fire departments [NFPA 2013e]. NFPA 1710 states the following: “On-duty fire suppression personnel shall be comprised of the numbers necessary for fire-fighting performance relative to the expected fire-fighting conditions. These numbers shall be determined through task analyses that take the following factors into consideration:

- Life hazard to the populace being protected.
- Provisions of safe and effective fire-fighting performance conditions for the fire fighters.
- Potential property loss.
- Nature, configuration, hazards, and internal protection of the properties involved.
- Research by NIST and UL on methods for strategically ventilating and isolating fires to delay or prevent flashover by use of manual door control (requires additional staffing).
- Types of fireground tactics and evolutions employed based on standard operating procedures, staffing, type of apparatus used, and results expected to be obtained at the fire scene [NFPA 2013e].

Following a community hazard/risk assessment, fire service leaders prepare a plan for timely and sufficient coverage of all hazards and the adverse risk events that occur. This plan is often referred to as a ***Standard of Response Coverage***. Standards of response coverage can be defined as those written policies and procedures that establish the *distribution* and *concentration* of fixed and mobile resources of an organization [NIST 2013a].

Resource distribution is associated with geography of the community and travel time to emergencies. Distribution is typically measured by the percent of the jurisdiction covered by the first-due units within a specified time frame [NFPA 2013e]. Concentration is also about geography and the arranging of multiple resources, spacing them so that an initial "effective response force" can arrive on scene within the time frames established by community expectation and fire service leadership. Response time goals for first-due units (distribution) and for the total effective on-scene emergency response force (concentration) drives fire department objectives like fire station location, apparatus deployed and staffing levels. The service level objectives established in any community drives response time performance by all responding resources and the assembly of effective on-scene fire-fighting (or EMS) response force. Both response time performance and assembly times subsequently drive resource distribution and concentration. If response times and force assembly times are low, it is more likely that sufficient resources have been deployed, which is associated with more positive outcomes from risk events. Conversely, if response times and force assembly times are high, it is more likely that insufficient resources have been deployed, which is associated with more negative outcomes. Fire service leaders must take into account several other considerations when preparing a standards of response coverage. These considerations should include an assessment of the probability or likelihood that a particular event will occur [NFPA 2013a].

In many departments, company officers are primarily responsible for crew management, crew safety, crew accountability, and communication with other operating units on scene and with the incident commander. These company officers do not directly engage in stretching hoselines, advancing and operating hose streams, normal truck company operations including ventilation, or related tasks. The officer can be available to focus on crew management, situational awareness and crew accountability. However, officers will assist in conducting searches and removing victims when necessary. These officer tasks are essential to fire fighter and civilian life safety, since studies show that situational awareness and human error are contributing factors in nearly 20% of the fireground line-of-duty deaths, and that 40% of fire fighter injuries are attributed to situational awareness [NIST 2013a].

Urban fire departments should staff companies commensurate with the tactical hazards, high-hazard occupancies, high incident frequencies, geographic restrictions, and other pertinent factors as are common in urban environments. For example, the Fire Department of New York (FDNY) staffs rescue companies and ladder companies with a minimum of one officer and five fire fighters. FDNY engine companies are staffed with one officer and four fire fighters. The Chicago Fire Department staffs rescue companies with one officer and five fire fighters. Also, Chicago Fire Department ladder companies and engine companies are staffed with one officer and four fire fighters [NIST 2013b].

At this incident, engine and ladder companies operated with an officer and three fire fighters. The heavy rescues are staffed with an officer and three fire fighters. The staffing levels are consistent throughout the city. Based upon the workload of the fire department (call volume, working fires, and deployment criteria), the staffing allows for tasks to be completed based upon the capabilities of the company. At the beginning of the incident, Engine 33 arrived on scene, but the 4-inch supply line could not be stretched to the hydrant due to the lack of staffing. Also, first-alarm companies had to perform the rescue of building occupants, which required companies to be split.

Recommendation #5: Fire departments should ensure that a tactical worksheet is used by Command during initial fireground operations and maintained throughout the incident.

Discussion: The tactical worksheet is a vital piece of equipment because it helps the incident commander organize the incident from the initial onset of the incident. The benefit of using a tactical worksheet is that critical information is documented as well as providing reminders, prompts, and a convenient workspace for tracking companies and apparatus. For fire departments that provide a staff assistant or incident command technician, the district chief or battalion chief has the ability of starting the tactical worksheet enroute to the incident. The incident commander has the ability to record vital information that may help them make future operational decisions. By documenting the assignments of division/group supervisors, and division/group resources, the incident commander creates a visual reference of the overall fireground organization and deployment [NFPA 2014a].

The use of a tactical worksheet can assist the incident commander to track various task assignments on the fireground. It can be used along with preplan information and other relevant data to integrate information management, fire evaluation, and decision making. The tactical worksheet should record unit status and benchmark times and include a diagram of the fireground, occupancy information, activities checklist(s), and other relevant information. The tactical worksheet can also help the incident commander in continually conducting a situation evaluation and maintaining personnel accountability [NFPA 2014a].

The advantages of using a tactical worksheet are:

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

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

The department in this incident has Standard Operating Procedure (SOP) #207 *Personnel Accountability System*, which states, “All District and Deputy Chiefs carry the “Tactical Command Sheet,” designed to assist the initial incident commander with accountability during the early stages of the incident prior to the set-up of the Command Board. It is an abbreviated and more portable version of the full command board." The command board is set up upon the arrival of the deputy chief on a second alarm.

At this incident, Car 4 arrived on scene with Engine 7. The incident command technician (ICT) parked the vehicle across the street from the fire building. Engine 33 was already on the scene and stretching a line in the front door. The ICT donned his turnout gear and SCBA and entered the building with Engine 7 and helped stretch Engine 7's hoseline. Car 4 assumed command of the incident. As the ICT and Engine 7 entered the building, a violent change in fire conditions occurred. The conditions became untenable for the fire fighters from Engine 7. They moved out of the building to the landing of the front steps. Then the officer of Engine 33 called a Mayday.

The tactical worksheet is a vital resource because it helps the incident commander organize fireground operations. Also the tactical worksheet provides reminders, prompts, and a convenient workspace for tracking companies and apparatus. It allows the incident commander to slow down during an incident (although the worksheet can be used for fires big and small, as well as EMS incidents, to help develop proficiency) and record vital information that may help make future operational decisions. By documenting the assignments of division/group officers, and division/group resources, the incident commander creates a visual reference of the overall fireground organization and deployment [NFPA 2014a]. The tactical worksheet provides the necessary documentation when command of an incident is transferred. Upon arrival of C6 (deputy chief), the Car 6 ICT initiated the command board and Car 7 was assigned Accountability Officer (Resource Status).

Recommendation #6: Fire departments should implement a personnel accountability system to be used at all emergency incidents.

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 is designed to track 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 through 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 by this system.

A personnel accountability system is a system that readily identifies both the location and function of all members operating at an incident scene [NFPA 2013a; NFPA 2014a]. 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 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 [NFPA 2014a].

A functional personnel accountability system requires the following:
- Development and implementation of a departmental SOP.
- Necessary components and hardware.
- Training all members on the operation of the system.
- Strict enforcement during emergency incidents.

There are many different methods and tools for resource accountability. Some examples are:
- Tactical worksheets.
- Command boards.
- Apparatus riding lists.
- Company responding boards.
- Electronic bar-coding systems.
- Accountability tags or keys (e.g., PASSPORT System) [NFPA 2014a].

Resource accountability should be assigned to personnel who are responsible for maintaining the location and status of all assigned resources at an incident. As the incident escalates, resource status would be placed under the Planning Section. This function is separate from the role of the incident commander. The incident commander is responsible for the overall command and control of the incident. Due to the importance of responder safety, resource status should be assigned to a dedicated member as the size and complexity of the incident dictates. A number of positions could function in this role including an incident command technician, staff assistant, chief officer, or other defined member. As the incident escalates and tactical-level management components (e.g., divisions or groups) are assigned, the resource status officer (accountability officer) works with the division or group supervisors to maintain an on-going tracking and accountability of members [FIRESCOPE 2012]. A properly initiated and enforced personnel accountability system enhances fire fighter safety and survival. It is vital that resources can be identified and located in a timely manner.

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

In order for the personnel accountability system to properly function, the process should include a standard operating procedure that defines each function's responsibility 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.

The department in this incident has a Standard Operating Procedure (SOP) #207 *Personnel Accountability System,* which states, "All District and Deputy Chiefs carry the "Tactical Command

Sheet," designed to assist the initial incident commander with accountability during the early stages of the incident prior to the set-up of the Command Board. It is an abbreviated and more portable version of the full Command Board." The Command Board is set up upon the arrival of the deputy chief on a second alarm.

At this incident, Command called for a personnel accountability report at 1521 hours, which was 39 minutes into the incident and Box 1579 was operating at the eighth alarm. Car 7 was assigned as accountability officer. Due to the number of companies operating at the incident plus companies in staging, a personnel accountability report was not completed until after 1605 hours. The personnel accountability system should be initiated with the first arriving resource. The department provides each district chief with an incident command technician (ICT). The ICT can start the personnel accountability process upon arrival and maintain this process throughout the incident.

Recommendation #7: Fire departments should provide the incident commander with a Mayday tactical checklist in the event of a Mayday.

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

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 needs 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 [NFPA 2013d; NFPA 2014a].

A checklist is provided in **Appendix Three, 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 who is missing, trapped, or injured.

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

Recommendation #8: Fire departments should ensure that the incident commander incorporates Command Safety into the incident management system.

Discussion: The purpose of Command Safety is to provide the incident commander with the necessary resources on how to use, follow, and incorporate safety into the incident management system at all incidents. Command Safety is used as part of the eight functions of command developed by Fire Chief Alan V. Brunacini (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 way and a close connection between the safety officer and the incident command. 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 [Brunacini 2002; Brunacini and Brunacini 2004]

A major objective of the incident management system is to create, support, and integrate an incident commander into this process. The incident commander will direct the geographical and functional needs of the entire incident on the task, tactical, and strategic level. 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 [Brunacini 2002; Brunacini and Brunacini 2004].

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 the responsibility as the strategic-level incident manager and the overall incident safety manager [NFPA 2014a].

Following this incident, several Command Safety issues were addressed by the fire department as part of their recovery process. These issues included fireground communications personnel accountability, use of a tactical worksheet (which complements personnel accountability and crew integrity), and a continuous scene size-up and evaluation.

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

Recommendation #9: Fire departments should develop a training program for staff assistants or incident command technicians.

Discussion: The function of a staff aide (e.g., chief's aide, emergency incident technician, field incident technician, or staff assistant) is an essential component of the incident management system [Brunacini 2002]. Functions of the staff aide include maintaining the tactical worksheet; maintaining personnel accountability of all members operating at the incident (resource status and situation status); monitoring radio communications on the dispatch, command, and fireground channels; control information flow by computer, fax, or telephone; and accessing reference material and pre-incident plans [Ciarrocca and Harms 2011; Los Angeles Fire Department 2011; Phoenix Fire Department 2010]. NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety* states in Chapter 8, "Command Safety," that the staff aide is assigned to facilitate the tracking and accountability (resource status) of the assigned companies or crews [NFPA 2014a].

Some fire departments use fire fighters as staff aides and other fire departments use fire officers to serve as a staff aide for a command officer. Regardless of the rank of the staff aide, the staff aide has to be trained in the duties and responsibilities in order to proficiently function and meet the expectations of the incident commander. These job functions include:

- Size up of the incident
  - Address of incident
  - Type of incident
  - Name of incident
  - Resources assigned and responding to the incident
  - Life hazard
  - Additional resources needed
  - Exposure problems
  - Location of the command post
- Maintaining communications with the dispatch center or fire department communications center
  - Dispatch channel
  - Command channel
  - Tactical channels
- Situation status (what is the incident doing)
  - Are we making progress on this incident?
- Resource status (what are they doing)
  - Personnel accountability system (e.g. PASSPORT System)—accountability board or tactical worksheet
  - How, what, and where are companies operating?
  - Who is in staging?
- Staging
  - Staging area manager(s)
  - Separate tactical channel
- Tactical worksheet

Teletype printout can be used as initial *Incident Briefing* (ICS Form 201).
Transfer information immediately upon arrival to the department's tactical worksheet and document companies by assignment or location (personnel accountability system).
Diagram the incident starting with Side Alpha.
Document divisions and groups with assigned supervisor.
Document response of other resources on scene (e.g., law enforcement, other fire departments).

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

At a structure fire, an incident command technician (ICT) is initially assigned to Side Charlie to report conditions to Command. The ICT then goes inside with the first-alarm companies. In order to ensure that personnel accountability is started during initial fireground operations, the ICT should assist the incident commander with the tactical worksheet as needed. Then the ICT starts the personnel accountability system process as defined by the department's SOP. At this incident, due to the immediate issues of life safety, the ICT assisted with the rescue of the building occupants.

Recommendation #10: 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 are aimed at quantifying emerging theories about how fires are different today, largely due to new building construction and the composition of home furnishings and products. In the past, these products were mainly composed of natural materials, such as wood and cotton, but now contain large quantities of petroleum-based products and synthetic materials that burn faster and hotter and generate large volumes of fuel-rich smoke. Where a fire in a room once took approximately 20 minutes to "flashover"—igniting all the contents—this can happen with today's furnishings in as little as 4 to 5 minutes [NIST and UL 2013; Madrzykowski and Kerber 2009].

In addition, modern living spaces tend to be more open, less compartmentalized, and better insulated than homes built years ago. As a result, interior residential fires can generate oxygen-depleted, fuel-rich 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 2009].

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, forcing 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.

Fire suppression operations are frequently conducted from the interior of the structure as a means of introducing fire fighters into the building to locate occupants, 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 [NIOSH 2009; NIOSH 2012, NFPA 2013]. 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 onto the known fire location in order 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.

Based upon the NIST and UL research, NIOSH [2012] suggests 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 exiting fire gases during tactical operations. All ventilation must be coordinated with suppression activities. Uncontrolled ventilation allows additional oxygen into the structure that may result in a rapid increase in the fire development and increased risk to fire fighters due to increased heat-release rates.
- **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. 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 ventilation-limited fire conditions.

- **Rapid Intervention.** Fire department rapid intervention procedures should be updated to ensure that during fire fighter Mayday incidents, water is put on the fire as soon as possible and ventilation openings are controlled.

The fire service has recently been introduced to (and many fire departments have adopted) the acronym *SLICE-RS* by the International Society of Fire Service Instructors, which has been specifically designed to help first-arriving company officers apply recent research on modern fuels and fire dynamics to their early strategic and tactical decisions on the fire ground.

- **S**ize up all scenes.
- **L**ocate the fire.
- **I**dentify and control the flow path.
- **C**ool the heated space from a safe location.
- **E**xtinguish the fire.
- **R**escue and **S**alvage (are actions of opportunity that must be considered not only at the initiation of operations, but throughout the incident) [Modern Fire Behavior, 2014].

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 and should find its way into every after-action review. The intent is to locate the fire, cool the heated space from a safe location, and ensure for the safety of the fire fighters. 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. These two actions are always active, from initial scene size-up to extinguishment.

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 increase fire fighter effectiveness and to save lives of civilians and fire fighters.

Recommendation #11: Fire departments should ensure that fire fighters use structural fire-fighting protective hoods on all structure fires.

Discussion: NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* states that members should be provided and use a protective ensemble that meets the requirements in NFPA 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* [NFPA 2013h]. Protective hoods are an integral part of the overall protective ensemble. They are included as an interface device to protect the areas of the fire fighter's head, face, and neck that are not covered by the protective helmet, SCBA facepiece, and protective coat collar and collar closure. These hoods are typically constructed of knitted material with a face opening to fit around the SCBA facepiece and "bib" extensions of the material to remain tucked under the fire fighter's coat. NFPA 1971 states that protective hoods have a lower thermal insulation requirement than garments (a TPP rating of 20 for protective hoods, compared to the minimum 35 required for garments). Protective hoods still have to meet all of the flame and heat resistance requirements typically associated with garment materials. As a consequence, protective hoods are heavy, single-ply or double-ply materials using Nomex®, PBI®, P84®, Basofil®, Kevlar®, and FR rayon fibers. The lower TPP rating for the hoods is justified on the basis that as an interface device, other ensemble components (mainly the helmet ear covers, which are also required to have a minimum TPP rating of 20) work together to afford the needed thermal insulation [Stull and Stull 2014; NFPA 2013h].

Owing to their knit constructions, hoods are typically "one size fits all" but should be carefully selected to fit properly with the other equipment, primarily the SCBA facepiece. Because hoods are repeatedly stretched over the facepiece and the wearer's head, some hoods quickly lose their shape and can fail to properly protect the fire fighter [Stull and Stull 2014]. NFPA 1971 has attempted to address this requirement with a test for measuring the hood face opening size after repeated donning and doffing of the hood on a manikin head form [NFPA 2013h, 2014b].

Features for hoods are relatively simple. These usually consist of:

- The type of face opening (some hoods are designed to accommodate specific respirator facepieces).
- The length of the sides, front, and back (sometimes referred to as "bibs").

Some of the reluctance to using protective hoods has been due to resistance by some fire fighters to the idea of total encapsulation of the body. Many more traditional fire fighters claim that they use their ears as "early warning" sensors to detect excessive heat and know when to leave. Unfortunately, the sensitivity of ears to heat also makes them very vulnerable to high heat. Protective hoods have repeatedly demonstrated their effectiveness in covering those exposed portions of the face not covered by other elements of the ensemble [Stull and Stull 2014].

At this incident, protective hoods were not worn by the individual fire fighters. While the lack of protective hoods were not found to be a contributory cause to the fatalities as determined in this investigation, the fire service should consider using complete protective ensembles, including protective hoods, for structural fire-fighting.

Recommendation #12: Fire departments should ensure that all members engaged in emergency operations receive annual proficiency training and evaluation on fireground operations.

Discussion: In order to ensure for the proficiency and competency of fire department members, the fire department should conduct annual skills evaluation to verify minimum professional qualifications. This annual evaluation should address the qualifications specific to the member’s assignment and job description. This process should be structured in a manner where skills are evaluated on a recurring cycle with the goal of preventing the degradation of skills and abilities and ensuring for the safety of members. Proficiency evaluation and training provides an opportunity to ensure that all fire officers and fire fighters are competent in the knowledge, skills, and abilities in fireground operations. NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* requires a fire department to establish and maintain a training, education, and professional development program with the goal of preventing occupational deaths, injuries, and illnesses. This ensures members are trained and competencies are maintained in order to effectively, efficiently, and safely execute all responsibilities [NFPA 2013d].

This process is consistent with the organizational statement that establishes the existence of the fire department. The services the fire department is authorized and expected to perform, the organizational structure, and the job descriptions and functions of fire department members are essential in formulating a structured training program [NFPA 2013d]. The primary goal of all training, education and professional development programs is the reduction of occupational injuries, illnesses, and fatalities. As members progress through various job duties and responsibilities, the department should ensure the introduction of necessary knowledge, skills, and abilities to members who are new in their job titles as well as ongoing development of existing skills [NFPA 2015].

NFPA 1410 *Standard on Training for Emergency Scene Operations* defines basic evolutions that can be adapted to local conditions and serves as a method for the evaluation of minimum acceptable performance during initial fireground operations [NFPA 2015]. Proficiency training for fireground operations and emergency incidents should be conducted annually. This training should include, but not be limited to, scene size-up, situational awareness, use of the incident management system, personnel accountability system, strategy and tactics, search and rescue, hoseline operations, ladder operations, ventilation, thermal imaging cameras, fireground communications, use of rapid intervention teams, and Mayday operations.

As part of the department's analysis process of this incident, the commissioner has initiated a "back to basics" training program for the department. This process involves a structured training program that consists of company-level training conducted at the fire academy. All companies will be required to participate in live-fire training evolutions annually at the fire academy. This training will be completed by each district on each shift. The training will be conducted by companies who are dispatched as part of a first-alarm assignment in their first-due area.

Recommendation #13: Fire departments should consider using large-volume SCBA cylinders for operations in medium- and high-risk occupancies.

Discussion: A typical 30-minute (1200-liter) SCBA cylinder may not provide an adequate quantity of breathing air for fire fighters working in multi-family, commercial, or high-rise occupancies. The 1200-liter cylinder will last an average fire fighter actively engaged in suppression activities about 15–18 minutes [Gagliano et al. 2008]. NFPA 1852 *Standard on Selection, Care and Maintenance of Open-circuit Self-contained Breathing Apparatus,* A.5.1.5, states, "During extreme exertion, for example, actual service time can be reduced by 50 percent or more" [NFPA 2013f]. In addition to the degree of user exertion, other conditions that effect the SCBA service time include:

- Physical condition of the fire fighter.
- Emotional conditions, such as fear or excitement, which can increase the user's breathing rate.
- Degree of training or experience the user has had with such equipment.

- Amount of air in the cylinder at the beginning of use; the cylinder should be fully charged at the beginning of use.
- Facepiece fit.
- Use in a pressurized tunnel or caisson.
- Condition of the SCBA.
- The SCBA effective dead air space.

SCBAs that are certified by NIOSH include a rated service time based on laboratory tests required by NIOSH. The SCBA is tested using a specified breathing machine with a breathing rate of 40 liters/minute. NIOSH uses the 40 liters/minute rate because it represents a moderate work rate that an average user can sustain for a period of time. To attain a rated service time of 30 minutes, during this 40 liter/minute test, the typical SCBA cylinder has to contain 1200 liters or more of compressed breathable air. A 45-cubic-foot cylinder has a capacity of 1273.5 liters, based on 28.3 cubic feet. Because actual work performed by fire fighters often results in a ventilation rate that exceeds 40 liters/minute, these fire fighters frequently do not attain the rated service time of 30 minutes [NFPA 2013f].

Fire departments should ensure that fire fighters have enough air in their cylinder to complete the mission of their work assignment. A 30-minute (1200 liter) SCBA might be sufficient for fire fighters operating in a 3000-square-foot, single-family dwelling. For fire fighters operating in a multi-family, commercial, or high-rise occupancy, a 1200-liter cylinder might not be sufficient. Fire fighters must have enough air by volume to effectively provide a work period inside an IDLH atmosphere and still contain enough air volume to exit the IDLH with their reserve air intact. The primary benefit of an 1800-liter cylinder is the substantial increase in reserve air if an emergency occurs. The intent of the additional breathing air is to keep the same work period but also increase the amount of emergency reserve air.

In conjunction with the department's community risk assessment program, a risk assessment should include, but not be limited to:

- The expected hazards that can be encountered by fire fighters using SCBA.
- The type of duties to be performed, frequency of use, and the organization's experiences.
- The organization's geographic location and climatic conditions.

An assessment can identify various occupancies in a jurisdiction that require additional breathing air. The companies assigned to the areas or occupancies can be equipped with 1800-liter cylinders. Cylinders are made of significantly lighter materials and contain higher pressure, greater volume, and smaller profile. All SCBA manufacturers are now offering these cylinders. Some manufacturers are offering higher pressure (5500 psi) cylinders, which reduce the weight and increase the volume over existing cylinders. The most important part of the needs assessment is to identify the areas of the jurisdiction that need the increased air volumes and then provide the equipment and training to those companies that respond or could be called upon to respond to incidents in those areas. NFPA 1852 *Standard on Selection, Care and Maintenance of Open-circuit Self-contained Breathing Apparatus* provides fire departments with basic criteria for evaluation and selecting open-circuit SCBA [NFPA 2013f].

In this incident the fire department provided current edition, certified SCBA with 4500-psi composite 1200-liter (30-minute) cylinders to all fire fighters. Many fire fighters reported that end-of-service-time indicators (EOSTIs) were sounding inside the fire building in the IDLH atmospheres in less than 20 minutes. With a change to 1800-liter cylinders, this would allow a true 20-minute work period with emergency reserve air capacity.

Recommendation #14: Fire service research organizations, standards making organizations, equipment manufacturers, and fire departments should consider the effects of thermal degradation on fire attack hose.

Discussion: During this incident, the 1¾-inch attack hoseline used by Engine 33 was burned through during the initial fire-fighting operations. Engine 33 had stretched the hoseline down the stairs from the first floor to the basement. This placed the hoseline in the flow path of the fire and super-heated gases coming up the stairs. The 1¾-inch hoseline was burned completely in two. The 2½-inch hoseline that Engine 7 stretched to the first floor was severely damaged as well.

During the investigation of this incident, NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) investigators reviewed previous cases and identified several instances in which hoselines had been burned through during structural fire-fighting operations. Current hoseline standards do not address the thermal performance of attack hoselines, and technical information published by manufacturers does not include thermal performance data. Attack hose is defined by NFPA 1961 *Standard on Fire Hose* [NFPA 2013g] as "hose designed to be used by trained fire fighters and fire brigade members to combat fires beyond the incipient stage. Attack hose is designed to convey water to hoseline nozzles, distributor nozzles, master stream appliances, portable hydrants, manifolds, standpipe and sprinkler systems and pumps used by fire departments." The hoseline serves not only as a tool to help extinguish the fire but also provides a measure of safety to the hoseline crew. Attack hose can be used as a means to locate an escape route in the event of Mayday or other emergency.

In an effort to better understand the thermal performance of attack hose, NIOSH FFFIPP investigators contacted the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) for assistance. In response, the ATF Fire Research Laboratory began a series of tests to explore the impact of radiant heat on attack hose. The ATF Research Laboratory established heat flux values and developed full-scale tests to replicate fireground conditions. To date, the testing has included full-scale burns and bench testing using samples of new and used 1¾-inch attack hose of varying grades and construction. Tests are being conducted with hose samples dry and charged at both high and low heat flux levels. Hose similar to that used in this incident was incorporated in the test samples and continued testing will include samples of 2½-inch hose of varying styles and manufacturer. The results, including documentation of the test methods, will be made available to NFPA and the fire service at the completion of the test series.

The NFPA Technical Committee on Fire Hose has discussed two issues, but no final action has been taken yet. First is to develop a registry on reported hose failures. Second is to develop a safety alert about fire hose and thermal degradation.

It is hoped that this information will prompt further research, discussion, a review of fireground tactics by fire departments, and action on the part of fire service research organizations, equipment manufacturers, standard-making organizations, and fire departments.

Additionally,

Recommendation #15: Code-setting organizations and municipalities should consider requiring the use of sprinkler systems in residential structures. Especially residential occupancies having high fuel loads, other unique life-safety hazards, and to establish retroactive requirements for the installation of fire sprinkler systems.

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

Fire development beyond the incipient stage presents one of the greatest risks fire fighters are exposed to during fireground operations. This risk exposure to fire fighters can be dramatically reduced when fires are controlled or extinguished by automatic sprinkler systems.

NFPA statistics show that most fires large enough to activate a sprinkler system are controlled by just one or two sprinkler heads [NFPA 2008]. An automatic fire sprinkler system also reduces the exposure risk to fire fighters during all phases of fireground operation and allows the safe egress of building occupants before the fire department arrives on scene. Finally, by controlling fire development, the risks associated with the potential for structural collapse and during overhaul operations are greatly reduced, if not eliminated.

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Investigator Information

This incident was investigated by Murrey Loflin, Matt Bowyer, Steve Miles, and Stacy Wertman with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. The report was authored by Murrey Loflin. Two subject matter experts who assisted with the investigation and provided the technical review were Deputy Chief Michael McPartland of the Fire Department of New York and Peter Van Dorpe, Chief at Algonquin-Lake in the Hills Fire Protection District and retired Director of Training for the Chicago Fire Department. Additionally, Adam St. John, Fire Protection Engineer with the Bureau of Alcohol, Tobacco, Firearms, and Explosives, Stephen Kerber, Director, UL Fire Fighter Safety Research Institute, and Dan Madrzykowski, fire protection engineer in the Fire Fighting Technology Group of the Fire Research Division (FRD) of the Engineering Laboratory (EL) at NIST served as a subject matter experts due to their expertise with modern fire behavior and wind-driven fires. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

Additional Information

Modern Fire Behavior

This site is meant to serve as a clearinghouse of news and training information related to Modern Fire Behavior and Modern Building Construction Research, Tactics, and Practices along with actual street experiences. http://modernfirebehavior.com/

National Institute for Standards and Technology and Underwriters Laboratories

These two agencies provide information including training videos showing the findings from NIST and UL research conducted in cooperation with the Fire Department of New York on Governor's Island in 2012. http://www.firecompanies.com/modernfirebehavior/governorsislandonlinecourse/story.html.

Flashover TV sponsored by FireRescue.com includes a series of training presentations by NIST researcher Dan Madrzykowski.
http://flashovertv.firerescue1.com/videos/1875870-nist-and-ul-research-on-fire-dynamic-case-studies-part-4/

Information on completed fire-fighting research studies available at the National institute of Standards and Technology website at http://www.nist.gov/el/fire_research/firetech/index.cfm.

The information on completed fire-fighting research studies available at the UL Firefighter Safety Research Institute website at www.ULfirefightersafety.com.

IAFC Rules of Engagement for Firefighter Survival

The International Association of Fire Chiefs (IAFC) is committed to reducing fire fighter fatalities and injuries. As part of that effort the nearly 1,000 member Safety, Health and Survival Section of the IAFC has developed DRAFT "*Rules of Engagement for Structural Firefighting*" to provide guidance to individual fire fighters, and incident commanders, regarding risk and safety issues when operating on the fireground. The intent is to provide a set of "model procedures" for structural fire-fighting to be made available by the IAFC to fire departments as a guide for their own standard operating procedure development. http://www.iafcsafety.org/downloads/Rules_of_Engagement.

IAFF Fire Ground Survival Program

The purpose of the International Association of Fire Fighters (IAFF) Fire Ground Survival Program is to ensure that training for Mayday prevention and Mayday operations are consistent between all fire fighters, company officers and chief officers. Fire fighters must be trained to perform potentially life-saving actions if they become lost, disoriented, injured, low on air or trapped. Funded by the IAFF and assisted by a grant from the U.S. Department of Homeland Security through the Assistance to Firefighters (FIRE Act) grant program, this *comprehensive fire ground survival training program* applies the lessons learned from fire fighter fatality investigations conducted by the National Institute

for Occupational Safety and Health (NIOSH) and has been developed by a committee of subject matter experts from the IAFF, the International Association of Fire Chiefs (IAFC) and NIOSH.
http://www.iaff.org/HS/FGS/FGSIndex.htm

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety* (2014 edition)
The primary focus of the revision to NFPA 1561 in the 2014 edition is develop requirements directly aimed at reducing and eliminating fireground injuries and fireground deaths of fire department members. The most apparent change addition to this edition has been the document title to include "Command Safety" and the creation of a new chapter, *Command Safety*. This chapter is intended to provide a foundation on how to incorporate the incident management system at all emergency incidents especially *Type V* and *Type IV* incidents.

The chapter on "Command Safety" clearly defines the requirements for the incident commander to meet including establishing a fixed Command Post, personnel accountability, the use of staff aides, rapid intervention crews, and the appointment of a safety officer and assistant safety officer(s)(as needed) plus the expectations and authority of the safety officer. There are annexes that cover *Functional Assignments for High-Rise Building Incidents, Development of Subordinate Officers or Implementing a More Efficient Management System, Incident Management for the Fire Service on Type 5 or Type 4 Incidents,* and *Structural Fire Fighting — Risk Assessment and Operational Expectation.*

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

Disclaimer

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these Web sites. All web addresses referenced in this report were accessible as of the publication date.

Lieutenant and Fire Fighter Die and 13 Fire Fighters are injured in a Wind-driven Fire in a Brownstone—Massachusetts

Appendix One

Status Investigation Report of Two
Self-Contained Breathing Apparatus
Submitted By:
The NIOSH Division of Safety Research

NIOSH Task Number 19925
(***Note:*** *Full report is available upon request*)

Background

As part of the ***National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program***, the Technology Evaluation Branch agreed to examine and evaluate two SCBA identified as Scott Health and Safety model AirPak 4.5, 4500 psi, 30-minute, self-contained breathing apparatus (SCBA).

This SCBA status investigation was assigned NIOSH Task Number 19925. The NIOSH Division of Safety Research (NIOSH/DSR) and fire department were advised that NIOSH would provide a written report of the inspections and any applicable test results.

The SCBA units, contained within cardboard boxes, were delivered to the NIOSH facility in Bruceton, Pennsylvania on November 6, 2014. After their arrival, the packages were taken to building 20 and stored under lock until the time of the evaluations.

SCBA Inspection

The packages were opened initially in the General Respirator Inspection Area (Building 20) on November 14, 2014 and an initial visual inspection was conducted by Tom Pouchot, Certification Coordinator NPPTL. A reference SCBA was included by the fire department. On November 17, 2014, the SCBA data logger for Unit #2 was down loaded by personnel from Scott Health and Safety with NIOSH personnel present. The SCBAs were inspected extensively on November 14 and 17, 2014. The SCBA identified as the fire department SCBA, was labeled by NPPTL as SCBA Unit #1, and was inspected on November 14, 2014. The SCBA identified as fire department SCBA was labeled by NPPTL as SCBA Unit #2, and was inspected on November 17, 2014. A third SCBA was included as a reference unit and was labeled *Unit Reference*. The SCBA units involved in the incident were extensively examined, component by component, in the condition they were received to determine the conformance of the unit to the NIOSH-approved configuration. The units were identified as the Scott Health and Safety Company model AirPak 4.5, 30 minute, 4500 psi units, NIOSH approval numbers TC-13F-0076CBRN. The visual inspection process was documented photographically.

Lieutenant and Fire Fighter Die and 13 Fire Fighters injured in a Wind-driven Fire in a Brownstone—Massachusetts

Also on November 17, 2014 Scott Health and Safety conducted a down-loading of the data logger for SCBA Unit #2. The SCBA Unit #1 data logger could not be down loaded due as the unit was extensively damage. Once all inspections were completed, the SCBA units were repackaged and placed back in Building 20 in a secured and locked room.

The condition of each major component of each of the SCBA's that were photographed with a digital camera.

It was judged that only Unit #2 could be safely pressurized and tested using a substitute cylinder and facepiece provided by the fire department. Unit #2 and the Unit Reference were tested on February 27, 2015.

SCBA Testing

The purpose of the testing was to determine the conformance of each SCBA 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 conformance of each SCBA 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):
Positive Pressure Test [§ 84.70(a)(2)(ii)]
1. Rated Service Time Test (duration) [§ 84.95]
2. Static Pressure Test [§ 84.91(d)]
3. Gas Flow Test [§ 84.93]
4. Exhalation Resistance Test [§ 84.91(c)]
5. Remaining Service Life Indicator Test (low-air alarm) [§ 84.83(f)]

National Fire Protection Association (NFPA) Tests (in accordance with NFPA 1981, 1997 Edition):
6. Air Flow Performance Test [Chapter 5, 5-1.1]

Unit #2 was the only unit in a condition to be tested along with the Unit Reference. These units were tested on February 27, 2015 using a substitute cylinder and facepiece.

Summary and Conclusions

Two SCBA units along with a reference SCBA unit were submitted to NIOSH by the NIOSH Division of Safety Research for the fire department for evaluation. The SCBA units were delivered to NIOSH on November 6, 2014 and initially inspected on November 14, 2014. The units were identified as a Scott Health and Safety model AirPak 4.5, 4500 psi, 30-minute, SCBA (NIOSH approval number

TC-13F-0076CBRN). Scott Health and Safety performed a downloading of the Unit #2 data logger on November 17, 2014. The complete inspections of the SCBA units were conducted on November 14, 2014 for Unit #1 and on November 17, 2014 for Unit #2. The Unit #1 was extensively damaged while Unit #2 suffered only slight levels of heat damage, exhibited other signs of wear and tear and both units were covered generally with dirt and grime. The cylinder valve as received on Unit #2 was in the closed position. The cylinder gauge on Units #2 read 0 psig. The cylinder valve hand-wheel could be turned. No cylinder was included with Unit #1. The regulator and facepiece mating and sealing areas on the Unit #2 were relatively clean but for Unit #1 the facepiece and regulator were locked together due to the damage of both components. There was some dirt on the inside of the facepiece of Unit #2. Unit #1 facepiece was extensively damaged. Unit #2 had some scratches present on the lens. The lens on Unit #1 extensively damaged. Visibility through the facepiece lenses of Units #2 was fair as the lens had scratches and dirt present heat damage.

The facepiece head harness webbing on the Unit #2 was in fair condition with dirt present and some evidence of wear. Unit #1 facepiece head harness was missing. Only the PASS on the Unit #2 functioned. The NFPA approval label was only on present on Unit #2 and readable.

The air cylinder on the Unit #2 had a manufactured date of 10/2011. 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 10/2016 is required. Therefore the cylinder was within the hydro certification when last used. The cylinder on Unit #2 was partially black. No air was remaining in the cylinder.

Replacement air cylinders with a current hydrostatic re-test qualification were supplied by the fire department. These cylinders were substituted for all Units #2 and Unit Reference tests. In addition, the facepieces were replaced by a facepiece supplied the fire department. No other maintenance or repair work was performed on the units at any time.

SCBA Unit #2 did meet the requirements of the NIOSH Positive Pressure Test, as the unit did maintain a positive pressure, minimum 0.1 inches of water, for the 30 minute minimum duration of the unit. Unit #2 **did meet** the requirements of all of the other NIOSH tests.

SCBA Unit Reference met the requirements of the NIOSH Positive Pressure Test, with a minimum pressure of 0.00 inches of water. The Unit Reference **did meet** the requirements of 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 SCBAs were returned to storage pending return to the fire department.

If Unit #2 is to be placed back in service, the SCBA must be repaired, tested, cleaned, 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.

Appendix Two
Personal Protective Equipment Evaluation
Examination of Fire Fighter Protective Ensemble Items

An examination was made of the selected personal protective equipment worn by the lieutenant and fire fighter from Engine 33, who sustained fatal injuries in a Brownstone on March 26, 2014. These items included the protective coat and protective pants worn by the lieutenant and fire fighter and the station/work uniform worn by the lieutenant.

The lieutenant and fire fighter from E33 entered the structure on the first floor and proceeded down the stairs with a 1¾ inch hose to the basement. Shortly after being in the basement, the fire conditions deteriorated significantly trapping both fire fighters in the basement. Following a Mayday from the lieutenant, radio communications indicated that there was no water to their hoseline. Approximately 30 minutes after entering the structure, a rapid intervention team was were able to remove the fire fighter from E33 from the basement. The lieutenant was not recovered until several hours later.

The protective coat and protective pants worn by fire fighter showed low to moderate thermal damage. Due to the extended time for which he was exposed to the thermal conditions, the protective capabilities of this clothing had been exceeded. In contrast, the protective coat, protective pants, and station/work uniform pants worn by the lieutenant exhibited extreme degradation with burn through of several areas of his turnout gear. The degradation extended to his station/work uniform pants as well.

It was the general conclusion that the protective clothing worn by both fire fighters were not contributory to their fatal injuries. This is given the severe fireground conditions that existed during their entrapment in the basement before they could be located and recovered. Both fire fighters were exposed to extended high heat conditions. The lieutenant had a much long exposure given the extreme conditions that prevented other fire fighters from entering the area where he was trapped.

Although not contributory to this incident, several general recommendations to department regarding personal protective equipment:

- transitioning all of its turnout gear to the current edition of NFPA 1971, *Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*;
- provide structural fire-fighting protective hoods for all members;
- instruct all members in the proper wearing of these clothing items;
- retain the personal protective equipment for a period of at least two years or otherwise deemed necessary by the fire department.

Appendix Three
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;