Command and Control of the RIC Deployment

Approved and Adopted by the
Office of the State Fire Marshal

Recommended for adoption by the Statewide
Training and Education Advisory Committee
and the
State Board of Fire Services

STUDENT MANUAL

February 2011

COMMAND AND CONTROL OF THE RIC DEPLOYMENT

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Mission Statement

The mission of State Fire Training is to enable the California fire service to safely protect life and property through education, training, and certification.

Fire Service Training and Education Program

The Fire Service Training and Education Program (FSTEP) was established to provide specific training needs of local fire agencies in California. State Fire Training coordinates the delivery of this training through the use of approved curricula and registered instructors.

The FSTEP series is designed to provide both the volunteer and career fire fighter with hands-on training in specialized areas such as fire fighting, extrication, rescue, and pump operations. All courses are delivered through registered instructors and can be tailored by the instructor to meet your department's specific need. Upon successful completion of an approved FSTEP course, participants will receive an Office of State Fire Marshal course completion certificate.

Acknowledgments

State Fire Training coordinated the development of the material contained in this guide. Before its publication, the Statewide Training and Education Advisory Committee (STEAC) and the State Board of Fire Services (SBFS) recommended this guide for adoption by the State Fire Marshal (SFM). This guide is appropriate for fire service personnel and for personnel in related occupations.

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"We gratefully acknowledge the hard work and accomplishments of those before us who built the solid foundation on which this program continues to grow."

Course Outline

Course Objectives: To provide the student with…

a) Information on Rapid Intervention Crew (RIC) terminology and the tools necessary to conduct a fire fighter rescue operation.
b) A methodology for conducting a risk management assessment of structural fire fighting critical fireground factors in an effort to prevent a fire fighter emergency situation.
c) Conduct an analysis of fire fighter line-of-duty injuries and fatalities case studies, taking into account both risk and critical fireground factors, in order to learn from and prevent a fire fighter emergency situation.
d) Provide command awareness and the control techniques required to effectively manage a fire fighter emergency event should the situation occur.
e) The opportunity to manage a fire fighter emergency situation should fire fighters become lost or trapped inside a burning structure.

Course Content **8:00**

Preassignment

1. Orientation and Administration 0:45
2. Critical Fireground Factors and the Risk Management Process..... 1:15
3. Fire Fighter Line-of-duty Death and Injury Case Studies..... 1:00
4. Command Awareness and Managing A RIC Deployment..... 1:30
5. Emergency Traffic Simulations 3:30

Texts and References

- California Code of Regulations (CCR), Title 8, Section 5144(g)
- ICS-910: Firefighter Incident Safety and Accountability Guidelines, FIRESCOPE, July 2008
- OSHA 29 Code of Federal Regulations (CFR) 1910.134
- NFPA 1250: Recommended Practices in Emergency Service Organization Risk Management, 2004 Edition
- NFPA 1500: Standard On Fire Department Occupational Safety And Health Program, 2007 Edition
- 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, 2010 Edition
- NFPA 1720: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments, 2010 Edition

- NIOSH #20000349: Commercial structure fire claims the life of one fire fighter – California http://www.cdc.gov/niosh/fire/reports/face9807.html
- NIOSH #20020725: Supermarket fire claims the life of one career fire fighter and critically injures another career fire fighter – Arizona http://www.cdc.gov/niosh/fire/reports/face200113.html
- NIOSH #20032349: Career engineer dies and fire fighter injured after falling through floor while conducting a primary search at a residential structure fire – Wisconsin http://www.cdc.gov/niosh/fire/reports/face200626.html
- NIOSH #20032969: Career fire fighter dies in residential row house structure fire – Maryland http://www.cdc.gov/niosh/fire/reports/face200628.html
- NIOSH #20033136: Career fire fighter dies when trapped by collapsed canopy during a two alarm attached garage fire – Pennsylvania http://www.cdc.gov/niosh/fire/reports/face200708.html
- NIOSH #20033835: Career fire fighter dies in wind driven residential structure fire – Virginia http://www.cdc.gov/niosh/fire/reports/face200712.html
- Rapid Intervention Company Operations, Mason and Pindelski, 2006 Edition
- U.S. Fire Fighter Fatalities, NFPA, 2008
- U.S. Fire Fighter Injuries, NFPA, 2008
- U.S. Fire Problem, NFPA 2008

Calendar of Events

TITLE	TIME	ACTIVITY
Precourse Assignment #1		Review
Precourse Assignment #2		Matrix
Welcome And Course Overview	0:45	1-1
Critical Fireground Factors And The Risk Management Process	1:15	
Fire Fighter Line-of-duty Death And Injury Case Studies	1:00	
Command Awareness And Managing A RIC Deployment	1:30	
Emergency Traffic Simulations	3:30	4-1
Classroom Hours:	**8:00**	

Precourse Assignments

Each student is required to complete the following two precourse assignments prior to the class:

- ❒ Precourse Assignment #1: RIC Terminology and Tools
- ❒ Precourse Assignment #2: Fire Fighter Fatality and Injury Case Study Analysis

Precourse Assignment #1: RIC Terminology and Tools

Time Frame:	Preassignment
Materials Needed:	• Command and Control of the RIC Deployment Student Manual, SFT, 2010 Edition, Pages 3-10
Introduction:	This activity provides the students the opportunity to come to class with an understanding of Rapid Intervention Crew terminology as well as tool cache requirements.
Directions:	1. Review the Glossary and Basic Tool Cache Requirements. 2. Be prepared for a test on this information at the beginning of class.

Glossary

1/3-1/3-1/3 rule.....A baseline parameter to determine working time for a RIC involved in large-area search operations. The rule implies good air management practices based upon consumption rates. One-third of a cylinder to get in, one-third of a cylinder to get out, and one-third of a cylinder remaining for safety.

2-in/2-out rule.....Provision in OSHA 1910.134 that outlines deployment of first-arriving fire personnel and provision of personnel available for their rescue if needed.

90-degree angle collapse...Wall collapse where a large portion or even the entire wall falls outward at a 90-degree angle.

A-frame collapse .....Collapse that result when a floor separates from the exterior wall creating a void space toward the center of the structure.

Accountability system.....A system or process used to track personnel while operating on an emergency incident.

Backdraft.....When oxygen is introduced into an area holding superheated products of incomplete combustion resulting in an immediate ignition of the products.

Balloon frame construction.....Wood-stud framing system that runs continuously from the ground-level to the attic that provides channels that allow for rapid fire spread.

Buddy breathing .....An emergency procedure in which two fire fighters share a single air source when one of them is experiencing a problem with their own source.

CAN.....Conditions-Actions-Needs

Control/Entry Supervisor.....RIC member stationed at an entry point that is responsible for tracking the RIC's progress and working air time.

Convected heat currents.....Heat transfer by the movement of air currents.

Curtin wall collapse .....Wall collapse where a wall crumbles or collapses upon itself straight downward.

Dead load.....The weight of a building an any permanent feature, including structural members and building materials such as floors, walls, HVAC systems, etc.

Debriefing ..... The final stage of an emergency incident that involves fire fighter's ability to talk about the incident which may also include speaking with qualified individuals to help deal with stress related factors.

Disorientation ..... Mental state that a fire fighter may experience if he or she becomes lost or confused while working in a hazardous atmosphere.

EBS ..... Emergency breathing system.

Emergency air supply unit ... A modified air supply including a facepiece that is used for rapid intervention maneuvers that require a transfer of air from RIC member and a down fire fighter.

Emergency breathing system (EBS) ..... A feature on some SCBAs that allows one user to share their air supply with another.

Emergency radio traffic ..... Used to signify that a priority message is to follow on the radio.

Flashover ..... Gases trapped at the ceiling that reaches their ignition temperature spontaneously involving the entire interior space.

Hailing system ..... A system used to help locate a downed fire fighter or civilian in a collapse situation. Rescuers are placed at strategic locations on the debris pile. With complete silence one rescuer will call out for a victim response. If there is no victim response the next rescuer will call out. This continues until a victim responds, then a rescuer at another location will call out to help pinpoint the position of the response.

IDLH ..... Immediately dangerous to life and health.

Image inversion ..... Objects and fire fighters known as active emitters may not be discernable on the viewing screen of a thermal imaging camera due to higher temperatures and infrared energy being created by the fire environment. Active emitters may appear dark on the view screen.

Immediately dangerous to life and health (IDLH) ..... An atmosphere that when entered could result in immediate fire fighter or civilian injury or death.

IMS ..... Incident Management System.

Incident Management System (IMS) ..... An organizational system used to manage resources at an emergency incident.

Inward/Outward collapse.....Collapse that result when the top of a wall partially falls inward while the bottom of the wall falls outward.

Lean-to collapse.....Collapse caused when the supports for the roof or floor of a building fall to one side.

Lightweight truss construction.....Type of construction that obtains its strength from compression and tension of materials used in its construction as opposed to mass. Pieces of truss are held together with metal gusset plates, nails, or glue that fail under high heat conditions resulting in failure of the truss.

Lightweight construction.....Type of construction in which the structural members that provide framework and support are fabricated out of composite materials made up of wood chips and glue. These materials will degrade very quickly when exposed to heat.

Lightweight I-beam.....Structural member which uses a center portion composed of wood chips held together with glue. I-beams are used to span large areas and can fail very quickly if unprotected and exposed to high heat.

LUNAR.....Acronym used by a lost or trapped fire fighter during an Emergency Traffic to relay the following pertinent information, **L**ast know location, **U**nit, **N**ame, **A**ssignment, and **R**esources needed.

Mayday.....Term used only to signify that a person is in a life threatening situation and needs immediate assistance. A fire fighter emergency can be declared by anyone having knowledge of someone in distress.

Metal-framed construction..Type of construction in which the structural members that provide framework and support are fabricated out of metal components. These materials will degrade very quickly when exposed to heat.

Mule kicking.....A technique performed by a distress fire fighter for penetrating a wall for emergency egress from one area to another when the use of a tool is not available.

NFPA.....National Fire Protection Association

NIOSH.....National Institute for Occupational Safety and Health

OSHA ..... Occupational Safety and Health Administration (Fed or State???)

OSHA 29 CFR 1910.134 ..... OSHA standard that covers the parameters required for a respiratory protection program. It contains the two-in/two-out rule or 2-in/2-out.

Oriented search ..... A systematic search technique that provides good coverage of a small or medium sized open area in place of a complete right- or left-hand search.

PAC-CAN ..... Systematic process used by RIC personnel when they find a downed fire fighter. Pass - silence alarm, Assess - fire fighter to determine whom it is and what their air level is, Communicate - critical information to RIC leader who then communicates the critical information to the RIC Group Supervisor. Followed by Conditions of fire, Actions - what is RIC going to do, Needs - what needs to be done to be successful.

Pancake collapse ..... Collapse that results fro the failure of a structures bearing wall causing the roof and floors to collapse upon each other.

PAR ..... Personnel accountability report.

PASS ..... Personal accountability safety system.

PASS Device ..... Personal alarm safety system worn by each fire fighter that will go into an audible alarm if the fire fighter fails to move. This alarm should alert other fire fighters of a possible emergency.

Penciling ..... Technique used during fire attack to determine heat levels within the room. Short bursts of water are directed at the ceiling to determine heat conditions. If water droplets fail to fall back down, flashover may be imminent. Effective penciling can help prevent flashovers from occurring.

Personnel accountability report (PAR) ..... Roll call of companies operating at an emergency incident. Commonly performed when mode of operation changes (i.e., offensive to defensive), or a significant event such as a fire fighter emergency or collapse.

PIA ..... Post-incident analysis.

Point of no return.....Refers to a fire fighter's individual management of air supply. It is determined by the amount of air consumed going into a structure versus the amount of residual air needed to exit the structure.

Positive pressure ventilation .Utilization of fans to force air into an enclosure or void by creating pressure differentials. This method of ventilation can affect fire behavior inside a structure; therefore, it must be coordinated closely with interior crews.

Post-incident analysis (PIA).....A recap and in-depth review of an incident or training session to seek out information to address areas that went well as well as areas that need improvement.

Post traumatic stress disorder.....Condition that can occur when a fire fighter is exposed to a critical incident outside of what can be considered a normal work environment.

PPE.....Personal protective equipment.

PPPN .....Acronym used to determine a crew's **P**ersonnel accountability, **P**osition on the incident, **P**rogress made, and **N**eeds to be successful.

Preincident planning.....A building walk-through, inspection, or survey prior to an emergency taking place that provides knowledge about the building, potential fire behavior, pre-established strategic and tactics scenarios.

Radio-assisted feedback .....A procedure using two portable radios that are placed closely together and keyed to the talk position, creating a high-pitched feedback sound. This feedback sound can be heard over a downed fire fighter's radio and be used to assist a RIC team in finding the downed fire fighter's location.

Rapid intervention.....Actions taken during fire suppression and other incidents that provides continual evaluation of incident scene safety concerns or rescue of fire fighters.

Rapid Intervention Crew (RIC) .....Team of specially trained fire fighters who are solely responsible for the safety, search, and rescue of trapped or lost fire fighters at an emergency incident. Ideally, the RIC should be made up of four fire fighters.

Rapid Intervention Crew Officer .....Company Officer in charge of the Rapid Intervention Crew.

Rapid Intervention Group Supervisor.....Chief Officer or Company Officer in the absence of a second chief officer who managing a RIC operation. The RIC Supervisor communicates with the RIC and reports directly to the Operations Chief or the IC when the Operation position has not been filled.

Red alert tone .....A tone used to notify on-scene rescue personnel that a fire fighter accident or emergency has occurred.

RIC .....Rapid Intervention Crew.

Risk management process.....A method used to recognize and then reduce the risks to fire fighters. The process includes situational awareness, hazard assessment, hazard control, decision point, and evaluation.

RIT.....Rapid Intervention Team.

Roof decking.....Materials that make up the construction of a roof before covering materials such as asphalt are applied.

Safety Officer .....Person assigned by the Incident Commander that is responsible for recognizing and controlling immediate danger to all incident personnel.

Sheathing.....Material applied to wood-frame structure over structural framing to which exterior material finish is applied.

Shoring .....Process in which lumber, screw jacks, air bags, hydraulic systems are used to support weakened areas for the purpose of rescue operations.

Size-up the building .....The process of providing multiple visible structure type indicators, such as, shape and size, construction type, egress points on a structure; which may include, doors, security gates, rollup doors, barred windows, etc., fire conditions outside and inside the structure. Your own mental blue-print of the building.

Skip breathing.....Technique used by a fire fighter when lost or trapped that maximizes their SCBA air supply.

Slice tool .....Also known a metal cutting torch that uses rods and pure oxygen to generate heat in thousands of degrees to cut and penetrate metal.

Softening the building.....The process of providing multiple entry and egress points on a structure, which may include, opening locked doors, security gates, rollup doors, barred windows, etc., without affecting fire conditions inside the structure.

Support lean-to collapse .....Collapse that results from the failure of one side of a roof or floor that falls until it rests and is supported by substantial objects inside the structure.

Tactical worksheet .....Check sheet used to help keep track of the tactics employed to accomplish the strategic goals of the incident or specific operations, such as, RIC operations.

Thermal imaging camera (TIC)....Device that used infrared energy technology that allows fire fighters the ability to ascertain objects by shape in conditions that do not allow normal vision. Some models also monitor heat conditions.

TIC .....Thermal imaging camera.

Unsupported lean-to collapse .....Collapse where one side that has failed is without any support. This failed side floats freely and is very unstable and could result in a secondary collapse.

Void search .....A physical search that is conducted in a collapse environment by rescuers moving over and around debris, locating spaces created by the collapse of building materials.

V-shaped collapse.....Collapse that is caused by the failure of an interior support, resulting in void spaces on both sides of the collapse toward the bearing walls.

Walk-out basement.....Architectural feature in the construction of a building with an elevation difference between the grade at the front the building and the back of the building.

Wall breach .....The penetration of a wall through various methods for the purposes of emergency egress by a lost or trapped fire fighter or entry by RIC personnel for rescue purposes.

Wood frame construction ....Type of construction in which the structural members that provide framework and support are fabricated out of wood. Most common type of construction.

Basic Tool Cache Requirements

- ❒ Salvage cover for tool placement.
- ❒ RIC bag.
  - 1-hour SCBA bottle with regulator and mask connected with 3 feet of hose (minimum).
  - Emergency breathing system (EBS) manifold (male/female connections) is recommended
  - Universal adaptor connection (UAC) connection with 3 feet of hose (minimum).
- ❒ Forcible entry tools.
  - Halligan bar.
  - Sledge hammer.
  - Flat head axe.
- ❒ Flashlight.
- ❒ Radio for each member with lapel microphone (if possible).
- ❒ Tag line.
- ❒ Power tools (based on construction types).
  - Rotary saw with metal blades.
  - Chainsaw.
  - Reciprocating saw.
- ❒ Cable cutter.
- ❒ Thermal imaging camera (TIC) (sleep mode in staging).
- ❒ Lighting.
- ❒ Ground ladders.

Rescue Tool Cache

- ❒ Air bags.
- ❒ Cribbing.
- ❒ Shoring.
- ❒ Lighting.
- ❒ Rescue litter.
- ❒ Backboard.
- ❒ Blowers.
- ❒ Jacks.
- ❒ Additional RIC bag.

Precourse Assignment #2: Fire Fighter Fatality and Injury Case Study Analysis

Time Frame: Preassignment

Materials Needed:

- Command and Control of the RIC Deployment Student Manual, SFT, 2010 Edition, Topics 1-3: Fire Fighter Line-of-duty Deaths and Injury Case Studies
- Fire Fighter Fatality and Injury Analysis Matrix
- Pen or pencil

Introduction: This activity provides you the opportunity to analyze why these tragic situations occurred and learn from the mistakes of others.

Directions:

1. Review the Fire Fighter Fatality and Injury Analysis Matrix. Pay particular attention to the critical factors to be analyzed.
2. Read case studies 1-3. However, you will participate in simulations using case studies 1, 2, 4, 5, and 6 and need to review all six case studies.
3. Complete the matrix as described below. Document your findings for each of the critical factors in the matrix using the following variables:

   2 = Did Contribute to Risk
   1 = Did Not Contribute to Risk
   0 = Inadequate Information to Determine A Finding
4. Once you have entered the corresponding variable for each of the three case studies, enter the total number of case studies indicated as "Contributing to Risk" (given a "2") in the FINDINGS column.
5. Findings of two or more represent common critical factors may have resulted in the fire fighter(s) injury or fatality. Findings totaling two or less would not be a critical factor.

   FINDINGS ≥2 = Shows Pattern of Critical Factors
   FINDINGS ≤1 = No Pattern or Critical Factors
6. Bring your completed matrix to class and be prepared to discuss your findings.

Example

Facts	1	2	3	FINDINGS
Dispatch Information Communicated	2	2	1	2

Name: _____ Date: _____

FIRE FIGHTER FATALITY AND INJURY ANALYSIS MATRIX				
CRITICAL FACTORS	CASE STUDY			FINDINGS
	1-WI	2-CA	3-AZ	
Facts				
Dispatch information communicated				
Size up conducted properly				
Risk assessment conducted properly				
Communications utilized properly				
Policies and/or SOPs followed				
Incident command established properly				
Accountability maintained				
Probabilities				
Strategic objectives properly defined				
Reflex times considered				
Structural deficiencies considered				
Fire growth and intensity anticipated				
Fire spread/structural impact anticipated				
Threat to life and property evaluated				
Weather conditions considered				
Water supply and fire flow adequate				
Fire attack and ventilation coordinated				

FIRE FIGHTER FATALITY AND INJURY ANALYSIS MATRIX				
CRITICAL FACTORS	CASE STUDY			FINDINGS
	1-WI	2-CA	3-AZ	
Own Situation				
Incident command and control adequate				
Fire-fighting training, experience and performances				
Staffing levels adequate				
Rapid intervention crew trained/in place				
Personnel survival training adequate				
Emergency traffic procedures understood and followed				
Mutual aid capabilities				
Search techniques conducted properly				
Thermal imaging camera utilized properly				
Decisions				
Decisions made with life hazard as primary objective				
Overall scene management				
Plan of Operation				
Strategy clearly defined and understood by personnel on scene				
Tactical objectives understood				

NIOSH Case Study #1: Wisconsin

Career Engineer Dies and Fire Fighter Injured After Falling Through Floor While Conducting a Primary Search at a Residential Structure Fire

NIOSH – Fire Fighter Fatality Investigation and Prevention Program July 20, 2007

Summary

On August 13, 2006, a 55-year-old male, career engineer (the victim) died and another fire fighter was injured after falling through the floor at a residential structure fire. (Photo #1) The victim and fire fighter had arrived in their ambulance and assisted the first-due engine attach a 5" supply line at approximately 1227 hours. The engine company was conducting a fast attack on a suspected basement fire, while a ladder company conducted horizontal ventilation. The ambulance crew had advanced to the front of the structure when the Incident Commander requested them to conduct a primary search.

Photo 1: Incident site.

The victim and injured fire fighter proceeded to conduct a left hand search at approximately 1234 hours. They took a couple of steps to the left just inside the front door to conduct a quick sweep. Visibility was near zero with minimal heat conditions. Because of the smoke conditions, they kneeled, sounded the ceramic tile floor, and took one crawling step while on their knees. They heard a large crack just before the floor gave way sending them into the basement. The basement area exploded into a fireball when the floor collapsed. The victim fell into the room of origin while the injured fire fighter fell on the other side of a basement door into a hallway. The injured fire fighter was able to eventually crawl out of a basement window. The victim was recovered the next day.

NIOSH recommends:

Conduct preincident planning and inspections of buildings within their jurisdictions to facilitate development of safe fire ground strategies and tactics

Use a thermal imaging camera (TIC) during the initial size-up and search phases of a fire

Ensure fire fighters are trained to recognize the danger of operating above a fire and identify buildings constructed with trusses

Additionally, building code officials and local authorities having jurisdiction should: Consider modifying the current building codes to require that lightweight trusses be protected with a fire barrier on both the top and bottom

Introduction

On August 13, 2006, a 55-year-old male, career engineer (the victim) died and a fire fighter was injured after falling through the floor at a residential structure fire. On August 14, 2006, the USFA notified the NIOSH of the fatality. On August 16, 2006, the IAFF notified NIOSH of the fatality. On September 11-12, 2006, a Safety and Occupational Health Specialist and a Senior Investigator investigated the incident. Meetings were held with the fire department, IAFF members and city representatives. Interviews were conducted with the officers and fire fighters of the fire department who were directly involved in the incident. The NIOSH investigators reviewed the fire department's report, photos and sketches of the incident site, SOGs, medical examiner's report, dispatch log, and training records. The incident site was visited and photographed.

Department

The career fire department is staffed by 188 professional fire fighters and operates out of seven stations responding to approximately 9,000 calls each year. The department provides fire and injury prevention, fire suppression, technical rescue, and emergency medical services to a community of approximately 105,000 residents in a geographic area of about 47 square miles.

Training

Fire fighter training in the state of Wisconsin is regulated through the Department of Commerce and the training is conducted through the Wisconsin Technical College System. The State requires fire fighters to complete the Entry-level Fire Fighter Parts I and II. The career department's training program requires their probationary fire fighters to complete the NFPA Level I and II training.

The victim had more than 17 years of fire-fighting experience. In addition to the NFPA Level I and II equivalency in probationary fire school, the victim had completed other training including building construction, preincident planning, hazardous materials, technical rescue, and ventilation.

The injured fire fighter had more than 10 years of fire-fighting experience. In addition to the NFPA Level I & II equivalency in probationary fire school, she had completed other training including building construction, preincident planning, fire behavior principles, rapid intervention crew, and ventilation.

Structure

The structure was built in 1999, and was a two-story, single family residence of ordinary construction which encompassed approximately 3,500 square feet of living area above grade and 2,100 square feet below grade. (Diagram #1)

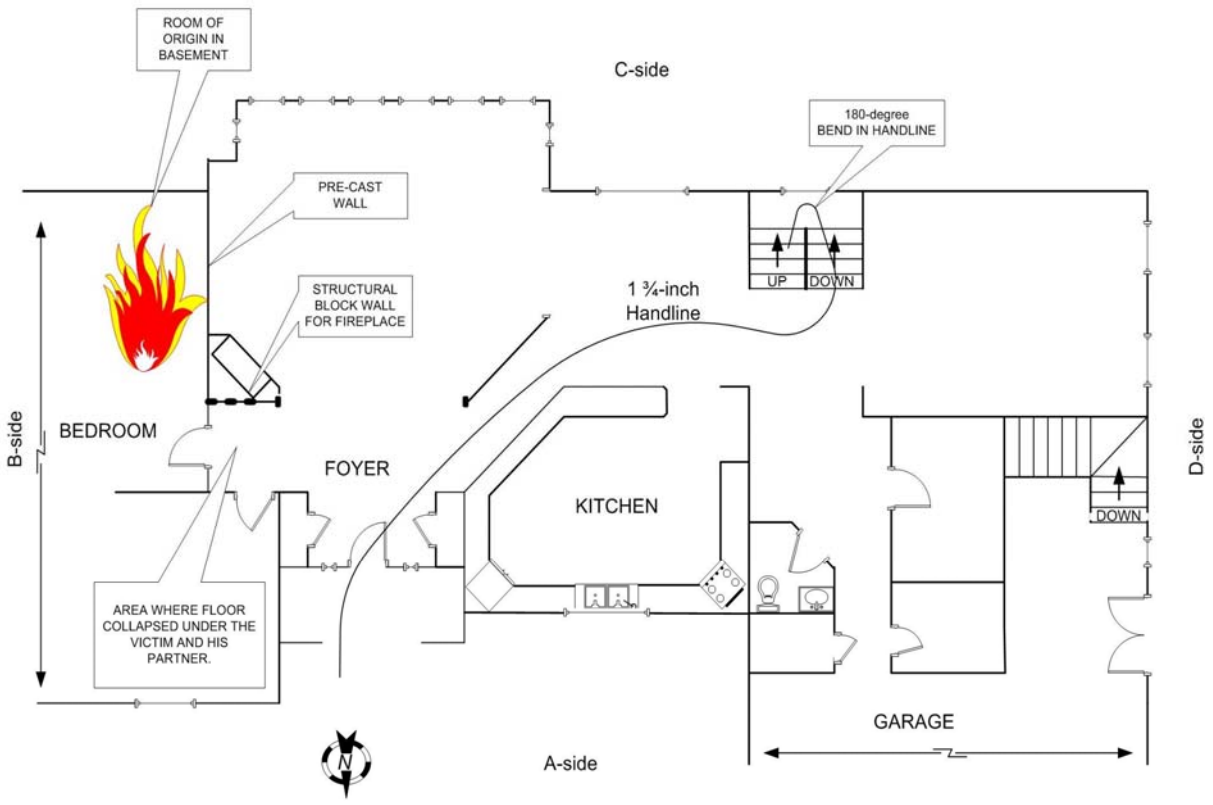


Diagram 1: Partial first floor layout aerial view relevant sections only.

The floors of the structure involved in this incident consisted of a lightweight wooden parallel-chord truss system and engineered wooden "I" beams. Lightweight wooden parallel-chord trusses typically consist of wooden members measuring 2" wide by 4" deep and are held together by sheet metal surface fasteners referred to as gusset plates. Engineered wood "I" beams are typically formed with a 2" by 3" or 2" by 4" top and bottom cord with a sheet of plywood or particle board vertically sandwiched in between as a web.

The origin of the fire was located in a section of unfinished basement that was approximately 750 square feet. The precast basement walls in the room of fire origin were

framed and insulated with foam sheets. (Photo #2) The ceiling in the room consisted of exposed floor trusses that were supported with wooden beams and metal post jacks. (Photos #3 and #4)

Photo 2: Framed precast walls with sheets of foam insulation.

Photo 3: Wooden beam and metal post jacks with bottom gusset plates from floor joists pinned to beam by first floor framing after entire floor joist consumed by fire.

Photo 4: Wooden beam and metal post jack.

The hallway which separated the unfinished from the finished basement had a concrete block wall for the structural support of the chimney to the south, and a framed wall possibly with drywall to the north.

Note: This is the area where the victim and fire fighter fell into when the floor collapsed.

The first floor had a radiant floor heating system installed on top of the subfloor. This system consisted of a flexible hose that circulated hot water and was layered in concrete approximately 3" thick. (Photo #5)

Photo 5: Transition between foyer and hallway where floor collapsed.

Weather

Clear and sunny, temperature averaging 68°F, wind averaging 7 mph from the south.

Investigation

On August 13, 2006, a 55-year-old male career engineer (the victim) died and a fire fighter was injured after falling through the floor at a residential structure fire. At approximately 1223 hours, dispatch received a call of a possible structure fire at a local residence. Ambulance 451 (A451), Engine 451 (E451), and Ladder (L451) were dispatched from the same station to the scene. E451 was the first to arrive on the scene at approximately 1227 hours, and the officer reported light smoke showing as they started to attach a 5" supply line to a hydrant. The victim and Fire Fighter from A451 assisted in making the hydrant connection. The E451 crew pulled a 2½" gated wye with a 100-foot section of 1¾" handline to the front door. They were met by a neighbor who told them he had tried to enter the structure because he thought someone might be inside. L451 was now at the front door assisting with stretching the handline and they were preparing to make forcible entry. The crew from E451 noticed light grey smoke pushing from a vent next to the front door that appeared to be coming from the basement. They asked the neighbor if there was an entrance into the basement that was below grade. The neighbor was unsure. The officer proceeded to do a 360-degree size-up and search for another way into the basement. He passed command through face to face communication to the second due officer who was on the scene from L451. The Engineer from L451 forced entry through the front door.

The officer from E451 noticed another vent near the ground on the C-side of the structure that was pushing black smoke with burning particles. Upon his return to the front door, he told his crew of two Fire Fighters to mask up for entry to search for the fire in the basement.

He requested that the positive pressure ventilation (PPV) fan be used at the front door to facilitate horizontal ventilation so his crew could search for an interior stairway into the basement and attack the fire.

Battalion Chief 411 arrived on the scene and took over command from L451 at approximately 1232 hours. Ladder 451 set up and started the PPV fan at the front door and proceeded to the C-side of the structure to conduct horizontal ventilation at approximately 1233 hours. A451 finished making connections to the hydrant and were making their way up the driveway as a crew from E451 prepared to enter the structure. Upon entry, the officer and two Fire Fighters from E451 encountered yellow/brown smoke that filled the entire first floor of the structure. Visibility was near zero with minimal heat conditions. The crew entered the foyer and conducted a right hand search for an entry into the basement. They were unsuccessful and changed directions. The officer from E451 heard L451 tell command they vented the basement windows. He called command and requested that the first floor windows be vented. Within minutes visibility improved and they could see across the kitchen area to the stairway which led to the basement.

The crew from E451 walked over to the stairs and started to stretch the hose down the stairway into the basement which had a landing that was midway down the stairs. The officer put a Fire Fighter on the landing which made a 180-degree turn to flake out the hoseline. The nozzleman made his way down the stairs and opened the door into the basement which was full of thick black smoke. He stepped and immediately fell down because of an extremely slippery floor. He made several attempts to stand up when his Lieutenant stepped and slipped onto the floor knocking him further into the room. He then could feel intense heat coming from the B-side of the basement. Visibility was zero.

The IC requested the victim and the Fire Fighter from A451 to conduct a primary search of the first floor at approximately 1234 hours. The victim and injured Fire Fighter finished donning their equipment and made entry through the front door. They took a couple of steps to the left to conduct a quick sweep. The injured Fire Fighter followed the victim as they both went to their knees because of the thick smoke conditions. The injured Fire Fighter held onto the victim's boot to start the search. They sounded the ceramic tile floor and took one crawling step forward and heard a loud crack and then they both fell through the floor into the basement. The basement area exploded into a fireball when the floor gave way sending them into the basement. The victim fell into the room of origin. The injured Fire Fighter was separated from the victim during the collapse from the resulting debris and fell into an area facing the concrete block wall of the chimney's foundation. She was instantly surrounded by flames as she shielded herself with whatever debris she could find. She took refuge against the block wall as she tried to protect herself while she yelled to try to find the victim. She called for Mayday four times, but due to the fire conditions and intense situation, she did not hear a response.

At the same time, the crew from E451 made their way back up the stairs from the basement to the front door. The entire foyer area was engulfed in flames at this time. Another crew was

spraying water through the front door which allowed the crew from E451 to jump through the flames and out the front door. The injured Fire Fighter who fell into the basement felt the water and saw the fire darken down. She stood up and once again encountered extreme heat conditions which immediately melted her facepiece. She turned away from the fire and pushed her way through debris created from the collapse and made it into the next room of the basement. She saw a window and could hear crews operating at the rear of the structure. She was able to make her way to the rear of the structure where the crews assisted her out through the windows.

Photo 6: Windows on C-side of structure where fire fighter exited basement.

After the MAYDAY call, the IC activated the RIT, which immediately entered the basement by a set of stairs through the garage in an attempt to locate the victim and the injured Fire Fighter. (Photo #6) Crews also entered the basement through the windows at the rear of the structure. The room of origin was unattainable due to the collapse debris and extensive fire. The remaining basement area was searched thoroughly until all crews were ordered to evacuate due to impending structural collapse. The operation was declared defensive until the fire was put out and the structure could be protected from collapse. The victim was recovered from the room of fire origin the next day.

Cause of Death

The medical examiner listed the cause of death as smoke inhalation and thermal burns. The injured Fire Fighter had first-degree burns to approximately 15% of her back and upper arms and she also suffered a fractured hip and ribs.

Recommendations/Discussions

Recommendation #1

> *Fire departments should conduct preincident planning and inspections of buildings within their jurisdictions to facilitate development of safe fire ground strategies and tactics.*

Discussion

NFPA 1620, Recommended Practice for Preincident Planning, 2003 Edition §4.4.1 states, "the preincident plan should be the foundation for decision making during an emergency situation and provides important data that will assist the incident commander in developing appropriate strategies and tactics for managing the incident." This standard also states, "The primary purpose of a preincident plan is to help responding personnel effectively manage emergencies with available resources. Preincident planning involves evaluating the protection systems, building construction, contents, and operating procedures that can impact emergency operations." A preincident plan identifies deviations from normal operations and can be complex and formal, or simply a notation about a particular problem such as the presence of flammable liquids, explosive hazards, modifications to structural building components, or structural damage from a previous fire.

In addition, NFPA 1620 outlines the steps involved in developing, maintaining, and using a preincident plan by breaking the incident down into pre-, during- and post-incident phases. In the preincident phase, for example, it covers factors such as physical elements and site considerations, occupant considerations, protection systems and water supplies, and special hazard considerations. Building characteristics including type of construction, materials used, occupancy, fuel load, roof and floor design, and unusual or distinguishing characteristics should be recorded, shared with other departments who provide mutual aid, and if possible, entered into the dispatcher's computer so that the information is readily available if an incident is reported at the noted address.

Typically, preincident planning focuses on commercial buildings and the specific hazards they have due to their size, construction, and contents. Modern building components, specifically engineered wood trusses, have allowed residential structures to be designed and built in sizes rivaling commercial buildings. The hazards with this type of construction are the same in both commercial and residential structures. Engineered wood trusses that are exposed to fire weaken or fail very quickly. Inspections and preincident planning of large residential construction should be given the same consideration as commercial buildings.

Recommendation #2

Fire departments should use a TIC during the initial size-up and search phases of a fire.

Discussion

A TIC can be a useful tool for initial size up and for locating the seat of a fire by assisting fire fighters in quickly getting crucial information about the location of the source (seat) of the fire from the exterior of the structure, so they can plan an effective response with the entire emergency team. Knowing the location of the most dangerous and hottest part of the fire may help fire fighters determine a safe approach and avoid structural damage in a building that might have otherwise been undetectable. Ceilings and floors that have become dangerously weakened by fire damage and are threatening to collapse may be spotted with a thermal imaging camera. A fire fighter about to enter a room filled with flames and smoke can use a TIC to assist in judging whether or not it might be safe from falling beams, walls, or other dangers. The use of a TIC may also provide additional information the Incident Commander can use during the initial size-up. TICs should be used in a timely manner, and fire fighters should be properly trained in their use and be aware of their limitations.

In this incident, members of the initial attack crew had difficulty navigating out of the foyer in order to find the basement stairs. They were attempting to search for the seat of the fire to extinguish it. The use of a TIC during initial size-up and entry into the structure could have confirmed a general location for the seat of the fire in the basement. This information may have influenced the fire department as to what areas might have been structurally damaged.

Recommendation #3

Fire departments should ensure fire fighters are trained to recognize the danger of operating above a fire and identify buildings constructed with trusses.

Discussion

The danger of being trapped above a fire is greatly influenced by the construction of the burning building. Of the five basic building construction types (fire resistive, noncombustible, ordinary construction, heavy timber, and wood-frame) the greatest danger to a fire fighter who must operate above the fire is posed by wood-frame construction. Vertical fire spread is more rapid in this type of structure. Flames may spread vertically and trap fire fighters operating above the fire in four ways: up the interior stairs, through windows (auto-exposure), within concealed spaces, or up the combustible exterior siding. Extreme caution must be used in determining if the structural stability of the flooring system is adequate to facilitate the operations.

The floors of the structure involved in this incident consisted of a lightweight wooden parallel-chord truss system and engineered wooden "I" beams. Lightweight wooden parallel-chord trusses typically consist of wooden members measuring 2" wide by 4" deep and are held together by sheet metal surface fasteners referred to as gusset plates. The gusset plates have numerous V-shaped points cut through them that may penetrate the wood's surface approximately ¼"-½". This steel plate could act as a heat collector which can transfer heat to the V-shaped points, destroying the tensioned wood fibers holding the gusset plate in place.

Engineered wood "I" beams are typically formed with a 2" by 3" or 2" by 4" top and bottom cord with a sheet of plywood or particle board vertically sandwiched in between as a web. No specific time limit has been established for how long fire fighters should operate under or on truss floors or engineered wood "I" beams that are exposed to fire. Even though standard fire engineering calculations show that lightweight trusses may be expected to collapse under 10 minutes in a fully developed fire, it is not recommended that a time limit be set. When it is determined that the building's trusses have been exposed to fire, any fire fighters operating under or above them should be immediately evacuated. Materials used for radiant floor heating could decrease the time for structural failure by trapping the heat below the floor. Fire fighters who sound the floor with a tool to determine structural integrity will likely get a false reading from the lightweight concrete used in radiant floor heating. Operating above a fire with floor trusses and lightweight concrete used in radiant floor heating should not be attempted.

Recommendation #4

> ***Additionally, Municipalities, Building Code Officials and Local Authorities having jurisdiction should consider modifying the current codes to require that lightweight trusses are protected with a fire barrier on both the top and bottom.***

Discussion

Trusses are typically assembled in a system to provide structural support for a roof or floor. The roof or flooring system is certified for the required fire rating by testing the entire assembly such as an attic or floor space with a roof or subfloor covering on the top and a ceiling component on the bottom. The fire-resistance of the assembly can be viewed as the sum of the resistance of all the components used in the assembly. As mentioned previously, lightweight trusses that are exposed to fire may fail in less than 10 minutes. Lightweight floor trusses constructed as an "I" beam have been reported to fail to support their load in under 6 minutes.

In this incident, the floor trusses for the first floor did not have any protection on the bottom cord, which immediately exposed the trusses to fire in the basement. Unfinished basements are very common throughout the country. It is critical for trusses that are used in a load-

bearing assembly be protected with a thermal barrier such as gypsum wallboard. The function of the thermal barrier is the critical factor in the fire performance of the assembly. Municipalities, Building Code Officials, and Local Authorities having jurisdiction should also include experienced fire personnel throughout any developmental review process concerning life safety to the public and fire department members.

Investigator Information

This incident was investigated by Jay Tarley, a Safety and Occupational Health Specialist, and Rich Braddee, a Senior Investigator, Division of Safety Research, NIOSH. An expert technical review was provided by Battalion Chief Ted Fehr, Tukwila Fire Department.

NIOSH Case Study #2: California

Commercial Structure Fire Claims the Life of One Fire Fighter

NIOSH – Fire Fighter Fatality Investigation and Prevention Program July 24, 1998

Summary

On March 8, 1998, one male fire fighter, the Captain on Engine 57 (the victim), died while trying to exit a commercial structure after his egress was cut off by the wooden trussed roof that collapsed. Task Force 66 was the first on-scene and reported light smoke showing from a one-story commercial building. A ventilation team from Truck 66 proceeded to the roof of the building and commenced roof ventilation. Forcible entry into the building required about 7½-9½ minutes from arrival on-scene to force open the two metal security doors in the front. While fire companies waited for the security doors to be opened, fire conditions changed dramatically on the roof. Fire was coming from the ventilation holes opened by the ventilation crew. As soon as the security doors were opened, three engine crews (Engine 66, Engine 57, and Engine 46) advanced hoselines through the front door in an attempt to determine the origin of the fire. Approximately 15 feet inside the front door, the fire fighters encountered heavy smoke with near zero visibility conditions. The engine crews advanced their hoselines approximately 30 to 40 feet inside the building.

As conditions continued to deteriorate inside the building, the members from the four engine companies involved in the fire attack began to withdraw. During this time the victim became separated from his crew and remained in the building. The victim was subsequently located by the Rapid Intervention Team and cardiopulmonary resuscitation was performed immediately and en route to the hospital, where the victim was pronounced dead.

NIOSH recommends:

Ensure that incident command conducts an initial size up of the incident before initiating fire-fighting efforts, and continually evaluate the risk versus gain during operation at an incident.

Ensure that incident command always maintains close accountability for all personnel at the fire scene.

Ensure communications are established between the interior and exterior attack crews, e.g., the ventilation crew and the interior fire attack crew should communicate conditions among themselves and back to incident command.

Ensure that rapid intervention teams are in place before conditions become unsafe.

Ensure that some type of tone or alert that is recognized by all fire fighters be transmitted immediately when conditions become unsafe for fire fighters.

Ensure sufficient personnel are available and properly functioning communications equipment are available to adequately support the volume of radio traffic at multiple-responder fire scenes.

Consider placing a bright, narrow-beamed light at the entry portal to a structure to assist lost or disoriented fire fighters in emergency egress.

Introduction

On March 8, 1998, a 38-year-old male fire fighter, the Captain on Engine 57 (the victim), entered a commercial structure with heavy smoke and flames emitting from the roof. The victim, along with several other fire fighters, entered the structure through the front door while additional fire fighters continued to ventilate the wooden, arched-truss roof. While the fire fighters exited the building due to deteriorating conditions, the victim became disoriented, his SCBA ran out of air, and his egress was eventually cut off by a partial collapse of the wooden trussed roof. Approximately 22 to 24 minutes after he entered the building, the victim was found unresponsive. On March 16-18, 1998, an investigation of this incident was conducted by Ted A. Pettit, Chief of the Trauma Investigations Section, and Richard W. Braddee, Frankie C. Washenitz, and Tommy N. Baldwin, Safety and Occupational Health Specialists. Meetings were conducted with members of the fire department's Significant Incident Investigation Team (SIIT), Battalion Chiefs, Assistant Chiefs, Training Chiefs, Fire Fighters responding to the incident, and the IAFF Union Representative. Copies of photographs from the incident site were obtained from the fire department along with an estimated time line of the incident. Training procedures and a preliminary report prepared by SIIT were reviewed, and a videotape from the fire scene and a transcription of dispatch tapes were obtained. A site visit to the incident scene was conducted.

The Fire Fighter Fatality Investigation and Prevention Program is conducted by the NIOSH. The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

http://www.cdc.gov/niosh/firehome.html
or call toll free 1-800-35-NIOSH.

The fire department involved in the incident serves a population of 3½ million in a geographic area of 470 square miles. The fire department is comprised of approximately 3,300 employees, of whom 3,026 are fire fighters. At their fire academy, the fire department provides all new fire fighters with the basic 20 weeks of training that covers NFPA Fire Fighter Level I and the majority of NFPA Fire Fighter Level II. The training is designed to cover all areas of fire departments operations, including fire safety, state and federal codes, fire behavior, fire protection and safety, and self-contained breathing apparatus. Refresher training courses are continued throughout the year during each shift. The fire department's written

standard operating procedures manual was reviewed and appeared to be complete. The victim had 17 years of fire-fighting experience.

Investigation

On March 8, 1998, at 0220 hours Pacific Standard Time, Battalion 13 and Task Force 66, which included Engine 66 (Captain, Engineer, and two Fire Fighters), Engine 266 (Engineer), Truck 66 (Captain, Apparatus Operator, and three Fire Fighters) and Rescue 866 (two Fire Fighter/EMTs) received the initial dispatch of a reported structure fire. Also responding were Engine 57 (Captain, Engineer, and two Fire Fighters), Engine 46 (Captain, Engineer, and two Fire Fighters), and Engine 34 (Captain, Engineer, and two Fire Fighters). Light Force 26 was also dispatched and was later replaced by Light Force 33, which included a Captain, Apparatus Operator, Engineer, and three Fire Fighters (a Light Force is a truck and 200 series engine, i.e., Truck 33 and Engine 233). At 0222 hours, Battalion 13 and Task Force 66 arrived on-scene and reported light smoke emitting from a one-story commercial building that measured 110-feet long by 59-feet wide, which contained a dog treats preparation operation.

At 0223 hours, four members from Truck 66 (Captain and three Fire Fighters) went to the roof, via a 35-foot ground extension ladder, to start ventilation procedures as one of the fire fighters (inside member) of Truck 66 went to the front security door to evaluate entry conditions. As the ventilation crew went up the ladder, they noticed several windows on the south side of the building through which they could see fire in the ceiling area, which they reported to incident command. When they reached the roof, they reported grayish brown smoke emitting through a roof vent.

Engine 57 arrived on-scene at 0224 hours and was assigned to assist with backup as soon as the Inside Member of Truck 66 made entry into the building. Truck 66's Inside Member began to make forcible entry through the front metal security door of the building using a rotary saw and then by kicking the door. During this time, two members from Engine 66 retrieved a 1¾" handline off the pumper and laid it out by the front door. At approximately 0226 hours, Engine 33 arrived on-scene and, after several minutes, assisted Truck 66's Inside Member at the front door. A fire fighter from Engine 33 used a sledgehammer to beat open the front door. The total process of gaining entry into the structure took approximately 7½-9½ minutes from the time companies arrived on the scene.

As Truck 66's ventilation team approached the center of the roof, they saw fire coming from a vent. The ventilation team opened an initial hole, approximately 4-feet by 4-feet, but was driven back by heavy fire and heat. By 0226 hours, members of Truck 66 were on the roof and reported the fire was somewhat heavy near the center ventilation hole. Even though flames were showing through the roof, they stated the roof still felt solid. Due to changing conditions, Battalion 13 requested two additional task forces at approximately 0226 hours, and Operations Control Division (OCD) dispatched Division II and Battalion 3 to the scene (the aforementioned units were delayed due to equipment failure at the OCD.

Between 0230 and 0232 hours, after gaining entry, the Captain and two Fire Fighters from Engine 66 advanced a 1¾" handline through the front door, followed by the Captain and two Fire Fighters from Engine 57 with a 1½" handline, and the Captain from Engine 46 with a 1¾" handline. A 15-foot long hallway with offices on one side and a storage area above led from the front door to a door into the manufacturing area. Approximately 15 feet inside the front door, the companies encountered heavy smoke conditions with near zero visibility, but little heat. Due to considerable storage inside the building, advancing the hoselines was very difficult due to 55 gallon drums (some empty and some containing dog treats) that were stored at the plant. At 0231 hours, a Captain and two Fire Fighters from Engine 33 advised the IC they had 10-foot pike poles and were going in with fire attack to help pull ceilings.

Fire Fighters from Engine 66 and Engine 46 advanced their hoselines 30 to 40 feet inside the building but found no fire. As Engine 57's inside members advanced into the structure, their Engineer stayed in the hall area and helped advance the hoseline. Engine 33's inside members advanced beyond the office area into the manufacturing area, and they raised their pike poles to touch the ceiling or roof. The pike poles proved ineffective since the fire fighters were beyond the mezzanine area which was 6 to 13 feet above the office area. Interior fire fighters reported they could hear the saws on the roof and knew that ventilation was taking place, but the heat and smoke level was intensifying as they advanced into the structure.

At 0232 hours, the Captain from Truck 66 advised Battalion 13 that they were getting real good fire out of the roof and were getting off.

Captains on the interior radioed Battalion 13 that they couldn't seem to find the fire; however, they were still advancing. The victim and the Captain of Engine 46 met on the inside of the structure and determined they were not making progress locating the fire. After speaking with the Captain (the victim) and considering the deteriorating conditions, the Captain on Engine 46 ordered a retreat and his crew to follow their hoseline to exit. The crew attempted to follow hoselines on the floor to locate the exit; however, hoselines were tangled on the floor, creating a problem on exiting. The victim (Captain of Engine 57) also ordered his crew to exit the structure. At 0236 hours, Battalion 13 advised all the interior companies to withdraw from the structure due to information received from the roof and the interior crews; however, the Captain of Engine 46 on the interior did not hear the order to withdraw.

Engine 57's crew stated they could walk slightly bent over, but felt heat coming down from above, and there was no visibility. The crews also stated that they were within touching distance of each other throughout the operations. The members of Engine 57 exited with the victim leading and the remaining two fire fighters following. The victim began walking toward the exit as the nozzleman of Engine 57 started lifting the hose to bring it out with them. The middle fire fighter made physical contact with the victim to verify his location and then went back to help the nozzleman. After pulling the nozzleman in the direction of the victim, the middle fire fighter again made physical contact with the victim and proceeded

forward. As the two fire fighters followed the victim to exit the structure, the middle fire fighter lost physical contact with the nozzleman for a second time. The middle fire fighter let go of the victim and reached back to pull the nozzleman. After making physical contact with the nozzleman again, the middle fire fighter reached forward to locate the victim. The middle fire fighter could not physically locate or make any verbal contact with the victim. The nozzleman yelled for the victim four times but did not receive an answer. The nozzleman related that he heard a SCBA low-air alarm sounding, which he thought was the victim's.

The nozzleman and fire fighter from Engine 57, without their Captain (victim), dropped down to locate a hoseline to guide them out. The nozzleman and fire fighter of Engine 57 stated that as they were following the line out they discovered that they were going back into the structure when they reached the nozzle. They immediately turned around and followed the same line out. The fire fighters stated that the hoselines inside were tangled together, making the hoseline hard to follow. At this point, the middle Fire Fighter stated that he spotted a light, and both members crawled toward it with the nozzleman following. It was the flashlight of Engine 57's Engineer. Upon their exit, the nozzleman and Fire Fighter asked if their Captain (victim) had made it out yet, and the Engineer of Engine 57 responded saying their Captain (the victim) had not come out.

A Fire Fighter from Engine 33 who became disoriented and was having trouble exiting, activated his radio's emergency trigger which signaled OCD he was having trouble on the interior. At 0238 hours, Battalion 13 was advised that Engine 33 needed assistance on the inside and that a fire fighter from Engine 33 was having trouble exiting. At approximately the same time, the other two members of Engine 33 exited the structure and discovered they were missing a member. The Engine 33 Captain (with a low amount of air) retrieved a flashlight from Engine 57 and re-entered the structure in search of his Fire Fighter. Within a few seconds, the Captain of Engine 33 found his missing Fire Fighter and they both exited the front of the structure at approximately 0239 hours. Also at this time, the Division 2 Assistant Chief advised OCD he was on-scene and would assume command.

By approximately 0242 hours the roof had fallen in and was blocking the front entry into the manufacturing area where the fire attack companies had just exited. After the nozzleman and fire fighter changed their air bottles, the nozzleman of Engine 57 went back to the front entrance with another fire fighter and a 2½" hoseline. Their hoseline and those operated by members from Engine 66, Engine 46, and Engine 33 proved to be ineffective because of the volume of fire in the entrance area.

The Captain from Engine 33 stated that at approximately 0243 hours, he informed IC in a face to face conversation that the Captain on Engine 57 (victim) was missing and still inside. This was not confirmed by the Command Post staff.

At approximately the same time, the IC radioed companies on-scene and asked if someone could give him a status on Engine 57. Engine 66 radioed the IC and stated

Engine 66 was accounted for and they were going to look for Engine 57's Captain, who was still missing.

Due to heavy fire conditions at the front of the structure, Engine 15, who was assigned as the Rapid Intervention Team, proceeded to the rear of the structure to a rolling steel door. The Inside Member of Truck 66 and members from Engine 34 had earlier used a rotary saw to open the large steel door in the rear of the structure to allow access.

By 0246 hours, the personnel involved in the rescue attempt had no success in gaining entry to the structure, and with the conditions beginning to further deteriorate, IC advised Truck 66's Apparatus Operator to start putting water on the fire from the ladder pipe.

At 0254 hours, Engine 15 radioed the IC that they had found the Captain on Engine 57 (victim), but their message was not heard by the IC due to heavy radio traffic. At 0256 hours, Truck 66 radioed Engine 266 and stated that entry was made in the rear through the rolling steel door and the RIT of Engine 15 would be entering. At that time, Truck 66's Apparatus Operator was advised by IC that Engine 15 had made access through the rear door and that they needed them to shut down the ladder pipe temporarily. At 0257 hours, the red alert tone was generated by the OCD.

At 0258 hours, Engine 15 was successful in notifying IC that they had found the victim and they would be coming out the back of the building (where they entered). When the victim was found, his helmet had been knocked off, the SCBA facepiece lens was missing, and his PASS device (set to automatic) was alarming.

Rescue 66 initiated ALS procedures and transported the Captain (victim) to a local hospital, arriving at approximately 0322 hours. The Captain was pronounced dead in the emergency room.

NOTE: There were two confirmed Automatic PASS device activations at this incident. One activation occurred inside when the Captain from Engine 66 lost his PASS device. The victim was eventually found approximately 21 feet east of this PASS device. It is undetermined if the victim heard this PASS device sounding and moved toward it. Of the 12 fire fighters/officers who entered the manufacturing area, the Nozzle Member and Hydrant Member of Engine 46 recall hearing a PASS device sounding in the alarm mode while they were inside the structure. The Hydrant Member from Engine 46 stated he heard a PASS device in the background when he approached the loops in the hose. The Nozzle Member of Engine 46 also heard a PASS device approximately 1 to 2 minutes before beginning to withdraw from the structure. The second PASS device alarm activation was from the victim's device. It may never be known for certain why the Captain (victim) became separated from his company and ultimately entrapped.

Cause of Death

According to the medical examiner, the cause of death was smoke inhalation and thermal burns.

Recommendations/Discussion

Recommendation #1

Fire departments should ensure that command conducts an initial size-up of the incident before initiating fire-fighting efforts, and continually evaluate the risk versus gain during operation at an incident.

Discussion

One of the most important size-up duties of the first-in officers is locating the fire and determining its severity. This information lays the foundation for the entire operation. First, it determines the number of fire fighters and the amount of apparatus and equipment needed to control the blaze. Second, it assists in determining the most effective point of fire extinguishment attack, and the most effective method of venting heat and smoke. Several factors must be evaluated in conducting the size-up, e.g., type of structure, time of day, contents of the structure, potential hazards, etc. The size-up should also include risk versus gain during incident operations. The following general factors are important considerations: (1) occupancy type involved; (2) smoke conditions; (3) type of construction; (4) age of structure; (5) exposures; and (6) time considerations--time of incident, time fire was burning before arrival, time fire was burning after arrival, and effective attack made.

Recommendation #2

Fire departments should ensure that fire command always maintains close accountability for all personnel at the fire scene.

Discussion

Accountability on the fireground is paramount and may be accomplished by several methods. It is the responsibility of every officer to account for every fire fighter assigned to his or her company and relay this information to Incident Command. Fire fighters should not work beyond the sight or sound of the supervising officer unless equipped with a portable radio. This member should communicate with the supervising officer by portable radio to ensure accountability and indicate completion of assignments and duties. When the assigned duties are completed the fire fighter should radio this information to the supervisor then return to the supervisor for additional duties. As a fire escalates and additional fire companies respond, a communication assistant with a command board should assist the Incident Commander with accounting for all fire fighter companies at the fire, at the staging area and at rehabilitation. One of the most important aides for accountability at a fire is an Incident Management System.

Recommendation #3

> *Fire departments should ensure communications are established between the interior and exterior attack crews, e.g., the ventilation crew and the interior fire attack crew should communicate conditions among themselves and with Incident Command.*

Discussion

The size-up of a fire can be accomplished from both inside and outside of the building. Often times due to construction features (mezzanines, attic space, partitions, etc.), interior crews may not be able to readily find or see the seat of the fire. Roof ventilation teams will often be able to provide a size-up of smoke and fire conditions to the IC and interior fire attack teams. It is important that ventilation and extinguishing operations be coordinated to achieve the maximum gain with minimal risk. Engine Companies need to be aware of possible truck problems causing delayed ventilation (steep roofs, difficult laddering, roof covering, and poor access). Truck Companies need to be aware of possible Engine Company problems which may cause a delay in fire extinguishment (security bars, occupancy type, tall ceilings, congested conditions, mezzanines, etc.). The IC must be informed if Truck and/or Engine Companies encounter problems, which may affect their operation(s). In addition, Truck and Engine Companies need to communicate their progress or lack of progress to each other and the IC.

Recommendation #4

> *Fire departments should ensure that RITs be established and in position immediately upon arrival at the fire scene.*

Discussion

A RIT should be positioned to respond to every major fire. The team should report to the officer in command and remain at the command post until an intervention is required to rescue a fire fighter(s). The RIT should have all the tools necessary to complete the job, e.g., a search rope, rescue rope, first aid kit and a resuscitator to use if a fire fighter becomes injured. Many fire fighters who die from smoke inhalation, or a flash over, or are caught or trapped by fire actually become disoriented first. They are lost in smoke, their SCBA runs out of air, or they cannot find their way out in the smoke, and become trapped, and then fire or smoke kills them. The primary contributing factor, however, is disorientation. To prevent fire fighters from becoming disoriented at fires, they should be taught safe search procedures, such as clockwise or counter-clockwise search tactics, or they should have search lines or hoselines. The search lines should be tied to a substantial object outside of the fire area and should be laid behind as fire fighters enter smoke-filled occupancies. The search line can be used by fire fighters to find their way out when disoriented in smoke.

Recommendation #5

> *Fire departments should ensure that some type of tone or alert be transmitted immediately when conditions become unsafe for fire fighters.*

Discussion

There is a difference between withdrawing fire fighters and calling for an emergency evacuation of fire fighters. A normal withdraw action is ordered when a fire is spreading beyond the ability of fire fighters to control it. An emergency evacuation is ordered when an extremely serious emergency has occurred or is about to happen, such as missing fire fighter(s), explosion, or collapse. In an emergency evacuation, unlike a withdraw, fire department tools and hose are left behind and a roll call or a head count must be conducted as there may be a missing fire fighter. An emergency evacuation is a rare occurrence in the fire service, and because of its rarity confusion and delay usually occur when it is ordered. For this reason, there should be a prearranged signal, tone, or sound to alert fire fighters of an emergency withdraw; fire departments should train their members for an emergency evacuation upon receipt of the signal. Fire fighters should immediately exit the structure upon receipt of the prearranged signal, leaving behind tools and equipment, which can be removed later. Incident commanders should use the prearranged emergency evacuation signal or tone whenever they decide conditions are unsafe for interior fire fighting or an accident or emergency has occurred with a fire fighter.

Recommendation #6

> *Fire departments should ensure sufficient personnel are available and properly functioning communications equipment are available to adequately support the volume of radio traffic at multiple-responder fire scenes.*

Discussion

Fire ground communications at the fire scene became ineffective at times because of electronic problems and excessive communications. Throughout the course of a fire attack, incident command is unable to communicate effectively and receive all radio signals from fire fighters on-scene because of problems with the communication equipment. In the control of communications, the human factor is the deciding element. During the course of the operations, incident command must be heard and also must hear everyone on-scene. All members at an incident should follow the radio communication guidelines, keeping transmissions short, specific, and clear. However, these areas can't be complete if electronic problems occur. Therefore, fire departments should implement a backup communications plan to avoid unanticipated equipment problems at the fire scene. The plan should include backup electronic equipment, additional channels, training, and

consideration of face-to-face communication or the utilization of runners to communicate an important message if radio communication fails.

Recommendation #7

> *Fire departments should consider placing a bright, narrow-beamed light at the entry portal to a structure to assist lost or disoriented fire fighters in emergency egress.*

Discussion

In a dark, smoky environment, fire fighters often become lost or disoriented and all too often they are unable to escape. A bright, narrow-beamed light at the entry point could possibly assist fire fighters in emergency egress situations, i.e., when lost or disoriented. This investigation revealed that a light assisted some fire fighters in an emergency egress situation when they spotted the flashlight of Engine 57's Engineer.

NIOSH Case Study #3: Arizona

Supermarket Fire Claims the Life of One Career Fire Fighter and Critically Injures Another Career Fire Fighter

NIOSH – Fire Fighter Fatality Investigation and Prevention Program July 25, 2002

Summary

On March 14, 2001, a 40-year-old male career fire fighter/paramedic died from carbon monoxide poisoning and thermal burns after running out of air and becoming disoriented while fighting a supermarket fire. Four other fire fighters were injured, one critically, while fighting the fire or performing search and rescue for the victim. The fire started near a dumpster on the exterior of the structure and extended through openings in the loading dock area into the storage area, and then into the main shopping area of the supermarket. The fire progressed to five alarms and involved more than 100 personnel. Fire fighters removed the victim from the structure and transported him to a local hospital where he was pronounced dead.

NIOSH recommends:

Ensure that the department's standard operating procedures (SOPs) are followed and continuous refresher training is provided to ensure that a proper size-up, using common terminology, is conducted by all fire fighters responsible for reporting interior/exterior conditions to the Incident Commander (IC).

Ensure that preincident plans are established and updated on mercantile occupancies in their district.

Ensure that fire fighters manage their air supplies as warranted by the size of the structure involved.

Instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped.

Ensure that multiple Rapid Intervention Crews (RIC) are in place when an interior attack is being performed in a large structure with multiple points of entry.

Consider placing fire fighter identification emblems on the fire fighters' helmet and turnout gear.

Consider placing a bright, narrow-beamed light at all entry portals to a structure to assist lost or disoriented fire fighters in emergency egress.

Additionally, building owners should consider upgrading or modifying structures to incorporate new codes and standards to improve occupancy and fire fighter safety.

Fire departments should consider as a part of their preincident planning, educating the public they serve on the importance of building owners, building personnel, or civilians immediately reporting any fire conditions to the first-arriving fire company on the scene.

Manufacturers and research organizations should conduct research into refining existing and developing new technology to track the movement of fire fighters inside structures.

Introduction

On March 15, 2001, the International Association of Fire Fighters (IAFF) and the United States Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of the incident. The fire department involved also notified NIOSH of the incident, and the Chief of the department requested that NIOSH evaluate the self-contained breathing apparatuses (SCBAs) worn by the victim and the four injured fire fighters. During March 25 to April 1, 2001, three occupational safety and health specialists from the NIOSH Fire Fighter Fatality Investigation and Prevention Program and the Chief of the Surveillance and Field Investigations Branch investigated this incident. NIOSH investigators met with the Chief and his staff, the department fire marshal, representatives from the IAFF, a city attorney, and special agents from the Bureau of Alcohol, Tobacco and Firearms. The investigators interviewed officers and fire fighters involved in the incident. They reviewed the department's standard operating procedures (SOPs), the victim's and injured firefighters' training records, dispatch tapes and transcripts, tactical and accountability worksheets, and the department's report of the incident. The investigators also reviewed photographs, drawings, and floor plans of the incident site. They conducted a site visit, and the site was photographed and videotaped. On March 28, 2001, a physical scientist from the NIOSH Division of Respiratory Disease Studies conducted an evaluation of the department's SCBA maintenance program. As part of the investigation, NIOSH agreed to examine and evaluate five 3000 psi, 30-minute, self-contained breathing apparatus(SCBA). These SCBA were last used during interior fire-fighting operations at a structure fire on March 14, 2001. A summary of the report is attached as Appendix I. A follow-up visit was conducted by the three occupational safety & health specialists during June 18 to 24, 2001, to interview the officers of the command team involved in this incident. The fire department consists of 1,549 employees, of whom 1,258 are uniformed fire fighters. The department has 45 stations that serve a population of about 1.3 million in a geographical area of approximately 477 square miles.

Training and Experience

The department requires all fire fighters to complete a 12-week basic training program that meets the National Fire Protection Association (NFPA) Level I and Level II certification. The victim had 8 years of fire-fighting experience and NFPA Level I and Level II certification, and he was a certified paramedic. The critically injured fire fighter was a 35-year-old male fire fighter/paramedic with 4 years of experience. Three other fire fighters, who were not critically injured, had the following ages, ranks, and years of experience: a 40-year-old male fire

fighter/paramedic, 12 years; a 42-year-old male captain, 15 years; and a 44-year-old male fire fighter, 15 years.

Equipment and Personnel

- ❒ Initial dispatch at 1654 hours.
  - Due to the type of call (dumpster fire), only one engine on initial dispatch.
  - Engine 24 – Officer, Engineer, and two Fire Fighters.
  - Hazmat 4 – Engineer (self-dispatched and added to the call).
- ❒ Balance 2-1 at 1658 hours.
  - Engine 21 – Officer, Engineer, and two Fire Fighters.
  - Engine 14 – Officer, Engineer, and two Fire Fighters (self-dispatched and added to the call (fatal victim and one not critically injured fire fighter).
  - Ladder 24 – Officer, two Engineers, and one Fire Fighter.
  - Battalion Chief 3 – Chief Officer and one Assistant.
  - Rescue 21 – Two Fire Fighters (self-dispatched and added to the call).
  - Rescue 25 – Two Fire Fighters.
  - NOTE: This department refers to a rescue unit as an ambulance staffed with certified fire fighters and fire-fighting equipment.
- ❒ Balance (Rapid Intervention Crews [RICs] dispatched) at 1700 hours.
  - Engine 3 – Officer, Engineer, and two Fire Fighters.
  - Rescue 3 –Two Fire Fighters (injured Fire Fighter #1).
  - Utility Truck 1- Engineer.
- ❒ Balance First Alarm at 1708 hours.
  - Engine 34 – Officer, Engineer, and two Fire Fighters.
  - Engine 18 – Officer, Engineer, and two Fire Fighters.
  - Engine 25 – Officer (not critically injured), Engineer, and two Fire Fighters.
  - Engine 15 – Officer, Engineer, and two Fire Fighters.
  - Engine 4 – Officer, Engineer, and two Fire Fighters.
  - Engine 725 – Officer, Engineer, and two Fire Fighters.
  - Engine 710 – Officer, Engineer, and two Fire Fighters.
  - Ladder 26 – Officer, two Engineers, and one Fire Fighter.
  - Ladder 9 – Officer, two Engineers, and two Fire Fighters.
  - Ladder 1 – Officer, two Engineers, and two Fire Fighters.

- Battalion Chief 1 – Chief Officer and one Assistant.
- Communications Van – Engineer.
- Car 957 – Safety Officer.
- Car 94 – Division Chief/Safety Officer.
- Car 56 – Fire Marshal.
- NOTE: Additional chiefs and district safety officers also responded as a part of the first alarm.

❒ Second-alarm Companies at 1725 hours.

- Engine 30 – Officer, Engineer, and two Fire Fighters (not critically injured).
- Engine 1 – Officer, Engineer, and three Fire Fighters.
- Engine 6 – Officer, Engineer, and two Fire Fighters.
- Engine 9 – Officer, Engineer, and two Fire Fighters.
- Ladder 11 – Officer, two Engineers, and one Fire Fighter.
- Ladder 20 – Officer, two engineers, and one Fire Fighter.
- Battalion Chief 5 – Chief Officer and one Assistant.
- Battalion Chief 2 – Chief Officer and one Assistant.
- Battalion Chief 4 – Chief Officer and one Assistant.
- Battalion Chief 6 – Chief Officer and one Assistant.
- Additional units were dispatched on subsequent alarms; however, only those units directly involved in the fatal event are discussed in the investigation section of this report.

Structure

The structure was a 27,905-square-foot, L-shaped supermarket that was part of a strip mall (Diagram 2).

The structure had a slab concrete foundation and masonry block walls with steel beams and posts. The roof system consisted of open web steel trusses covered with wood, foam, and tar asphalt roofing. The ceiling height throughout the supermarket and lower-level storage area was approximately 20 feet. Second-floor platforms located above the coolers and the first-floor storage areas contained offices and storage areas. The main entrance to the supermarket was located on the eastside. The only other doors were a standard 3-foot wide steel exterior man-door and a 6-foot-wide steel roll-up door located on the south side. The layout of the supermarket is illustrated in Diagram 3. The supermarket was not equipped with a sprinkler system.

NOTE: The supermarket originally was constructed outside the city limits. The building was later annexed into the city but was not required to have a sprinkler system installed.

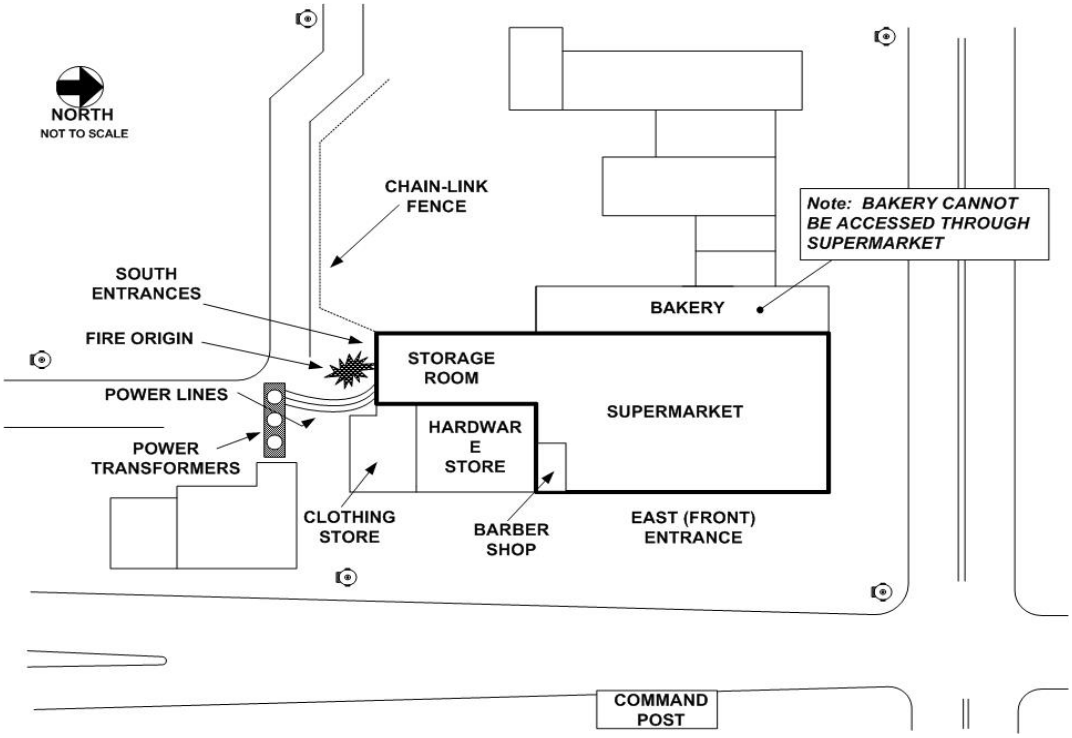


Diagram 2: Strip Mall Layout

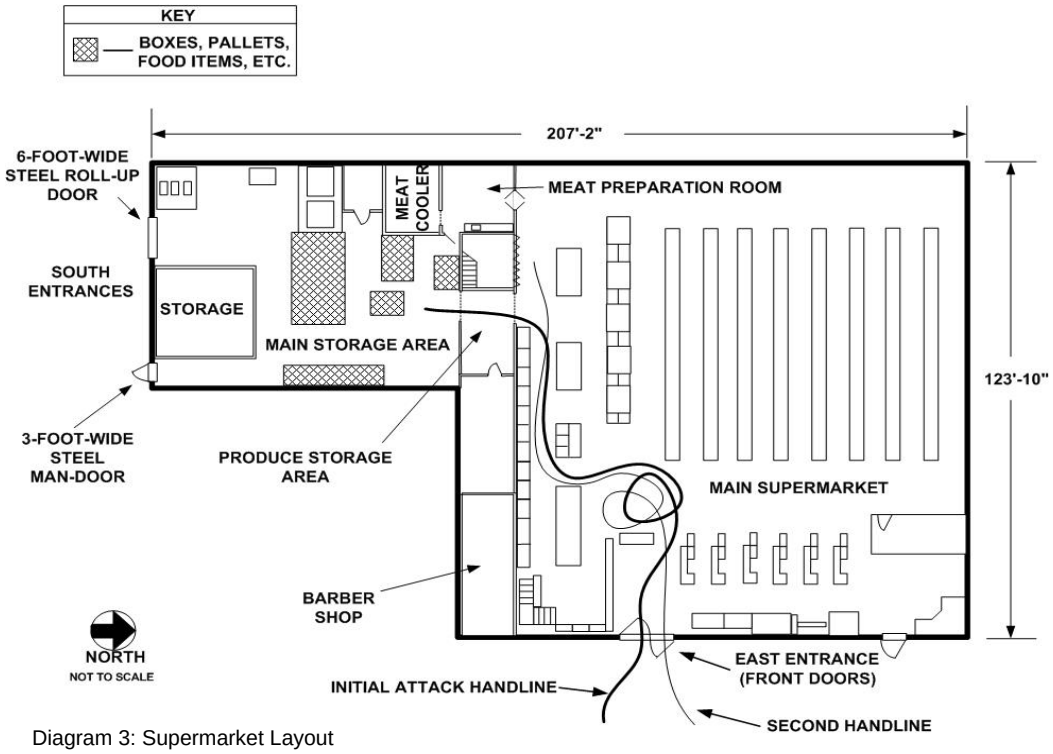


Diagram 3: Supermarket Layout

Investigation

On March 14, 2001, at 1654 hours, Engine 24 responded to a reported exterior cardboard fire at a supermarket. The Hazmat 4 engineer (who was in the area while returning from another call) arrived on the scene at 1657 hours and during initial size-up discovered the cardboard fire with exposure to the building. The engineer also noted that an electrical service drop into the supermarket was directly above the fire (Diagram 2). Hazmat 4 requested that central dispatch balance the alarm to a 2-1, and at 1658 hours, central dispatch balanced the alarm with Engine 21, Ladder 24, Battalion Chief 3 (BC3), and Rescue 25. Engine 14 and Rescue 21 self dispatched and responded to the scene.

Engine 24 arrived at 1700 hours, and the captain assumed command (IC). The Hazmat 4 engineer evacuated civilians from the supermarket and surrounding stores in the strip mall. BC 3 arrived on the scene and assumed the IC position and reassigned the Engine 24 captain as the west sector officer. The Engine 24 crew stretched a handline to the south side of the structure to attack the cardboard fire (Photo 7).

Photo 7: South Entrances of Supermarket

Because the service drop was arcing, the Engine 24 captain pulled his crew away from the building, and the IC requested central dispatch contact the power company to shutdown the power grid.

NOTE: The IC and first-arriving units were unaware that the supermarket was L-shaped and could be accessed from the east and south sides of the building. The east side was the main entrance to the shopping area of the supermarket and the south side, directly behind the clothing and hardware stores, was the location of the man-door and roll-up door entrances to the main storage area of the supermarket (Photo 8).

Photo 8: Main Storage Room

A supermarket employee stated in a police report that because of the large amount of fire emitting through the man-door and into the structure, he had begun moving propane cylinders and other merchandise away from the door before fire fighters began arriving on the scene. While he was moving the merchandise, the employee became aware that the fire had quickly spread to the interior and into the roof members. According to statements, this information was not reported to the fire fighters upon their arrival.

At 1702 hours, Engine 21 and Engine 14 arrived on the scene, followed by Rescue 25 and Ladder 24 at 1703 hours. Ladder 24 was assigned the roof sector to search for fire extension and to ventilate. Crews from Engine 21 and Rescue 21 checked the clothing and hardware

stores for fire extension and civilians. Fire fighters found no fire extension or civilians in either store; however, they found heavy smoke conditions in the rear of the hardware store. The Engine 14 crew, including the victim, were ordered into the east side (front) of the supermarket to check for fire extension and civilians.

At 1707 hours, Engine 3 arrived on the scene as the designated Rapid Intervention Crew (RIC). After the Engine 3 officer reported heavy smoke emitting from the west side of the supermarket, the IC reassigned them to advance a handline into the bakery on the west side to check for fire extension. Because the fire had extended into the structure, the IC requested that central dispatch balance the initial call to a first alarm.

The electrical power to the south side of the building was shutoff, allowing crews to gain access through the roll-up door. The officer from Engine 24 was reassigned as south sector officer after reporting to the IC that heavy smoke was emitting from the wall vents on the west and south sides.

While Engine 14 crewmembers were searching the supermarket in the main shopping area, they encountered a light haze of smoke banked down to approximately 4 feet below the ceiling. In the produce preparation area, which led into the storage area, they encountered a thick, black smoke accompanied by heat. At 1709 hours, the officer from Engine 14 reported the conditions to the IC and informed him that the Engine 14 crew was stretching a handline into the supermarket.

At 1711 hours, the crew from Engine 14, the officer and two fire fighters from Engine 3, and the crew from Rescue 3 advanced two handlines through the east-side (front) entrance. At 1712 hours, the IC assistant confirmed to the IC that they had a working interior fire. The south sector officer reported to the IC that crews from Rescue 25 and Engine 24 were advancing two handlines through the roll-up door into the storage area, where they encountered heavy smoke banked down to floor level. The IC radioed back a caution that Engine 14 was operating on the opposite side of the storage area and that they should be aware of opposing streams.

At 1714 hours, Engine 14, Engine 3, and Rescue 3 advanced a handline into the produce storage area, and Engine 3 advanced a second handline through the supermarket toward the meat preparation room, which was located along the west wall of the structure (Diagram 3). Conditions in the supermarket deteriorated as the structure began to fill with thick, black smoke. The crew from Engine 14, an officer and fire fighter from Engine 3, and a fire fighter from Rescue 3 were operating in the produce storage area (Photo 9). Another fire fighter from Rescue 3 (injured fire fighter #1) and crewmembers from Engine 3 were on the second handline in the supermarket. NOTE: The crew from Ladder 24 cut a 6-foot by 6-foot ventilation hole in the roof over the storage area and then exited the roof because they were running low on air.

At approximately 1719 hours, central dispatch notified the IC that 25 minutes had elapsed. Additional crews were arriving on the scene, including the Command Van with support staff.

Photo 9: View of Produce Storage Area

The South Sector officer sent reports of heavy heat and smoke coming from the south-sector interior. At 1725 hours, the IC radioed central dispatch and requested the balance of a second alarm. The IC began assigning on-scene and arriving units to the west exposure and to the east side of the strip mall in preparation for the transition from an offensive to a defensive operation. The crews from Engine 14, Engine 3, and Rescue 3 told NIOSH investigators that while they were operating in the main supermarket, the produce storage area, and the rear storage area, the heat was intensifying and the thick, black smoke was banked down to floor level. A fire fighter from Rescue 3 and a fire fighter from Engine 3, who were in the main supermarket area, noticed that the fire along the ceiling was intensifying. The crew members from Engine 14 and fire fighters from Engine 3 and Rescue 3, who were operating in the produce storage area, pulled ceiling and searched for fire extension. At this point, the victim told his officer that he was low on air. The officer from Engine 14 pulled his crew together and told them that they would follow the handline as a crew out of the building. Another Engine 14 crew member also reported to the officer that he was low on air.

The engineer who was originally on the nozzle led the exiting crew, followed by the victim, a fire fighter, and the officer. As they were following the handline out of the produce storage area, the victim and the fire fighter following him fell over some debris and became separated from the handline. The officer from Engine 14, still in the storage area, fell backward over debris and became disoriented, and the officer from Engine 3 put him back on the handline and sent him in the direction of the exit. Meanwhile, the victim and fire fighter from Engine 14, both back on their feet, walked into a wall and fell again. NOTE: It is believed that the victim and the Engine 14 fire fighter had stumbled into the main supermarket shopping area and were moving toward the meat preparation room. As the victim began moving quickly about the shopping area, the fire fighter grabbed his coat to stay with him. Simultaneously, the Engine 14 officer's low-air alarm began to vibrate, and he ran out of air as he approached the east (front) door. As he exited, he encountered the engineer from his crew who had preceded the victim and the fire fighter from Engine 14 on the handline.

The victim and the fire fighter realized they were lost and decided to radio a Mayday. The fire fighter attempted to radio the Mayday, but his transmission was unsuccessful. The victim then successfully radioed the Mayday on his radio. The IC immediately radioed the Engine 18 and Ladder 9 crews and ordered them to assume the RIC duties. Hearing the radio call, the officer from Engine 14 told the officer from Engine 21 to follow the handline to the area where his crew had been operating.

The officer from Engine 14 sent the crew from Engine 21 into the supermarket through the east (front) door to search for the lost fire fighter. NOTE: The Engine 14 officer thought that only one member of his crew was unaccounted for. The fire fighter from Engine 14 became separated from the victim near the meat preparation room. The fire fighter reentered the meat preparation room just as he ran out of air. He heard the radios of other fire fighters (officer and fire fighter from Engine 34) and moved toward them in the main storage area. The fire fighter had become debilitated by the smoke and was assisted out the man-door on the south side of the building by the officer and a fire fighter from Engine 34. Fire fighters assumed that they had rescued the victim; however, once the fire fighter from Engine 14 was removed from the building, fire fighters soon realized that the victim was still inside. The fire fighter from Engine 14 was later transported to a local hospital where he was admitted for treatment of smoke inhalation.

At 1729 hours, the victim radioed a transmission to the crews asking them not to back out because he needed help. The IC radioed back asking for his location. The victim replied that he was in the rear behind something, out of air, and down on the ground sucking in smoke. The IC advised him to stay calm and told him that crews were on their way to assist him. At approximately 1730 hours, the officer from Engine 21 heard someone yelling in the vicinity of the produce storage area. As he followed the voice, he ran into the victim, who was standing near one of the initial attack lines in the main supermarket area. The officer grabbed the victim, asked him to identify himself, and attempted to place him on the

handline. The victim, who had removed his regulator from his facepiece because he was out of air, was resistive and reportedly appeared disoriented. On a second attempt, the officer was able to get the victim on his knees and on the handline. Soon after, the victim stood up, turned, and quickly moved toward the rear of the supermarket as the Engine 21 officer attempted to grab him and keep him on the handline. It is believed that the victim headed back toward the meat preparation room. A fire fighter from Rescue 3 who was in the main storage area, upon hearing the victim's voice, headed toward the sound and ran into the victim just outside the swinging door that led from the main storage area into the meat preparation room. The victim told the Rescue 3 fire fighter that he was out of air, and the fire fighter told him to stay calm and follow him. The victim turned and headed away from the fire fighter toward the meat preparation room as the fire fighter grabbed the victim and told him that he was going the wrong way. As the victim turned, he knocked the Rescue 3 fire fighter down and the two became separated. Returning to his feet, the fire fighter tried to find the victim but ran out of air and was forced to leave the building.

NOTE: During this time, the IC made numerous attempts to contact the victim to tell him to activate his Personal Alert Safety System (PASS);however, the victim did not respond. Injured Fire Fighter #1, who was low on air, was about to exit when he heard the victim's voice coming from the direction of the meat preparation room. He followed the victim's voice until he met up with the victim in the meat preparation area. Injured Fire Fighter #1 radioed the IC at 1734 hours that he had found the victim, that they were by themselves, and that they were both out of air. Injured Fire Fighter #1 ran out of air, partially removed his facepiece, and pulled his hood over his face. NOTE: At this point, Injured Fire Fighter #1 was near the meat cooler while the victim was about 8 feet away in the meat preparation room (Diagram 4). The victim's PASS was not sounding at this time. At 1735 hours, the IC ordered fire fighters to break out (ventilate) the windows on the east (front) side.

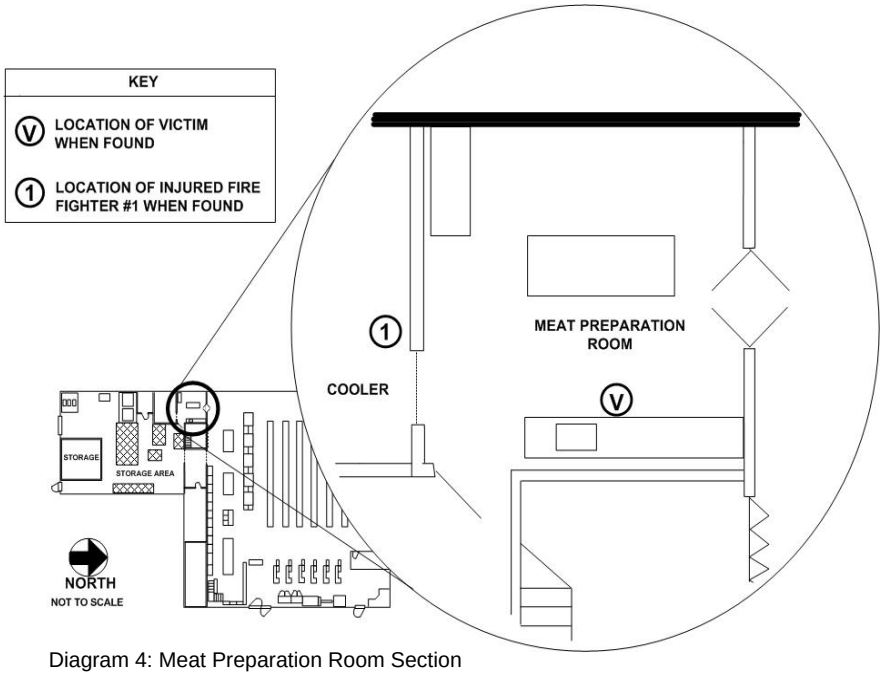


Diagram 4: Meat Preparation Room Section

At 1736 hours, the IC believed that the victim had been rescued and removed from the building. This "victim" was really the fire fighter from Engine 14 who had been with the victim. The IC ordered all fire fighters out of the building because he ordered fire-fighting operations to change from offensive to defensive. Note: After crews exited the building, flames engulfed the east side of the supermarket, preventing any further entry through the east (front) door. From this point forward, all rescue crews entered and exited through the two doors on the south side of the building. Safety officers posted at the man-door and roll-up door controlled access and assignments of rescue crews. The officer from Engine 25, now operating in the main storage area, followed a path to the meat cooler and found Injured Fire Fighter #1 (Diagram 4 and Photo 10).

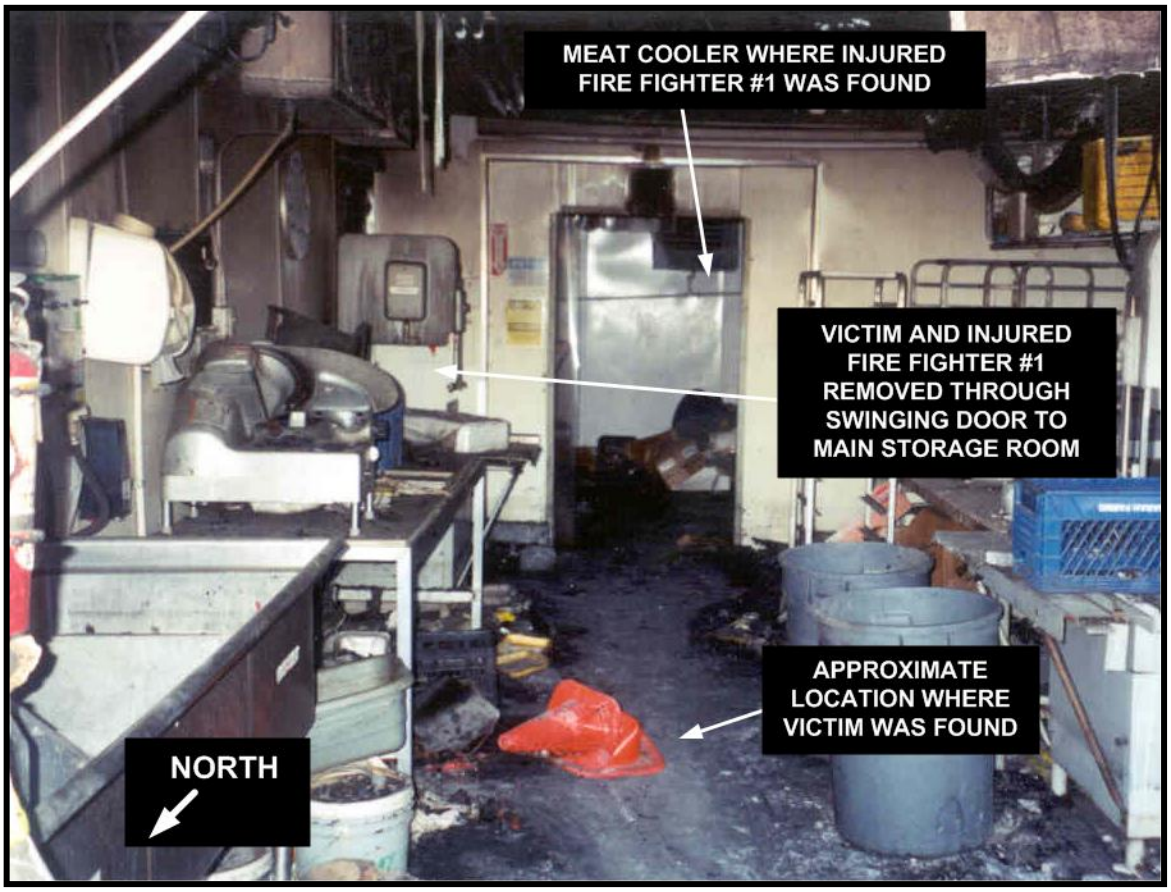


Photo 10: Meat Preparation Room

The officer radioed the IC that he had one fire fighter down and that he needed assistance. The officer made a second transmission that he and his crew had found the victim and that they were bringing him out. NOTE: When the Engine 25 officer referred to Injured Fire Fighter #1 as "one fire fighter down," his crew and IC believed that he was referring to the victim, not another downed fire fighter. The officer passed Injured Fire Fighter #1 to his crew in the

main storage area, and they took him out of the building through one of the doors on the south side. Note: A fire fighter, who was among the fire fighters outside the building, recognized that Injured Fire Fighter #1 was not the victim. The officers and IC then realized that the victim was still inside. At 1739 hours, the IC ordered all fire fighters off the roof and out of the building because they were going defensive as soon as the victim was out. NOTE: Before the Engine 25 officer passed Injured Fire Fighter #1 to his crew, Injured Fire Fighter #1 told the officer that the victim was nearby. As the IC was ordering fire fighters out, the Engine 25 officer located the victim in the meat preparation room. The victim was unresponsive, and his PASS device was sounding. The Engine 25 officer, who was alone with the victim, made an emergency transmission that was not received by the IC. At 1740 hours, an officer from Engine 4 heard the transmission and radioed that a fire fighter was down in the southwest corner. The Engine 25 officer, unable to move the victim, ran out of air, removed his facepiece and regulator, and attempted to crawl out of the building. Simultaneously, crews from Engine 6 and Engine 710 entered the south side of the building and proceeded toward the produce storage area. As crewmembers from Engine 6 neared the produce storage area, they heard a PASS device sounding from their left (meat preparation room). The Engine 6 crew encountered the officer from Engine 25 (his PASS device was not sounding) and passed him to the Engine 710 crew, who assisted him out of the building. The Engine 25 officer, the third fire fighter to become injured, was transported to a local hospital and treated for smoke inhalation.

The Engine 6 crew continued toward the sounding PASS device and found the victim lying unconscious on his back with his facepiece partially removed. They checked the victim for a pulse and could not find one. Numerous crews participated in the removal of the victim from the building. Fire fighters were hampered in their removal efforts by the victim's size (he was 6 feet, 4 inches tall, and he weighed about 289 pounds [in addition to the weight of his gear]) and the amount of debris blocking their path through the main storage area to the south-side roll-up door. Approximately 19 minutes elapsed from the point when fire fighters found the unconscious victim to the point when the victim was removed from the building. Fire fighters immediately began cardiopulmonary resuscitation(CPR) and advanced life support (ALS) on the victim at the scene.

Injured Fire Fighter #1 (the critically injured firefighter from Rescue 3), was transported to a local hospital for treatment of smoke inhalation. At the hospital, his carboxyhemoglobin level was measured at 29 percent. Three other fire fighters who had suffered smoke inhalation, a fire fighter from Engine 14, an officer from Engine 25, and a fire fighter from Engine 30, were treated at a local hospital and released.

Cause of Death

The medical examiner listed the victim's cause of death as thermal burns and smoke inhalation. The victim's carboxyhemoglobin level was listed at 61 percent at the time of death.

Recommendations/Discussions

Recommendation #1

Fire departments should ensure that the department's standard operating procedures (SOPs) are followed and continuous refresher training is provided.

Discussion

The purpose of the department's SOP is to account for all fire fighters on the fireground. This SOP provides the command staff a means to track and account for all fire fighters. The following guidelines within this SOP should be followed:

- ❒ All companies should follow orders, stay together, and report any changes to the Incident Commander.
  - This will allow the IC to maintain an accurate tracking and awareness of where resources are committed at an incident and the accountability of all personnel.
- ❒ Sector officers are assigned as needed and the sector officers respond accordingly.
  - Sector officers are responsible for maintaining an accurate tracking and awareness of crews assigned to them. This will require the sector officer to be in his/her assigned area and maintaining close supervision of assigned crews.
- ❒ Company officers shall maintain a current electronic roster of personnel responding on the apparatus.
- ❒ All crews will work for Command or Sectors –no free-lancing.
- ❒ Crews arriving on the scene should remain intact.
  - Two or more members will be considered a minimum crew size.
  - Each member must have a radio.
- ❒ All crews entering a hot zone must have a supervisor.
- ❒ All crews will go in together, stay together, and come out together.
  - Reduced visibility and increased risk will require very tight togetherness.
- ❒ The IC is immediately notified of any fire fighters who are not accounted for.
- ❒ Fire conditions and strategies are continuously evaluated.
- ❒ Fire fighters make clear reports when a Mayday is transmitted.
- ❒ Lost or trapped fire fighters manually activate their PASS device.
- ❒ Fire fighters always remain in contact with the hoseline or lifeline and use it as a guide to exit.
- ❒ Fire companies should complete preincident plans.
  - Refresher training should be provided to all fire fighters on a regular basis or as needed when changes are made to the department's SOPs.

Recommendation #2

Fire departments should ensure that a proper size-up, using common terminology, is conducted by all fire fighters responsible for reporting interior/exterior conditions to the Incident Commander (IC).

Discussion

A size-up should be a systematic process to determine the critical fireground factors that lead to the strategy and development of attack. The size-up should consist of observing the fireground factors, a risk management plan, determining the proper strategy, developing an Incident Action Plan (IAP) and the deployment of personnel. A proper size-up can only be conducted by fire fighters that are trained to identify a common understanding of fire conditions (interior/exterior) and are able to communicate the findings using standardized terminology that is understood by all fire fighters. The size-up should not be delayed or be a time-consuming process but should continue throughout operations. The initial size-up will provide information to the IC that will be crucial for determining the appropriate action.

When dealing with large structures, such as a strip mall, all fire fighters should conduct their own size-up for their personal safety. When conducting a size-up, all fire fighters should be aware and report to the IC any condition or variable that could possibly affect the strategy. For example, when the roof crew gets on the roof and finds that the building incorporates a fire wall, the officer or fire fighters should immediately radio the IC and report where the fire wall is and where it goes. This will provide information to help the IC determine the layout of the interior sections of the large structure or in this case, strip mall.

Just as importantly, an interior size-up should be conducted by an officer or senior fire fighter and reported to the IC. Since the IC is staged at the command post (outside), the interior conditions should be communicated as soon as possible to the IC. Interior conditions could change the IC's strategy or tactics. For example, if heavy smoke is emitting from the exterior roof system, but fire fighters cannot find any fire in the interior, it is a good possibility that the fire is above them in the roof system. It is important for the Incident Commander to immediately obtain this type of information to help make the proper decisions.

A proper size-up begins from the moment the alarm is received, and it continues until the fire is under control. Several factors must be evaluated in conducting the size-up, e.g., type of structure, time of day, contents of the structure, potential hazards, etc. The size-up should also include risk versus gain during incident operations. The following factors are important considerations:

- ❒ Occupancy type involved and rescue possibilities.
  - The type of occupancy can have a great effect on the aspects of the fire attack. The type of occupancy could assist in determining the structure's layout, hazardous materials, and the possibility of civilians (e.g., civilians will be present in a hospital around the clock).

- Smoke conditions.
  - The smoke conditions can provide the Incident Commander with additional information about the fire. For example, if the fire is in the roof and burning roofing materials, the smoke would probably appear to be thick and black.
- Type of construction.
  - The type of construction will be one of the most important areas to identify. The type of structure could provide the Incident Commander information such as how the building may hold up under fire conditions or if the building is generally subject to collapse under fire conditions.
- Type of roof system.
  - The roof system should be one of the first things that is determined before fire fighters enter a burning structure. One type of roof system is the lightweight truss roof. The structural goal of the lightweight truss is to distribute loads over a large area.
- Age of structure.
  - The Incident Commander should ascertain the age of the building when determining strategy or tactics. The age of the structure can provide the Incident Commander with information to help determine the building's integrity or other vital information such as construction methods or construction materials.
- Exposures.
  - The Incident Commander should evaluate the whole picture. The protection of exposures near or connected to a burning building should be included in the strategic plan.
- Time considerations.
  - Information such as time of incident, time fire was burning before arrival, time fire was burning after arrival, and type of attack, is some of the most important information the Incident Commander should have.

Recommendation #3

Fire Departments should ensure that preincident plans are established and updated on mercantile occupancies in their district.

Discussion

NFPA 1620 states that "Preincident planning in a mercantile occupancy involves not only the emergency responders, but administrators, section or department supervisors, and other staff members." The primary purpose of a preincident plan is to help responding personnel effectively manage emergencies with available resources. Preincident planning involves identifying the protection systems, building construction, contents, and operating procedures that can impact emergency operations. The construction of the building in terms of the size of the building (both vertical and horizontal), building features (fire walls, fire

barriers, roofs, and floors),access points, areas where products of combustion could spread due to a lack of structural barriers (e.g., stock areas), and building services, should be determined. Strip shopping centers or rows of attached mercantile occupancies have common walls.

Most occupancies present an ever-changing environment making ongoing maintenance of the preincident plan as critical as the original development of the plan. Where conditions indicate that a change in a preincident plan is warranted, the plan should be updated and distributed to the appropriate persons and agencies.

A system to utilize the preincident plan should be designed to allow access to the plan, or a summary with key elements of the plan, while in route and during the incident. Some supplemental detailed information such as building plans can be kept in a lock box or other secured area.

Recommendation #4

Fire departments should ensure that fire fighters manage their air supplies as warranted by the size of the structure involved.

Discussion

Air consumption will vary with each individual's physical condition, the level of training, the task performed, and the environment. Depending on the individual's air consumption and the amount of time required to exit a hostile environment, the low air alarm may not provide adequate time to exit. Working in large structures (high rise buildings, warehouses, and supermarkets) require that fire fighters be cognizant of the distance traveled and the time required to reach the point of suppression activity from the point of entry. When conditions deteriorate and the visibility becomes limited, fire fighters may find that it takes additional time to exit when compared to the time it took to enter the structure.

Recommendation #5

Fire Departments should instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped.

Discussion

As soon as a fire fighter becomes lost or disoriented, trapped ,or unsuccessful at finding his/her way out of a hazardous situation (e.g., interior of structure fire), he or she must recognize that fact and initiate emergency traffic. He or she should manually activate his or her personal alert safety system (PASS) device and announce "Mayday-Mayday" over the radio. A "Mayday-Mayday" call will receive the highest communications priority from Dispatch, Incident Command, and all other units. The sooner Incident Command is notified and a RIC is activated, the greater the chance of the fire fighter being rescued. Fire fighters

should initiate emergency traffic while they are still capable and not wait until they are too weak or low on air to call for help.

Recommendation #6

> *Fire departments should ensure that multiple Rapid Intervention Crews (RIC) are in place when an interior attack is being performed in a large structure with multiple points of entry.*

Discussion

Typically, a RIC is designated to stand by and monitor activity in case an emergency situation should occur. A RIC should consist of at least two fire fighters and should be available for rescue of a fire fighter or a team if the need arises. It would be ideal to have a full company or a minimum of four fire fighters make up the RIC; however, this may not be possible due to staffing issues. In large structures, multiple RICs should be established and possibly positioned in different sectors. When RICs enter large structures, they may use the majority of their air supply trying to locate an injured, down, or disoriented fire fighter. For this reason, backup RICs should be in place to replace the initial RIC when they exit. The RICs should be fully equipped with the appropriate protective clothing, protective equipment, SCBA, and any specialized rescue equipment that might be needed, given the specifics of the operation underway. Once a RIC is established, they should remain the RIC throughout the operation. They should constantly survey the fireground operations and be in communication at all times with the IC and companies on the fireground. As fireground operations continue, the RIC teams should observe the following:

- ❒ Where fire fighters are entering and exiting.
- ❒ How many fire fighters are inside.
- ❒ Where the fire fighters are operating.
- ❒ What operations are taking place.
- ❒ The layout of the structure.
- ❒ The structure (i.e., trussed roof, metal roof, etc.) and hazards that could exist with the structure (i.e., possible collapse areas, etc.).
- ❒ Hazards they might encounter (i.e., chemicals, tanks, etc.).
- ❒ The fire's condition (i.e., fire spread, fire in the roof, etc.).
- ❒ If an emergency occurs, what will be their best route to enter or exit.
- ❒ What equipment they will need if an emergency occurs (i.e., airbags, hydraulic jacks, additional air bottles, etc.).

Each incident is different, and additional concerns should also be taken into consideration. Many functions are expected from the RIC members during an incident. If an emergency occurs, the RIC(s) should have full air bottles, a good understanding of the overall situation, and be able to respond in a safe manner to perform the search or rescue. If the RIC is used

for an emergency operation, a second RIC should be put in place in case an additional emergency should occur. Note: Fire departments should ensure that they assess all risk factors when making the decision to send a RIC into a structure that has already been the scene of an emergency evacuation, search, or rescue.

- ❒ Fire fighters should consider using a hoseline or a rope bag with luminescent lights to mark a victim's location if an injured or down fire fighter cannot be removed and firefighters have to exit without the victim.

A part of the RIC's equipment should be a hoseline or rope bag with luminescent lights. When an injured or down fire fighter is located by a RIC and they cannot remove the fire fighter, a hose line or rope bag with luminescent lights could be used to mark the victim's location for other RICs to follow. If the victim's PASS device has been turned off to protect communications, the RICs should ensure that the PASS is reactivated when rotating out.

- ❒ Fire departments should ensure that fire fighters receive continuous training for search-and-rescue operations.

RICs will be mostly responsible for search-and rescue operations; however, it may be hard to predict who the RIC will be in some cases. For this reason all fire fighters should be familiar with the RIC operations and the different situations they may encounter. Fire fighters should be given training to save other fire fighters and/or themselves in emergency situations. When a fire fighter becomes injured, low on air, disoriented, or is exposed to high levels of carbon monoxide, it is hard to predict how the fire fighter may react. This should be covered in the training and a plan of action should be developed and implemented to deal with such rescues. Alternatively if staffing is available, fire departments should designate rescue companies whose main purpose on the fireground is to support fire operations and conduct search and rescue of fire fighters.

Recommendation #7

Fire departments should consider placing fire fighter identification emblems on the fire fighters' helmet and turnout gear.

Discussion

When fire fighters enter smoke-filled structures the visibility is usually very poor, thereby reducing the possibilities of easily identifying each other. Some fire departments color code their helmets so fire fighters, officers, or the chief can be easily identified on the fireground. Fire departments can also use name, number, or company emblems to identify each individual fire fighter on the fireground. This could assist fire fighters on the fireground to identify a lost or disoriented fire fighter. The fire department involved in this incident provides station uniforms (T-shirts) that are labeled with each fire fighter's name. During this incident, rescue crews removed the T-shirts from the unconscious firefighter (Injured Fire Fighter #1), making it difficult to determine who the rescued fire fighters were.

Recommendation #8

> *Fire departments should consider placing a bright, narrow-beamed light at all entry portals to a structure to assist lost or disoriented fire fighters in emergency egress.*

Discussion

In a dark, smoky environment, fire fighters often become lost or disoriented, and all too often they are unable to escape. A bright, narrow-beamed light at the entry point could possibly assist fire fighters in emergency egress situations, i.e., when lost or disoriented. Past NIOSH investigations have revealed that a light placed at the entry portals assisted some fire fighters in emergency egress situations.

Recommendation #9

> *Building owners should consider upgrading or modifying structures to incorporate new codes and standards to improve occupancy and fire fighter safety.*

Discussion

Building codes and standards have been developed which are used as guidelines for new building design and construction. Unfortunately, before municipalities adopted or enforced specific codes and standards, many buildings were designed and constructed without incorporating such standards. New or improved codes have been established which can improve the safety of existing structures. Sprinkler systems are one specific area of concern for large structures. It is proven that sprinkler systems reduce the loss of property and life. There is also a strong possibility that sprinklers could reduce fire fighter fatalities since they contain, and even extinguish, fires before the arrival of the fire department. Sprinklers are currently the most proactive fire safety approach in building construction. The structure involved in this incident did not have a sprinkler system.

Recommendation #10

> *Fire departments should consider as part of their preincident planning, educating the public they serve on the importance of building owners, building personnel, or civilians immediately reporting any fire conditions to the first-arriving fire company on the scene.*

Discussion

Fire growth or conditions is one of the most important pieces of information for the first-arriving fire company on the scene of any fire. If possible, the person who witnessed the fire should stand by in a safe location until the first arriving fire company arrives on the scene. NFPA 1620, 2-3.3, suggests that the preincident plan should provide for available facility

personnel to advise responding personnel of current conditions upon arrival. The current conditions reported would include; the location of the fire, the approximate time the fire started, the fire's growth, the fire's condition, and if possible, the layout of the structure. This will help the fire fighters decide their tactics and strategy to attack the fire.

The standard operating procedures for this department recommend that fire companies should complete preincident plans.

In this incident, a supermarket employee had witnessed the fire and begun removing items from the rear storeroom as the fire department responded. The witness removed several items from the storeroom before seeing the fire go up the wall and into the ceiling. The witness then exited, and seeing that the fire department had arrived, did not report the conditions to any fire department personnel.

Recommendation #11

> *Manufacturers and research organizations should conduct research into refining existing and developing new technology to track the movement of fire fighters inside structures.*

Discussion

Fire fighter fatalities often are the result of fire fighters becoming lost or disoriented on the fireground. The use of systems for locating lost or disoriented fire fighters could be instrumental in reducing the number of fire fighter deaths on the fireground. One such system, a wireless tracking system, requires locating three accurately placed spread-spectrum transmitters around a building to provide positioning information. Other systems may include a UHF radio system or an infrasound low frequency detector. Research into refining existing systems and developing new technologies for tracking the movement of fire fighters on the fireground should continue.

NIOSH Case Study #4: Virginia

Career Fire Fighter Dies in Wind Driven Residential Structure Fire

NIOSH – Fire Fighter Fatality Investigation and Prevention Program May 16, 2008
Revised June 10, 2008 to clarify Recommendation #2

Summary

On April 16, 2007, a 24-year-old male career Fire Fighter (the victim) was fatally injured while trapped in the master bedroom during a wind-driven residential structure fire. At 0603 hours, dispatch reported a single-family house fire. At 0609 hours, the victim's ladder truck was second to arrive on-scene.

Fire was visible at the back exterior corner of the residence. Noticing cars in the driveway, no one outside, and no lights visible in the house, the Lieutenant from the first-arriving engine called in a second alarm.

A charged 2½" hoseline was stretched to the front door by the first-arriving engine crew. The engine crew stayed at the door with the attack line while the cause of poor water pressure in the hoseline was determined. The victim and his Lieutenant, wearing their SCBAs, entered the residence through the unlocked front door. With light smoke showing, they walked up the stairs to check the bedrooms.

The victim and his Lieutenant cleared the top of the stairs and went straight into the master bedroom. With smoke beginning to show at ceiling level, the victim did a right-hand search while the Lieutenant with thermal imaging camera (TIC) in-hand checked the bed. Suddenly the room turned black then orange with flames. The Lieutenant yelled to the victim to get out.

While verbal communication among the crew was maintained, the Lieutenant found the doorway and moved toward the stairs. He ended up falling down the stairs to a curve located midway in the staircase. The Lieutenant tried to direct the victim to the stairs verbally and with a flashlight. As the wind gusted up to 48 miles per hour (mph), the wind-driven fire and smoke engulfed the residence. The Incident Commander (IC) ordered an evacuation and the Lieutenant was brought outside by the engine and rescue company crews. The ladder truck Lieutenant received burns on his ears and right index finger. At 0614 hours, the rescue company officer issued a Mayday followed by the victim's Mayday.

With protection from hoselines, several attempts were made by the engine and rescue company crews to reach the second floor. On the third attempt the stair landing was reached but the ceiling started collapsing and flames intensified. At 0621 hours, due to the intensity of the fire throughout the structure, all fire fighters were evacuated, operations turned defensive, but the incident continued in rescue mode. At 0657 hours, the victim was found in the master bedroom partially on a couch underneath the front windows.

NIOSH recommends:

Ensure that standard operating procedures (SOPs) for size-up and advancing a hoseline address the hazards of high winds and gusts.

Ensure that primary search and rescue crews either advance with a hoseline or follow an engine crew with a hoseline.

Ensure that staffing levels are sufficient to accomplish critical tasks.

Ensure that fire fighters are sufficiently trained in survival skills.

Ensure that Mayday protocols are reviewed, modified and followed.

Ensure that water supply is established and hoses laid out prior to crews entering the fire structure.

Ensure that fire fighters are trained for extreme conditions such as high winds and rapid fire progression associated with lightweight construction.

Additionally, municipalities should:

Ensure that dispatch collects and communicates information on occupancy and extreme environmental conditions.

Although there is no evidence that the following recommendation could have specifically prevented this fatality, NIOSH investigators recommend that fire departments: Ensure that radios are operable in the fireground environment.

Introduction

On April 16, 2007, a 24-year-old male career fire fighter (the victim) was fatally injured while trapped in the master bedroom during a residential structure fire. On April 17, 2007, the fire department, U.S. Fire Administration (USFA), and the International Association of Fire Fighters (IAFF) notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality. On May 6-9, 2007, a General Engineer and a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated the incident. Photographs of the incident scene were taken and meetings were conducted with the Battalion Chief of Health and Safety (fire department's investigating team leader), Fire Marshal, and an IAFF representative. Interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's standard operating guidelines (SOGs), the officers' and victim's training records, photographs of the incident scene, written witness statements, the coroner's report, and a weather station report. At the request of the fire department, NIOSH examined and evaluated the victim's self-contained breathing apparatus (SCBA). The SCBA was examined component by component to determine conformance to the NIOSH approved configuration. The SCBA was too damaged to test performance. (See NIOSH Appendix on at the end of this case study.)

Fire Department

The combination department has nineteen fire stations, three administrative worksites, a warehouse, and a training facility. A total of 1,478 fire and rescue personnel (452 career and 1,026 volunteer) serve a population of about 384,000 residents in a geographic area of about 348 square miles.

Personal Protective Equipment

At the time of the incident, the victim was wearing personal protective equipment consisting of turnout coat and pants, gloves, a helmet, hood, SCBA with an integrated PASS device, and he carried a radio. Given the condition of the victim's SCBA, the NIOSH post-incident evaluation could not determine if the SCBA performance contributed to the fatal incident.

Apparatus and Personnel

Dispatch reported a single family house fire at 0603 hours.

- ❒ On-scene at 0608 hours.
  - Engine #12 [E12] – Lieutenant (LT#1), Engine Operator, and a Fire Fighter.
- ❒ On-scene at 0609 hours.
  - Truck #12 [T12] – Lieutenant (LT#2), Truck Operator, and two Fire Fighters (one the victim).
  - FireMedic #12 [M12] – Lieutenant and a Fire Fighter.
- ❒ On-scene at 0610 hours.
  - Rescue #10 [R10] – Lieutenant, Driver Operator, and three Fire Fighters.
  - Engine #10 [E10] – Technician II (Acting Officer), Engine Operator, and a Fire Fighter.
- ❒ On-scene at 0611 hours.
  - Battalion Chief/Incident Commander (IC).
- ❒ On-scene at 0612 hours.
  - Engine #20 [E20] – Captain, Engine Operator, Engine Operator in-training, and two Fire Fighters.
  - Ambulance #10 [A10] – Lieutenant and two Fire Fighters.
  - Safety #02 - Safety Officer (SO).
- ❒ On-scene at 0618 hours.
  - Engine #2 [E2] – Lieutenant, Engine Operator, and two Fire Fighters.

Training/Experience

The victim had completed National Fire Protection Association (NFPA) Fire Fighter Level I and II, cardiopulmonary resuscitation, critical incident stress management, haz mat operations, Fire Fighter Survival Skills I and II, Infection Control, and several other technical courses. The victim was a career fire fighter with one year of fire-fighting experience.

The Incident Commander (IC) had completed Intermediate and Advanced National Incident Management System, Intermediate and Advanced Incident Command System,

several hazardous materials courses, and various other administrative, personnel, and technical courses. The IC is a career fire fighter with 24.5 years in the fire service at the time of the incident

Lieutenant #1 (LT#1) had completed Fire Fighter 1 and 2, Fire Officer I, Incident Officer, several hazardous materials courses, fireground tactics, and various other administrative and technical courses. LT#1 is a career fire fighter with eight plus years in the fire service at the time of the incident.

Lieutenant #2 (LT#2) had completed Fire Fighter 1 and 2, Fire Officer 1 and 2, Fire Fighter Survival Skills 1 and 2, Advanced Fire Fighter Safety Skills, several hazardous materials courses, and various other administrative and technical courses. LT#2 is a career fire fighter with eight years in the fire service at the time of the incident.

The Safety Officer (SO) had completed Fire Fighter 1, 2, and 3, Fire Officer 1 and 2, Field Officer, Incident Officer, Fire Fighter Survival Skills 1 and 2, several hazardous materials courses, and various other administrative and technical courses. The SO is a career fire fighter with a total of 16.5 years in the fire service at the time of the incident.

Building Information

The building was an approximately 6,000 square foot, two-story plus finished walkout basement, nonsprinklered residential structure that was constructed of wood framing with vinyl siding and a brick veneer front on the exterior. The residence had a large 700 square foot wood deck that ran three quarters the length of the rear of the structure on the first floor (C-side). The roof consisted of wood rafters with fiberglass shingles over oriented strand board sheathing (Photo #11).

Weather

At the time of the incident, the conditions were overcast with an approximate temperature of 45°F and a measured sustained wind speed of 25 mph from the Northwest with wind gusts up to 48 mph.

Investigation

On April 16, 2007, a 24-year-old male career fire fighter (the victim) was fatally injured while trapped in the master bedroom during a wind-driven residential structure fire. At 0603 hours, dispatch reported a single family house fire. At 0608 hours, the victim's ladder truck [T12] was second on the scene directly behind engine 12 [E12]. The crews encountered fire in the B/C exterior corner of the residence underneath and along the deck on the first floor on the C-side on the structure. The wind was blowing at speeds of 25 to 48 mph. The residence was located at the top right side of a drainage where the wind was directed onto the C-side of the house. The Lieutenants from E12 and T12 (LT#1 and LT#2 respectively) walked around opposite sides of the structure and met in front to discuss the size-up. Noticing cars in the driveway, no one outside, and no lights visible in the house, LT#1 called in a second alarm.

(Note: A neighbor drove to the residence and woke the residents. He walked them to another neighbor's house and walked back to move his vehicle in anticipation of the fire department's arrival. No one relayed to the fire department that the residents were out of the house until after interior operations were underway.)

Photo 11: A-side where the victim entered. Victim was found in the second floor master bedroom above the bay window.

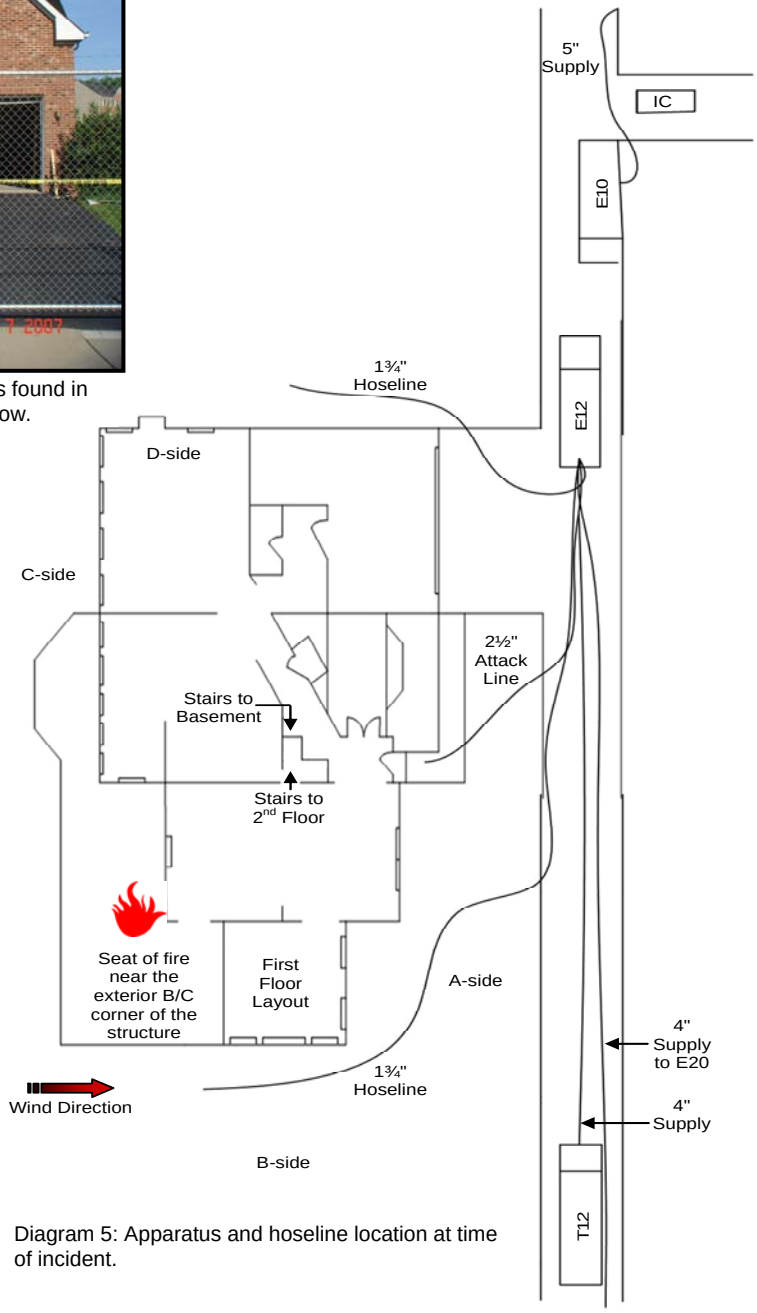


Diagram 5: Apparatus and hoseline location at time of incident.

A charged 2½" hoseline was stretched to the front door from E12 by the E12 crew. LT#2 and the victim donned their SCBA while waiting to enter the structure. The victim tried the door, which was unlocked, so the victim and LT#2 walked into the foyer. E10 arrived on-scene and was instructed by LT#1 to pull 300 feet of 1¾" hoseline from E12 in case it would be needed in the rear. At 0611 hours, with a light haze of smoke visible on the first floor, the T12 crew walked up the stairs to check the bedrooms. The E12 crew was delayed at the door with the attack line due to poor water pressure. LT#1 straightened out several kinks in the hose prior to entering the structure. At the top of the stairs, LT#2 and the victim encountered smoke banked down 3 feet from the second floor ceiling and went to the D-side of the residence towards the master bedroom. At 0611 hours, a Battalion Chief arrived on-scene and assumed incident command. E20 arrived on-scene and was instructed by the IC to pull 200 feet of 1¾" hoseline from E12 and cover the D-side exposures. (Diagram #5)

LT#2 and the victim came to a set of double doors. The right door was open and they entered the master bedroom. With smoke showing at ceiling level, the victim did a right-hand search and LT#2 with a TIC in-hand checked the bed. Suddenly the room turned black then orange with flames. LT#2 yelled to the victim to get out. While verbal communication among the crew was maintained, LT#2 found the doorway and crawled towards the stairs, falling to the curve located midway in the staircase. LT#2 communicated verbally and visually (via a flashlight) in an attempt to direct the victim to the stairs. LT#2 had been burned on his ears and right index finger. (Note: Personal protective equipment (PPE), such as hood and gloves were properly worn. However, the helmet liner was not properly down over the ears. The PPE received direct flame impingement and heat exposure.)

LT#1 and his crew along with the R10 crew were still at the front door which had slammed closed. When the door was re-opened, fire engulfed the doorway and LT#1 started yelling for LT#2 and the victim to come down the stairs. LT#1 noticed the severe change in the fire conditions in the stairway and requested an emergency evacuation. At 0613 hours, the wind-driven fire and smoke engulfed the residence. Fire was coming out of the eaves on the D-side of the structure. The E20 crew was flowing water on the D-side and the E10 crew was flowing water on the A-side of the residence, but the wind hampered the attack. Several ladders were thrown on the A- and D-sides to the second floor, and on the C-side deck to the first floor, but the high winds and extreme heat made it difficult to stabilize the ladders against the building.

The engine operator from E12 blew the air horn for 10 seconds to signal an evacuation. The IC gave a follow-up order to evacuate over the fireground channel. Concurrently, the R10 crew located LT#2 in the staircase area and brought him outside. At 0614 hours, LT#2 informed them that the victim was near the stairs. The R10 Lieutenant issued a Mayday. It was shortly followed on the radio by the victim's Mayday. Two lines, a 2½" and a 1¾", were flowing on the A-side of the structure with minimal impact. (Note: From the beginning of the incident, low water pressure in two hoselines was an issue. Removing kinks in the hoses

helped somewhat, but pressure problems persisted. It was undeterminable if the resultant low pressure was at the hydrant, engines, and/or due to hoseline deployment.)

At 0615 hours, LT#1 and a R10 Fire Fighter made it to the top of the stairs, but heat pushed them down. Several attempts were made by the E12 and R10 crews to go back up to the second floor. On the third attempt to ascend the staircase, and the second time the landing was reached, the ceiling started collapsing and flames intensified.

At 0621 hours, the Safety Officer, seeing the intensity of the fire throughout the structure, instructed the IC to call for another evacuation. The engine operator from E12 blew the air horn for a second time. At this point, the incident turned to a defensive attack, but rescue mode continued. At 0621 hours, the E2 crew was designated as the Rapid Intervention Team (RIT) and entered the C-side of the structure with a 1¾" hoseline to search for the victim in case a floor collapse had occurred.

At 0631 hours, additional crews attempted to re-enter and search for the victim, but they were unable to reach the second floor due to intense heat and fire conditions. At 0634 hours, command requested dispatch of a third alarm. At 0643 hours, crews with TICs in hand were able to reach the second floor, but due to structural collapse and high-heat conditions, access to second floor areas was limited.

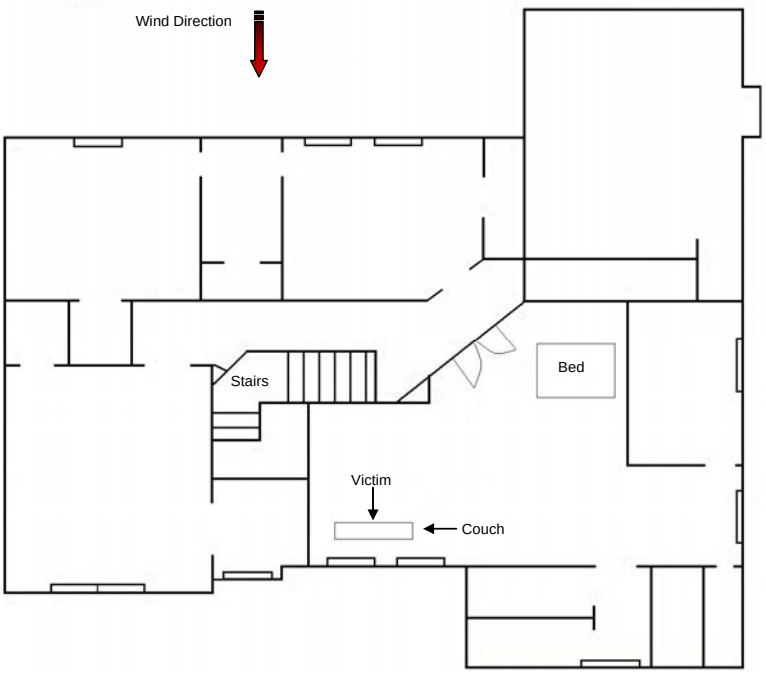


Diagram 6: Location of the victim on the second floor master

(Note: The victim's PASS was never heard by fire fighters on the fire ground. Due to extreme heat damage, post incident testing was not possible.) At 0657 hours, the victim was found in the master bedroom partially on a couch underneath the bedroom A-side windows. (Diagram #6) The coroner listed the cause of death as thermal and inhalational injuries.

Recommendations/Discussions

Recommendation #1

Fire departments should ensure that SOPs for size-up and advancing a hoseline address the hazards of high winds and gusts.

Discussion

Fire departments should develop SOPs for incidents with high-wind conditions including defensive attack if necessary. Weather can be considered as critically important when at the extreme and relatively unimportant during normal conditions. Wind has a strong effect on fire behavior which includes supplying oxygen, reducing fuel moisture, and exerting physical pressure to move the fire and heat. Wildland fire fighters are very familiar with these effects of wind on the rate at which fire spreads. According to Dunn, "When the exterior wind velocity is in excess of 30 miles per hour, the chances of conflagration are great; however, against such forceful winds, the chances of successful advance of an initial hoseline attack on a structure fire are diminished. The fire fighters won't be able to make forward hoseline progress because the flame and heat, under the wind's additional force, will blow into the path of advancement."

Fire fighters should change their strategy when encountering high wind conditions. An SOP should be developed to include obtaining the wind speed and direction, and guidelines established for possible scenarios associated with the wind speed and the possible fuel available, similar to that in wildland fire fighting. When the interior attack line has little or no effect on the fire, the line should be withdrawn and a second hoseline should be advanced on the upwind side of the fire. This method may require the use of an aerial ladder or portable ladder, if safety permits.

Recommendation #2

> *Fire departments should ensure that the primary search and rescue crews either advance with a hoseline or follow an engine crew with a hoseline.*

Discussion

Hoselines can be the last line of defense and the last chance for a lost fire fighter to find egress from a burning building. According to the USFA Special Report: Rapid Intervention Teams and How to Avoid Needing Them, the basic techniques taught during entry level fire-fighting programs describe how to escape a zero-visibility environment using only a hoseline. However, as years elapse from the time of basic training, fire fighters may overlook this technique. Exiting a structure in zero visibility should be simple, fast and easy for a fire fighter with a hoseline. A fire fighter

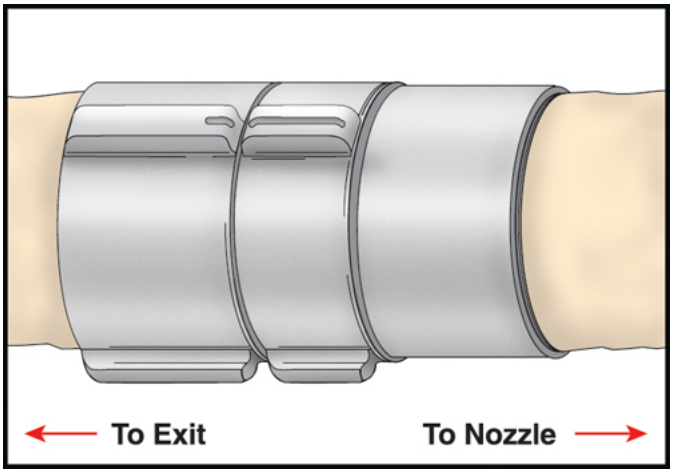


Diagram 7: Hose couplings will indicate the direction toward the exit.
From IFSTA Essentials of Fire Fighting, Fifth Edition.

operating on a hoseline should search along the hose until a coupling is found. Once found, the fire fighter can "read" the coupling and determine the male and female ends. (Diagram #7) IFSTA's Essentials of Fire Fighting teaches that the female coupling is on the nozzle side of the set and the male is on the water side of the set. In most cases, the male coupling has lugs on its shank while the female does not. Once oriented on the hose, a fire fighter can follow the hoseline in the direction away from the male coupling which will take you toward the exit. There are a number of ways that fire hose can be marked to indicate the direction to the exit, including the use of raised arrows and chevrons that provide both visual and tactile indicators. Fire departments may use a variety of techniques to train fire fighters on how to identify hoseline coupling and the direction to the exit, based on the model of hose used by the department. The key point is that this training needs to be conducted and repeated often so that fire fighters are proficient in identifying the direction to the exit in zero visibility conditions while wearing gloves, the hose entangled, and with various obstructions present. This procedure should be incorporated into SOPs, trained upon, and enforced on the fireground.

In this incident, the truck crew went into the master bedroom doing a search without a hoseline. The engine crew with the hoseline was still at the front door when the truck crew went into the bedroom. Seconds later heavy smoke and flames blew through the upstairs hallway. The fire department's SOGs allow for the primary search and rescue crew not to have a hoseline as long as they are within sight of a crew with a hoseline. However, situations arise where conditions change in seconds preventing a fire fighter from following the hoseline to safety unless it is immediately available.

Recommendation #3

> *Fire departments should ensure that staffing levels are sufficient to accomplish critical tasks.*

Discussion

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, 2004 Edition identifies the minimum resources for an effective fighting force to perform critical tasks. These tasks include establishing water supply, deploying an initial attack line, ventilating, performing search and rescue, and establishing a rapid intervention team, etc. NFPA 1710 recommends that the minimum staffing levels for an engine company to perform effective and efficient fire suppression tasks is four.

In this case, the first-arriving engine (E12) was staffed with a Lieutenant, an engine operator and a fire fighter. They stretched a charged 2½" attack line to the front door of the involved building for the initial attack. It is extremely difficult for a two-person crew (Lieutenant and Fire Fighter) to advance or operate a 2½" hoseline without assistance. For large diameter hoselines, a 3- or 4-person operation significantly increases mobility and efficiency. Had the

attack line been a 1¾" hoseline, they would have been much better able to rapidly advance a charged line up the stairs.

Recommendation #4

> *Fire departments should ensure that fire fighters are sufficiently trained in survival skills.*

Discussion

Fire fighters trapped or disoriented inside a room should be trained to rapidly locate doors and windows in order to escape. This is a skill that every interior structural fire fighter should possess and is typically taught in Fire Fighter Survival Skills I and II classes. Understanding when to self-rescue, and when to stay in a location to be rescued are critical. Fire departments should provide periodic refresher training to ensure fire fighters can effectively apply this training in different scenarios.

Recommendation #5

> *Fire departments should ensure that Mayday protocols are reviewed, modified and followed*

Discussion

Fire fighters must act promptly when they become lost, disoriented, injured, low on air, or trapped. First, they must transmit a distress signal while they still have the capability and sufficient air. The next step is to manually activate their PASS device. To conserve air while waiting to be rescued, fire fighters should try to stay calm and avoid unnecessary physical activity. If not in immediate danger, they should remain in one place to help rescuers locate them. They should survey their surroundings to get their bearings and determine potential escape routes, and stay in radio contact with Incident Command and rescuers. Additionally, fire fighters can attract attention by maximizing the sound of their PASS device (e.g., by pointing it up in an open direction), pointing their flashlight toward the ceiling or moving it around, and using a tool to make tapping noises.

A crew member or other fire fighter who recognizes a fellow fire fighter is missing or in trouble should quickly try to communicate with the fire fighter via radio and, if unsuccessful, initiate a mayday for that fire fighter providing relevant information as described above.

Department protocol requires that when a Mayday is transmitted, the IC must either personally handle the situation or designate another officer to do so. Part of "handling" a mayday is to communicate with the trapped or lost fire fighters and with any other fire fighters or officers involved. The IC or designated officer must communicate the emergency to all fireground personnel to minimize extraneous radio communication and designate another radio channel for normal fireground operations.

Recommendation #6

Fire departments should ensure that the water supply is established and hoses laid out prior to crews entering the fire structure

Discussion

Successful fire suppression and fire fighter safety depends upon discharging a sufficient quantity of water to remove the heat being generated and provide safety for the interior attack crews. When advancing a hoseline into a fire structure, air should be bled from the line once it is charged, and before entering the structure. Fire fighters should continually train in establishing a water supply, proper hose deployment, and advancing and operating hoselines to ensure successful interior attacks.

In this incident, after the 200 feet of 2½" attack line and 300 feet of 1¾" hoseline were deployed from E12, there were complaints of low water pressure in both lines. The officer from E12 removed some kinks from the 2½" attack line which had a positive effect on the pressure. The pressure at both the E12 and the supply pumper E20 supposedly reported no fluctuations. There may have been a combination of factors contributing to low water pressure, such as fluctuating residential water pressure, pressure problems at one or both engines, and/or supply line issues. There was insufficient information in this incident to make a determination as to the cause of low water pressure.

Recommendation #7

Fire departments should ensure that fire fighters are trained for extreme conditions such as high winds and rapid fire progression associated with lightweight construction

Discussion

Training is one of the most important steps in fire fighter safety. Fire fighters must strive to retain information and skills that are presented in training. Training provides the necessary tools and fundamental knowledge to keep a fire fighter safe from injury. Just taking the training is not enough; the fire fighter needs to use their skills/information routinely on the fireground or at an actual emergency. Time is necessary to actually become proficient in those skills which are necessary for operational success in the field. In this era of new lightweight construction, training procedures covering strategy and tactics in extreme operational conditions, such as high winds and lightweight building construction (i.e., materials and design) are needed for all levels of fire fighters. Lightweight constructed buildings fail rapidly and with little warning, complicating rescue efforts. The potential for fire fighters to become trapped or involved in a collapse may be increased. There are twenty-nine actions fire fighters can take to protect themselves when confronted with buildings utilizing lightweight building components as structural members. They range from looking for signs or indicators that these materials are used in buildings (such as, newer structures, large

unsupported spans, and heavy black smoke being generated) to getting involved in newer building code development.

Recommendation #8

> *Municipalities should ensure that dispatch collects and communicates information on occupancy and extreme environmental conditions*

Discussion

The dispatch center should be aware of extreme environmental conditions on an hourly basis. Local weather forecasts and conditions are ready available in various media forms. When extreme weather conditions are present or the possibility exists, this information should be transmitted to the responding station when the call goes out. In addition, if the 911 caller does not relay any information about the occupancy of the fire structure, the dispatcher should explicitly ask the caller if they know if the structure is occupied.

Recommendation #9

> *Although there is no evidence that the following recommendation could have specifically prevented this fatality, NIOSH investigators recommend that: Fire departments ensure that radios are operable in the fireground environment*

Discussion

The fireground communications process combines electronic communication equipment, a set of standard operating procedures, and the fire personnel who will use the equipment. To be effective, the communications network must integrate the equipment and procedures with the dynamic situation at the incident site, especially in terms of the environment and the human factors affecting its use. The ease of use and operation may well determine how consistently fire fighters monitor and report conditions and activities over the radio while fighting fires. Fire departments should review both operating procedures and human factors issues to determine the ease of use of radio equipment on the fireground to ensure that fire fighters consistently monitor radio transmissions from the IC and respond to radio calls. The need to have properly functioning equipment during fire operations is critical.

In this incident, several fire fighters commented that radios were malfunctioning due to water shorting out the lapel microphone. However, the victim's radio was heard loud and clear during his mayday, along with several communications describing his believed location and request for water due to the extreme heat.

Investigator Information

This incident was investigated by Matt Bowyer, General Engineer, and Virginia Lutz, Safety and Occupational Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Division of Safety Research at NIOSH. Vance Kochenderfer, NIOSH Quality Assurance Specialist, National Personal Protective Technology Laboratory, conducted an evaluation of the victim's self-contained breathing apparatus. An expert technical review was conducted by Battalion Chief of Safety John J. Salka, Jr., New York City Fire Department.

NIOSH Appendix

Summary of Status Investigation Report
NIOSH Task No. TN-15210

Background

As part of the NIOSH Fire Fighter Fatality Investigation and Prevention Program, the Technology Evaluation Branch agreed to examine and evaluate one Mine Safety Appliances 4500 psi SCBA.

This SCBA status investigation was assigned NIOSH Task Number TN-15210. The submitter was advised that NIOSH would provide a written report of the inspections and any applicable test results. The SCBA, sealed in a corrugated cardboard box, was delivered to the NIOSH facility in Bruceton, Pennsylvania on May 25, 2007. Upon arrival, the sealed package was taken to the Fire Fighter SCBA Evaluation Lab (Building 108) and stored under lock until the time of the evaluation.

SCBA Inspection

The package was opened and the SCBA inspection was performed on June 20, 2007. The SCBA was inspected by Vance Kochenderfer, Quality Assurance Specialist, of the Technology Evaluation Branch, National Personal Protective Technology Laboratory (NPPTL), and NIOSH. The SCBA was examined, component by component, in the condition as received to determine its conformance to the NIOSH-approved configuration. The entire inspection process was videotaped. The SCBA was identified as a Mine Safety Appliances (MSA) model; however, the damage was too extensive to determine the exact type. The unit is extremely fire-damaged. Most of the plastic, rubber, and fabric components of the SCBA have been consumed. No performance testing could be conducted on the unit.

Personal Alert Safety System Device

An ICM 2000 Plus Personal Alert Safety System (PASS) device was incorporated into the pneumatics of the SCBA. During the inspection, the PASS device could not be activated. The case was opened and representatives of MSA were able to retrieve stored data from the unit, and the last five uses are presented in Appendix II of the full NIOSH Status Investigation Report (not included). The data indicate that the unit's battery was exhausted six minutes into

the last use while the cylinder pressure was 3350 psi and the internal temperature 130°F. From the limited data available, there is no indication of unusual performance of the SCBA.

Summary and Conclusions

An SCBA was submitted to NIOSH for evaluation. The SCBA was delivered to NIOSH on May 25, 2007 and inspected on June 20, 2007. The unit was identified as an MSA 4500 psi SCBA, but the exact model and NIOSH approval number could not be determined. The SCBA has suffered severe fire damage and is not functional.

It is difficult to draw conclusions about the unit given its state. The cylinder valve was found to be fully open and the cylinder empty, which would be consistent with the SCBA being used to cylinder exhaustion. Data retrieved from the ICM 2000 Plus PASS device do not suggest any malfunction during the last recorded use. In light of the information obtained during this investigation, the Institute has proposed no further action at this time. Following inspection and testing, the SCBA was returned to the package in which it was received and stored under lock in Building 108 at the NIOSH facility in Bruceton, Pennsylvania, pending return to the submitter. Due to the extensive damage to the unit, it does not appear possible for it to be returned to service and it should be replaced.

NIOSH Case Study #5: Maryland

Career Fire Fighter Dies in Residential Row House Structure Fire

NIOSH – Fire Fighter Fatality Investigation and Prevention Program December 7, 2007

Summary

On October 10, 2006, a 40-year-old male career fire fighter (the victim) was fatally injured during a residential structure fire. At 0222 hours, dispatch reported a residential two-story row house structure fire with possible parties trapped. Battalion Chief #1 was the first on-scene and assumed Incident Command (IC). Squad 11 (SQ11) arrived followed by Engine 41 (E41) as heavy black smoke poured out of the front of the residence. A civilian jumped from an A-side second story window and another confused civilian was walking around on the sidewalk; both were attended to by fire fighters. Two E41 Fire Fighters (the victim and FF#1) led a SQ11 Fire Fighter (FF#2) into the residence with a 1¾" attack line. They entered a narrow hallway and passed through a door to the foot of the stairs that lead to the second floor. The E41 Lieutenant entered the structure and requested the building be vented due to the heat. At 0228 hours, Battalion Chief #2 (Rear IC) arrived on-scene and reported to the C-side of the structure per the request of the IC. The victim advanced to the top of the stairs when conditions became extremely hot. Shortly after hearing that the fire's origin may be in the basement causing the crew to back out, the victim feeling the intense heat ran by FF#1 and into FF#2 (from SQ11) knocking them both to the floor with the front door closing behind them and pinching the hoseline. FF#2 struggled to get his arm out the crack of the door while FF#1 was trying to get the victim off of FF#2. Officers and fire fighters were outside trying to pull the fire fighters out and were able to get FF#1 and FF#2 out through a partial opening of the door. The victim could not get out until the door was removed. FF#1 and FF#2 were pulled out at 0232 hours and the victim was removed at 0235 hours. Immediately, paramedics on-scene attended to the two fire fighters and the victim. The victim was given cardiopulmonary resuscitation (CPR) and transported to the hospital. FF#1 and FF#2 were transported to the hospital and treated for severe burns.

NIOSH recommends:

Ensure that thermal imaging cameras (TIC) are used during initial size-up.

Ensure that ventilation is coordinated with the interior attack.

Ensure that tools such as door wedges are utilized to prevent water flow and escape problems.

Ensure that a Rapid Intervention Crew (RIC) is on-scene prior to an attack crew entering a hazardous environment.

Ensure that department policies and procedures are followed.

Introduction

On October 10, 2006, a 40-year-old male career fire fighter (the victim) was fatally injured during a residential structure fire. On October 11, 2006, the fire department notified the NIOSH of this fatality. On October 12, 2006, a General Engineer and an Occupational Safety and Health Specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program conducted an investigation. Photographs of the incident scene were taken and meetings were conducted with the Safety Chief of the involved fire department, representatives from the City's Arson Office, and union representatives. The victim's protective clothing, SCBA, and PASS device were examined. On November 15-16, 2006 interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's SOGs, the Arson Investigator's report, the officers' and victim's training records, photographs of the incident scene, written witness statements, dispatch transcriptions, the coroner's report and amateur video of the incident.

Photo 12: Front (A-side) of the structure where the victim entered.

Fire Department

The career department has thirty-nine stations with a total of 1,611 career fire fighters serving a population of over 651,154 residents in a geographic area of approximately 92 square miles.

Personal Protective Equipment

At the time of the incident, the victim was wearing personal protective equipment consisting of turnout coat and pants, gloves, a helmet, an SCBA with an integrated PASS device, and carried a portable radio. The NIOSH SCBA post-incident test results did not suggest any contributing factor to the incident. (See NIOSH Appendix at the end of this case study.)

Apparatus and Personnel

- ❒ On-scene at 0225 hours.
  - Battalion Chief #1 [BC1] - Incident Commander (IC).

- Engine #41 [E41] - Lieutenant, Pump Operator, Fire Fighter (the victim) and Fire Fighter/Paramedic Apprentice (FF#1).
- Medic #20 [M20] - Two Paramedics.

❒ On-scene at 0226 hours.
- Squad #11 [SQ11] - Acting Lieutenant, Pump Operator, Fire Fighter, and Fire Fighter/Paramedic Apprentice (FF#2).
- Truck #20 [T20] - Lieutenant, two Emergency Vehicle Drivers, and Fire Fighter.

❒ On-scene at 0227 hours.
- Engine #51 [E51] - Captain, Pump Operator, and two Fire Fighters.
- Truck #3 [T3] - Captain, two Emergency Vehicle Drivers, and Fire Fighter.

❒ On-scene at 0228 hours.
- Engine #5 [E5] - Lieutenant, Pump Operator, and two Fire Fighters.
- Battalion Chief #2 [BC2] - Rear IC

❒ On-scene at 0232 hours.
- Medic #10 [M10] - two Paramedics.

❒ On-scene at 0237 hours.
- Engine #50 [E50] - Lieutenant, Pump Operator, and two Fire Fighters.
- Medic #10 [M10] - two Paramedics.

Photo 13: Rear (C-side) of fire structure that was totally involved upon arrival.

Training/Experience

The victim was a career fire fighter with 19 years of fire-fighting experience. He had completed the National Fire Protection Association (NFPA) Fire Fighter Level I and II training, Field Training, Developing Fireground Expertise, Fire Fighter Survival Training and various other administrative and technical courses.

The Incident Commander had completed the National Incident Management System training, Incident Scene, Construction Awareness, Risk Management, Developing Fireground Expertise, Leadership Skills and various other administrative and technical courses.

The Rear IC had completed the National Incident Management System training, Incident Scene, Building Construction Awareness, Fire Officer Training, Leadership Skills and various other administrative and technical courses.

Building Information

The 1,320 square foot building was a 1920s two-story residential row house structure without an automatic fire suppression system (Photos #12 and #13) that was constructed of wood balloon framing with the interior being remodeled to make first and second floor apartments. The basement was accessible from the first floor interior and an exterior alley door. The flat roof consisted of wood rafters with tar and paper over wood boards.

Investigation

On October 10, 2006, a 40-year-old male career fire fighter, (the victim) was fatally injured during a residential structure fire. At 0222 hours, dispatch reported a residential two-story row house structure fire with possible parties trapped. At 0225 hours, Battalion Chief #1 (IC) was first to arrive on-scene. The IC drove in the front of the structure then drove around the block to look down the alley to the rear (C-side) of the structure during size-up, due to this being a row house in the middle of the block, and returned to the front (A-side). SQ11 then arrived, followed by E41 as heavy black smoke poured out of the front of the residence. A civilian jumped from an A-side second story window and another confused civilian was walking around on the sidewalk. Both were promptly attended to by fire fighters. E41 covered SQ11 on the hydrant per standard operating guidelines. However, SQ11 did not stretch the first attack line; instead, two E41 fire fighters (the victim and FF#1) led a Squad 11 fire fighter (FF#2) into the residence with a 1 ¾ attack line from SQ11's pumper. Other members of SQ11 were putting on their gear and grabbing a second back up line. They entered a narrow hallway and went through an open door at the bottom of the stairs that led to the second floor.

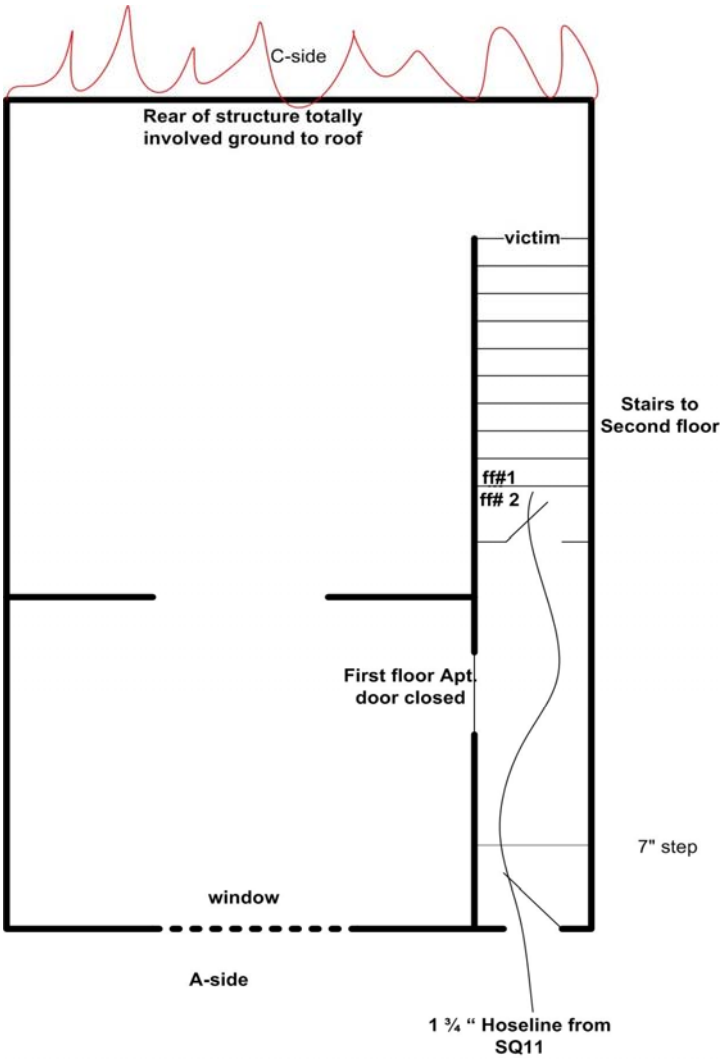


Diagram 8: Location of victim and fire fighters on the hoseline prior to the incident.

The E41 Lieutenant entered the structure and requested the building

be vented due to the heat. At 0228 hours, Battalion Chief #2 (Rear IC) arrived on-scene and reported to the C-side, where Truck 3 (T3) was trying to position ladders while Engines 5 and 51 were stretching line from opposite ends of the rear alley. The basement was heavily involved and fire was starting to blow out the first and second floors in the rear. Operations were being hindered by numerous electric lines in the rear of the fire structure. At 0231 hours, the IC called for a second alarm and for the utility company to cut the power. Truck 20 (T20) positioned their aerial ladder to the roof so a fire fighter could vent the roof while other crew members positioned a ground ladder to the front second floor window to vent. FF#1 and FF#2 manned the hoseline at the base of the stairs while the victim advanced to the top of the stairs (Diagram #8). No fire was seen by any member of the interior attack crew at this time and there appeared to be no fire impingement from the interior towards the front of the structure. The T20 fire fighter on the roof opened up several sky lights, but the back skylight had self vented, so the fire fighter went back to the A-side of the first sky light to open up a hole in the roof, but fire started blowing out and he couldn't finish. At 0231 hours, the interior crew learned that the fire's origin may be in the basement and to start backing out. At 0232 hours, conditions became extremely hot inside the fire structure and the victim suddenly ran by FF#1 and into FF#2 (from SQ11). FF#2 fell to the floor with the victim on top of him. They came to rest against the metal front door, forcing it to close off the front entrance. This pinched the hoseline in the door frame, leaving a small gap between the metal door and the door frame (Diagram #9). In addition to being pinched, the hose possibly got bundled up behind the door along with the victim's body, adding to the difficulty of getting the door open. FF#2 was pinned to the floor and managed to get his arm through the small gap at the door

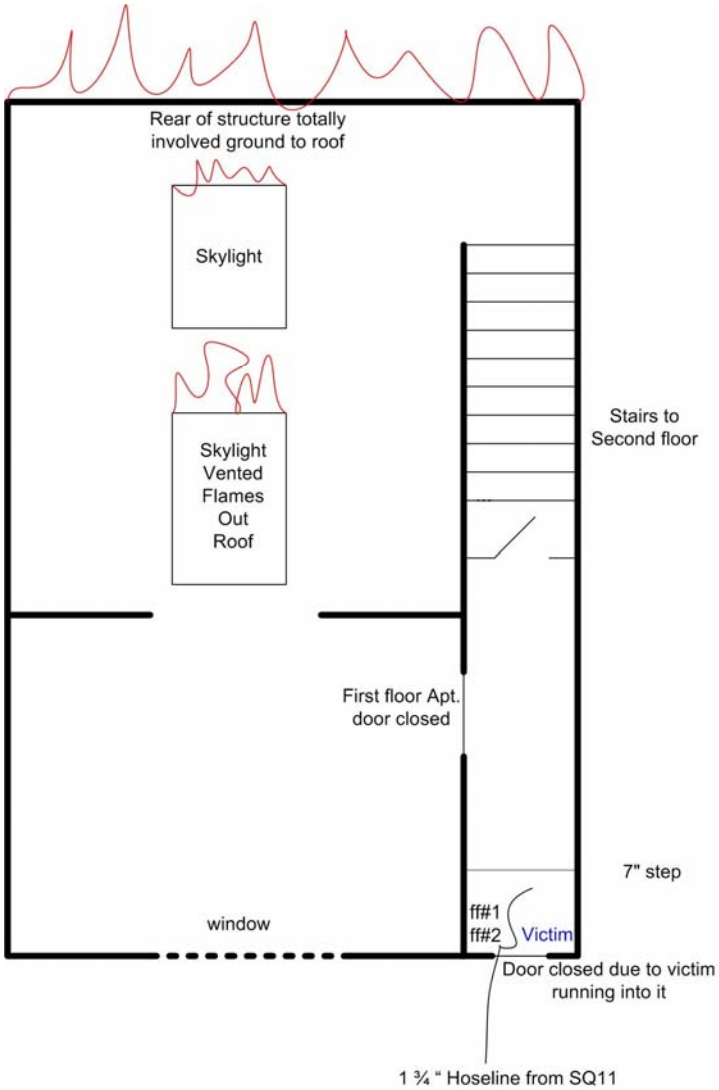


Diagram 9: Location of victim and injured fire fighters trapped behind the door.

while FF#1 tried to get the victim off of FF#2. At this point, the IC requested a RIC, which had not been established.

The E41 Lieutenant and several other fire fighters, who had exited the fire structure just prior to the door closing, were outside trying to pull the fire fighters out of the structure and began to force open and remove the door. At 0232 hours, FF#1 and FF#2 were pulled out of the partially forced opened door and were attended to by the Paramedics. At 0235 hours, the door was removed, and the victim could be seen on the floor with his mask off and hood missing. Fire fighters carried the victim to the Paramedics, who administered CPR and transported to the hospital where he was pronounced dead. FF#1 and FF#2 were transported to the hospital and treated for severe burns.

Injuries

Both fire fighters #1 and #2 received burns on both hands, wrists, and forearms with more severe (3rd degree) burns on the left side (approximately covering 3% of their body).

Cause of Death

The coroner listed cause of death from smoke inhalation and thermal injuries. Soot was present in the airways. His heart blood carboxyhemoglobin saturation was 26%. Thermal injuries were present over approximately 30% of the body. Affected areas were the head, chest, hands, forearms, and lower back.

Recommendations/Discussions

Recommendation #1

> *Fire departments should ensure that TICs are used during initial size-up.*

Discussion

The use of a TIC can provide the IC with additional information during the initial size-up and for locating the seating of the fire. They can be used to quickly gather crucial information on the fire's location from the exterior of the structure, assisting with determining a rapid and safe approach to entering the structure. Also, fire fighters about to enter an area filled with flames and smoke can use the TIC to assist in determining the risks in advancing. TICs can also be useful for identifying structures that have been dangerously weakened by the fire. TICs should be used in a timely manner, and fire fighters should properly be trained in their use and be aware of their limitations.

Recommendation #2

> *Fire departments should ensure ventilation is coordinated with the interior attack.*

Discussion

Ventilation is performed to relieve the products of combustion, allowing fire fighters to advance on the fire. When venting, the principle is to pull the fire, heat, smoke, and toxic gases away from victims, stairs, and other egress routes.

In this incident, shortly after the skylights had been vented the fire immediately intensified forcing the victim to run down the stairs trying to escape. The victim was near the top of the stairs, in front of his crew and without a hoseline, and the rear of the structure was fully involved at the time the skylights were vented. The smoked filled second floor provided the needed oxygen when the skylight was vented, thus igniting the unburned fuel and pulling the flames towards the interior of the second floor over the victim near the top of the stairs.

Recommendation #3

> *Fire departments should consider the use of TICs during initial size-up to assess fire size/intensity and possible structural damage.*

Discussion

Wedges (generally wood or rubber) are commonly carried by fire fighters for a temporary shut-off of activated sprinkler heads or for holding doors open during fire-fighting or rescue operations. Doors are wedged open to prevent pinched or snagged hoses, which could cut-off a fire fighters protective stream, and to ease ingress/egress of fire fighters.

In this incident, a wedge may have kept the door open and kept the hose from getting pinched and bundled up behind the door which further hindered getting the door open.

Recommendation #4

> *Fire Departments should ensure that a RIC is on-scene prior to an attack crew entering a hazardous environment.*

Discussion

A RIC should be available for the rescue of members operating at emergency incidents. The team should report to the officer in command and remain at the command post until an intervention is required to rescue a fire fighter(s) or civilians. The RIC should have all tools necessary to complete the job (e.g., a search rope, first-aid kit, and a resuscitator) to use if a fire fighter becomes injured. Many fire fighters who die from smoke inhalation, from a flashover, or from being caught or trapped by fire actually become disoriented first. They are lost in smoke and their SCBAs run out of air, or they cannot find their way out through the smoke, become trapped, and then fire or smoke kills them. The primary contributing factor, however, is disorientation. The RICs only assignment should be to prepare for a rapid deployment to complete any emergency search or rescue when ordered by the IC. They will provide the suppression companies the opportunity to regroup and take a roll call instead of performing rescue operations. A RIC should preplan a rescue operation by finding

out fire structure information (i.e., construction materials, layout, entry/egress routes, etc.), crew location and assignments, and monitor radio traffic. When the RIC enters to perform a search and rescue, they should have full cylinders on their SCBAs and be physically prepared. When a RIC is used in an emergency situation, an additional RIC should be put into place in case an additional emergency situation arises. This additional RIC should be comprised of fresh, well-rested fire fighters.

In this incident, when the IC requested a RIC, one had not been established. Numerous fire fighters were at the door and promptly extricated two fire fighters and retrieved the victim after removing the door.

Recommendation #5

Fire departments should ensure that department policies and procedures are followed.

Discussion

Operational protocols, minimum equipment, personnel requirements, qualifications for team membership, and issues of training, drills, health and safety are all addressed in the fire department's SOPs. However, SOPs should be reviewed in-house, at a minimum, on an annual basis to see whether any changes are necessary. Every department member should have a copy of or easy access to SOPs, and each member should sign a statement indicating that he/she has read, understands, and agrees to abide by them.

In this incident, there were some SOPs that may have been deviated from unintentionally or circumstances didn't allow. For example, the information to "back-out" was received by the interior crew fire fighters but it was unclear who gave the order. The fireground operations SOP describing the duties of the first and second arriving engine was not followed, in that, the second engine initiated the search and rescue operation instead of the first engine. 4 In addition, there where issues regarding protective equipment, such as, missing hood, cylinder valve shut-off, and right hand glove removed. Witnesses state that the victim entered the structure with his mask on and the second stage regulator clicked in and gloves on. No one verified seeing the victim with his hood on. During the incident his cylinder valve was shut-off, his right hand glove was missing, his mask was dislodged, and his hood was missing, either initially or not recovered assuming the victim removed it in the fire structure.

Investigator Information

This incident was investigated by Matt Bowyer, General Engineer and Steve Berardinelli, Occupational Safety and Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Division of Safety Research at NIOSH. An expert technical review was provided by Harry Carter, Ph.D., CFO, MIFireE.

Appendix

Summary of Status Investigation Report
NIOSH Task No. 14886

Background

As part of the NIOSH Fire Fighter Fatality Investigation and Prevention Program, the Technology Evaluation Branch agreed to examine and evaluate one Dräger Safety 4500 psi, 45-minute SCBA.

This SCBA status investigation was assigned NIOSH task number 14886. The submitter was advised that NIOSH would provide a written report of the inspections and any applicable test results.

The SCBA, sealed in a corrugated cardboard box, was delivered to the NIOSH facility in Bruceton, Pennsylvania on October 30, 2006. The sealed package was taken to the Fire Fighter SCBA Evaluation Lab (Building 108) and stored under lock until the time of the evaluation.

SCBA Inspection

The package was opened and the SCBA inspection was initiated on March 6, 2007. A complete visual inspection of the SCBA was completed on that day by Vance Kochenderfer, Quality Assurance Specialist, of the Technology Evaluation Branch, NPPTL, and NIOSH. The SCBA was examined, component by component, in the condition as received to determine its conformance to the NIOSH-approved configuration. The visual inspection process was videotaped. The SCBA was identified as the Dräger Air Boss Evolution model.

Although the SCBA showed signs of extensive use and wear, it was determined that it could be safely pressurized and tested. The interior of the demand valve outlet was very dirty, suggesting the demand valve was detached from the facepiece in a smoky environment. There are a few signs of heat damage on the cylinder retention band, shoulder straps, and cylinder valve. The cylinder bears some scrapes which may render it unfit for use; it should be examined by a qualified retester before being returned to service. The damage to the cylinder valve is such that it should be repaired or replaced.

SCBA Compressed Air Cylinder Contents

During the inspection it was noted that the compressed air cylinder was partially pressurized. An air sample was collected from the cylinder and forwarded to a laboratory for analysis. The laboratory, Lab Services-ITR, analyzed the sample in accordance with the standards and methodologies found in the Compressed Gas Association's standard, ANSI/CGA G-7.1, Commodity Specification for Air. The analysis is attached as Appendix II.

The test report indicates that the sample met the standard for Grade D air. The sample also met OSHA's moisture content requirement in 29 CFR 1910.134(i)(4)(iii) as well as the more

stringent moisture content guidelines published in NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, 2002 Edition.

SCBA Testing

The purpose of the testing was to determine the SCBA's conformance to the approval performance requirements of Title 42, Code of Federal Regulations, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the SCBA's conformance to the NFPA air flow performance requirements of NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services, 1997 Edition.

The following performance tests were conducted on the SCBA:

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

1. Positive pressure test [§84.70(a)(2)(ii)]
2. Rated service time test (duration) [§84.95]
3. Static pressure test [§84.91(d)]
4. Gas flow test [§84.93]
5. Exhalation resistance test [§84.91(c)]
6. Remaining service life indicator test (low-air alarm) [§84.83(f)]

NFPA Tests (in accordance with NFPA 1981):

1. Air flow performance test [Chapter 5, 5-1.1]

The NIOSH tests were performed on March 7, 2007. Although the SCBA was not labeled as compliant with NFPA 1981, it was requested that the NFPA air flow performance test be performed and this was conducted on March 23, 2007. All testing was videotaped with the exception of the exhalation resistance tests and static pressure tests.

The SCBA ran out of air before its rated service time, causing the unit to fail the rated service time test and positive pressure test. It also had excessive exhalation resistance during the NFPA air flow performance test. A rattling noise was observed coming from the facepiece exhalation valve; it is possible that improper function of this valve could cause the failing test results. The unit met the requirements of all other tests. While the unit was capable of supplying air to the user, it was unable to provide the designed level of protection.

Summary and Conclusions

The SCBA submitted for evaluation was delivered to NIOSH on October 30, 2006 and inspected on March 6, 2007. The unit was identified as a Dräger Air Boss Evolution 45-minute, 4500 psi SCBA (NIOSH approval number TC-13F-379). The unit was determined to be in a condition safe for testing.

The unit was subjected to a series of seven performance tests. Testing was performed on March 7 and 23, 2007. The SCBA was able to meet the requirements of all tests except the

Rated Service Time Test, Positive Pressure Test, and NFPA Air Flow Performance Test. No maintenance or repair work was performed on the unit at any time.

In light of the information obtained during this investigation, NIOSH has proposed no further action on its part regarding the SCBA at this time. Following inspection and testing, the SCBA was returned to the package in which it was received and was shipped back to the submitter on April 5, 2007.

If the SCBA is to be placed back in service, it must be thoroughly inspected, repaired, and tested by a qualified service technician. The cylinder should be inspected by a certified retester before being put back into use, and the cylinder valve repaired or replaced.

NIOSH Case Study #6: Pennsylvania

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire

NIOSH – Fire Fighter Fatality Investigation and Prevention Program January 11, 2008
Revised on January 30, 2008

Summary

On February 4, 2007, a 27-year-old male career fire fighter (victim) and a 38-year-old male career fire fighter were trapped under a canopy that collapsed off a burning residential garage. The victim was pinned under the canopy debris, and was found not breathing while still wearing his SCBA and SCBA mask. The second fire fighter received injuries requiring time off from work. (Photo #14)

Photo 14: Incident scene. Photo courtesy of Fire Marshal's office.

As the fire fighters pulled the hoseline from the garage, the canopy, which was connected to the garage roof rafters by long metal bars, fell on both fire fighters, trapping them underneath. The designated rapid intervention team (who had just arrived on-scene) worked for approximately 10 minutes to extricate both fire fighters. The victim and injured fire fighter were sent to the local hospital by ground ambulance. The victim was pronounced dead at the hospital, and the injured fire fighter was treated for injuries requiring time off from work.

NIOSH recommends:

Review and follow existing standard operating procedures (SOPs) for structural fire fighting to ensure that fire fighters follow a "2 in 2 out" policy.

Ensure that adequate numbers of staff are available to immediately respond to emergency incidents.

Establish a collapse zone when structures become unstable.

Ensure that the incident commander continuously evaluates the risks versus gain when determining whether the fire suppression operation will be offensive or defensive.

Ensure that the first-arriving company officer does not become involved in the fire-fighting effort after assuming the role of the incident commander.

Ensure that a thermal imaging camera is used during size-up.

Ensure that a separate incident safety officer, independent from the incident commander, is appointed at each structural fire.

Introduction

On February 4, 2007, a 27-year-old male career fire fighter (the victim) died when he was trapped underneath a canopy which collapsed / separated from the front of a burning residential garage. A 38-year-old male career fire fighter (injured fire fighter) was also trapped under the canopy. The victim was found lying on his right side, not breathing while still wearing his SCBA. It was the victim's first working fire with this career department. The injured Fire Fighter received injuries that required time off from work.

On February 5, 2007, the U. S. Fire Administration notified the NIOSH Division of Safety Research (DSR) of this incident. On February 12 and 28, 2007 the DSR Chief of the Fatality Investigations Team, a DSR Safety Engineer, and a medical resident (guest researcher) from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Pennsylvania to investigate this incident. The NIOSH investigation team met with officials of the fire department, the mutual aid fire department that extricated the trapped fire fighters, representatives of the IAFF union, and local police and state police fire marshals. The investigation team conducted interviews with officers and fire fighters present at the scene, examined photographs of the incident scene, visited the fireground site, and reviewed other pertinent documents including the fire department's standard operating procedures and the victim's and incident commanders' training records. The victim's personal protective clothing worn at the time of the incident was examined. The victim's SCBA was transferred to the NIOSH NPPTL for evaluation and testing. The NIOSH test results (see full report) show the SCBA failed the positive pressure test and failed to meet the required 30 minute duration. These test failures are not believed to have significantly contributed to the fatality as the victim was trapped and could not move his arms to remove his facepiece when he ran out of air.

Fire Department

The career fire department involved in this incident serves a population of approximately 20,000 residents in a geographic area of about 3.2 square miles. It has a contract with a neighboring borough to cover an additional 3,850 residents.

In February 2007, the fire department consisted of 18 uniformed fire fighters and fire officers. The department has two fire stations and extensive written standard operating procedures. In 2006, the fire department responded to 37 structural fires.

Typical staffing is four fire fighters plus one officer per shift. Two fire fighters and an officer are located at Fire Station 1, and two fire fighters staff Fire Station 2. A standard work shift is 24 hours on-duty and 48 hours off-duty. Additionally, all off-duty fire fighters are called to report to Fire Station 1 when there is a confirmed structural fire. The fire fighters who arrive at the station are briefed and respond on an assigned apparatus.

Vehicles which the department operates include two engines (Engine 8 at Station 2 and Engine 9 at Station 1), a 75-foot telesquirt, a 100 foot aerial ladder truck, 1 pickup truck, and the Chief's command vehicle. Both engines have 500 gallon tanks with 2000 gallons per minute (gpm) pumps. The ladder truck has a 300 gallon tank and a 1,500 gpm pump. The department has one thermal imaging camera.

Just weeks prior to the incident, the department entered into a cooperative agreement with a neighboring combination fire department to provide mutual aid in the form of a designated RIT at all working fires in this department's jurisdiction. A 4-person RIT goes on standby when the principle fire department is dispatched, and responds when the fire is confirmed (second alarm). Their response time is 7-10 minutes.

Training and Experience

The fire department follows the city's requirements in hiring and training a probationary fire fighter. The minimum level of training required is NFPA Fire Fighter Level I.

Both the victim and the injured fire fighter had extensive training and fire-fighting experience during their careers. The victim had worked for the fire department for approximately one-half year, but had been a volunteer fire fighter in a neighboring borough for approximately 12.5 years. His training included NFPA Fire Fighter Level I, Emergency Medical Technician (EMT), and hazardous materials training.

The injured fire fighter had 18 years of total fire-fighting experience (11 years career at this department, in addition to 7 years as a volunteer). His training included Fire Fighter Level I, paramedic training, 7 weeks of annual training at the fire academy, driver operator training, and confined space rescue.

The Chief of the department had over 27 years of total fire-fighting experience at this department and served as Chief since 2004. His training included various fireground tactic and incident management classes. The Chief assumed incident command when he arrived at the fire scene and remained as the IC throughout the incident.

Administratively, the fire department enforces fire alarm and sprinkler system requirements. The city's Building Inspector's Office enforces building codes. The city follows the International Building Code.

Equipment and Personnel

The career fire department responded with 3 apparatus and 14 fire fighters on-scene prior to the fatal event. Only the units directly involved in operations preceding the fatal event are discussed in this report. Additional volunteer departments were dispatched after the collapse. The timeline for this incident included initial dispatch at 0934 hours. The response, listed in order of arrival and key events, includes:

- 0934 hours.
  - Initial alarm; via homeowner call to 911.
- 0938 hours.
  - Engine 8 (victim and injured Fire Fighter from Station 2) left Station 2.
  - Engine 8 arrived on-scene and reported heavy black smoke.
  - Engine 9 (one Captain, two Fire Fighters from Station 1) left Station 1.
- 0939 hours.
  - Command Vehicle (Chief) arrived on-scene; Chief assumes incident command.
- 0941 hours.
  - Engine 9 (one Captain, two Fire Fighters from Station 1) arrived on-scene.
    - Crew laid 4" hoseline to establish water supply.
    - Captain radioed for mutual aid.
    - Captain and IC performed 360 degree walk-around of structure.
- 0942 hours (approximate).
  - Engine 8 crew enters garage with charged hoseline.
- 0951 hours.
  - Dispatch notified power company and State Fire Marshal.
- 1000 hours.
  - Telesquirt-2 (TS-2) (four off-duty Fire Fighters called back to Station 1) arrived on-scene.
    - Prepared master stream.
    - Chief informed the injured Fire Fighter that master stream will start.
- 1007 hours.
  - Victim and the injured Fire Fighter exited garage to change SCBA bottles.
  - Victim and the injured Fire Fighter reentered garage.
  - Small burning debris hit the injured Fire Fighter.

- Victim and the injured Fire Fighter started to back out of the garage.

❒ 1010 hours.
- Ladder (four Fire Fighters, mutual aid RIT) arrived on-scene.
- Canopy collapsed.
- RIT began extrication of the injured Fire Fighter.

❒ 1018 hours.
- RIT extricated the injured Fire Fighter.

❒ 1027 hours.
- Air ambulance helicopter on-scene.

❒ 1028 hours.
- Victim extricated from collapse.

❒ 1030 hours.
- Two ground ambulances arrive on-scene (one advanced life support (ALS) and one basic life support (BLS)).

❒ 1041 hours.
- ALS ambulance to air landing zone with victim.
- Victim's heart is in pulseless electrical activity.

❒ 1047 hours.
- BLS ambulance arrived at the hospital's emergency room with the injured Fire Fighter.

❒ 1048 hours.
- ALS ambulance redirected to the emergency room.

Personal Protective Equipment

At the time of the incident, the victim and injured fire fighter were wearing their full array of personal protective clothing and equipment, consisting of turnout gear (coat and pants), helmet, Nomex® hoods, gloves, boots, and a SCBA with an integrated PASS. The victims were also equipped with portable radios.

Photo 15: Aerial view of house and garage.

Structure

The structure involved in this incident included a residential two story house with an attached garage built in 1910, and renovated in 1950. (Photo #15) The house

dimensions were approximately 48-feet long by 20-feet wide and the garage was approximately 24-feet long and 24-feet wide. (Diagram #10) The garage was of traditional wooden construction. The garage had a peaked gable roof with attic storage, and the floor was concrete. Several layers of siding were present on the garage including wooden clapboard, covered with weather brick, covered by aluminum siding.

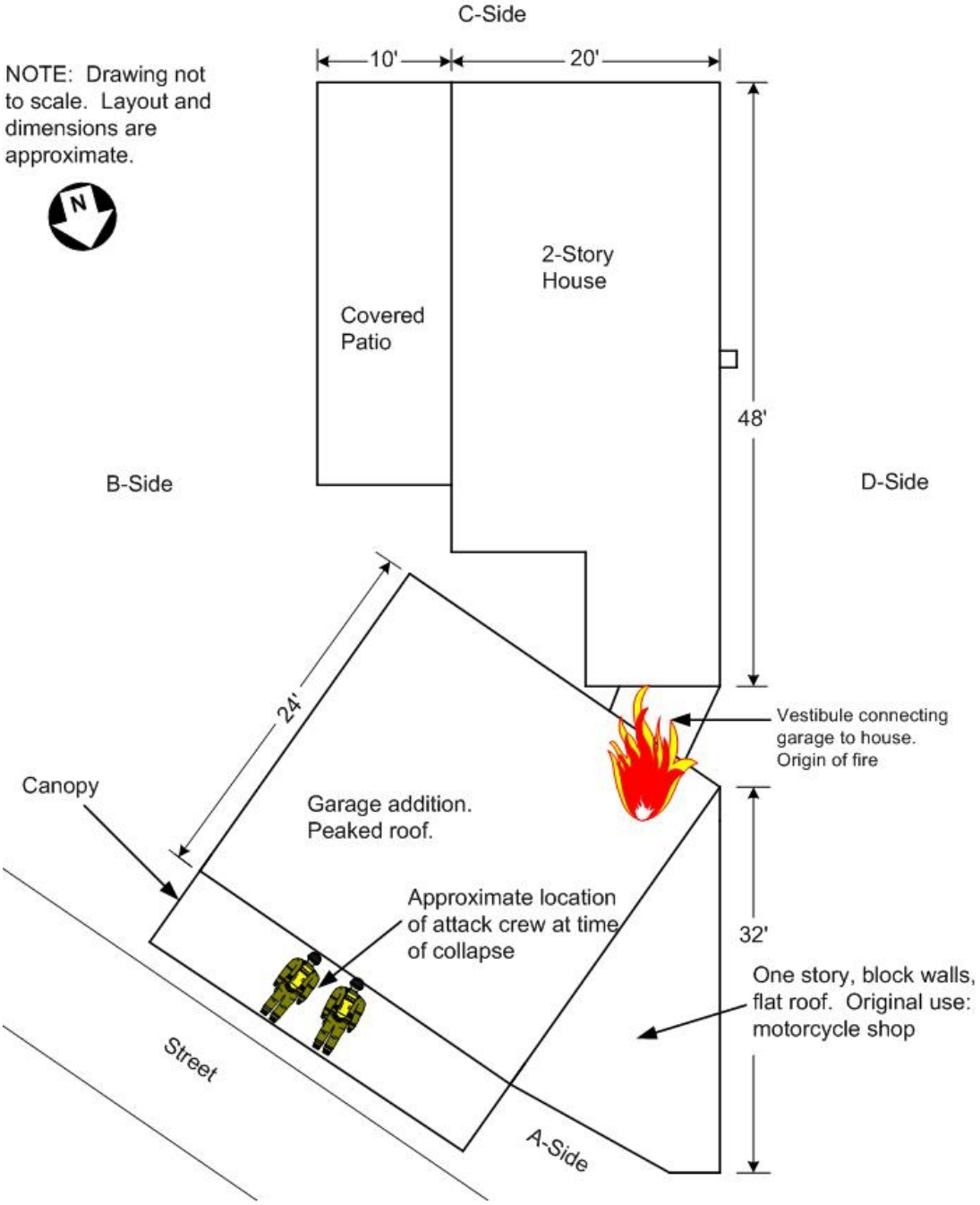


Diagram 10: House dimensions.

The garage was connected to the property's 2-story house by a small vestibule room. The home was of balloon construction, was 1,316 square feet, and was listed as having 5 rooms (2 bedrooms, 1 bathroom). The garage was also attached to an irregular-shaped concrete block structure that had been a commercial motorcycle shop at one time. (Photo #16)

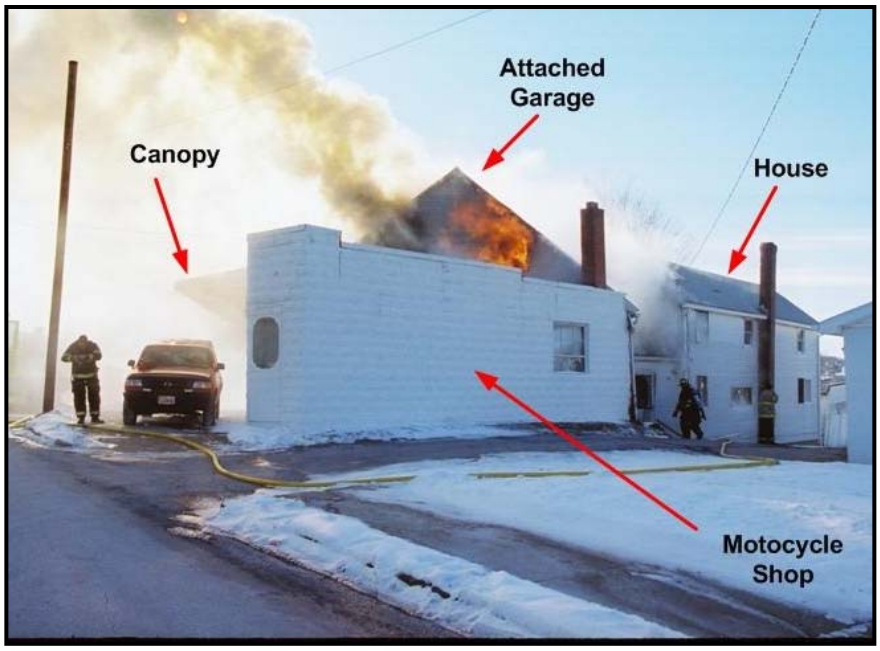


Photo 16: Canopy precollapse, D-side. Canopy is just visible above and to the right of the truck. Photo courtesy of Fire Marshal's office.

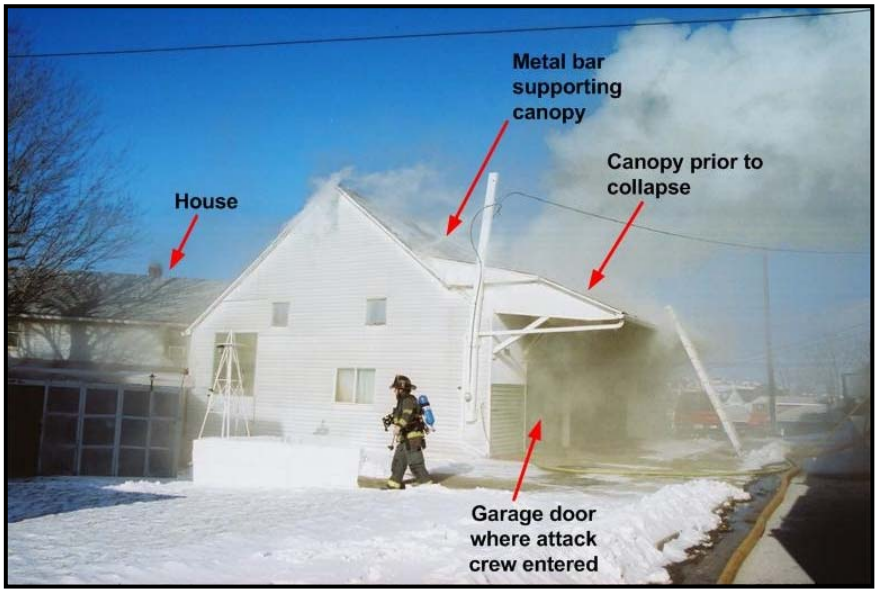


Photo 17: Canopy precollapse, B-side viewed from A-B corner. Photo courtesy of Fire Marshal's

A large canopy covered the main garage door. This canopy did not have support columns underneath. Three metal bars connected the canopy to the garage's roof rafters by turn buckles. (Photo #17) The canopy had a slight pitch for water runoff and it was two layers thick (studs, plywood, and shingles covered by another layer of studs, plywood, and shingles).

According to state fire marshal investigators, the cause and origin of the fire was faulty electrical wiring in the vestibule. The fire started low on an interior wall and traveled up the wall to both the house and garage. The fire spread rapidly through the garage attic area. The owner of the building tried to put the fire out with a ½" garden hose before calling the fire department. Both the house and the garage were extremely cluttered with an accumulation of various household articles which restricted access and made entry difficult.

Weather

The weather at the time of the incident included a temperature high of 14°F, and a low of 3°F. Winds were variable between 10-20 mph, with gusts up to 30 mph from the West and Northwest. No precipitation was reported on the day of the incident. It was determined that the cold weather conditions may have played a significant factor in this incident. Fire fighters were limited in their mobility and slipped on the frozen overspray, and equipment failed (low-pressure air bags failed to deploy to raise debris, regulator couplings froze and could not connect after becoming frozen). The streets around the structure were plowed prior to the incident.

Investigation

On February 4, 2007, at approximately 0934 hours, the homeowner called 911 (emergency dispatch) and reported a fire in his house. The homeowner had attempted to extinguish the fire with a garden hose for some time before reporting the fire. The municipal (career) fire department was immediately dispatched for "an unknown type fire."

At the time of the dispatch five fire fighters were on duty. A Captain and two Fire Fighters were working at Station 1, and two Fire Fighters were on duty at Station 2. Engine 8 (E8) was the first engine dispatched. It left Station 2 at 0938 hours with the victim (E8 FF) and injured Fire Fighter (E8 EO) on-board. The incident site was approximately six city blocks from Station 2.

The Chief of the department was off-duty but driving through town near Station 1 when he heard the dispatch. He immediately proceeded to the scene. Engine 9 (E9) left Station 1 with a Captain and two Fire Fighters on-board at 0938 hours. Just days prior to the incident, the same crews had responded to the same address for a downed power line and wondered whether this call was related.

Engine 8 arrived on the scene and the Fire Fighters saw heavy black smoke. The EO called dispatch to report what they saw, and the victim pulled a 150-foot length of 1¾" preconnected hoseline from the truck. The E8 EO confirmed the hose the E8 FF (victim) was

using, and then engaged the pump and charged the line. As this was occurring, the Chief arrived on-scene and assumed incident command while the two fire fighters were preparing to make entry. Note: Due to limited staffing, the fire department does not have a fire fighter stationed at the pump panel during fire suppression operations. The EO engages the pump than assists with handling the hoseline.

The homeowner met the E8 Fire Fighters at the garage door and told them the fire was in the back right corner of the garage. The E8 FF advanced through the open garage door (A-side) holding the nozzle, and the E8 EO backed him up. The E8 EO also carried an ax.

While en route, the E9 Captain heard Engine 8 arrive on-scene and report heavy smoke showing so he radioed dispatch to request the mutual aid RIT be dispatched. When Engine 9 arrived on-scene at 0941, the Captain radioed dispatch and requested a second alarm for additional mutual aid.

Engine 9 was positioned about 70 yards behind Engine 8. The crew on Engine 9 laid a 4" hoseline from the hydrant to Engine 8. The steamer valve blew off when the Engine 9 crew first tried to connect to the hydrant, so the hydrant was shut off, the steamer valve was reconnected, and the water flow was resumed. A volunteer fire fighter from a neighboring department arrived on-scene and assisted with connecting the line to the hydrant. Engine 8 did not run out of water during this process.

The Chief (IC) and the Captain did a 360 degree walk-around, and found a door on D-side that accessed the vestibule. Entry was attempted but could not be made due to the accumulation of cluttered objects inside.

After establishing the water supply to Engine 8, the Engine 9 Fire Fighters went to the structure to assist with the fireground operations. The volunteer fire fighter was asked to monitor the pumps on Engine 8. One E9 FF got a 24-foot ladder intending to vent the garage roof. The second E9 FF was directed by the IC to go to D-side to vent the windows in the house. The second E9 FF met the Captain on the D-side. Dispatch notified the power company and the State Fire Marshal of the fire at 0951 hours.

TS-2 arrived on-scene with four fire fighters at 1000 hours and prepared to start a master stream directed at the roof. TS-2 members laid a 4" hoseline from another hydrant to supply the master stream. The Captain directed the crew to make entry into D-side. Three fire fighters took a 1¾" preconnected handline to D-side along with irons (an axe and a Halligan bar). Entry was difficult due to clutter blocking the door. The E9 FF on D-side retrieved a 24-foot ladder from TS-2 and put it up to the second floor window. The Captain left D-side and walked completely around the house to check the conditions on the other sides. The IC assisted the fire fighters on D-side in knocking out windows in the house for horizontal ventilation.

The first E9 FF had just completed throwing a ladder up to the garage canopy (A-side) intending to vent the garage roof when the Captain returned and stated he needed manpower on B-side. A second 1¾" preconnected handline was pulled from E8 and pulled

to B-side, and the E9 FF took this nozzle and entered the house with the Captain following him. Fire was observed near the front of the house. The E9 FF began flowing water to knock the fire down. The Captain's SCBA ran low on air and his alarm began to sound, so both fire fighters backed out of the house. The Captain went to E8 to change his air cylinder while the other fire fighter remained at the B-side door and continued to flow water through the door.

Collapse

The IC called to the E8 EO as he and the victim were fighting the fire inside the garage. The E8 EO backed up a few steps to hear the IC say that the TS-2 master stream was going to go into operation to stop the fire spread on the backside of the house. The E8 FF (victim) remained in the garage, bouncing water off of the ceiling onto the fire. At this point, both E8 FFs backed out of the garage to change SCBA cylinders since they were running low on air.

Meanwhile, one of the fire fighters who arrived on TS-2 went to B-side to assist the E9 FF with the hand line while the Captain was changing his air cylinder. These two fire fighters made entry through the B-side door and into the house. They advanced about 10 feet and encountered heavy fire to the right. Water was directed in this area and appeared to be effective in knocking down the fire there. The Captain returned to B-side and called the two fire fighters outside to tell them that the master stream on TS-2 was going into operation. As the two fire fighters were talking with the captain, they heard an air horn and then heard the IC call a Mayday over the radio.

After changing cylinders, the E8 crew (victim and E8 EO) had re-entered the garage to resume putting water on the fire. Some debris from the ceiling fell on the E8 EO's head, knocking him to his knees. He told the E8 FF (the victim) that they needed to back out due to the deteriorating conditions.

Photo 18: Post-collapse, D-side. Courtesy of Fire Marshal's office.

They backed out of the garage door, but remained near the doorway and still under the canopy with the hoseline still in operation. The E8 FF was on his knees, directing the nozzle toward the fire. The E8 EO told the E8 FF they needed to back up more to get out from under the canopy. As they

were stepping back, the canopy collapsed on them without warning. (Photos #19–#21) They were approximately three minutes into their second SCBA cylinders.

The canopy hit the E8 EO in the back and knocked his helmet off. One arm was pinned by

Photo 19: Failed metal support rods bolted to roof rafter.
Courtesy of Fire Marshal's office.

Photo 20: Failed metal support rods and turnbuckle.

Photo 21: Post-collapse, D-side. Note failed metal support rods and turnbuckles.
Photo courtesy of Fire Marshal's office.

the construction materials of the canopy (2"x4" and 2"x6" lumber). The other arm was free, so he activated his PASS and started pounding on debris. He saw daylight and was able to move enough so that he could free his arm and wiggle out of his SCBA straps and scoot

toward the light. When he reached the light, he was able to wave his hand through a small opening in the debris. He removed his facepiece when the air in his SCBA cylinder ran out. The E8 EO heard the victim's PASS and was able to speak to him.

The IC had just returned to D-side and began knocking out windows for ventilation, when a civilian told him that the canopy had just collapsed on two fire fighters. The IC returned to A-side to see the collapse as the mutual aid RIT arrived on-scene. At 1010 hours, the IC called a Mayday and all the career fire fighters were directed to the front of the building. A volunteer fire department kept water flowing at the back of the house and garage.

Extrication

The mutual aid RIT arrived just as the canopy collapsed. Two civilians ran up to the RIT and told them that two fire fighters were trapped under the canopy. The RIT took its tool bag (cordless saw and drill, rope, hand tools, and irons) and the RIT Leader took a 6-foot steel roof hook.

The RIT Leader approached the front of the garage and directed his team to use cribbing to support the canopy. He then crawled into the void space between the collapsed canopy and the garage wall and was able to speak to the injured E8 FF.

Air bags were brought out to lift the collapsed canopy, but the intense cold and overspray froze the airbags and line couplings, rendering them useless. A mechanical spreader was used to lift the canopy, but it just broke through the wood without lifting the canopy and its use was discontinued. A ventilation fan was started to blow smoke away from the canopy.

The RIT then used power saws to cut the injured E8 FF out of the debris. The E8 EO told the RIT where he thought the victim was. (Note: it was stated by the RIT Leader that it was difficult to cut the victim out of the debris because his exact location was not known. Some rescuers reported hearing a muffled PASS device while others stated they did not hear a PASS device.) When found, the victim's upper torso was uncovered first. His facepiece and helmet were still on and in place. His arms were pinned, and he did not appear to be breathing. Additionally, the victim was laying on his right side because the SCBA tank was still on his back. Rescuers removed the victim's facepiece to administer oxygen while his legs were still pinned. The canopy was fully cut away and the victim was removed from the debris.

A helicopter landed on-scene, but it was not used because the victim did not have vital signs. Both the victim and the injured fire fighter were transported to the city hospital by ground ambulance. The E8 EO was treated for smoke inhalation and an ankle sprain.

Cause of Death

According to the coroners' findings, the cause of death for the victim was asphyxiation due to entrapment under a collapsed roof.

Recommendations/Discussions

Recommendation #1

Fire departments should review and follow existing SOPs for structural fire fighting to ensure that fire fighters follow a 2- in 2-out policy.

Discussion

The Occupational Safety and Health Administration (OSHA) Respirator Standard and Hazardous Waste Operations and Emergency Response Standard requires four persons (two in and two out); each with protective clothing and respiratory protection as the minimum number essential for the safety of those performing work inside a structure. The NFPA and the fire department's standard operating procedures also recommend 2-in and 2-out and that the team members should be in communication with each other through visual, audible, or electronic means to coordinate all activities, and determine if emergency rescue is needed. During this incident's initial response, the limited manpower both on duty and available, was not adequate to ensure compliance with two in two out requirements at all times.

Recommendation #2

Fire departments should ensure that adequate numbers of staff are available to immediately respond to emergency incidents.

Discussion

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, 2004 Edition contains recommended guidelines for minimum staffing of career fire departments.

NFPA 1710 §5.2.2 (Staffing) 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:

1. Life hazard to the populace protected
2. Provisions of safe and effective fire-fighting performance conditions for the fire fighters
3. Potential property loss
4. Nature, configuration, hazards, and internal protection of the properties involved
5. Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene."

The NFPA standard states that both engine and truck companies shall be staffed with a minimum of four on-duty personnel. The standard also states that in jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members. Jurisdictions where fire companies deploy quint apparatus designed to operate as either an engine company or a ladder company should also follow these same staffing guidelines.

NFPA 1710 also states that the fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 4-minute response time and/or the initial full alarm assignment within an 8-minute response time to 90% of the incidents as established in Chapter 4. The fire department shall have the capability to deploy an initial full alarm assignment within an 8-minute response time to 90% of the incidents as established in Chapter 4. The initial full alarm assignment shall provide for the following:

1. Establishment of incident command outside of the hazard area for the overall coordination and direction of the initial full alarm assignment. A minimum of one individual shall be dedicated to this task.
2. Establishment of an uninterrupted water supply of a minimum 1520 L/min (400 gpm) for 30 minutes. Supply line(s) shall be maintained by an operator who shall ensure uninterrupted water flow application.
3. Establishment of an effective water flow application rate of 1140 L/min (300 gpm) from two hoselines, each of which shall have a minimum of 380 L/min (100 gpm). Each attack and backup line shall be operated by a minimum of two individuals to effectively and safely maintain the line.
4. Provision of one support person for each attack and backup line deployed to provide hydrant hookup and to assist in line lays, utility control, and forcible entry.
5. A minimum of one victim search and rescue team shall be part of the initial full alarm assignment. Each search and rescue team shall consist of a minimum of two individuals.
6. A minimum of one ventilation team shall be part of the initial full alarm assignment. Each ventilation team shall consist of a minimum of two individuals.
7. If an aerial device is used in operations, one person shall function as an aerial operator who shall maintain primary control of the aerial device at all times.
8. Establishment of an Incident Rapid Intervention Crew (IRIC) that shall consist of a minimum of two properly equipped and trained individuals.

Due to staffing and manpower limitations within the department, the small size of the initial responding crews at this incident could not appropriately and safely respond to the necessary fireground operations–e.g. incident command, scene size-up, search and rescue, a staged IRIC, hydrant connections, ventilation, and medical aid and transport. Additional manpower was requested and off-duty fire fighters were called to return to work.

The city funds the fire department involved in the incident. According to the Fire Chief, staffing has been a concern since 1997 when a consultant was hired to determine the number of fire fighters needed for the city. The consultant recommended a minimum of 21, with at least 27 fire fighters as optimal.

Recommendation #3

> *Fire departments should establish a collapse zone when structures become unstable.*

Discussion

Buildings can collapse due to the structural damage directly caused by a fire, or the activities of fire-fighting operations. A fire department's familiarity with types of construction in their community is an important tool in safely fighting fires. Fire fighters should be able to immediately evacuate a building where collapse is possible. A collapse zone equal to one and a half times the height of the building should be established. This perimeter assists in keeping personnel out of imminent danger. Once a collapse zone is established, fire departments should enforce a "no re-entry" policy unless the Incident Commander is aware and approves. In this incident, the first crew arrived on-scene at 0938 hours and the collapse occurred at approximately 1010 hours. Fire fighters had been on the scene for 32 minutes and the fire had been affecting the structural integrity of the building for at least that long.

Fire fighters need to recognize the dangers of operating underneath or near overhanging awnings, porches, and other areas susceptible to collapse. Immediate safety precautions must be taken if factors indicate the potential for a building collapse. An external load, such as a parapet wall, steeple, overhanging porch, awning, sign, or large electrical service connections reacting on a wall weakened by fire conditions may cause a wall to collapse. Other factors include fuel loads, damage, renovation work, deterioration caused by the fire as well as pre-existing deterioration, support systems and truss construction. A collapse is a possibility after fire involvement of more than 10 minutes. The canopy which collapsed in this incident was supported by metal rods connected to the garage's roof rafters.

Recommendation #4

> *Fire departments should ensure that the Incident Commander continuously evaluates the risks versus gain when determining whether the fire suppression operation will be offensive or defensive.*

Discussion

The initial size-up conducted by the first-arriving officer allows the officer to make an assessment of the conditions and to assist in planning the suppression strategy. The following

general factors are important considerations during a size-up: occupancy type involved, potential for civilians trapped in the structure, smoke and fire conditions, type of construction, age of structure, exposures, and time considerations such as the time of the incident, length of time fire was burning before arrival, and time fire was burning after arrival. The Incident Commander must perform a risk analysis to determine what hazards are present, what the risks to personnel are, how the risks can be eliminated or reduced, and the benefits to be gained for interior or offensive operations. The initial size-up should include a complete 360° walk-around of the structure if possible.

The size-up must include continued assessment of risk versus gain during incident operations. According to NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, 2007 Edition, §A-6-2.1.1, "The acceptable level of risk is directly related to the potential to save lives or property. Where there is no potential to save lives, the risk to the fire department members must be evaluated in proportion to the ability to save property of value. When there is no ability to save lives or property, there is no justification to expose fire department members to any avoidable risk, and defensive fire suppression operations are the appropriate strategy." Retired New York City Fire Chief Vincent Dunn states, "When no other person's life is in danger, the life of the fire fighter has a higher priority than fire containment."

The first-responding officer, as well as the incident commander, needs to make a judgment as to what is at risk – people or property. This will help determine the risk profile for the incident. Many fire fighters stand by the notion that all incidents are "people" events until proven otherwise. Some fire fighters are willing to concede that a fire environment has become too hostile to sustain life and therefore, the only thing left to save is property.

In this incident, the structure involved was not occupied, the only resident of the adjoining house was known to be outside and the garage and house were greatly cluttered making entry difficult. The first crew arrived on-scene at 0938 hours and the collapse occurred at approximately 1010 hours. Fire fighters had been on the scene for 32 minutes and the fire had been affecting the structural integrity of the building for at least that long. Fire officers and fire fighters need to understand that they have very little time to offensively fight a fire once the structural elements have become involved and also how different construction types, age of construction, and factors such as the steel support rods on the canopy can be affected by fire.

Recommendation #5

> *Fire departments should ensure that the first-arriving company officer does not become involved in the fire-fighting effort when assuming the role of the Incident Commander.*

Discussion

Fire fighter safety starts with a strong command presence. According to NFPA 1561, Standard on Emergency Services Incident Management System, §4.1.1, "the Incident Commander shall be responsible for the overall coordination and direction of all activities at an incident." In addition to conducting an initial size-up, incident command should maintain a command post outside of the structure to assign companies and delegate functions, and continually evaluate the risk versus gain of continued fire-fighting efforts. According to the International Fire Service Training Association (IFSTA) publication, Fire Department Company Officer, there are three modes of operation for the first-arriving officer assuming IC: nothing showing, fast attack, and command.

"***Nothing-showing mode***. When the problem generating the response is not obvious to the first-in unit, the company officer should assume command of the incident and announce that nothing is showing. He should direct the other responding units to stage at Level I, accompany the crew on an investigation of the situation, and maintain command using a portable radio."

"***Fast-attack mode***. When the company officer's direct involvement is necessary for the crew to take immediate action to save a life or stabilize the situation, the officer should take command and announce that the company is in the fast-attack mode."

"***Command mode***. Because of the nature of some incidents, immediate and strong overall command is needed. In these incidents, the first-in officer should assume command by naming the incident and designating the command post, give an initial report on conditions, and request the additional resources needed."

In this incident, smoke coming from the roof and inside the building required the "Command mode" of operation. The first-arriving officer initiated the "Command mode" by declaring command of the incident over the radio and reporting smoke coming from the roof and inside the building. However, due to insufficient staffing and manpower limitations, the Incident Commander became involved in fire ground duties such as pulling hoselines and assisting in ventilation.

To effectively coordinate and direct fire-fighting operations on the scene, it is essential that the IC does not become involved in fire-fighting efforts. A delay in establishing an effective command post may result in confusion of assignments, lack of personnel and apparatus coordination which may contribute to rapid fire progression. The involvement of the initial IC in fire fighting also hampers the communication of essential information as command is transferred to later arriving officers.

Recommendation #6

> *Fire departments should consider using a thermal imaging camera as a part of the initial size-up operation to aid in locating fires in concealed areas.*

Discussion

Thermal imaging cameras are being used more frequently by the fire service. One function of the camera is to locate the fire or heat source. Infrared thermal cameras assist fire fighters in quickly getting crucial information about the location of the source (seat) of the fire from the exterior of the structure, so they can plan an effective and rapid response with the entire emergency team before initiating the interior attack. Knowing the location of the most dangerous and hottest part of the fire may help fire fighters determine a safe approach and avoid structural damage in a building that might have otherwise been undetectable. Ceilings and floors that have become dangerously weakened by fire damage and are threatening to collapse may be spotted with a thermal imaging camera. The use of a thermal imaging camera may provide additional information the IC can use during the initial size-up. 16 In this incident, the use of a thermal imaging camera may have aided the fire fighters in identifying that the fire was burning in the garage's roof rafters sooner, allowing them to exit the garage sooner.

Recommendation #7

Fire departments should ensure that a separate Incident Safety Officer, independent from the IC, is appointed at each structural fire.

Discussion

According to NFPA 1561, Standard on Emergency Services Incident Management System, 2005 Edition, §7.1.1, "The Incident Commander shall have overall authority for management of the incident (7.1.1) and the Incident Commander shall ensure that adequate safety measures are in place (7.1.2)." This shall include overall responsibility for the safety and health of all personnel and for other persons operating within the incident management system. While the IC is in overall command at the scene, certain functions must be delegated to ensure adequate scene management is accomplished. According to NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, "as incidents escalate in size and complexity, the incident commander shall divide the incident into tactical-level management units and assign an incident safety officer (ISO) to assess the incident scene for hazards or potential hazards (8.1.6)." These standards indicate that the IC is in overall command at the scene, but acknowledge that oversight of all operations is difficult. On-scene fire fighter health and safety is best preserved by delegating the function of safety and health oversight to the ISO. Additionally, the IC relies upon fire fighters and the ISO to relay feedback on fireground conditions in order to make timely, informed decisions regarding risk versus gain and offensive versus defensive operations. The safety of all personnel on the fireground is directly impacted by clear, concise, and timely communications among mutual aid fire departments, sector command, the ISO, and IC.

Chapter 6 of NFPA 1521, Standard for Fire Department Safety Officer, defines the role of the ISO at an incident scene and identifies duties such as recon of the fire ground and reporting

pertinent information back to the Incident Commander; ensuring the department's accountability system is in place and operational; monitoring radio transmissions and identifying barriers to effective communications; and ensuring established safety zones, collapse zones, hot zone, and other designated hazard areas are communicated to all members on-scene.

Larger fire departments may assign one or more full-time staff officers as safety officers who respond to working fires. In smaller departments, every officer should be prepared to function as the ISO when assigned by the IC. The presence of a safety officer does not diminish the responsibility of individual fire fighters and fire officers for safety. The ISO adds a higher level of attention and expertise to help the individuals. The ISO must have particular expertise in analyzing safety hazards and must know the particular uses and limitations of protective equipment.

The department involved in this incident did not have a permanent safety officer position and limited manpower and staffing at the incident did not allow for the designation of a separate Incident Safety Officer. A designated safety officer could have assisted with continual size-up and timely communications regarding safety on the fireground, including the need to establish a collapse zone.

Investigator Information

This investigation was conducted by Robert Koedam, Chief, Fatality Investigations Team, and Tim Merinar, Safety Engineer, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH. Vance Kochenderfer, NIOSH Quality Assurance Specialist, National Personal Protective Technology Laboratory, conducted an evaluation of the victim's self-contained breathing apparatus. Luci Kovacevic, MD, Guest Researcher at the NIOSH, Division of Safety Research also assisted in the investigation. This report was authored by Luci Kovacevic. An expert technical review was conducted by Battalion Chief of Safety, Stephen Miles, Virginia Beach (VA) Fire Department.

RIC Command and Control Exercises

Time Frame: 3:00

Materials Needed:

- Incident Command Worksheet
- Incident Command Responsibility Checklist
- Safety Officer Checklist
- RIC Responsibilities Checklist
- Pen or pencil
- White board or easel paper and easel, colored markers
- Two-channel portable radios (6 minimum)
- Full personal protective equipment

Introduction: These exercises are based on case studies reviewed during the course. Each exercise requires five students to assume various roles necessary to safety perform a fire fighter rescue.

Directions:

1. It will take 30 minutes to prepare for the exercise process.
2. The provided checklists will assist with managing the RIC operation and a portable radio to communicate with one another. Face to face communication should be used when appropriate.
3. Each member of your assigned group must assume one of the five roles:
   - Incident Commander
   - RIC Group Supervisor
   - RIC Leader
   - Division/Group Supervisor
   - Downed Fire Fighter in PPE and on-air
4. Each exercise is designed to be conducted in real time, but should not take more than 30 minutes, including critique time.
5. The exercise will start when the Downed Fire Fighter calls for Emergency Traffic and calls "Mayday."
6. Base your actions on the scenario provided. Remember these exercises are based on actual incidents that resulted in fire fighters being injured or killed.
7. Your performance will be graded. An individual performance sheet will be provided to you for future reference. These exercises are to begin your preparation for an actual incident. Additional training should occur when done with this course.

Case Study #1 Exercise: Wisconsin

Situation

You arrive on-scene at 1227 hours of a two-story single family residence with light smoke showing. A neighbor reports that he tried to enter the structure because he thought someone might be inside. Dark black smoke is seen coming from a vent near the ground on the C-side.

Building Information

The structure is approximately 3,500 square feet of living area above grade and 2,100 square feet below grade. The floors consist of lightweight wooden parallel-chord truss system and engineered wooden "I" beams. Radiant floor heating is installed on top of the subfloor consisting of flexible hose that circulated hot water and was layered in concrete approximately 3" thick. The structure is comprised of wood framing covered with vinyl siding topped with composition single roofing.

Weather

Clear and sunny, temperature averaging 68°F, wind averaging 7 mph from the south.

Apparatus and Personnel On-scene

The on-scene times reflect the actual times of the incident reviewed earlier in the class. For purposes of this exercise all units will be on-scene when Emergency Traffic is called.

- ❒ On-scene at 1227 hours
  - Engine #451 [E451] - Captain, Engineer, and two Fire Fighters
  - Ladder #451 [L451] – Captain, Engineer, and two Fire Fighters
  - Ambulance #451 [A451] – Two Fire Fighter/Paramedics
- ❒ On-scene at 1232 hours
  - Battalion Chief #411 [BC411] – Assumes incident command
- ❒ On-scene at 1235 hours
  - Engine #453 [E453] - Captain, Engineer, and two Fire Fighters
  - Engine #455 [E455] - Captain, Engineer, and two Fire Fighters

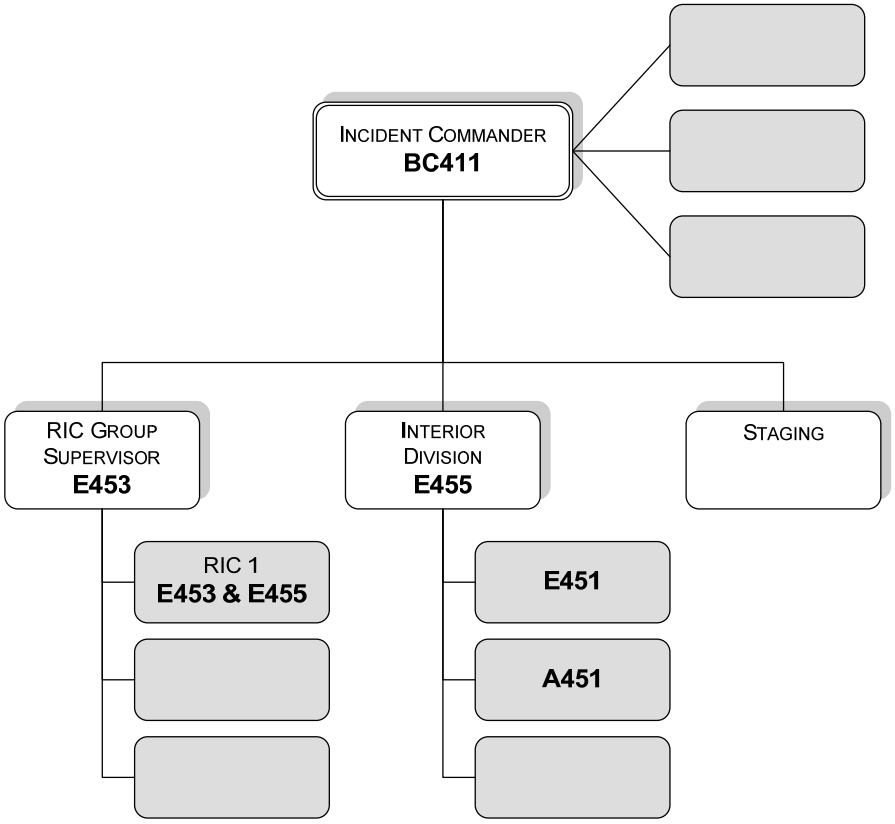
Additional Alarms Available if Requested by the IC

- ❒ Second alarm resources will arrive five minutes after the request.
  - Engine #301 [E301] – Captain, Engineer, and two Fire Fighters
  - Engine #302 [E302] – Captain, Engineer, and two Fire Fighters
  - Truck #304 [T304] – Captain, Engineer, and two Fire Fighters
  - Medic #301 [M301] – Two Fire Fighter/Paramedics
  - Battalion Chief #3 [BC3]

- ❒ Third alarm resources will arrive ten minutes after the request.
  - Engine #10 [E10] – Captain, Engineer, and two Fire Fighters
  - Engine #40 [E40] – Captain, Engineer, and two Fire Fighters
  - Medic #72 [M72] – Two Fire Fighter/Paramedics

Initial Action

All first alarm companies have been on-scene for approximately 10 minutes. Command and tactics have been established as follows:



Ambulance 451 assists in making a hydrant connection, while E451 pulls a 2½" gated wye with a 100-foot section of 1¾" hoseline to the front door. Ladder 451 assists with stretching the hoseline and prepares to make forcible entry. Engine 451 Captain assumes command then passes command to the L451 Captain.

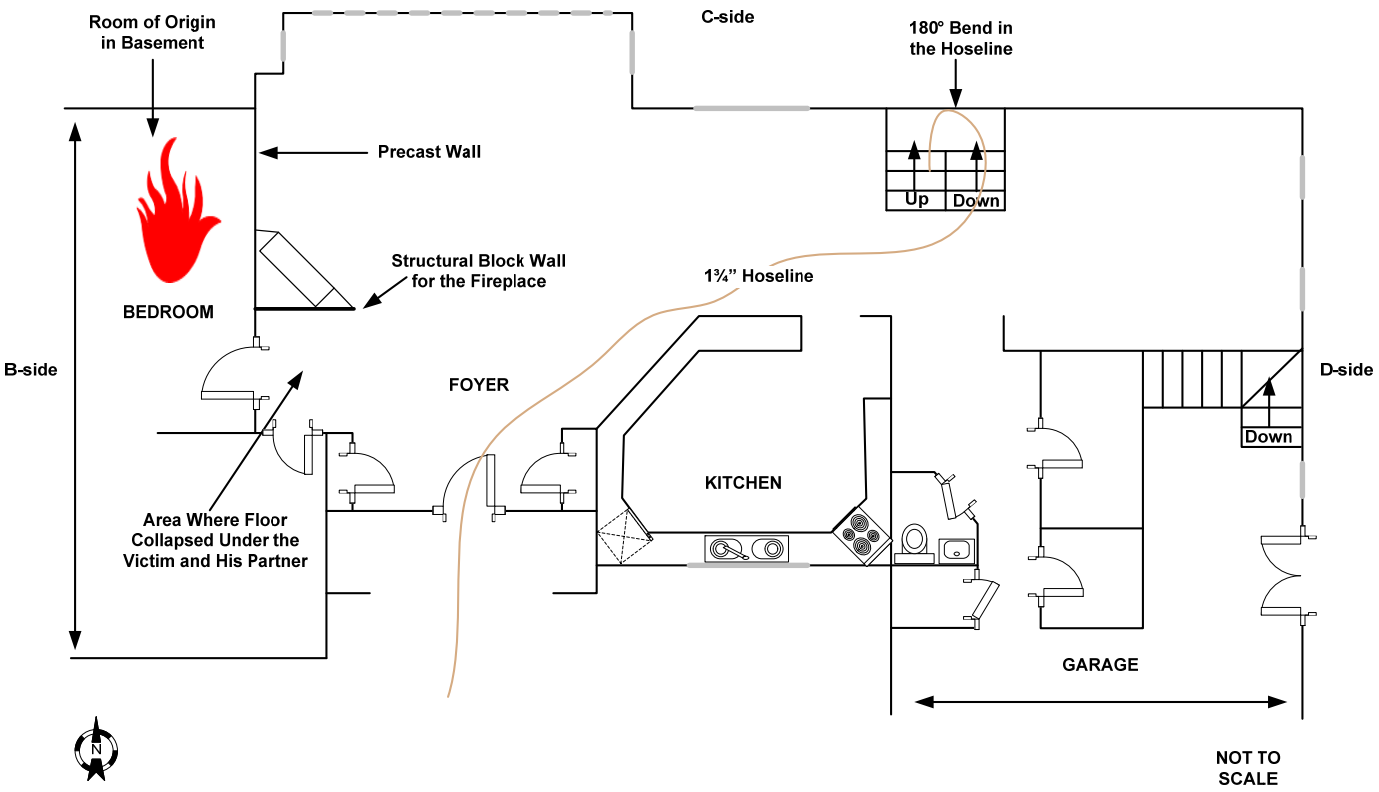
Battalion 411 arrives on-scene and assumes command from the L451 Captain. The Captain and two Fire Fighters from E451 enter the structure through the front door and encounter yellow/brown smoke throughout the entire first floor. They make a right-hand search for entry into the basement. A PPV fan is set up at the front door for horizontal ventilation, improving

visibility on the first floor. E451 extends a 1¾" hoseline down into the basement, encountering thick black smoke, an extremely slippery floor, and zero visibility. Intense heat can be felt from the B-side. Battalion 451 requests a second alarm.

The IC directs A451 Fire Fighters to conduct a primary search of the first floor. They enter the foyer resulting in failure of the floor. Both fire fighters fall into the basement resulting in a fireball. A451 FF#1 lands in the room of origin and FF#2 lands in another area of the basement, separated from the main body of the fire. FF#2 is exposed to high heat conditions and takes refuge in an adjoining room.

Exercise Assignments

- ❒ Incident Commander
  - Battalion Chief 411 has parked the command vehicle on the A-side and establishes command.
- ❒ RIC Group Supervisor
  - Engine 453 is assigned to RIC. E453 Captain stages the engine on the A/D-side of the structure, assumes RIC Group Supervisor, and prepares to manage a RIC operation.
- ❒ RIC 1 [E453]
  - Engine 453 Engineer is assigned the Lead position and is supported by two E453 Fire Fighters and the two E455 members. They prepare for a RIC operation.
- ❒ Division/Group Supervisor
  - Engine 455 Captain assumes Interior Division and is assisted by the Engineer and E451 crewmembers.
- ❒ Trapped Fire Fighter(s)
  - A451 FF#2 calls Emergency Traffic and issues a Mayday.


Room of Origin
in Basement
C-side
180° Bend in
the Hoseline
Precast Wall
Up
Down
Structural Block Wall
for the Fireplace
1¾" Hoseline
BEDROOM
B-side
FOYER
D-side
Down
KITCHEN
Area Where Floor
Collapsed Under the
Victim and His Partner
GARAGE
N
NOT TO
SCALE

Case Study #2 Exercise: California

Situation

Battalion 13 and Task Force 66 arrive on-scene and report light smoke emitting from a one-story commercial building. Three engine crews (Engine 66, Engine 57, and Engine 46) advance hoselines through the front door in an attempt to determine the origin of the fire. Conditions deteriorate inside the building and members from the three engine companies involved in the fire attack began to withdraw. Engine 57 Captain becomes separated from his crew and is lost in the building.

Building Information

Approximately 6,490 square-foot single-story commercial building. The building measures 110-feet long by 59-feet wide, which contains a dog treats preparation operation. The roof is constructed of a wooden arched-truss. The building has two metal security doors in the front.

Weather

Temperature is 65°F with winds variable between 3-5 mph from the West and Northwest.

Apparatus and Personnel On-scene

The on-scene times reflect the actual times of the incident reviewed earlier in the class. For purposes of this exercise all units will be on-scene when Emergency Traffic is called.

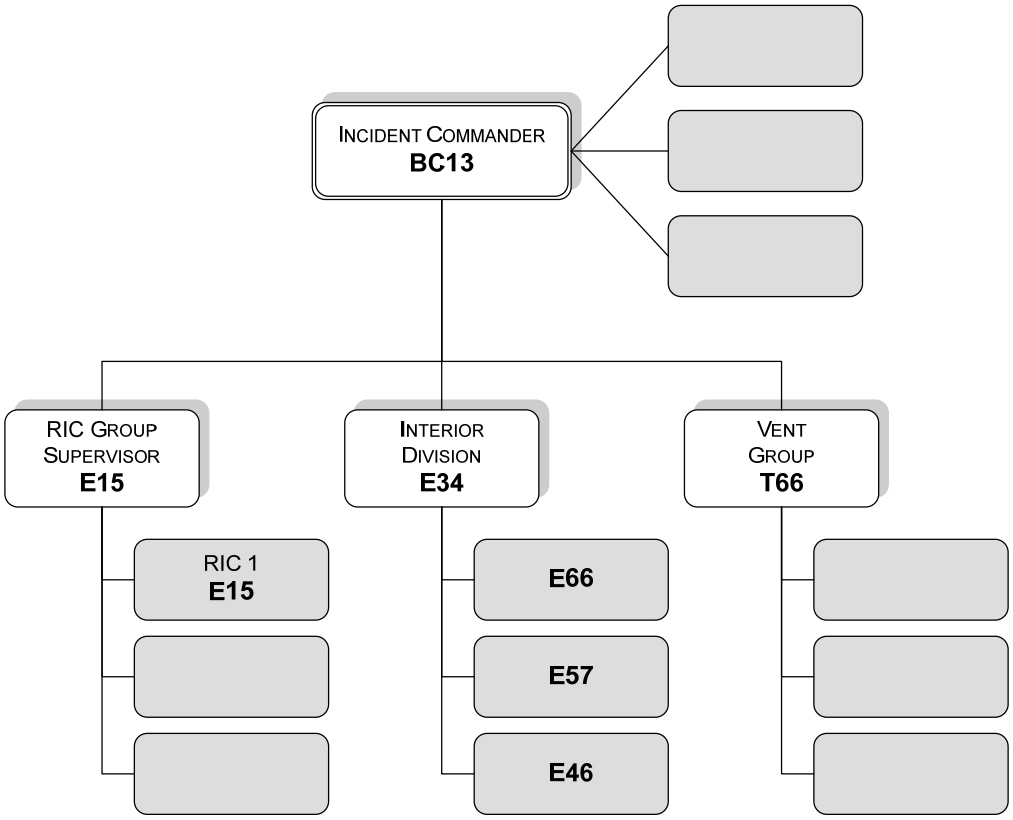
- ❒ On-scene at 0220 hours
  - Battalion Chief [BC13] – Assumes incident command
- ❒ On-scene at 0220 hours Task Force 66
  - Task Force 66
    - Engine 66 [E66] – Captain, Engineer, and two Fire Fighters
    - Engine 266 [E266] – Engineer
    - Truck 66 [T66] - Captain, apparatus operator, and three Fire Fighters
    - Rescue 866 – Two Fire Fighter/EMT-Is
- ❒ On-scene at 0224 hours
  - Engine 57 [E57] – Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 0225 hours
  - Engine 46 [E46] - Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 0227 hours
  - Engine 34 [E34] - Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 0231 hours
  - Engine 33 [E33] - Captain, Engineer, and two Fire Fighters
  - Engine 15 [E15] - Captain, Engineer, and two Fire Fighters

Additional Alarms Available if Requested by the IC

- ❒ Second alarm resources will arrive five minutes after the request.
  - Engine #58 [E58] – Captain, Engineer, and two Fire Fighters
  - Engine #47 [E47] – Captain, Engineer, and two Fire Fighters
  - Truck #34 [T34] – Captain, Engineer, and two Fire Fighters
  - Rescue #34 [R34] – Two Fire Fighter/EMT-Is
  - Battalion Chief #15 [BC15]
- ❒ Third alarm resources will arrive ten minutes after the request.
  - Engine #63 [E63] – Captain, Engineer, and two Fire Fighters
  - Engine #75 [E75] – Captain, Engineer, and two Fire Fighters
  - Truck #77 [T77] – Captain, Engineer, and two Fire Fighters
  - Rescue #77 [R77] – Two Fire Fighter/EMT-Is
  - Battalion Chief #17 [BC17]

Initial Action

All first alarm companies have been on-scene for approximately 10 minutes. Command and tactics have been established as follows:



Engine companies on-scene place hoselines in front of the secured doors. Forcible entry through the two metal security doors requires about 7½ to 9½ minutes from arrival on-scene.

Truck 66 goes to the roof, via a 35-foot ground extension ladder, to start ventilation procedures. The crew sees fire coming from a vent in the center of the roof. They cut a 4 foot by 4 foot ventilation hole and are driven back by heavy fire and heat.

The Engine 66 Captain and two Fire Fighters advance a 1¾" hoseline through the front door, followed by the Captain and two Fire Fighters from Engine 57 with a 1½" hoseline, and the Captain from Engine 46 with a 1¾" hoseline. Approximately 15 feet inside the front door, the companies encountered heavy smoke conditions with near zero visibility, but little heat. At 0231 hours, a Captain and two Fire Fighters from Engine 33 advised the IC they had 10-foot pike poles and were going in with fire attack to help pull ceilings.

Captains on the interior radioed Battalion 13 that they couldn't seem to find the fire; however, they were still advancing. The Captains from Engine 57 and 46 met inside of the structure and determine they are not making progress locating the fire. The Engine 46 Captain orders a retreat from the structure. Engine companies attempt to follow hoselines to locate the exit; however, the hoselines ware tangled, creating a problem on exiting. The Engine 33 Captain informs the IC in a face to face conversation that the Engine 57 Captain was missing and still inside.

Exercise Assignments

- ❒ Incident Commander
  - Battalion Chief 13 has parked his command vehicle on the A-side and establishes command.
- ❒ RIC Group Supervisor
  - Engine 15 is assigned to RIC and proceeds to the rear of the structure to a rolling steel door. Engine 15 Captain assumes RIC Group Supervisor and prepares to manage a RIC operation.
- ❒ RIC 1
  - Engine 15 Engineer is assigned the lead RIC entry and is supported with two Fire Fighters. They prepare for a RIC operation.
- ❒ RIC 2
  - Engine 33 crew of four to support RIC operations
- ❒ T66
  - Assigned to RIC operations
- ❒ RIC 3
  - Engine 34 crew of four to support RIC operations
- ❒ RIC 4
  - Engine 47 crew of four to support RIC operations

- ❒ Division/Group Supervisor
  - Engine 34 Captain assumes Interior Division and is supported by Truck 66
- ❒ Missing/Trapped Captain
  - Engine 57 Captain is lost inside the building and calls Emergency Traffic

Case Study #4 Exercise: Virginia

Situation

You arrive on-scene of a single-family house fire at 0603 hours and encounter fire in the B/C corner of the residence and underneath and along the deck on the first floor on the C-side on the structure. The wind is blowing up a drainage against the C-side of the house at speeds of 25-48 mph.

Building Information

The building is approximately 6,000 square feet, two-story plus finished walkout basement, nonsprinklered residential structure. It is constructed of wood framing with vinyl siding and a brick veneer front on the exterior. The residence had a large 700 square foot wood deck that extends three quarters the length on the first floor (C-side). The roof consists of wood rafters with fiberglass shingles over oriented strand board sheathing.

Weather

It is overcast, approximate temperature of 45°F, and a measured sustained wind speed of 25 mph from the Northwest with wind gusts up to 48 mph.

Apparatus and Personnel On-scene

The on-scene times reflect the actual times of the incident reviewed earlier in the class. For purposes of this exercise, all units will be on-scene when Emergency Traffic is called.

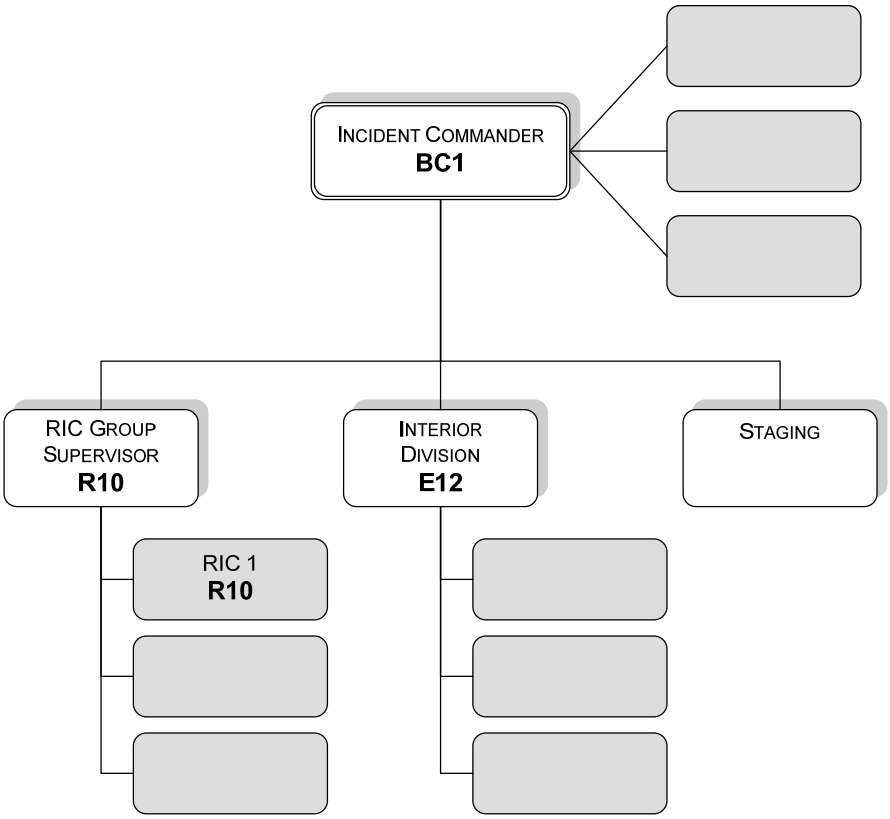
- ❒ On-scene at 0608 hours
  - Engine #12 [E12] – Captain, Engineer, and Fire Fighter
- ❒ On-scene at 0609 hours
  - Truck #12 [T12] – Captain, Engineer, and two Fire Fighters
  - FireMedic #12 [M12] – Two Fire Fighters
- ❒ On-scene at 0610 hours
  - Rescue #10 [R10] – Captain, Engineer, and three Fire Fighters
  - Engine #10 [E10] – Captain, Engineer, and one Fire Fighter
- ❒ On-scene at 0611 hours
  - Battalion Chief (IC)
- ❒ On-scene at 0612 hours
  - Engine #20 [E20] – Captain, Engineer, and two Fire Fighters
  - Ambulance #10 [A10] – Captain and two Fire Fighters
  - Safety #02 - Safety Officer
- ❒ On-scene at 0618 hours
  - Engine #2 [E2] – Lieutenant, Engine Operator, and two Fire Fighters

Additional Alarms Available if Requested by the IC

- ❒ Second alarm resources will arrive five minutes after request.
  - Engine #11 [E11] – Captain, Engineer, and two Fire Fighters
  - Engine #13 [E13] – Captain, Engineer, and two Fire Fighters
  - Truck #13 [T13] – Captain, Engineer, and two Fire Fighters
  - Medic #11 [M11] – Two Fire Fighter/Paramedics
  - Battalion Chief #2 [BC2]
- ❒ Third alarm resources will arrive ten minutes after request.
  - Engine #72 [E72] – Captain, Engineer, and two Fire Fighters
  - Engine #74 [E74] – Captain, Engineer, and two Fire Fighters
  - Medic #12 [M12] – Two Fire Fighter/Paramedics

Initial Action

All first alarm companies have been on-scene for approximately 10 minutes. Command and tactics have been established as follows:

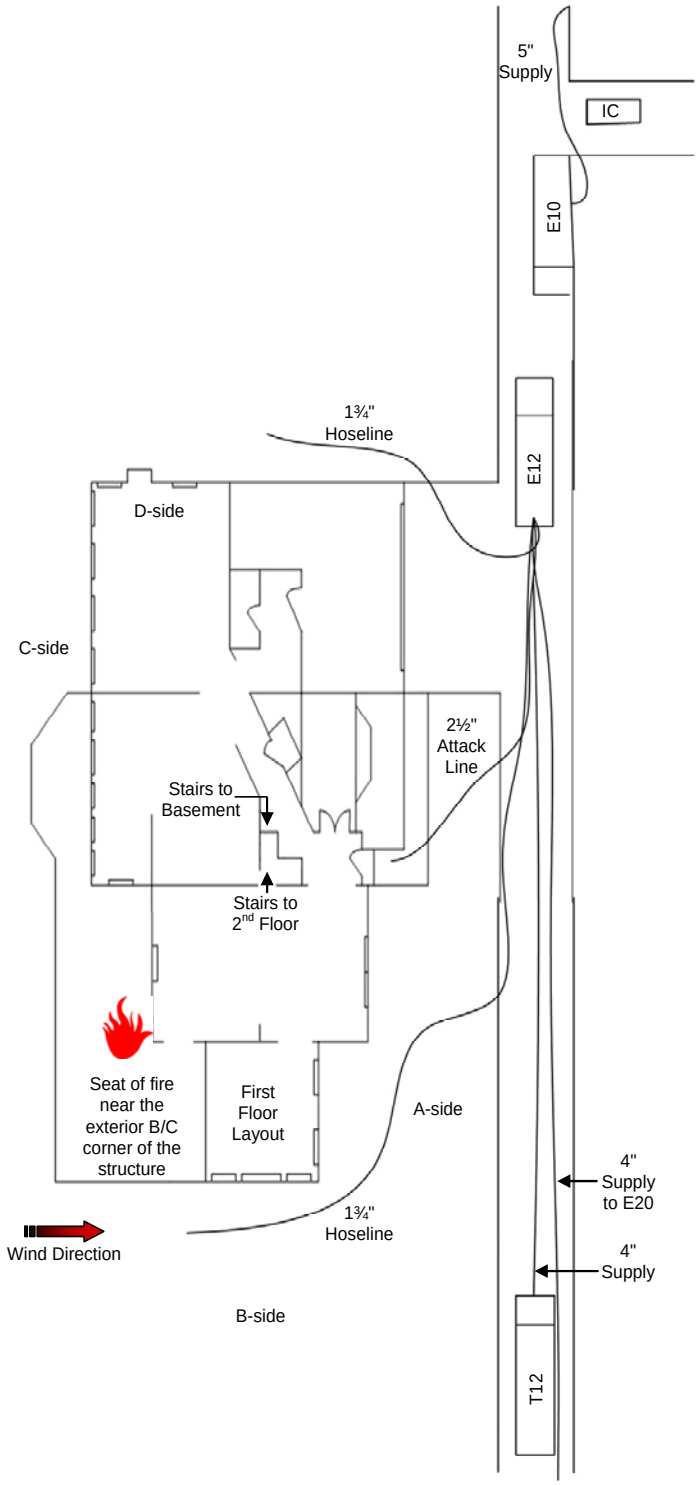


A charged 2½" hoseline was stretched to the front door from E12 by the E12 crew. Truck 12 Captain and Fire Fighter (FF) enter the structure through the front door. A 1¾" hoseline stretched from E12 to the rear of the structure. At 0611 hours, with a light haze of smoke visible on the first floor, Truck 12 Captain and FF walk up the stairs to search the bedrooms.

At the top of the stairs, T12 Captain and FF encountered smoke banked down 3 feet from the second floor ceiling and go to the D-side of the residence towards the master bedroom to begin a search. Suddenly the room turns black, then orange with flames. Truck 12 Captain exits the structure through the front door. T12 FF takes refuge in an adjoining room not impinged with flames. T12 Captain is burned on his ears and right index finger. E12 Captain notices the severe change in the fire conditions in the stairway and radios the IC for an emergency evacuation. Immediately following, T12 FF calls Emergency Traffic. E12 Captain is assigned Interior Division to coordinate fire attack and support RIC operations.

Exercise Assignments

- ❒ Incident Commander
  - Battalion Chief has parked command vehicle at the intersection on the A/D-side and establishes command.
- ❒ RIC Group Supervisor
  - Rescue 10 is assigned to RIC. R10 Captain stages the rescue on the A/D-side of the structure, assumes RIC Group Supervisor, and prepares to manage a RIC operation.
- ❒ RIC Leader
  - Rescue 10 Engineer is assigned lead for the RIC entry is supported with three Rescue 10 Fire Fighters. They prepare for a RIC operation.
- ❒ Division/Group Supervisor
  - Engine 12 Captain assumes Interior Division, initiates fire attack, and requests additional companies.
- ❒ Trapped Fire Fighter
  - Truck 12 Fire Fighter calls Emergency Traffic and issues a Mayday.


5" Supply
IC
E10
E12
1¾" Hoseline
D-side
C-side
2½" Attack Line
Stairs to Basement
Stairs to 2nd Floor
Seat of fire near the exterior B/C corner of the structure
First Floor Layout
A-side
4" Supply to E20
1¾" Hoseline
Wind Direction
4" Supply
B-side
T12

Case Study #5 Exercise: Maryland

Situation

You arrive on-scene at 0222 hours of a two-story row house fire with civilians reported trapped. One civilian has jumped from an A-side second story window and another confused civilian is walking around on the sidewalk. Heavy black smoke is pouring out of the front of the structure.

Building Information

Approximately 1,320 square foot building two-story residential row house constructed of wood balloon framing with the interior being remodeled to make first and second floor apartments. The basement was accessible from the first floor interior and an exterior alley door. The flat roof consisted of wood rafters with tar and paper over wood boards.

Weather

Cool and cloudy, temperature of 49°F, wind speed of 5 mph from the Northeast.

Apparatus and Personnel On-scene

The on-scene times reflect the actual times of the incident reviewed earlier in the class. For purposes of this exercise all units will be on-scene when the Emergency Traffic is called.

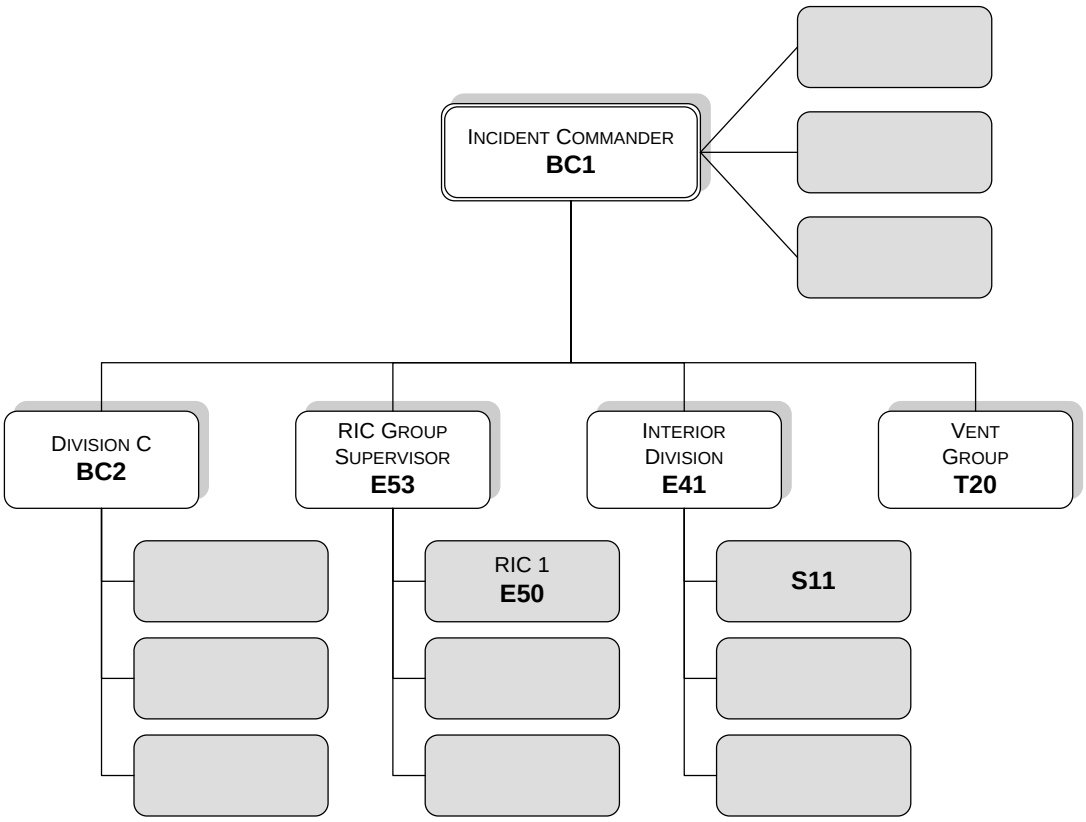
- ❒ On-scene at 0225 hours
  - Battalion Chief #1 [BC1] – Incident Commander
- ❒ On-scene at 0226 hours
  - Squad #11 [S11] – Captain, Engineer, and two Fire Fighters
  - Engine #41 [E41] – Captain, Engineer, and two Fire Fighters
  - Truck #20 [T20] – Captain, Engineer, and two Fire Fighters
  - Medic #20 [M20] – Two Fire Fighter/Paramedics
- ❒ On-scene at 0227 hours
  - Engine #51 [E51] – Captain, Engineer, and two Fire Fighters
  - Truck #3 [T3] – Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 0228 hours
  - Battalion Chief #2 [BC2]
- ❒ On-scene at 0232 hours
  - Medic #10 [M10] – Two Fire Fighter/Paramedics
- ❒ On-scene at 0237 hours
  - Engine #50 [E50] - Captain, Engineer, and two Fire Fighters

Additional Alarms Available if Requested by the IC

- ❒ Second alarm resources will arrive five minutes after the request.
  - Engine #53 [E53] – Captain, Engineer, and two Fire Fighters
  - Engine #44 [E44] – Captain, Engineer, and two Fire Fighters
  - Truck #45 [T45] – Captain, Engineer, and two Fire Fighters
  - Medic #30 [M30] – Two Fire Fighter/Paramedics
  - Battalion Chief #3 [BC3]
- ❒ Third alarm resources will arrive ten minutes after the request.
  - Engine #72 [E72] – Captain, Engineer, and two Fire Fighters
  - Engine #74 [E74] – Captain, Engineer, and two Fire Fighters
  - Medic #72 [M72] – Two Fire Fighter/Paramedics

Initial Action

All first alarm companies have been on-scene for approximately 10 minutes. Command and tactics have been established as follows:



Medic 20 begins treatment of the two civilians with assistance from M10. A charged 1¾" hoseline is stretched into the front door from S11 by the two E41 Fire Fighters and a S11 Fire

Fighter. The hoseline must be maneuvered through a narrow hallway to the base of the stairs that leads to the second floor. Engine 41 Captain requests that the structure be ventilated.

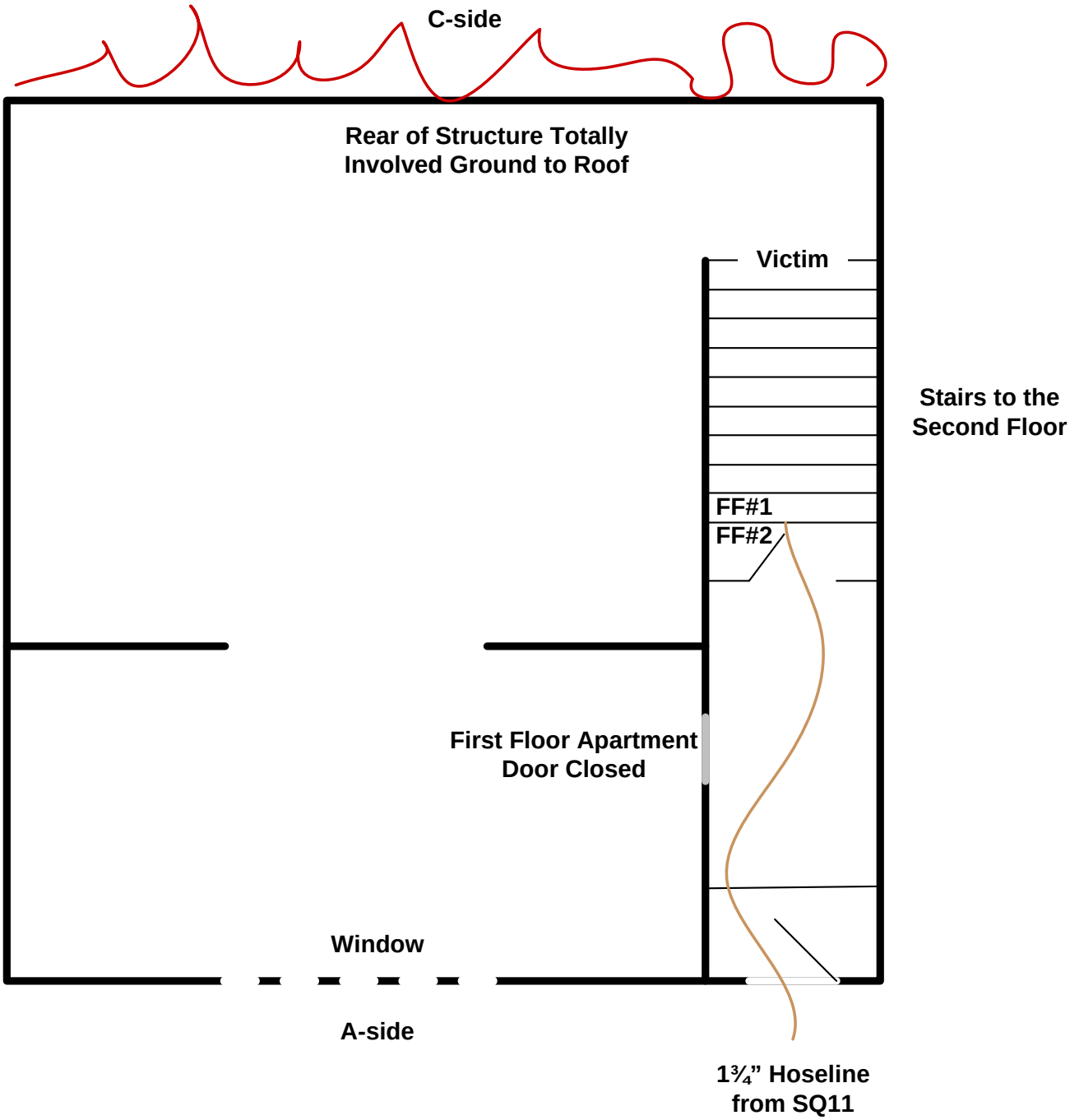
Battalion 2 reports to the rear exposure. Truck 3 is attempting to position ladders while Engines 50 and 51 are stretching lines from opposite ends of the rear alley. The basement is heavily involved and fire is starting to blow out the first and second floors in the rear. Operations are being hindered by numerous electric lines in the rear of the structure. The IC requests a second alarm.

Truck 20 positioned their aerial ladder to the roof for ventilation while other crew members positioned ground ladders to the front second floor window to vent. The T20 FF opens several sky lights, but the back skylight has self vented and fire begins to vent from the A-side of the roof.

No fire is seen by any member of the interior attack crew when they enter the structure and there appears to be no fire impingement from the interior towards the A-side. Engine 41 FF#1 advances to the top of the stairs but is forced to retreat due to extreme heat. He runs to the base of the stairs, running into the S11 FF, knocking them both to the floor. The front door is force closed by the falling fire fighters also pinching the 1¾" hoseline. S11 FF struggles to get his arm out of the crack of the door while E41 FF#2 attempts to get E41 FF#1 off of S11 FF. The IC requests a RIC, which had not been established.

Exercise Assignments

- ❒ Incident Commander
  - Battalion Chief 1 has parked the command vehicle on the A-side and establishes command.
- ❒ RIC Group Supervisor
  - Engine 53 is assigned to RIC. E53 Captain stages the engine on the A/B-side of the structure, assumes RIC Group Supervisor, and prepares to manage a RIC operation.
- ❒ RIC 1 – [E50]
  - Engine 50 Engineer is assigned to lead the entry and is supported by two E53 Fire Fighters and the four members of E44. They prepare for a RIC operation.
- ❒ RIC 2 – [E53]
  - Engine 53 crew will be assigned to RGS to support rescue operations.
- ❒ RIC 3 – [E44]
  - Engine 44 crew will be assigned to RGS to support rescue operations.
- ❒ Division/Group Supervisor
  - Engine 41 Captain assumes Interior Division and is supported by three members of S11.
- ❒ Trapped Fire Fighter(s)
  - E41 Fire Fighter #2 calls Emergency Traffic and issues a Mayday.


C-side
Rear of Structure Totally Involved Ground to Roof
Victim
Stairs to the Second Floor
FF#1
FF#2
First Floor Apartment Door Closed
Window
A-side
1¾" Hoseline from SQ11

Case Study #6 Exercise: Pennsylvania

Situation

The building owner attempted to extinguish the fire for several minutes before calling the fire department. He advises you that the fire is in the back right corner of the garage. Thick black smoke is seen coming from the garage.

Building Information

Approximately 1,316 square-foot balloon-frame constructed two-story residence. The basement is accessible from the first floor interior and an exterior alley door. The flat roof consisted of wood rafters with tar and paper over wood boards.

A 576 square-foot garage is attached and comprised of traditional wooden construction with a peaked gable roof with attic storage and concrete floor. Several layers of siding are present on the garage including wooden clapboard, covered with weather brick, covered by aluminum siding. The garage is connected to the 2-story house by a small vestibule and is also attached to an irregular-shaped concrete block structure. A large canopy covers the main garage door.

Weather

Temperature of 14°F, winds variable between 10-20 mph gusting up to 30 mph from the west and northwest.

Apparatus and Personnel On-scene

The on-scene times reflect the actual times of the incident reviewed earlier in the class. For purposes of this exercise all units will be on-scene when Emergency Traffic is called.

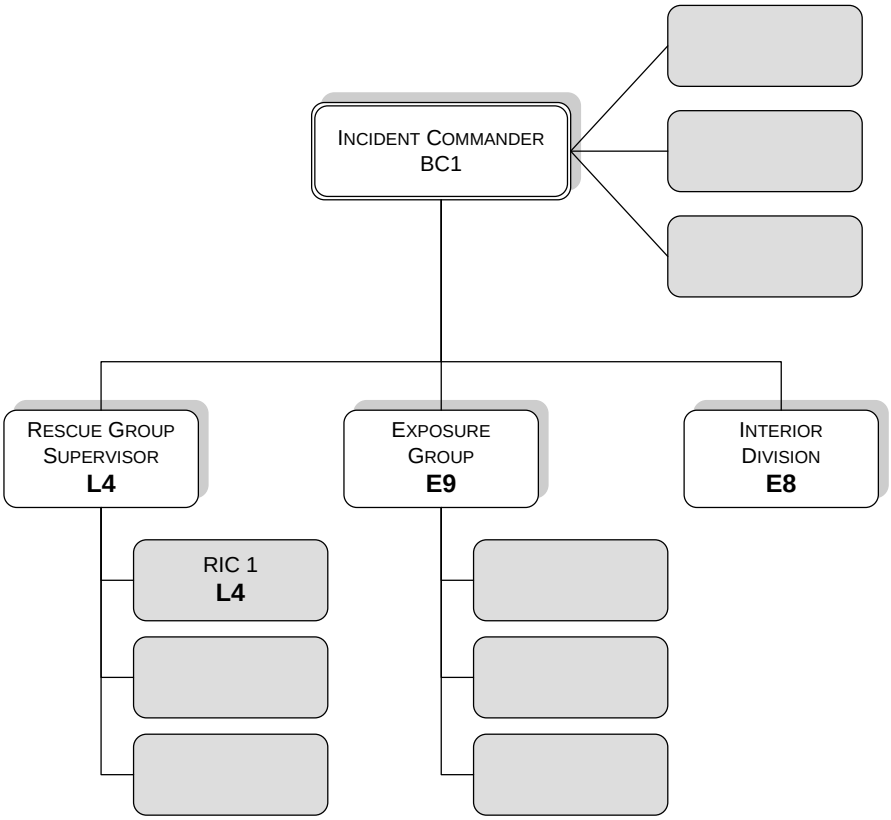
- ❒ On-scene at 0938 hours
  - Engine #8 [E8] – Engineer and Fire Fighter
- ❒ On-scene at 0939 hours
  - Battalion Chief #1 [BC1] – Assumes incident command
- ❒ On-scene at 0941 hours
  - Engine #9 [E9] – Captain and two Fire Fighters
- ❒ On-scene at 1000 hours
  - Telesquirt #2 [TS2] - Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 1010 hours
  - Ladder #4 [L4] - Captain, Engineer, and two Fire Fighters
- ❒ On-scene at 1030 hours
  - Medic #10 [M10] - Two Fire Fighter/Paramedics
  - Ambulance #15 [A15] – Two EMT-Is

Additional Alarms Available if Requested by the IC

- ❒ Second alarm resources will arrive five minutes after the request.
  - Engine #301 [E301] – Captain, Engineer, and two Fire Fighters
  - Engine #302 [E302] – Captain, Engineer, and two Fire Fighters
  - Truck #304 [T304] – Captain, Engineer, and two Fire Fighters
  - Medic #301 [M301] – Two Fire Fighter/Paramedics
  - Battalion Chief #3 [BC3]
- ❒ Third alarm resources will arrive ten minutes after the request.
  - Engine #10 [E10] – Captain, Engineer, and two Fire Fighters
  - Engine #40 [E40] – Captain, Engineer, and two Fire Fighters
  - Medic #72 [M72] – Two Fire Fighter/Paramedics

Initial Action

All first alarm companies have been on-scene for approximately 10 minutes. Command and tactics have been established as follows:



Engine 8 Engineer and Fire Fighter pulled a 1¾" hoseline from the engine and advanced the line through the open garage door on the A-side. The Battalion Chief arrived on-scene and assumed Incident Command. Engine 9 requests a second alarm and a mutual aid RIC and lays a large diameter hose (LDH) to Engine 8. One E9 Fire Fighter began laddering the garage while the second fire fighter began to vent window on the residence.

TS2 arrives on-scene laying an LDH from another hydrant and preparing for master stream application. Three TS2 Fire Fighters pull a 1¾" hoseline to the D-side of the garage and attempt entry into the vestibule.

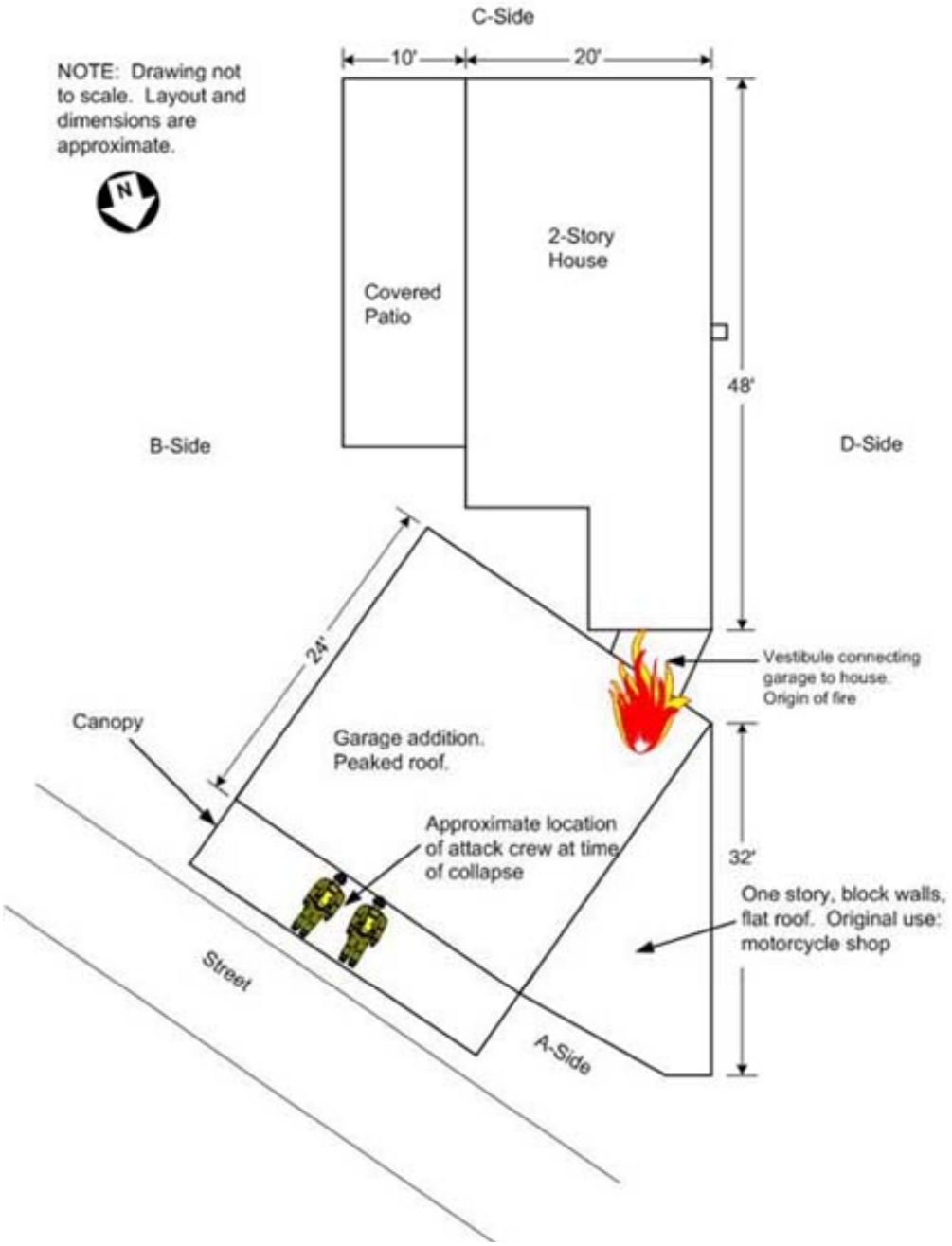
Engine 9 Captain and Fire Fighter pull a second 1¾" hoseline from E8 to the B-side of the house. Fire is observed toward the front of the residence.

Engine 8 Engineer and Fire Fighter exit the garage to replace their air cylinders and re-enter the garage. Debris begins falling from the ceiling knocking the E8 Engineer to the ground. The Engineer and Fire Fighter back out to the doorway of the garage. The canopy over the garage collapses onto the E8 Engineer and Fire Fighter. Ladder 4 arrives on-scene and is assigned to RIC operations.

Exercise Assignments

- ❒ Incident Commander
  - Battalion Chief 1 has parked the command vehicle on the A-side and establishes command.
- ❒ RIC Group Supervisor
  - Ladder 4 is assigned to RIC. L4 Captain stages the ladder truck on the A/B-side of the garage, assumes RIC Group Supervisor, and prepares to manage a RIC operation.
- ❒ RIC 1
  - Ladder 4 Engineer is assigned the lead RIC position and is supported with two Fire Fighters. They prepare for a RIC operation.
- ❒ Division/Group Supervisor
  - Engine 9 Captain assumes Exposure Group.
- ❒ Trapped Engineer and Fire Fighter
  - Engine 8 Engineer is trapped.
  - Engine 8 Fire Fighter is trapped and unconscious.

Figure 1


C-Side
10'
20'
NOTE: Drawing not to scale. Layout and dimensions are approximate.
N
2-Story House
Covered Patio
48'
B-Side
D-Side
24'
Vestibule connecting garage to house. Origin of fire
Canopy
Garage addition. Peaked roof.
Approximate location of attack crew at time of collapse
32'
One story, block walls, flat roof. Original use: motorcycle shop
Street
A-Side

Assignment Actions Checklists

Incident Commander

- ❒ Emergency Traffic declaration to alert fireground that a fire fighter emergency has been declared.
- ❒ Move nonaffected units to a secondary fireground channel.
- ❒ Receive LUNAR report from trapped fire fighter.
- ❒ PAR conducted.
- ❒ Immediately requested additional alarms.
- ❒ Commit and brief RIC on situation.
- ❒ Change plan to high priority rescue operation.
- ❒ Withdraw companies from affected areas as needed.
- ❒ Reinforce fire-fighting positions.
- ❒ Open and unlock all doors.
- ❒ Ventilate to maintain tenability.

Provide Additional Lighting

- ❒ Closely coordinate and control search efforts.
- ❒ Monitor structural integrity.
- ❒ Maintain strong control of incident and crews.
- ❒ Control media.
- ❒ Assign aids to monitor radio channels.
- ❒ Special call additional officers.

RIC Group Supervisor

- ❒ Report to IC for briefing.
- ❒ Designate a staging area for equipment.
- ❒ Confirm fireground operations radio channel and RIC radio channel.
- ❒ Reconnoiter; Confirm location of fire and volume, Occupancy, Building Construction, Exits, Utility status.
- ❒ Expected fire extension.
- ❒ Where fire companies are operating.
- ❒ How long have they been operating.
- ❒ What progress has been made.
- ❒ Communicate with trapped fire fighter(s) and receive updated LUNAR reports.
- ❒ Communicate with RIC Group Leader(s), monitoring entry time – Air Aware, timely CAN reports.

RIC Group Leader(s)

- ❒ Receive briefing from RIC Group Supervisor.
- ❒ Confirm fireground operations radio channel and RIC radio channel.
- ❒ Reconnoiter; Confirm location of fire and volume, Occupancy, Building Construction, Exits, Utility status.
- ❒ Expected fire extension.
- ❒ Where fire companies are operating.
- ❒ How long have they been operating.
- ❒ What progress has been made.
- ❒ Compile RIC equipment cache.
- ❒ Communicate with RIC Group Supervisor, entry time, PAR, lowest air level.
- ❒ Communicate CAN reports.
- ❒ Monitor air usage and work time before egress.

Division/Group Supervisor

- ❒ Receive assignment and companies assigned from IC.
- ❒ Confirm fireground operations radio channel and RIC radio channel.
- ❒ Confirm location of fire and volume.
- ❒ Expected fire extension.
- ❒ Where fire companies are operating.
- ❒ How long have they been operating.
- ❒ What progress has been made.
- ❒ Communication and supervise companies assigned to the division.
- ❒ Monitor building and fire conditions.
- ❒ Coordinate with ventilation group or division.

Trapped Fire Fighter(s)

- ❒ Communicate an Emergency Traffic to Command.
- ❒ Utilize portable radio emergency button if equipped – to Command Center or Dispatch.
- ❒ Communicate a LUNAR report –to IC.
- ❒ Be prepared to communicate on any channel.
- ❒ Activate PASS device between communications.
- ❒ Continue to search for way out.
- ❒ Move to safe refuge area when needed.
- ❒ Take resting position near wall, doorway or hallway.
- ❒ Control breathing (skip breath), stay calm, conserve air – monitor air levels.
- ❒ Point flashlight toward ceiling, use tools to indicate position.
- ❒ Provide RIC Group Supervisor updated LUNAR reports when necessary.