2013
17

Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

November 25, 2014

Career Fire Fighter Killed by Structure Collapse While Conducting Interior Search for Occupants Following 4th Alarm – Texas

Executive Summary

On May 20, 2013 a 51-year-old male career fire fighter (the victim) was conducting a primary search for occupants after the fourth alarm at a fire in an apartment complex and was killed inside the building when it collapsed. The victim and his partner were in the first floor hallway knocking on doors to the apartments, which were inset from the hallway by small vestibules. The victim's partner was in the vestibule knocking on the third door to the left and the victim was in the hallway going to knock on the third door on the right. In an instant the second floor walkway and possibly the third floor walkway collapsed into the first floor hallway killing the victim. The victim's partner was trapped in the inset of the doorway.

Fire conditions at Side C prior to collapse
(Photo courtesy of fire department)

Contributing Factors

- *Inadequate building construction*
- *Sprinkler system not working near origin of fire*
- *Incident command*
- *Communications*
- *Inadequate Size-up*
- *Tactics.*

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Key Recommendations

- *Fire departments should ensure that the Incident Commander establishes a stationary command post, maintains the role of director of fireground operations, and does not become involved in fire-fighting efforts*
- *Fire departments should ensure that the Incident Commander conducts an initial size-up and risk assessment of the incident scene before interior fire fighting operations begin*
- *Fire departments should ensure critical benchmarks are communicated to the Incident Commander*
- *Fire departments should develop, implement and enforce clear procedures for operational modes. Changes in modes must be coordinated between the Incident Command, the command staff and fire fighters*
- *Fire departments should ensure the pre-designated Incident Safety Officer assumes that role upon arrival on the fireground*
- *Fire departments should ensure that fire fighters are trained in situational awareness, personal safety, and accountability*
- *Fire departments should train on and understand the use and operation of elevated master streams and its effects on structural degradation*
- *Fire departments should ensure that pre-determined assignments are assumed and staffed*
- *Fire departments should train all fire fighting personnel in the risks and hazards related to structural collapse*
- *Municipalities, Building Owners, and authorities having jurisdiction should ensure that sprinkler systems are installed in multi-family housing units. Municipalities and authorities having jurisdiction should consider requiring building owners to regularly inspect sprinkler systems to ensure they are functioning properly.*

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Introduction

On May 20, 2013 a 51-year-old male career fire fighter (the victim) was searching for occupants after the fourth alarm and was killed inside the three-story residential apartment building when it collapsed. On May 20, 2013, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On June 17-23, 2013, two safety and occupational health specialists and the project officer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Texas to investigate this incident. The NIOSH investigators met with the fire department, union members, the coroner's office, and the state fire marshal's office. Interviews were conducted with fire fighters and officers who were on scene during this incident. The incident scene was visited and photographed. NIOSH investigators also reviewed the victim's training records, the Incident Commander's training records and the department's standard operating procedures.

Fire Department

This career department consists of 1,900 members that provide their residents with fire suppression and protection, emergency rescue capabilities, and emergency medical first responder services. There are 57 fire stations located strategically throughout the city that serve a population of more than 1,200,000 people in a geographic area of approximately 385 square miles. A minimum of four firefighters respond on each of the fire engine and aerial ladder truck companies. These fire stations house 56 fire engines, 22 aerial ladder trucks, five aircraft rescue firefighting apparatus, nine Booster pumpers, one Haz Mat Unit, as well as 40 front line Rescues/MICUs[a] and three Peak Demand Rescues.

Training and Experience

Incident Command

The Incident Commander (IC) had more than 30 years of experience and training on topics including Incident Command System ICS 100-400, Incident Safety Officer, instructional techniques for company officers, and National Incident Management System NIMS 701-704.

Victim

The victim had more than 28 years of experience and training on topics including fire fighting

[a] MICU or mobile intensive care unit is a vehicle, usually a specially designed minivan or truck, with the capacity for providing emergency care and life support to those severely injured or ill at the scene of an accident or natural disaster while transporting them to a medical facility where treatment may continue

intermediate, National Incident Management System NIMS 701-704 and Incident Command System ICS100 and ICS 700.

Personal Protective Equipment

At the time of the incident, each fire fighter entering the structure was wearing their full ensemble of personal protective clothing and equipment, consisting of turnout coats and pants, structural fire fighting protective Nomex® hood, helmet, gloves, boots, and a self-contained breathing apparatus (SCBA) with integrated personal alert safety system (PASS) device. The NIOSH investigators examined and photographed the personnel protective clothing and SCBA worn by the victim. Since they were not considered to have contributed to the fatality, the fire department did not send the personnel protective clothing and SCBA to NIOSH for further evaluation.

Battalion Chief and Command Tech Responsibilities

Based upon the fire department's standard operating procedures (SOPs), there are specific roles for Battalion Chiefs and their drivers, or Command Techs (CT), based on the order of arrival and assignment at the incident. The first due Battalion Chief (BC) should always assume the role of Incident Commander which requires him/her to set up and run the incident. Upon arrival, the department's SOPs also require the IC to first conduct a walk-around to size-up the incident and then manage the fire from the back of his/her vehicle, which is the designated stationary Command Post. While managing the fire, the IC is also responsible for monitoring and managing the radio traffic for the fireground activities.

The first due Command Tech (CT) is responsible for setting up the Incident Command Board located at the stationary command post. The purpose of the Incident Command Board is to direct and track all personnel dispatched to the fire. Setting up the board should be conducted with direction from the IC.

The second due Battalion Chief has the responsibility of Incident Safety Officer. This position does not become involved in fire fighting efforts and operates as a staff member who reports only to the IC. The second due CT assists with Command Post functions as needed.

The third due Battalion Chief maintains communication with central dispatch for additional resources and any pertinent information that may be relayed from Central dispatch. The position can also assist with the command board and personnel placement as needed. The third due CT will assist at the Command Post as needed.

The fourth due Battalion Chief reports to the Command Post and his CT has the responsibility of establishing and managing the staging area.

Weather

The incident occurred during the early morning hours of May 20, 2013, and the approximate temperature was 68°F with wind speeds ranging between 18 – 20 miles per hour.[1]

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Structure

The apartment complex where the incident occurred was built in 1980 and consisted of three separate structures, each comprised of three buildings interconnected by a series of indoor stairwells and outdoor covered walkways, for a total of nine separate apartment buildings. The structure where the incident occurred was in the middle of the complex, specifically in Building 5, which was connected to Buildings 4 and 6. Each apartment building consisted of three floors, with eight separate apartments on each floor. All three buildings were connected by a fully enclosed glass atrium at the south side of Building 5. The atrium was the primary entrance into building 5, which was also accessible by the walkways between Buildings 4 and 6.

The apartments varied in size from 715 to 1066 square feet (see Diagram 1). Each apartment structure was constructed on a concrete slab and was Type-V construction, which consisted of parallel-chord trusses covered with ½-inch plywood for support of the floors and roof. The exterior and interior walls were constructed of 2x4's and the interior hallways were constructed with 2 x 6's supported by galvanized joist hangers nailed to header boards that were attached with nails to the end of the parallel chord trusses (see Photo 1 and Photo 2). The doors that led to each apartment were recessed approximately 30 inches, creating a vestibule at the apartment's entrance (see Photo 3, Diagram 1). At the time of the fire, the fire building and the other buildings in the complex were being reinforced in the hallways to address the structural instability caused by nailing the header boards to the ends of the parallel chord trusses. The NIOSH investigators were able to inspect many of these areas and observed areas where a contractor had used lag screws or bolts to strengthen this connection point. Most building hallways inspected by the NIOSH investigators also had an additional 2x6 installed by the contractor under the original one to add additional support to the floor joists (see Photo 4). This work had not yet been completed in the fire building. Although required, building permits were not obtained for the work completed to structurally improve the instability in the hallways.

The buildings had a fire alarm system and there were sprinklers located in the trash chute just above each trash chute opening located at the end of each hallway (see Diagram 1). The trash chute, which was where the fire originated, was enclosed in the building at the end of the hallway with a dumpster located at ground level that was accessed for removal by an outside door. The top of the trash chute terminated in the attic space of the apartment building and did not provide any type of barrier to prevent a fire from spreading throughout the attic. The sprinkler heads were not working at the time of the fire because the sprinkler system did not have its own water supply, but was connected to the building's main water supply. At the time of the fire, a building maintenance worker was attempting to fix a water leak in a residence on the third floor and had shut off the main water supply to the building.

Official pre-planning reports of these apartment buildings had not been completed. There have been numerous fires at this complex to which the fire department had responded in the past, so the fire fighters and the department were aware of the building's lightweight construction features. The most recent building permit to repair fire damage on the building where the incident occurred was filed in 2011.

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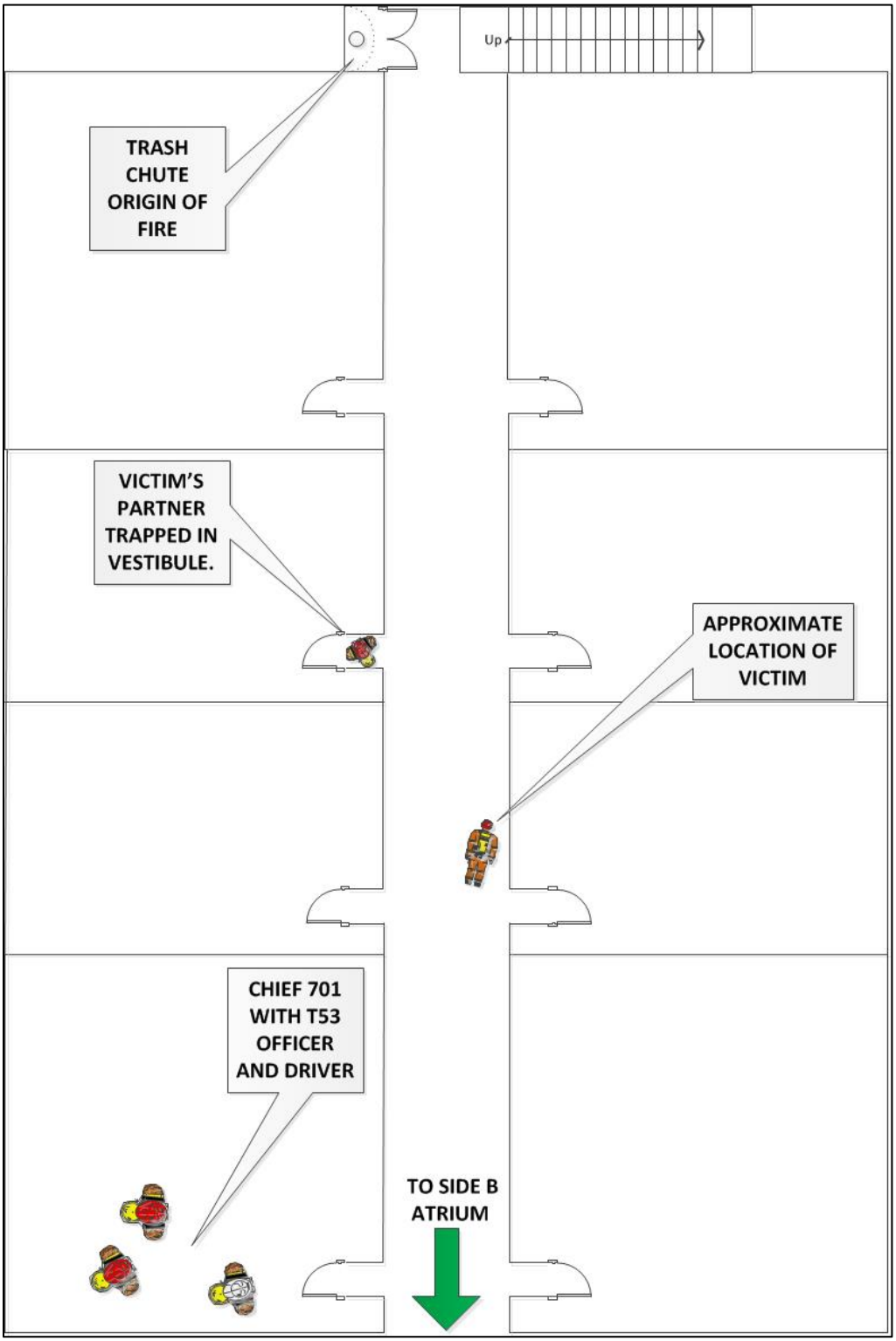

Diagram 1. Apartment layout.

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Photo 1. Hallway support construction in collapse area.
(NIOSH Photo)

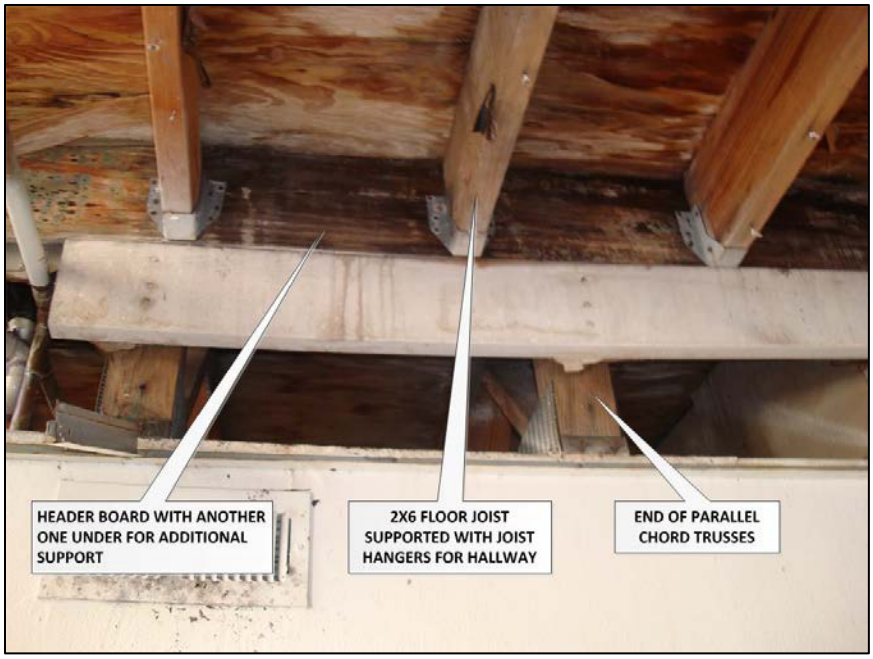

Photo 2. Close-up detail of hallway support construction.
(NIOSH Photo)

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Photo 3. Apartment entrance recessed where victim's partner was trapped after collapse.
(NIOSH Photo)

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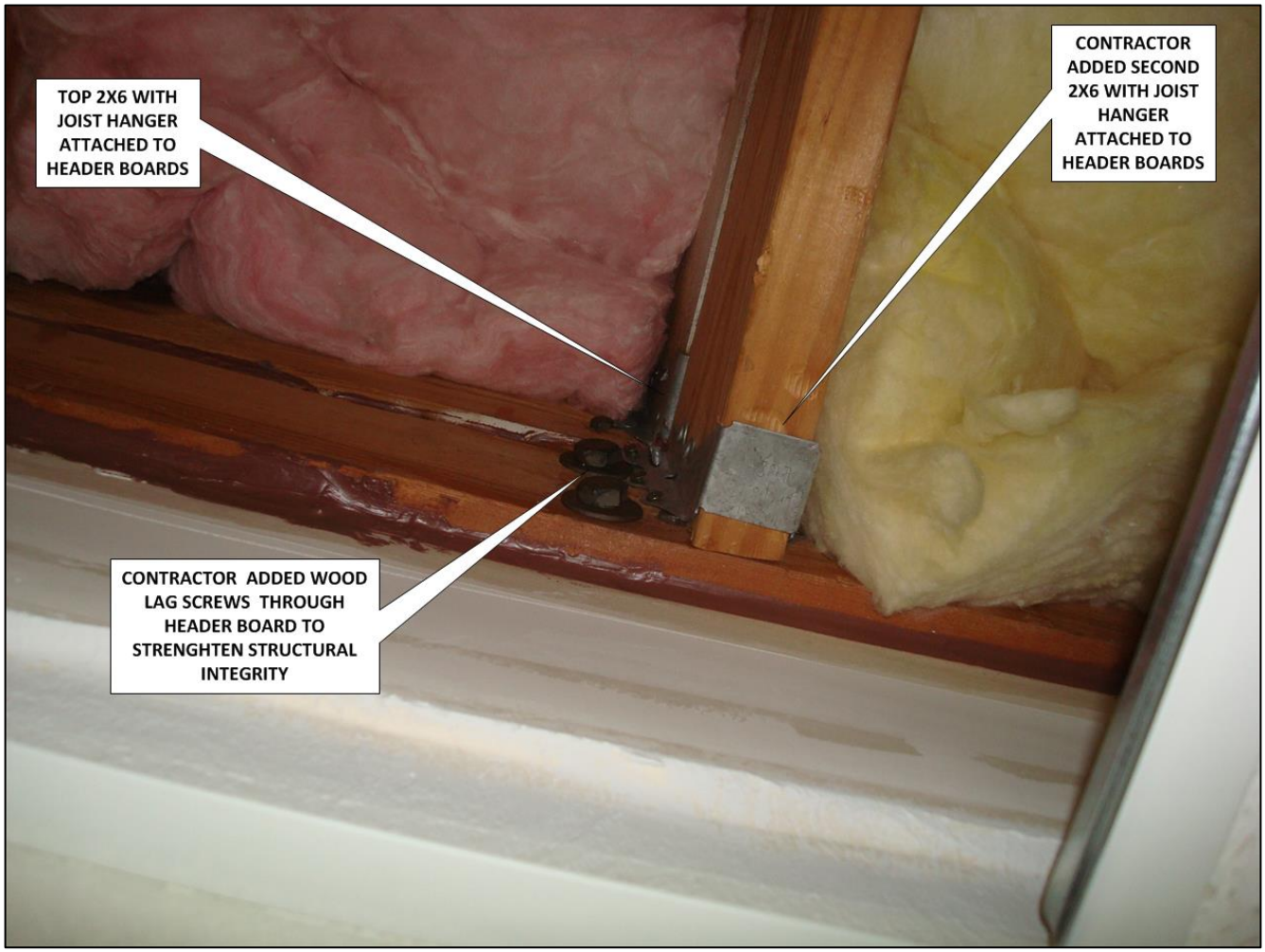

Photo 4. Double 2x6 floor joists and lag screws added by contractor in an attempt to improve structural integrity within the apartment complex.
(NIOSH Photo)

Timeline

An approximate timeline summarizing the significant events in this incident is listed below. The times are approximate (rounded to the nearest minute) and were obtained by studying the available dispatch channel records, witness statements, run sheets and fire department records. These timelines are condensed to the specific events in this incident surrounding the fatality that occurred during a defensive mode of operations. The timeline is not intended, nor should it be used, as a formal record of events.

- 0251 hours—Automatic fire alarm
- 0258 hours—Upgrade to structure fire, 1st alarm—E57, E28, E29, T57, T37, B04, B02, R57

- 0259 hours—Requests 2nd alarm—684, 685, 782, 806, 820, 829, 896, B03, B07, E19, E20, E22, E37, R19, R29, T19, T20, T56, USAR 19
- 0330 hours—Request 3rd alarm—E39, E55, E56, T39, 881, 784, 825
- 0330 hours—Defensive operations
- 0405 hours—Requests 4th alarm—E02, E31, E48, T53, 802
- 0420 hours—Defensive mode update
- 0450 hours—Mayday/structural collapse

Investigation

On May 20, 2013 at approximately 0251 hours, central dispatch received an automatic alarm at an apartment complex. Engine 29 (E29) and Truck 57 (T57) both responded for the auto alarm. T57 reported fire through the roof and called for a full alarm. T57 directed E29 to the north entrance where the fire was located. The E29 officer pulled up the hydrant map and noticed all the hydrants were locate on the south side of the complex. He told his driver to enter the complex on the north side and they circled around to the south side to size-up the fire building.

The E29 crew stretched a 3-inch supply line to their engine and prepared to stretch a line into a glass atrium common area where three apartment buildings joined (see Photo 5). Battalion Chief 4 (BC4) was the first due chief officer to arrive on scene at 0305 hours. BC4 entered through the south entrance and drove past the E29 crew to the fire building. The BC4 Command Tech (CT4) dropped BC4 off at the A/B corner of the apartment complex where fire was extending through the roof. BC4 told his CT4 to park the vehicle and set up the command board while he donned his gear. The driveway to the north of Side B had a carport adjacent to it across from the fire building. The height of the carport was too low to allow the command board to be set up with the BC4's vehicle. CT4 pulled the vehicle to Side C of the apartment complex and set up the command board in the back of the vehicle in a parking lot facing the fire building (see Photo 5). BC4 remained on Side A to direct the fire attack. CT4 was a back-up driver and only drove once or twice a month. For most of the initial response, he was alone in the parking lot without supervision or communication as to where units were located, or knowledge of their operating instructions. As other Battalion Chiefs arrived on scene, they began to fill the roles of Division and Group Commanders to oversee fire operations. *Note: Setting up the Command Post on Side C caused confusion since the command post and the Incident Commander typically set up the stationary command post on Side A (see Photo 5).*

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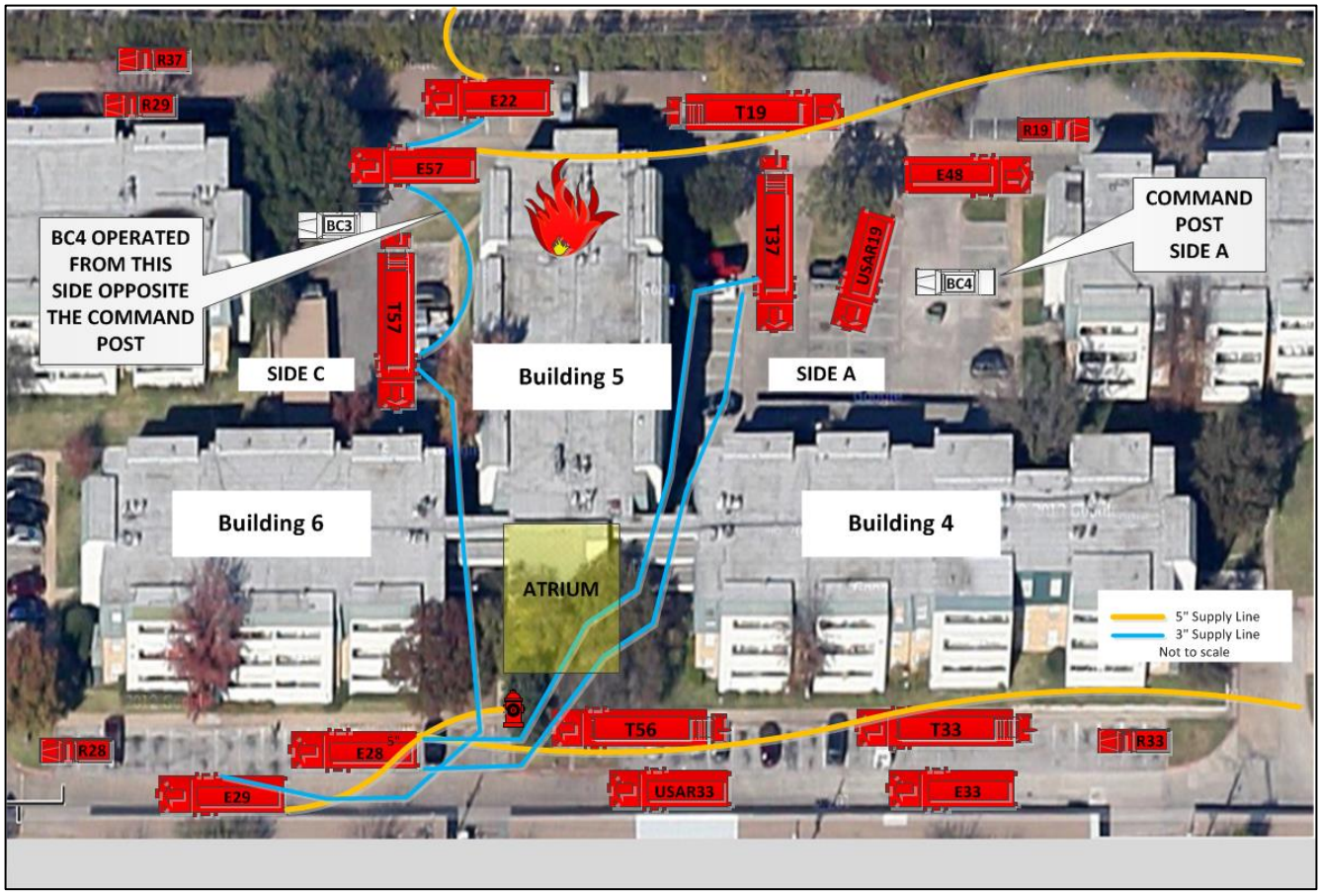

Photo 5. Aerial View of incident scene.
(Photo - Google Maps)

At approximately 0310 hours, a Deputy Chief arrived, reported to the Command Post, and assumed Incident Command (IC). He immediately noticed that there was no chief officer present at the Command Post and that the Command Board was not completed. He ordered a third alarm. There was also a discrepancy as to the division designations. He conducted a 360-degree size-up and spoke face-to-face with the battalion chiefs in each division and told them their new divisions and responsibilities. *Note: Side A and Side C were switched to ensure Side A corresponded with the location of the Command Post as shown in Photo 5.*

Battalion Chief 2 (BC2) and Command Tech 2 (CT2) arrived on scene at 0312 hours and reported to the Command Post. The IC assigned CT2 to assist with setting up the Command Board and BC2 was assigned the role of Incident Safety Officer (ISO). BC2 was to walk the perimeter and walk the interior of the fire building to get a visual layout of the building. He walked the entire length of the first floor of the fire building with no visible fire conditions. He then walked half-way down the second floor hallway and encountered light smoke and heat. He was not on air and went back to the

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Command Post to report his findings. He was then given the order to oversee the search and evacuation operations on Side B in the atrium area for both the first and second floors.

BC4 had T57 set up on the A/B corner of the fire building for aerial operations. E57 and Engine 28 (E28) reported to BC4. E57 was ordered to prepare for exterior fire attack. Battalion Chief (BC3) arrived on scene at 0313 hours. *Note: BC3 reported in to BC4 and thought that he was reporting to the IC.* BC4 sent BC3 to the third floor with the crew from Engine 28 (E28) to evacuate civilians and fight the spread of fire down the third floor hallway. BC4 then walked down to the atrium and ordered the crew from Engine 29 (E29) to evacuate the civilians from the second floor. E20 was to evacuate the civilians on the first floor and then assist with the second floor evacuation.

During this time, as CT4 was setting up the command board, a woman appeared on a third floor balcony shouting to be rescued. CT4 called for Truck 37 (T37) to come to Side C of the building to set up their aerial ladder for civilian rescue. After the rescue, he called for Engine (E28) to supply T37 with water. At this time, he received a request for water from Engine 57 (E57). He called for Engine 22 (E22) to provide water supply for E57. The multiple fire ground tasks the initial CT4 had to complete distracted him from completing his primary function of setting up the command board. *Note: The initial decision to not operate from a stationary Command Post created confusion for the remaining responding units. Arriving units and personnel were following department procedures that dictate Side A is where the Command Post should be set up. BC4 was directing fireground operations using division designations from the side he was located at, which contributed to the confusion. Side A will be referred to as the side where the Command Post was located throughout the remainder of the report.*

Battalion Chief 7 (BC7) arrived at the staging area at approximately 0328 hours. Command Tech 7 (CT7) began to establish and manage the resources in staging. BC7 reported to the Command Post to check in, but did not find an Incident Commander and realized that the Command Board had not been set up yet. He immediately called for his Command Tech, CT7, to report to the Command Post to assist CT4 and CT2 with setting up the Command Board to provide accountability for all the units on the fireground. BC7 then went into the atrium area on Side B to assist with the suppression and evacuation activities.

The E20 crew was on the first floor with BC2 just inside the first floor hallway and started their primary search. They found and removed several occupants from the first floor and handed them over to a rescue company. One occupant was removed via a sitting walker by rolling him out into the atrium and across the street. BC2 was in the atrium when the E20 crew told him that the search was complete and that there was fire in the last door on the left, which was the laundry chute. BC2 then gave them the order to proceed to the second floor to begin a primary search and evacuate occupants.

The E28 crew was on the third floor conducting a primary search. To provide water on the third floor, the T57 crew pulled a hoseline from a standpipe located in Building 6 (see Photo 4). The E28 and T57 crews pulled the ceiling in the common area just before the door that leads into the apartment hallway. They encountered moderate smoke, but no fire. They entered the hallway and conducted their primary search with a thermal imager (TI). They completed their primary search of the apartments that were

tenable. The last two apartments on the north end of the hallway were engulfed in fire. They pulled ceiling in the apartment hallway and encountered fire and thick pressurized smoke. BC3 ordered them to back out of the apartment hallway and into the atrium. BC3 stated that he reported over the radio that the third floor primary search was completed.

The E29 crew was on the second floor and opened the door to the apartment hallway. Flames were visible at the ceiling towards the far end of the hallway. The E29 officer pulled his crew out and retrieved a 1 ¾-inch handline. They then entered to conduct their primary search with the officer utilizing a TI. Just like the E28 crew on the third floor, E29 completed their primary search of the apartments on the second floor that were tenable. The last two apartments on the north end of the hallway were also fully involved with fire. They completed their search and were extinguishing the fire in the ceiling as they exited the apartment hallway. The E29 officer noticed that the floor trusses in the ceiling above them (supporting the third floor), were on fire.

The E20 crew made it to the second floor to assist with a primary search. The E20 crew reported to the E29 officer that they had completed their primary search of the first floor. The E29 crew members were low on air and exited to change their bottles. The E29 officer exited and reported to BC4 that a primary search had been completed on the first floor and that a primary search had been completed on the second and third floors that were tenable. BC4 stated that he reported over the radio that a primary search of the first floor had been conducted and that the second and third floor apartments that were not fully engulfed were completed.

The IC moved to the Command Post, which was still in the process of identifying all of the operating units, their company locations and functions (see Photo 5 and Photo 6). He called for an emergency evacuation, a personnel accountability report (PAR), and for defensive operations. He ordered that master streams be deployed and T37, T57, and Truck 19 (T19) began flowing water from their ladder pipes.

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Photo 6. Command Tech trying to fill in the command board at the back of the command vehicle (BC4) at approximately 0354 hours.
(Photo courtesy of fire department)

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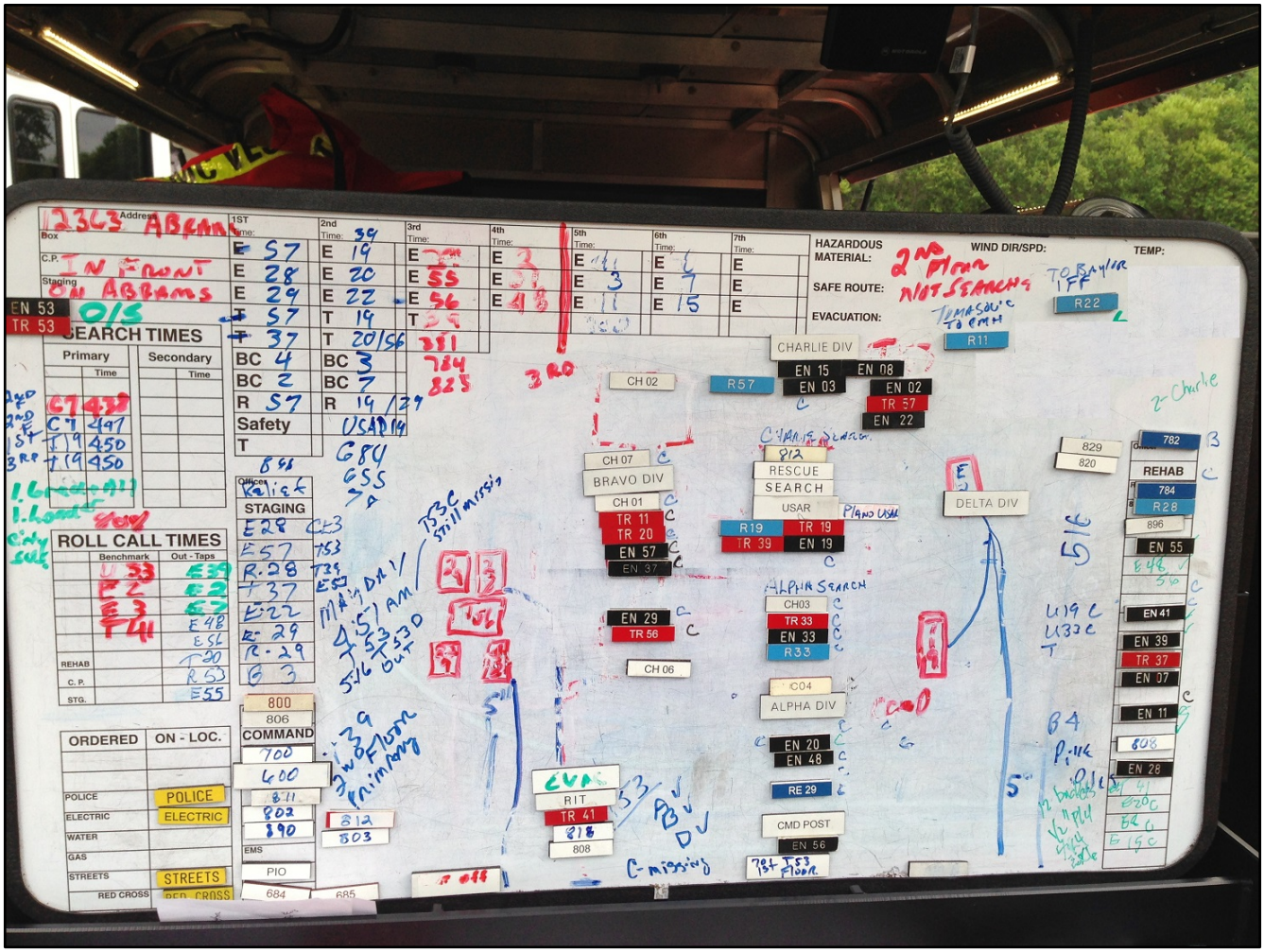

Photo 7. **Finished command board, which was photographed the day after the fire.**
(Photo courtesy of fire department)

Fourth alarm companies were reporting to staging and the Command Post for assignments. Truck 53 (T53) arrived on the scene at approximately 0411 hours and reported to the staging area, however, the staging area was not staffed. The T53 officer radioed the IC who told him to report to the Command Post with his crew. T53 arrived at the Command Post at approximately 0420 hours and the IC ordered him to take his crew and evacuate Building 4. *Note: There were reports being relayed over the radio of crew members still removing occupants from the buildings other than the fire building. There weren't any crews operating in the fire building at this time due to the operations still being defensive (Photo 8).*

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Photo 8. Defensive fire conditions on Side C at approximately 0428 hours.
(Photo courtesy of fire department)

Chief Officer 701 arrived and reported to the Command Post. The IC told 701 that crews were still pulling residents from the first floor of the fire building and to gear up and prepare to make entry to finish a primary search of the first floor of the fire building. T53 had just finished evacuating Building 4 and reported to the Command Post. According to information provided to NIOSH investigators, it was reported that the IC told 701 to take the T53 crew to search the first floor of the fire building. (*Note: During the interview process, NIOSH investigators received conflicting reports as to the actual assignment given.)* Chief Officer 701 and the T53 crew proceeded from Side-A to the atrium on Side-B (Photo 9). BC7 was there acting as the Division-B Commander. 701 asked the Division-B Commander how long T37 had been flowing their ladder pipe from Side A and requested to have it shut down so they could complete their order finishing the primary search of the first floor of the fire building.

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Photo 9. **T53 crew preparing to enter fire building from Side A for interior search at approximately 0444 hours, prior to the collapse.**
(Photo courtesy of fire department)

Inside the atrium, the T53 officer told the crew to put on their masks and break up into 2-person search teams to conduct a quick search. 701 accompanied the T53 officer and his driver and started the search of the first apartment on the right. The victim and his partner took the next apartment down the hallway on the right. The T53 officer and his crew finished the search of the apartment on the right and moved quickly to the first apartment on the left. The victim and his partner encountered a locked door on both of the second apartments on the right and left side of the hallway. They moved down to the third set of apartments. The doors to the apartments were inset from the hallway by small vestibules. The victim's partner was in that area knocking on the third door to the left and the victim was going to knock on the third door on the right. In an instant the second floor walkway and possibly the third floor walkway collapsed into the first floor hallway trapping and killing the victim. The victim's partner was trapped in the inset of the doorway. He called a Mayday, activated his stand

alone pass device and requested the IC to shut off the ladder pipes for fear of being drowned. *Note: At the time of the collapse, there were 7 master streams in operation.*

Contributing Factors

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

- Inadequate building construction
- Sprinkler system not working near origin of fire
- Incident command
- Communications
- Inadequate Size-up
- Tactics.

Cause of Death

According to the death certificate, the medical examiner listed the victim's cause of death as due to mechanical compression of the chest.

Recommendations

Recommendation #1: Fire departments should ensure that the Incident Commander establishes a stationary command post, maintains the role of director of fireground operations, and does not become involved in fire-fighting efforts.

Discussion: According to NFPA 1561, §5.3.1, "The incident commander shall have overall authority for management of the incident."[2] In addition to conducting an initial size-up, the Incident Commander must establish and maintain a command post outside of the structure to assign companies, delegate functions, and continually evaluate the risk versus gain of continued fire fighting efforts. In establishing a command post, the Incident Commander shall ensure the following (NFPA 1561, §5.3.7.1):

1. The command post is designated to establish presence and visibility. In most cases, this would be located in or limited to the Incident Commander's vehicle. Part of the 360-degree size-up is to determine the best location for the command post.
2. The command post includes radio capability to monitor and communicate with assigned tactical, command, and designated emergency traffic channels for that incident.
3. The location of the command post is communicated to the communications center.
4. The Incident Commander, or his or her designee, is present at the command post.

5. The command post should be located in the incident cold zone.

The use of a tactical worksheet can assist the IC in keeping track of various task assignments on the fireground. It can be used along with pre-plan information and other relevant data to integrate information management, fire evaluation and decision making. The tactical worksheet should record unit status, benchmark times, and include a diagram of the fireground, occupancy information, activities checklist(s), and other relevant information. This can also aid the Incident Commander in continually conducting a situation evaluation and maintaining accountability.[3] 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 and 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 collection and communication of essential information as command is transferred to later arriving officers. In this incident, a stationary command post was never established and separate and uncoordinated activities were taking place in multiple locations. This contributed to a failure to size-up the overall incident scene, to properly evaluate risk versus gain, and to maintain accountability on the fireground.

Recommendation #2: Fire departments should ensure that the Incident Commander conducts an initial size-up and risk assessment of the incident scene before interior fire fighting operations begin.

Discussion: Among the most important duties of the first officer on the scene is conducting an initial size-up of the incident. This information lays the foundation for the entire operation. It determines the number of fire fighters and the amount of apparatus and equipment needed to control the blaze, assists in determining the most effective point of fire extinguishment attack, the most effective method of venting heat and smoke, and whether the attack should be offensive or defensive. A proper size-up begins from the moment the alarm is received and it continues until the fire is under control. The size-up should also include assessments of risk versus gain during incident operations.[4-9] Retired Chief Alan Brunacini recommends that the arriving IC drive partially or completely around the structure whenever possible to get a complete view of the structure. While this may delay the IC's arrival by a few seconds, this drive-by may provide significant details not visible from the command post.[3] The size-up should include an evaluation of factors such as the fire size and location, length of time the fire has been burning, conditions on arrival, occupancy, fuel load and presence of combustible or hazardous materials, exposures, time of day, and weather conditions. Information on the structure itself including size, construction type, age, condition (evidence of deterioration, weathering, etc.), evidence of renovations, lightweight construction, loads on roof and walls (air conditioning units, ventilation ductwork, utility entrances, etc.), and available pre-plan information are all key information which can effect whether an offensive or defensive strategy is employed.[2, 10] The size-up and risk assessment should continue throughout the incident.

Fires in commercial structures are typically more dangerous than residential building fires. Retired Assistant Chief Vince Dunn states that defensive operations should be used more often at special occupancy and commercial buildings. Chief Dunn cites statistics that 4 fire fighters die for every

100,000 residential fires compared to 9 fire fighter deaths for every 100,000 commercial structure fires.[5]

Interior size-up is just as important as exterior size-up. Since the IC is staged at the command post (outside), the interior conditions should be communicated to the IC as soon as possible. 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. Other warning signs that should be relayed to the IC include dense black smoke, turbulent smoke, smoke puffing around door frames, discolored glass, and a reverse flow of smoke back inside the building. It is important for the IC to immediately obtain this type of information to help make the proper decisions. Departments should ensure that the first officer or fire fighter inside the structure evaluates interior conditions and reports them immediately to the IC.

In this incident, arriving officers concentrated on the A and D-sides of the structure. A complete 360 degree size-up was never conducted by the initial IC as he became involved in issuing tactical assignments to incoming companies at what was initially Side A and did not make it to the Command Post on Side C. As noted, the side designations were later switched so that the Command Post was located on Side A after the switch.

Recommendation #3: Fire departments should ensure critical benchmarks are communicated to the Incident Commander.

Discussion: The size-up of interior conditions is just as important as exterior size-up. The Incident Commander monitors exterior conditions while the interior conditions are monitored and communicated to the Incident Commander as soon as possible from company officers. Knowing the location and the size of the fire inside the building lays the foundation for all subsequent operations. Interior conditions could change the Incident Commander's initial strategy.[9] Also, when operating inside the structure, company officers should communicate to the Incident Commander when making initial entry, searching and clearing areas, during fire attack, progressing between floors, and exiting the structure. Interior crews can aid the Incident Commander in this process by providing reports of the interior conditions as soon as they enter the fire building and by providing regular updates, especially when benchmarks are met (e.g., "primary search complete is all clear" and "the fire has been knocked down").

Proper size-up and risk versus gain analysis requires that the Incident Commander gather a number of key pieces of information and be kept informed of the constantly changing conditions on the fireground. The Incident Commander must develop and utilize a system that captures pertinent incident information to allow continuous situational evaluation, effective decision making, and development of an incident management structure. Decisions can be no better than the information on which they are based. The Incident Commander must use an evaluation system that considers and accounts for changing fireground conditions in order to stay ahead of the fire. If this is not done, the Incident Action Plan will be out of sequence with the phase of the fire and the Incident Commander will be constantly surprised by changing conditions.[2-3, 11-12]

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Retired Fire Chief Alan Brunacini states that critical fireground factors, including interior and exterior conditions, are among the many items that the Incident Commander must consider when evaluating tactical situations. These items provide a checklist of the major issues involved in size-up, decision making, initiating operations, and review and revision. The Incident Commander deals with these critical factors through a systematic management process that creates a rapid, overall evaluation; sorts out the critical factors in priority order; and then seeks out more information about each factor. The Incident Commander must train and prepare (through practice) to engage in conscious information management. Incident factors and their possible consequences offer the basis for a standard incident management approach. A standard information approach is the launching pad for effective incident decision making and successful operational performance. The Incident Commander must develop the habit of using the critical factors in their order of importance as the basis for assigning the specific assignments that make up the Incident Action Plan. The Incident Commander must create a standard information system and use effective techniques to keep informed at the incident. The Incident Commander can never assume the action-oriented responder engaged in operational activities will stop what they are doing so they can feed the Incident Commander with a continuous supply of top-grade objective information. It is the Incident Commander's responsibility to do whatever is required to stay effectively informed.[7]

In this incident, several critical fireground issues should have been communicated by radio to "Command":

- Completion of primary search of each floor of the fire building
- Interior fire conditions throughout the complex
- Initiation of master stream operations

These are all critical fireground tasks that may have impacted the outcome of the incident.

Recommendation #4: Fire departments should develop, implement and enforce clear procedures for operational modes. Changes in modes must be coordinated between the Incident Command, the command staff and fire fighters.

Discussion: Fire departments need to have clear, well established procedures for different operational modes. A risk versus gain analysis (also known as a risk / benefit evaluation) is one of the most useful tools the Incident Commander has for reducing the overall risk to fire fighters during an incident (thus enhancing their overall safety and health). The risk versus gain analysis guides the Incident Commander in determining whether operations should be offensive or defensive in nature. Clearly defined standard operating procedures for different operational modes are necessary to ensure operations are carried out safely, as the tactics for different operational modes will vary greatly. Any time the decision is made to switch from one operational mode to another, particular attention should be given to make sure that the switch is communicated to all personnel at the incident and that confirmation of the change is received.[13] The text book *Incident Command System (ICS) Model Procedures Guide for Incidents Involving Structural Fire Fighting, High-Rise, Multi-Casualty,*

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Highway, and Managing Large-Scale Incidents Using NIMS-ICS [14] is an example of reference material that can help guide the tactical and incident management decision making process.

The decision to employ offensive versus defensive strategies and tactics, as well as to switch between offensive and defensive strategies, must be based upon recognized risk management principles. NFPA 1561 *Standard on Emergency Services Incident Management System*, 2014 Edition,[2] Chapter 5.3.15 states "In situations where the risk to emergency services responders is excessive, as defined in 5.3.16, activities shall be limited to defensive operations." Chapter 5.3.19 states "The following risk management principles shall be utilized by the incident commander:

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

When the T53 went to conduct primary search again, the strategy that all the companies on the fireground were operating under was defensive. There were seven master streams in operation at the time. It was never communicated to the rest of the fireground that T53 was going interior to conduct another primary search and to shut down their master streams.

Recommendation #5: Fire departments should ensure the pre-designated Incident Safety Officer assumes that role upon arrival on the fireground.

Discussion: A pre-designated Incident Safety Officer can monitor the incident action plan, conditions, activities, and operations to determine whether they fall within the criteria as defined by the fire department's risk management plan.

NFPA 1561 *Standard on Emergency Services Incident Management System* states in Paragraph 5.3.1 that "The Incident Commander shall have overall authority for management of the incident."[2] NFPA 1561 Paragraph 5.3.2 states, "The Incident Commander shall ensure that adequate safety measures are in place."[2] With the advent of the incident command system, the goal is to ensure that the Incident Commander is responsible for the safety and welfare of all members and other first responders that were on-scene at an incident.

Based upon the size and complexity of an incident, the Incident Commander must delegate responsibilities that include safety. The incident command system can be expanded to include functions necessary to effectively command and control an incident. Though the Incident Commander is still responsible for the safety and welfare of all members and first responders on-scene, this responsibility is delegated to the Incident Safety Officer.[15] A pre-designated Incident Safety Officer, independent of the Incident Commander, responds automatically to incidents as defined by the fire department. Upon arrival at the incident, the safety officer should meet with the Incident Commander

to confirm the Incident Safety Officer assignment and be integrated into the personnel accountability system. Upon confirmation, the Incident Safety Officer should obtain the following information:

- Overall situation status and resource status
- Strategy and incident action plan
- Known hazards and concerns plus the establishment of control zones
- Status of rapid intervention crews
- Establishment of the rehabilitation group
- Confirmation of established radio communication channels (command channel, tactical channels)

Once the information is obtained, the Incident Safety Officer should don the personal protective equipment appropriate for the potential hazards that he/she will be exposed to. **Also, the Incident Safety Officer should be identified by a vest or helmet**.[2] The Incident Safety Officer should perform a reconnaissance of the incident and began initiating functions of this position. Based upon the size and complexity of the incident, the Incident Safety Officer may request the appointment of assistant Incident Safety Officers.

Types of incidents that might require expansion of the safety officer role include the following:

- Incidents covering a large geographical area (e.g., high-rise structure) that include numerous branches, divisions, or groups.
- Incidents where significant acute or chronic responder health concerns require coordination and input to the planning section (responsible for accounting for the organizational structure, availability of resources, deployment of resources, and the situation status reports).
- Incidents requiring interface with local, state, federal, or other health and safety representatives.
- Multiagency incidents where Unified Command is established.
- Incidents where Area Command is established.[15]

Assistant Incident Safety Officers assigned to branches, divisions, or groups can be addressed according to their area of responsibility. For example, an assistant Incident Safety Officer assigned to "Division Alpha" can be addressed as "Division Alpha Assistant Incident Safety Officer." The assistant Incident Safety Officers assigned to branches, divisions, or groups report to and follow direction from the Incident Safety Officer in the command staff, but the assistant Incident Safety Officer works with the supervisory person in the assigned branch, division, or group to assure safety conditions are being met.[2, 16-18]

NFPA 1521 *Standard for Fire Department Safety Officer* defines the role of the Incident Safety Officer (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 zones, and other designated hazard areas are communicated to all members on scene.[15]

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Larger fire departments should consider one or more full-time dedicated Incident Safety Officers who are on duty and can routinely respond to working fires (e.g., full-time shift safety officers). In smaller departments, every officer should be prepared to function as the Incident Safety Officer when assigned by the Incident Commander. The presence of an Incident Safety Officer does not diminish the responsibility of individual fire fighters and fire officers for their own safety and the safety of others. The dedicated Incident Safety Officer adds a higher level of training, attention, and expertise to help the Incident Commander, division commanders, as well as the fire fighters and fire officers. The Incident Safety Officer must have particular expertise in analyzing safety hazards and must know the particular uses and limitations of protective equipment.[6, 18-19]

Experience is an extremely valuable resource. The Incident Safety Officer must understand the effects of fires on materials and construction types.[17] One of the important functions of an Incident Safety Officer is to offer judgment about the collapse potential of buildings during incidents. To do this, Incident Safety Officers must front-load their building construction knowledge so that they can "read" the building and predict collapse potential. This ability comes from a long-term commitment to reading and studying information on building construction. Knowledge of building construction starts with an understanding of the loads, forces, and materials found in the structural makeup of buildings. The Incident Safety Officer can provide a fire department with a higher level of expertise to perform the necessary incident scene functions and assist the Incident Commander with fire ground safety.

Some Incident Commanders believe that any fire officer should be able to fill the fire department Incident Safety Officer function at any time under any circumstance, and therefore believe their agency really does not need a pre-designated Incident Safety Officer. Just as Incident Commanders have various levels of knowledge and expertise, so do other fire officers. Likewise, the requirements necessary to be a fire officer may change from department to department, a problem if mutual aid situations arise. Additionally, the emphasis placed on safety may vary from one Incident Commander to another.[20]

Chief Stephen Raynis (Chief of Safety with the New York City Fire Department) notes: *"If a fire officer is not usually assigned as an ISO, it is very difficult to remove ones' self from the thought process of being a tactical officer and concentrate on safety concerns only."* [21]

In this incident, there was early confusion as to where the command post was located and the incident commander was not located at the command post to give assignments to arriving personnel. The department's SOPs dictate that the second due chief assumes the role of safety officer. BC4 was not at the Command Post and did not have complete knowledge of what personnel were on the scene, their order of response, locations, or duties. When the Deputy Chief arrived at the Command Post, the IC (BC4) was operating on the opposite side of the fire building. BC2 arrived at the Command Post and was assigned by the Deputy Chief to be the ISO. BC3 reported to BC4, thinking that BC4 was still the IC, and was assigned by BC4 to assist in fire fighting efforts.

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Recommendation #6: Fire departments should ensure that fire fighters are trained in situational awareness, personal safety, and accountability.

Discussion: All fire fighters operating at an incident should maintain situational awareness and conduct a continuous risk assessment throughout the incident, reporting unsafe or changing conditions to the Incident Commander. For incidents in which the transfer of "Command" occurs multiple times, the incident is of long duration, or the incident scene covers a large geographical area, the collapse zones need to be continuously enforced.[22] Fire fighters need to understand the importance of situational awareness and personal safety on the fire ground. The fire ground dangers and hazards can and do change as the incident becomes larger and the event duration increases. The structural conditions of the fire building(s) can change significantly and endanger areas of the fire ground that were not present earlier in the event.

Essentials of Fire Fighting and Fire Department Operations[4] defines situational awareness as an awareness of the immediate surroundings. On the fire ground, every fire fighter should be trained to be constantly alert for changing and unsafe conditions. Even though a safety officer may have been designated for the incident, all personnel are obligated to remain alert to their immediate surroundings. They must maintain their situational awareness and be alert for unsafe conditions. This applies not only to the conditions found within a burning structure, but to the exterior fire ground as well.[19] In virtually every case, structural collapse results from damage to the structural system of the building caused by the fire or by fire-fighting operations. The longer a fire burns in a building, the more likely that the building will collapse. Other factors like the age of the structure, type of construction, and pre-existing structural damage or deterioration can also lead to an accelerated building collapse.[23]

One of the most critical aspects of coordination between crews is maintaining situational awareness. The opposite of situational awareness is tunnel vision where the fire fighters become so focused on fire-fighting or other operational assignments that they fail to sense changes in their environment. Fire fighters can maintain their situational awareness by looking up, down, and around themselves as well as listening for new or unusual sounds and feeling vibrations or movement. Fire fighters and officers should communicate any changes in their environment to other members as well as to the Incident Commander.

The International Association of Fire Chiefs, Safety, Health and Survival section developed the "Rules of Engagement for Structural Fire Fighting." The rules of engagement have been developed to assist both the fire fighter and the Incident Commander (as well as command team officers) in risk assessment and "Go or No-Go" decisions (See the Appendix for the complete list). The fire ground creates a significant risk to fire fighters and it is the responsibility of the Incident Commander and command organization officers to minimize fire fighter exposure to unsafe conditions and stop unsafe practices.[24] The rules of engagement can assist the Incident Commander, company officers, and fire fighters (who are at the highest level of risk) in assessing their situational awareness. One principle applied in the rules of engagement is that fire fighters and the company officers are the members most at risk for injury or death and will be the first to identify unsafe conditions and practices. The rules integrate the fire-fighter into the risk assessment decision making process. These members should be

the ultimate decision makers as to whether it's safe to proceed with assigned objectives. Where it is not safe to proceed, the rules allow a process for that decision to be made while still maintaining command unity and discipline.

Chief Christopher Naum, SFPE (Command Institute) notes, "*In most situations involving a structure fire, the probability of and anticipation for structural collapse or compromise are inevitably minimized, overlooked or at times disregarded until the catastrophic conditions present themselves with little to no time to react accordingly. The loss of situational awareness coupled with distracted attention to subtle or obvious pre-collapse building indicators and gaps in building and construction system knowledge combine to elevate operational risks to personnel on the fireground at structure fires.*"[24, 25]

In this incident, the fire had consumed the upper section of the apartment complex and there were multiple master streams in operation. Many veteran battalion chiefs knew of the lightweight construction utilized in these apartment complexes from fighting prior fires at this location. The incident was into the 4th alarm and into the second hour of the incident and the incident command board was not completed and probably did not show that a primary search had already taken place. The civilians had been evacuated during the primary search completed by the first arriving companies which was witnessed by and reported to chief officers.

Incident Commanders, division/group supervisors, safety officers, company officers, and fire fighters need to understand the hazards associated with building construction, the structural effects of master streams, survivability profiles and how they can take personal action such as being aware of un-noticed hazards and communicating those concerns and actions to the appropriate levels in the command structure. Fire fighters and officers operating at an incident should maintain situational awareness and conduct a continuous risk assessment throughout the incident, reporting unsafe or changing conditions to the Incident Commander. The length of time the fire was burning, the observed fire burning above the second floor hallway ceiling, the large volume of fire on all levels, and multiple master streams in operation were indicators that a structural collapse should be expected.

Recommendation #7: Fire departments should train on and understand the use and operation of elevated master streams and its effects on structural degradation.

Discussion: Master streams are an effective tool for fire suppression operations. Master streams can deliver a large volume of water over a distance while reducing the direct exposure of fire fighters to the fire. Master stream operations can also accelerate structural degradation and can increase the risk of a building collapse.[4, 21, 25] When multiple master streams are flowing water onto a building, the additional weight of the water can rapidly increase the potential for structural collapse. Water weighs 8.33 pounds per gallon. A master stream flowing 1,000 gallons per minute can add an additional 8,330 pounds per minute that the structure, already deteriorated by fire, must support. In 30 minutes, the additional weight contributed by this master stream could add 249,900 pounds or 125 tons of additional weight to the structure.[9] Direct impingement of the master stream at close range can also directly contribute to structural degradation by dislodging bricks, breaking windows and other building

components. Master streams can also push fire throughout the interior of a structure, leading to fire spread.

Another important indicator that fire fighters and officers should look for is the presence or lack of water runoff during master stream operations. If multiple outside streams are being applied to a structure and there is little or no water runoff, the water must be accumulating somewhere.[26] As noted above, the additional weight added by standing water on roofs or floors can significantly contribute to the risk of structural collapse. Fire fighters and fire officers need to understand this fact and take this into consideration as part of the incident action plan. If a collapse zone has not already been established, then one should be established as quickly as possible. Fire fighters should not be allowed to enter the collapse zone without the direct permission of the incident commander.[11]

During this incident, there were seven master streams in operation for an extended period of time. A decision was made to change tactics back to offensive to conduct a primary search of the fire building after the arrival of the 4th alarm companies. When the T53 crew went interior to conduct their search, the master streams were not shut down.

Recommendation #8: Fire departments should ensure that pre-determined assignments are assumed and staffed.

Discussion: Many fire departments have pre-determined support assignments to help ensure that critical positions and functions within the incident command structure are staffed. Pre-determined assignments are usually based upon the order of dispatch. Incident Safety Officer, staging and rapid intervention crews are just some of the pre-determined assignments that are routinely determined based upon the order of dispatch.

In this incident, the fire department had procedures in place that called for the second-due battalion chief to assume the role of safety officer and also defined the duties for incoming Command Technicians, such as the responsibility of establishing and maintaining staging. In this incident, incoming resources were reporting to both the Command Post on Side C (later designated as Side A) and to BC4 on Side A. Normal procedures should ensure that pre-determined assignments are assumed and staffed. The dispatcher can aid this procedure by verbally reminding the responding units of their pre-determined assignments over the radio. The dispatcher can also repeat this information to the Incident Commander. For example, following the dispatch assignment, the dispatcher could state: “Battalion XYZ, you are the designated Safety Officer.” After the responding unit confirms the assignment, the dispatcher could then state: “Dispatch to Command: Battalion XYZ is the assigned Safety Officer.” This process helps to ensure that the assignment is understood by the responding unit and that the Incident Commander knows who the designated safety officer will be.

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Recommendation #9: Fire departments should train all fire fighting personnel in the risks and hazards related to structural collapse.

Discussion: Proper training is an important aspect of safe fire ground operation. Both officers and fire fighters need to be aware of different types of building construction and their associated hazards.[9, 27-30] For example, collapsing roof systems can exert pressure on supporting exterior walls, increasing the potential for wall collapse. Different roof systems may collapse at different rates.[31] While heavy timber roof systems will withstand more degradation by fire than lightweight engineered roof trusses, both types are subject to failure.[5] Different phases of the fire suppression activities, such as the initial attack, offensive, defensive, and overhaul phases will have different hazards. However, the potential for collapse exists in any fire-damaged structure.[31] One source of information related to structural collapse hazards is the National Institute of Standards and Technology, Building and Fire Research Laboratory (NIST / BFRL). A DVD containing videos and reports related to structural collapse can be obtained from the NIST website http://www.bfrl.nist.gov/.[32]

Establishing priorities is another primary factor in safe fire ground operation that should be included in fire fighter training programs. The protection of life should be the highest goal of the fire service. According to retired Chief Vince Dunn, "When there is no clear danger to civilians, the first priority of firefighting should be the protection of fire fighters' lives and when no other person's life is in danger, the life of the fire fighter has a higher priority than fire containment or property consideration."[5] In this incident, crews had already completed occupant searches on each floor of the fire building and there were no indications that civilians were still inside the first floor. It is also noted that defensive operations had already been in place for some time prior to the collapse.

Recommendation #10: Municipalities, Building Owners, and authorities having jurisdiction should ensure that sprinkler systems are installed in multi-family housing units. Municipalities and authorities having jurisdiction should consider requiring building owners to regularly inspect sprinkler systems to ensure they are functioning properly.

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

In this incident, the three-story apartment building did have a sprinkler system, including a sprinkler head in the trash chute near where the fire originated. However, the sprinkler system did not have its own water supply, but was connected to the building's main water supply. At the time of the fire, a building maintenance worker was attempting to fix a water leak in a residence on the third floor and had shut off the main water supply to the building. A properly operating a sprinkler system with its

own separate water supply possibly could have contained the fire to the point of origin in the trash chute and prevented extension of the fire to the building. Containing or extinguishing the fire would have significantly reduced the risk to all emergency responders.

References

1. Weather Underground [2013]. Weather conditions for May 20, 2013. http://www.wunderground.com/history/airport/KDAL/2013/5/20/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA. Date accessed: August 12, 2014.

2. NFPA [2014]. NFPA 1561 *Standard on Emergency Services Incident Management System*, 2014 Edition. Quincy, MA: National Fire Protection Association.

3. Brunacini AV [1985]. Fire command. Quincy, MA: National Fire Protection Association.

4. IFSTA [2008]. Essentials of fire fighting, 5th ed. Oklahoma State University. Stillwater, OK: Fire Protection Publications, International Fire Service Training Association.

5. Dunn V [1992]. Safety and Survival on the Fireground. Saddle Brook NJ: Fire Engineering Books and Videos.

6. Dunn V [2000]. Command and Control of Fires and Emergencies. Saddle Brook NJ: Fire Engineering Book and Videos.

7. Brunacini AV [1985]. Fire command. Quincy, MA: National Fire Protection Association.

8. Dunn V [1998]. Risk management and lightweight truss construction. New York: WNYF, Official training publication of the New York City Fire Department, 1st issue.

9. NIOSH [1999]. *NIOSH Alert: Request for assistance in preventing injuries and deaths of fire fighters due to structural collapse.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS/NIOSH Publication No. 99-146. http://www.cdc.gov/niosh/docs/99-146/ .

10. NFPA [2007]. NFPA 1500: Standard on Fire Department Occupational Safety and Health Program. Quincy, MA: National Fire Protection Association.

11. Klaene B, Sanders R [2000]. *Structural fire-fighting*. Quincy, MA: National Fire Protection Association.

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

13. NIOSH [2010]. *NIOSH ALERT: Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires*. July 2010. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS/NIOSH Publication No. 2010-153. http://www.cdc.gov/niosh/docs/2010-153/.

14. NIMS [2000]. Incident Command System (ICS) Model Procedures Guide for Incidents Involving Structural Fire Fighting, High-Rise, Multi-Casualty, Highway, and Managing Large-Scale Incidents Using NIMS-ICS. Book 1 - First Edition. National Incident Management System Consortium. Stillwater, OK: Fire Protection Publications.

15. NFPA [2008]. NFPA 1521 Standard for fire department safety officer. 2008 ed. Quincy, MA: National Fire Protection Association.

16. National Incident Management System Consortium [2008]. Incident Command System (ICS) model procedures guide for incidents involving structural fire fighting, high-rise, multi-casualty, highway, and managing large-scale incidents using NIMS ICS, Book 1. Stillwater OK: Fire Protection Publications, Oklahoma State University.

17. FIRESCOPE [2007]. Field operations guide. Riverside, CA: FIRESCOPE, ICS 420-1.

18. NIOSH [2012]. *A career captain dies and 9 fire fighters injured in a multistory medical building fire—North Carolina*. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report F2011-18 http://www.cdc.gov/niosh/fire/reports/face201118.html .

19. NIOSH [2010]. *Career lieutenant dies following floor collapse into basement fire and a career fire fighter dies attempting to rescue the career lieutenant—New York*. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report F2009-23 http://www.cdc.gov/niosh/fire/reports/face200923.html .

20. Dodson D [2007]. Fire department incident safety officer. 2nd edition. New York: Thomson Delmar Learning.

21. NIOSH [2013]. *Career Lieutenant and Fire Fighter Killed and Two Fire Fighters Injured by Wall Collapse at a Large Commercial Structure Fire - Pennsylvania.* Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. FACE Report F2012-13 http://www.cdc.gov/niosh/fire/reports/face201213.html.

22. Dodson D [1999]. Fire department incident safety officer. 1st edition. New York: Thomson Delmar Learning.

23. NIOSH [2014]. *NIOSH Workplace Solution: Preventing deaths and injuries to fire fighters by establishing collapse zones at structural fires*. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS/NIOSH Publication Number 2014-120. http://www.cdc.gov/niosh/docs/wp-solutions/2014-120/

24. IAFC [2012]. Rules of engagement for structural firefighting. Fairfax VA: International Association of Fire Chiefs, Safety, Health and Survival Section. http://websites.firecompanies.com/iafcsafety/files/2013/10/Rules_of_Engagement_short_v10_2.12.pdf.

25. Naum C [2013]. Reading the building: the importance of the size-up. Firehouse Magazine, April: 128–131.

26. IFSTA [2010]. Building construction related to the fire service, 3rd ed. Stillwater, OK: Fire Protection Publications. International Fire Service Training Association.

27. Norman J [2005]. Fire officer's handbook, 3rd ed. Tulsa, OK: Penn Well Corporation: Fire Engineering.

28. NIOSH [2005]. *NIOSH Alert: Preventing injuries and deaths of fire fighters due to truss system failures*. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-132. http://www.cdc.gov/niosh/docs/2005-132/.

29. NIOSH [2007]. *Career fire fighter dies and chief is injured when struck by 130-foot awning that collapses during a commercial building fire – Texas*. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. FACE Report F2007-01. http://www.cdc.gov/niosh/fire/reports/face200701.html

30. Brannigan FL [1999]. Building construction for the fire service, 3rd ed. Quincy, MA: National Fire Protection Association, pp 517-563.

31. NIST [2011]. Structural Collapse. Gaithersburg, MD. National Institute of Standards and Technology, Fire Research Division. http://nist.gov/fire/collapse.cfm. Date accessed: September 10, 2014.

Investigator Information

This incident was investigated by Jay L. Tarley, Safety and Occupational Health Specialist, and Tim Merinar, safety engineer, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV, and Corey Butler, Occupational Safety and Health Specialist with the NIOSH Western States Office located in Denver, CO. An expert technical review was provided by retired Battalion Chief (ret) John Salka, Fire Command Training. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

Additional Information

Texas State Fire Marshal's Office / Texas Department of Insurance

The Texas State Fire Marshal's Office conducted a separate investigation of this incident. The Texas State FMO investigation report is available at http://www.tdi.texas.gov/reports/fire/documents/fmloddwilson.pdf. Additional investigation reports conducted by the Texas State FMO involving recent fire fighter line-of-duty deaths can be found at http://www.tdi.texas.gov/fire/fmloddindividuals.html.

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Appendix

Rules of Engagement for Fire-Fighter Survival:

- Size-up your tactical area of operation. (Pause for a moment, look over the area of operation, evaluate individual risk exposure, and determine a safe approach to completing your tactical objectives.)
- Determine the occupant survival profile. (Consider occupant survival as part of your individual risk assessment and action plan.)
- Do not risk your life for lives or property that cannot be saved. (Do not risk your life when fire conditions prevent occupant survival and when significant or total destruction of the building is inevitable.)
- Extend limited risk to protect savable property. (When trying to save a building, limit risk exposure to a reasonable, cautious, and conservative level.)
- Extend vigilant and measured risk to protect and rescue savable lives. (During high-risk primary search-and-rescue operations where lives can be saved, manage search-and-rescue operations in a calculated, controlled, and safe manner while remaining alert to changing conditions.)
- Go in together, stay together, and come out together, when two or more fire fighters operate as a team.
- Maintain continuous awareness of your air supply, situation, location, and fire conditions. (Maintain situational awareness by knowing where you are in the building and what is happening around you and elsewhere that can affect risk and safety.)
- Constantly monitor fire ground communications for critical radio reports.
- Report unsafe conditions or practices that can harm you. Stop, evaluate, decide. (Officers should prevent exposure to unsafe conditions or practices by allowing any member to raise an alert about a safety concern without penalty and by mandating supervisors address safety questions to ensure safe operations.)
- Abandon your position and retreat before deteriorating conditions can harm you. (Be aware and exit early to a safe area when you are exposed to deteriorating conditions, unacceptable risk, and a life-threatening situation.)
- Declare a Mayday as soon as you think you are in danger. (Officers should ensure fire fighters are comfortable with declaring a Mayday as soon as they think they are in trouble.)[23]

The Incident Commander's rules of engagement for fire-fighter safety:

- Rapidly conduct or obtain a 360-degree situational size-up of the incident. (As part of the risk assessment plan and action development plan, determine the safest approach to tactical operations before fire fighters are placed at substantial risk.)
- Determine the occupant survival profile. (Consider fire conditions in relation to the occupant survival of a rescue event before committing to a high-risk search and rescue.)
- Conduct an initial risk assessment and implement a safe action plan. (Before fire fighters are placed in high-risk positions on the fire ground, develop a safe action plan by conducting a size-up, assessing the survival profile, and completing a risk assessment.)

- Consider a defensive strategy when you do not have the resources to safely support and protect fire fighters. (Do not commit fire fighters to high-risk tactical objectives that cannot be accomplished safely due to inadequate resources on the scene.)
- Do not risk fire-fighter lives for lives or property that cannot be saved. Seriously consider a defensive strategy. (Do not commit fire fighters to high-risk fire-fighting operations that may harm them when fire conditions prevent occupant survival or when significant or total destruction of the building is inevitable.)
- Extend limited risk to protect savable property. (Limit risk exposure to a reasonable, cautious, and conservative level when trying to save a building that is believed, following a thorough size-up, to be savable.)
- Extend vigilant and measured risk to protect and rescue savable lives. (During high-risk search-and-rescue operations where lives can be saved, manage search-and-rescue and supporting fire-fighting operations in a highly calculated, controlled, and cautious manner while remaining alert to changing conditions.)
- Maintain frequent two-way communications and keep interior crews informed of changing conditions. (Request frequent progress reports and continually inform all interior crews of changing fire conditions observed from the exterior that may affect crew safety.)
- Obtain frequent progress reports and revise the action plan. (Obtain frequent progress reports to continually assess fire conditions and any risk to fire fighters and to regularly adjust and revise the action plan to maintain safe operations.)
- Ensure accountability of every fire fighter, their location, and status. (Maintain a constant and accurate accountability of the locations and status of all fire fighters within a small geographic area of accuracy within the hazard zone and be aware of who is presently in or out of the building.)
- Seriously consider a defensive strategy, if after completion of the primary search, little or no progress toward fire control has been achieved.
- Always have a rapid intervention team in place at all working fires.
- Always have fire-fighter rehab services in place at all working fires. (Ensure all fire fighters who endured strenuous physical activities at a working fire are rehabilitated and medically evaluated for continued duty and before being released from the scene.)[23]