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NIOSH Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation *July 26, 2004*

Partial Roof Collapse in Commercial Structure Fire Claims the Lives of Two Career Fire Fighters - Tennessee

SUMMARY

On June 15, 2003, a 39-year-old male career Lieutenant (Victim #1) and a 39-year-old male career fire fighter (Victim #2) died while trying to exit a commercial structure following a partial collapse of the roof which was supported by lightweight metal trusses (bar joists). The victims were part of the initial entry crew searching for the fire and possible entrapment of the store manager. Both victims were in the back of the store operating a handline on the fire that was rolling overhead above a suspended ceiling. A truck company was pulling ceiling tiles searching for fire extension when a possible backdraft explosion occurred in the void space above the ceiling tiles. Victim #1 called for everyone to back out due to the intense heat. At this point, the roof system at the rear of the structure began to fail, sending debris down on top of the fire fighters. Victim #1 and Victim #2 became separated from the other fire fighters and were unable to escape. Crews were able to remove Victim #2 within minutes and transported him to a local hospital where he succumbed to his injuries the following day. Soon after Victim #2 was removed, the rear of the building collapsed preventing further rescue efforts until the fire was brought under control. Victim #1 was recovered approximately 1 ½ hours later. NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should

- ***ensure that the first arriving company officer does not become involved in fire fighting efforts when assuming the role of Incident Command***
- ***ensure that the Incident Commander (IC) conducts an initial size-up and risk assessment of the incident scene before beginning interior fire fighting operations***
- ***conduct pre-incident planning and inspections for mercantile and business occupancies***
- ***ensure that ventilation is closely coordinated with the fire attack***

Commercial structure involved in arson fire

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (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. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. 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

www.cdc.gov/niosh/firehome.html

or call toll free **1-800-35-NIOSH**

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- ***ensure that fire fighters immediately open ceilings and other concealed spaces whenever a fire is suspected of being in a truss system***

- ***ensure that fire fighters performing fire fighting operations under or above trusses are evacuated as soon as it is determined that the trusses are exposed to fire***

- ***consider using a thermal imaging camera as a part of the size-up operation to aid in locating fires in concealed areas***

Additionally,

- ***Municipalities should consider requiring specific building construction information on an exterior placard***

INTRODUCTION

On June 15, 2003, a 39-year-old male career Lieutenant (Victim #1) and a 39-year-old male career fire fighter (Victim #2) died while trying to exit a commercial structure following a partial roof collapse. On June 16, 2003, the International Association of Fire Fighters (IAFF) and the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of these fatalities. On June 23, 2003, three Safety and Occupational Health Specialists and a Safety Engineer from the NIOSH Division of Safety Research investigated the incident. Meetings were conducted with the City Director and Deputy Director of Fire Services; a representative from the City Fire Prevention Bureau; the Chief Fire Marshal; District and Battalion Chiefs of the fire department; the local International Association of Fire Fighters (IAFF) representative; the City Safety Coordinator; an investigator from the Tennessee Department of Labor; and, representatives from the Bureau of Alcohol, Tobacco, and Firearms. Interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's standard operating procedures (SOPs), the victims' training records, and blueprints of the building; and inspected the victims' turnout gear. The incident site was visited and photographed. The investigators also conducted a site visit at a nearby store which was similar to the one involved in the incident.

At the request of the fire department, the victims' and another fire fighter's self-contained breathing apparatus (SCBA) were sent for further evaluation to the Respirator Branch in the NIOSH National Personal Protective Technology Laboratory. The purpose of the testing was to determine the SCBAs' conformance to the approval performance requirements of *Title 42, Code of Federal Regulations, Part 84 (42 CFR 84)*. Further testing was conducted to determine conformance to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service, 1997 Edition*[1]. A summary of the report is provided in Appendix I. Victim #1's SCBA, Unit #3, was severely damaged by fire and was unable to be tested. The SCBA used by a fire fighter from Engine 27 (see investigation section) is referred to as Unit #1 and Victim #2's SCBA is referred to as Unit #2. There was no evidence found to support that the SCBAs were a contributing factor to these fatalities.

Department

The career fire department has 1,500 uniformed personnel that operate out of 53 stations. The department serves a population of approximately 900,000 in an area of about 434 square miles.

Training

Victim #1 had more than 11 years of experience and had successfully completed numerous training courses

such as: the State's requirements for Fire Fighter Level-III, hazardous materials, forcible entry, fire fighter survival, emergency medical technician, and company commander training.

Victim #2 had more than 18 years of experience and had also successfully completed numerous training courses such as: the State's requirements for Fire Fighter Level-III, hazardous materials, forcible entry, fire fighter survival, emergency medical technician, and strategy and tactics.

Equipment

Additional units were dispatched; however, only those units directly involved in operations preceding the fatal event are discussed in the investigation section of this report.

Engine 31 [Lieutenant (Initial Incident Command/ Victim #1), two fire fighters (includes Victim #2), driver/operator]

Engine 26 [Lieutenant, two fire fighters, driver/ operator]

Truck 11 [Lieutenant, two fire fighters, driver/ operator]

Engine 27 [Lieutenant, two fire fighters, driver/ operator]

Truck 6 [Lieutenant, fire fighter, tillerman, driver/ operator]

Battalion Chief 2 [2nd Incident Command]

Battalion Chief 11 [C-D corner/sector command]

Rescue 2 [Lieutenant, two fire fighters, driver/ operator]

Division 1 [Deputy Chief (Final Incident Command)]

Building Information

The National Fire Protection Agency (NFPA), *Fire Protection Handbook, 18th Edition*[2], identifies this type of construction as Type II, non-combustible. Type II construction consists of structural members, including interior/exterior walls, columns, beams, girders, trusses, arches, floors and roofs that are made of noncombustible materials.

The building had 8,925 square feet of space, of which 6,670 square feet was retail space. It was not protected by sprinklers, nor were the open-web steel trusses protected by any fire resistive coating. The exterior walls were all constructed with 12-inch masonry blocks with a 4-hour fire rating. A new roof was installed April 10, 2001, and consisted of hot asphalt over a ¾-inch fiberboard membrane, covering corrugated metal sheeting. The flat roof was supported by unprotected open-web steel trusses commonly called bar joists (Photo 1). These joists were supported by the exterior side walls and interior steel columns.

The store was sectioned into two parts by a block wall with a man door for access between the two. The front section was for retail operations and consisted of a suspended ceiling which covered the bottom of the roof trusses. The discount mercantile operation in the front section contained merchandise ranging from automotive supplies to clothing. The rear section was used for storage and also consisted of a separate office space. The steel bar joists were open in the rear storage section, which shared the void space in the front created by the suspended ceiling.

INVESTIGATION

On June 15, 2003, a 39-year-old male career Lieutenant (Victim #1) and a 39-year-old male career fire fighter (Victim #2) died while trying to exit a commercial structure following a partial roof collapse. At approximately 1945 hours, Central Dispatch

received a call of a structure fire in a commercial occupancy with a possible entrapment and dispatched the first alarm assignments. Engine 31 (E31) was the first to arrive on the scene at 1950 hours and radioed Central Dispatch to report light smoke showing from the roof and in the building. The Lieutenant from E31 (Victim #1) assumed incident command (IC). The driver/operator from E31 began forcing the front door while the crew prepared to enter the store. Engine 26 (E26) and Truck 11 (T11) arrived on the scene at 1951 hours. Engine 26 began laying a 5-inch supply line from a hydrant to Engine 31. Truck 11 was ordered to the roof to investigate the air conditioning unit for a possible malfunction. Engine 27 (E27) arrived on the scene at 1952 hours and began assisting E31. Truck 6 (T6) arrived on the scene at 1953 hours and began forcing the door at the rear of the building, C-side (Diagram 1).

The IC (Victim #1) and the Lieutenant from E26 (Lt. 26) entered the building to investigate and search for the fire. Light smoke allowed the officers to see to the back of the store which was approximately 100 feet long. Victim #1 and Lt. 26 proceeded to the rear without donning their air masks. There was no visible fire in the store. Victim #1 and Lt. 26 entered the storeroom in the rear (Diagram 2) to search for the fire. The smoke conditions in the storeroom were heavier, but did not require the officers to don their air masks. Lt. 26 proceeded to the office located along the B-Side of the storeroom. He heard crackling behind the office door and opened it to investigate. The fire flared up with force which kept him from shutting the door. *Note: The fire originated in the store's office and was later determined to be an arson fire.*

At approximately 1952 hours Victim #1 radioed for a pre-connect. Lt. 26 exited to assist laying the handline. Battalion Chief 2 arrived on the scene at approximately 1954 hours and took over as the IC per department standard operating procedures (SOPs). Victim #2 and the fire fighter from E27 donned their SCBA and advanced a 200-foot 1 ¾ –inch pre-connect through the front door. A fire fighter from E31 stayed just inside the door to feed slack to the interior crew. Conditions allowed the crew to see the illuminated exit sign in the rear of the retail area. Approximately 4 to 5 minutes later, Lt. 26 pulled a 2 ½-inch pre-connect that had two 150-foot 1 ¾ -inch handlines attached by a gated wye. He connected the two 150-foot 1 ¾-inch handlines to make a 300-foot section to ensure the rear of the store could be reached. He then proceeded toward the rear of the retail area with a fire fighter from E26. Heavy smoke was now coming out of the front of the store and visibility was near zero throughout the entire store.

Three members from T11 put an extension ladder to the roof on the D-side of the structure to begin roof operations when they were ordered by the IC to enter the front of the store to pull ceiling tiles in the retail area. Just after this order, the driver and a fire fighter from T6 went to the roof to start ventilation at 1958 hours. Battalion Chief 11 (BC11) arrived on the scene at 1958 hours and was given command of the C-D Sector. BC 11 was approached by a store employee and was informed that the store manager might still be inside. *Note: The store manager was not inside the building.* Rescue 2 (R2) arrived on the scene at 1959 hours and was assigned as the rapid intervention team (RIT) on the A-side.

Lt. 26 radioed E31 for the lines to be charged. Both nozzles were opened and directed towards the office area which knocked down the fire behind the rear wall as it started to roll across the ceiling from the B-C corner. Victim #2 requested to be relieved on the nozzle by the firefighter from E27 who was backing him up on the handline. *Note: It is believed that Victim #2 took position behind the nozzleman to assist with the operation of the handline. This is*

the last time Victim #2 was seen until he was removed from the building. Victim #1 came up to the E27 fire fighter and directed him to bring the line to the storeroom. They experienced intense heat when they entered the storeroom, and when the handline was opened, they heard electrical popping sounds from the ceiling area.

At approximately the same time, a fire fighter from T11 was attempting to pull ceiling tiles with a 6-foot pike pole when the fire flared in the void space and blew an area of suspended ceiling and air vents downward onto the crews below (Diagram 2). *Note: It is believed that a possible backdraft[a] took place when the ceiling tiles were opened.* Victim #1 made a radio transmission ordering everyone to back out of the store. The intense heat and flames coming from the ceiling area forced the crews from T11 (Lieutenant and 2 fire fighters) and E26 (Lieutenant and a fire fighter) to back out of the store.

At approximately the same time, Victim #1 and the fire fighter from E27 were knocked to their knees by falling debris. At 2002 hours, 12 minutes after his arrival, Victim #1 called for help by stating "Mayday, Mayday, Engine 31. I'm trapped inside!" A low-air alarm could be heard in the background during this transmission. *Note: It is believed that a partial roof collapse occurred at this time (Photo 2).* The IC immediately deployed the RIT and called for a second alarm. Division Chief 1 arrived on the scene at 2003 hours and assumed Incident Command, while BC2 took over fire ground operations. Truck 6 forced open the rear door at 2003 hours. C-D Sector Command did not hear the Mayday call and requested additional manpower to search for the store manager.

Victim #1 requested to buddy breathe from the E27 fire fighter's SCBA. The E27 fire fighter stated that he was also low on air as his low-air alarm was sounding. The decision was made to follow the handline out of the structure. Their path was impeded from the partial collapse and their hoseline was buried under large piles of debris in the aisles. The fire fighter was crawling over the debris with Victim #1 holding onto his boot. The fire fighter from E27 heard a call for help off to his left side as they crawled over the pile.

The RIT team entered the front of the store and ran into Lt. 26 who was on his feet, but out of air. They removed him from the store thinking that he was the fire fighter who radioed the distress call. The IC called for a personal accountability report (PAR) at 2007 hours and determined that the firefighter who made the distress call was still inside and the RIT re-entered. The fire fighter from E27 made it over the pile of debris and then ran out of air. He was struggling to remain conscious when he saw a light and called out for help. The RIT found and carried out the fire fighter. The IC called for another PAR and confirmed that two fire fighters were now missing. The RIT entered a third time but the rear of the retail area was blocked by the roof collapse. The RIT was driven out by intense heat and advised command that the fire needed to be knocked down before they could re-enter.

Two members from T6 made two entries into the storeroom through the rear door (C-side) searching for the store manager. As they were exiting the second time, they heard a personal alert safety system (PASS) device sounding from near the wall separating the retail area from the storeroom. The crew reached the wall and made their way to a door leading to the retail area. They determined there were two PASS devices sounding on either side of the wall. They found Victim #2 inside the storeroom and notified command that they had found one fire

[a] Backdraft: "Instantaneous explosion or rapid burning of superheated gases that occurs when oxygen is introduced into an oxygen-depleted confined space." (International Fire Service Training Association: Fire Service Orientation and Terminology, 2001)

fighter at 2013 hours. Victim #2 was transported to a local hospital where he died the next day.

The two fire fighters on the roof from T6 reported a large roof sag at 2014 hours with fire extending through the roof on the B-side. They immediately exited the roof having completed only a partial ventilation hole. Additional attempts were made to rescue Victim #1; however, with conditions worsening it was decided to go to a defensive attack. Command sounded the evacuation horns at 2024 hours.

Crew members formed a rescue group and breached a hole in the B-side wall at 2110 hours (Photo 3). Victim #1 was removed and placed in an ambulance at approximately 2126 hours and transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

The cause of death as reported by the county medical examiner for Victim #1 was thermal burns. The cause of death for Victim #2 was thermal inhalation injury.

RECOMMENDATIONS/DISCUSSIONS

Recommendation #1: Fire departments should ensure that the first arriving company officer does not become involved in firefighting efforts when assuming the role of Incident Command. [3-5]

Discussion: Fire fighter safety starts with a strong command presence. According to NFPA 1561, §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 (IC) 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, command was never established and the first arriving officer was actually operating in the "Nothing-showing mode."

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 #2: Fire departments should ensure that the Incident Commander (IC) conducts an initial size-up and risk assessment of the incident scene before beginning interior fire fighting operations. [6-13]

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. Several factors must be evaluated in conducting the size-up including: type of structure, time of day and potential occupancy, contents of the structure, and potential hazards. The size-up should also include assessments of risk versus gain during incident operations. The main structural danger associated with Type II construction is roof collapse. The roofing system is supported by steel-bar joists and usually consists of a corrugated steel roof deck, a layer of felt paper, foam insulation, and asphalt water proofing. Knowledge about the type of construction, age of the building, and whether or not modifications or additions have been completed provides the IC with information on how the building may hold up under fire conditions or if the building is generally subject to collapse under fire conditions. For example, truss systems can fail quickly after being exposed to fire. Steel has no fire resistance and will fail when heated to temperatures that are routinely attained by fire. An unprotected steel-bar joist can collapse after five to ten minutes of exposure to fire. The temperature at which steel fails is 1,100 degrees Fahrenheit. Temperatures of 1,000 degrees Fahrenheit can be reached within the first five minutes of a fire, and 1,300 degrees Fahrenheit can be attained within 10 minutes.

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. There are also warning signs of a backdraft explosion that can be observed or relayed to the IC. These include dense black smoke, smoke puffing around doorframes, 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.

Recommendation #3: Fire departments should conduct pre-incident planning and inspections for mercantile and business occupancies. [4, 6, 7, 13-17]

Vincent Dunn states in *Command and Control of Fires and Emergencies*, "Most firefighters who die fighting fires perish in residential occupancies. This is a statistical matter: More fires occur in residences. However when we examine the number of firefighter deaths per fire we see that commercial occupancies are more dangerous to personnel. A study by the

NFPA from 1989 to 1993 revealed that 3.1 firefighters died for every 100,000 residence occupancy fires, and that 11.6 firefighters died for every 100,000 non residential occupancy fires, such as stores, offices and warehouses."

Pre-incident planning is a useful tool for identifying hazards and how to address them before an incident occurs in a commercial building. The pre-incident plan should not be confused with fire inspections which monitor code compliance. Pre-incident planning assumes an incident will occur and is one of the most valuable tools available for aiding responding personnel in effectively controlling an emergency. Fire departments should inspect buildings within their jurisdiction and note the type of construction, materials used, presence of trusses in the roof and floor, occupancy, fuel load, egress routes, and other distinguishing characteristics. Chapter 3 of NFPA 1620 recommends that these pre-incident plans address the structural integrity of walls, roofs, and floors. Data regarding roof and floor construction (e.g., wood joist, wood truss, steel joist, steel truss, beam and girder, etc.) should be recorded in the plan. Whenever possible, buildings should be inspected during the construction phase to aid in assessing the different types of construction, materials, etc. This pre-plan information should be entered into the dispatcher's computer so that when a fire is reported the dispatcher can notify, by radio, all first responders with critical information so they can take appropriate actions.

Recommendation #4: Fire departments should ensure that ventilation is closely coordinated with the fire attack. [6, 7, 9, 17, 18]

Discussion: Chapter 10 of the *Essentials of Fire Fighting*, 4th edition, states that "ventilation must be closely coordinated with fire attack. When a ventilation opening is made in the upper portion of a building (vertical ventilation), a chimney effect (drawing air currents from throughout the building in the direction of the opening) occurs." This is necessary to minimize the conditions for a flashover or backdraft. Ventilation is also necessary to improve the fire environment so that fire fighters can approach a fire for extinguishment.

The IC should determine if and where ventilation is needed during the initial size-up. The type of ventilation should be determined based on evaluation of the structure, conditions on arrival, and the information outlined by the pre-incident plan. Vertical ventilation of buildings consisting of Type II construction, including a roof system supported by steel-bar joists, should not be attempted if the trusses have been exposed to fire. Upon arrival of the fire department, the trusses had not been exposed to fire due to the fire consuming the oxygen where it was contained in the office. In this incident, vertical ventilation was attempted, but was canceled by the roof crew for fear of collapse after the trusses were exposed to fire.

Also, the ventilation crew did not have a saw blade that would cut through the metal roof decking. It is critical that fire fighters have available and properly use the correct tools to carry out ventilation. Pre-incident plans should be developed and followed to determine which tools are needed to complete the assigned tasks. In most cases, buildings of Type II construction will have metal roof decks.

Recommendation #5: Fire departments should ensure that fire fighters immediately open ceilings and other concealed spaces whenever a fire is suspected of being in a truss system. [4, 15]

Discussion: Fire fighters may have difficulty in finding the exact location of fire in a building, even though heavy smoke makes it clear that fire is present. Fire or heavy smoke from the roof suggests that the fire could be in concealed areas of the roof system.

The design of suspended ceiling panels provides a void to hide the fire and allow hot gases to accumulate which may flash when oxygen is introduced. When a truss is suspected to be above a ceiling, fire fighters should use a pike pole or other tools to open up the ceiling immediately and check for truss construction. Any ceiling below a truss void should be pulled and examined by fire fighters while standing near a doorway for rapid escape. When opening ceilings or other concealed spaces, it is important to have charged hose line(s) ready. If there is a fire barrier in the void, the same procedure should take place on the opposite side. If the fire emerges behind the fire fighter, egress may be cut off, leading to the possibility of entrapment. Fire fighters need to be aware of their location in relation to the nearest exit and also be aware of the location of other fire fighters in the area. The IC must consider and provide for alternative egress routes from all locations where fire fighters are operating.

Recommendation #6: Fire departments should ensure that fire fighters performing fire fighting operations under or above trusses are evacuated as soon as it is determined that the trusses are exposed to fire.[4, 10, 15]

Discussion: Even though standard fire engineering calculations show that lightweight trusses may be expected to collapse as soon as 6 to 13 minutes after exposure in a fully developed fire, it is not recommended to set a time limit on working under or above burning trusses. As stated in *Building Construction For the Fire Service*, "under fire conditions, truss failure is unpredictable." When fire fighters arrive on the scene of a building with trusses exposed to fire, it is virtually impossible to identify how long the trusses have been exposed to fire and set a time limit for fire suppression. When it is determined that the trusses have been exposed to fire, any fire fighters operating under or above them should be immediately evacuated. If it is not clear that the trusses have been exposed to fire, a defensive attack should take place until the conditions can be verified.

Recommendation #7: Fire departments should consider using a thermal imaging camera as a part of the size-up operation to aid in locating fires in concealed areas.[19]

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. 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 Incident Commander can use during the initial size-up. Thermal imaging cameras (TICs) should be used in a timely manner, and fire fighters should be properly trained in their use and be aware of their limitations.

Additionally,

Municipalities should consider requiring specific building construction information on an exterior placard.[20]

Discussion: Information regarding building construction is invaluable to fire fighters if a fire should occur. The information could provide fire fighters with details about roof type (lightweight truss, bowstring, etc.), roof materials (metal, wood, etc.),

roof loads (HVAC units, displays, etc.), sprinkler system(s), standpipe location, utilities (gas or electric), occupancy, occupancy hours, chemicals on site, pressurized cylinders, contact numbers, and the interior floor layout. This information could save the IC time when planning the fire attack. Additionally, the information would provide fire fighters with important information that they might not otherwise have. However, the presence of building construction placards should not preclude doing pre-incident planning and inspections. At a minimum, buildings could be marked with a triangle or the letter "T" on the outside of the building to warn fire fighters of the presence of truss construction. To ensure that fire fighters are aware of structures that might have a truss roof, the State of New Jersey has passed a law requiring all building owners to place an exterior placard on structures which incorporate a truss roof. Figure1 shows the signage used in New Jersey.

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INVESTIGATOR INFORMATION

This incident was investigated by Jay Tarley, Steve Berardinelli, and Mark McFall, Safety and Occupational Health Specialists, and Tim Merinar, Safety Engineer, Division of Safety Research, NIOSH.

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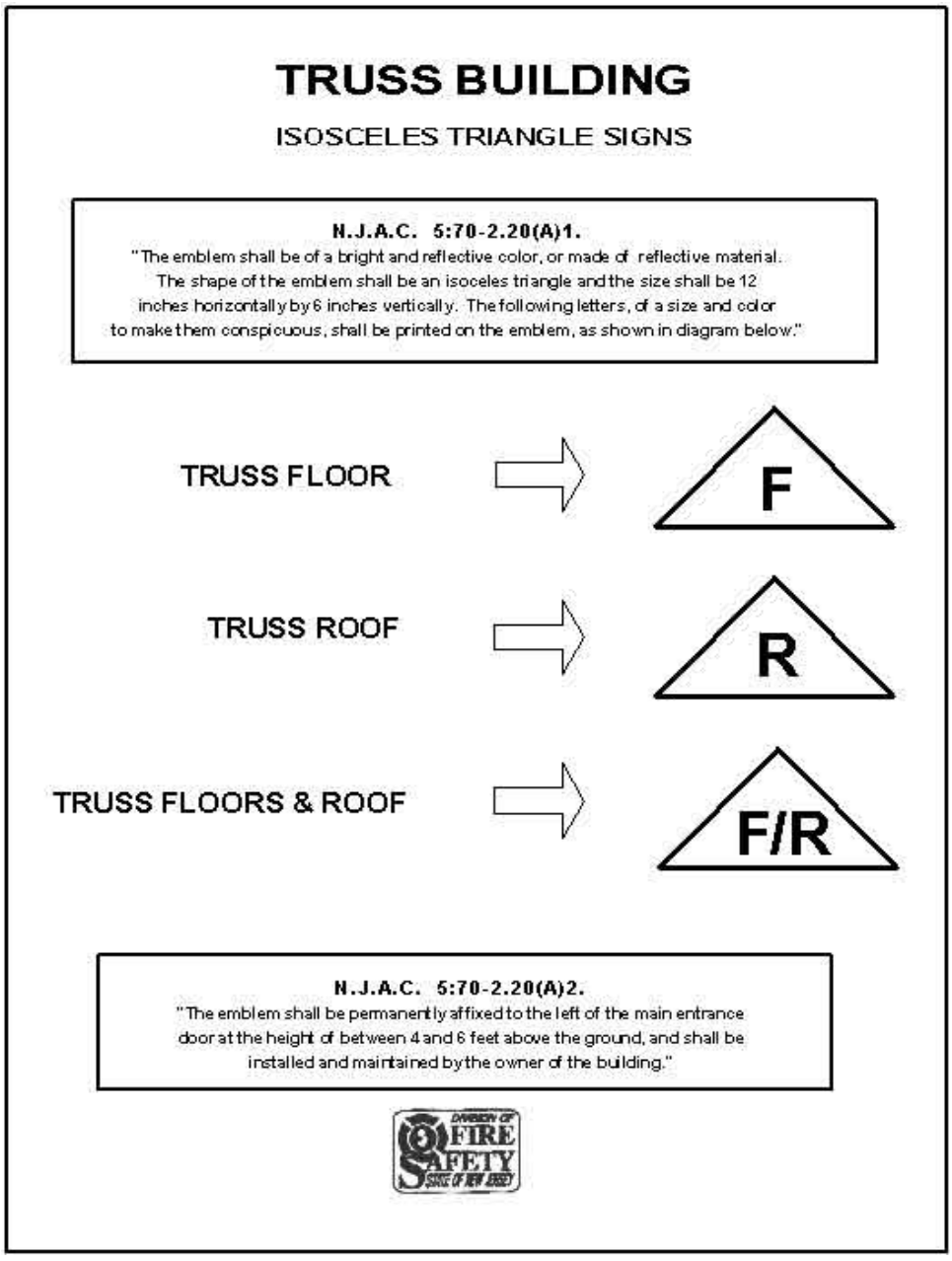

Figure 1. Truss Placard - State of New Jersey

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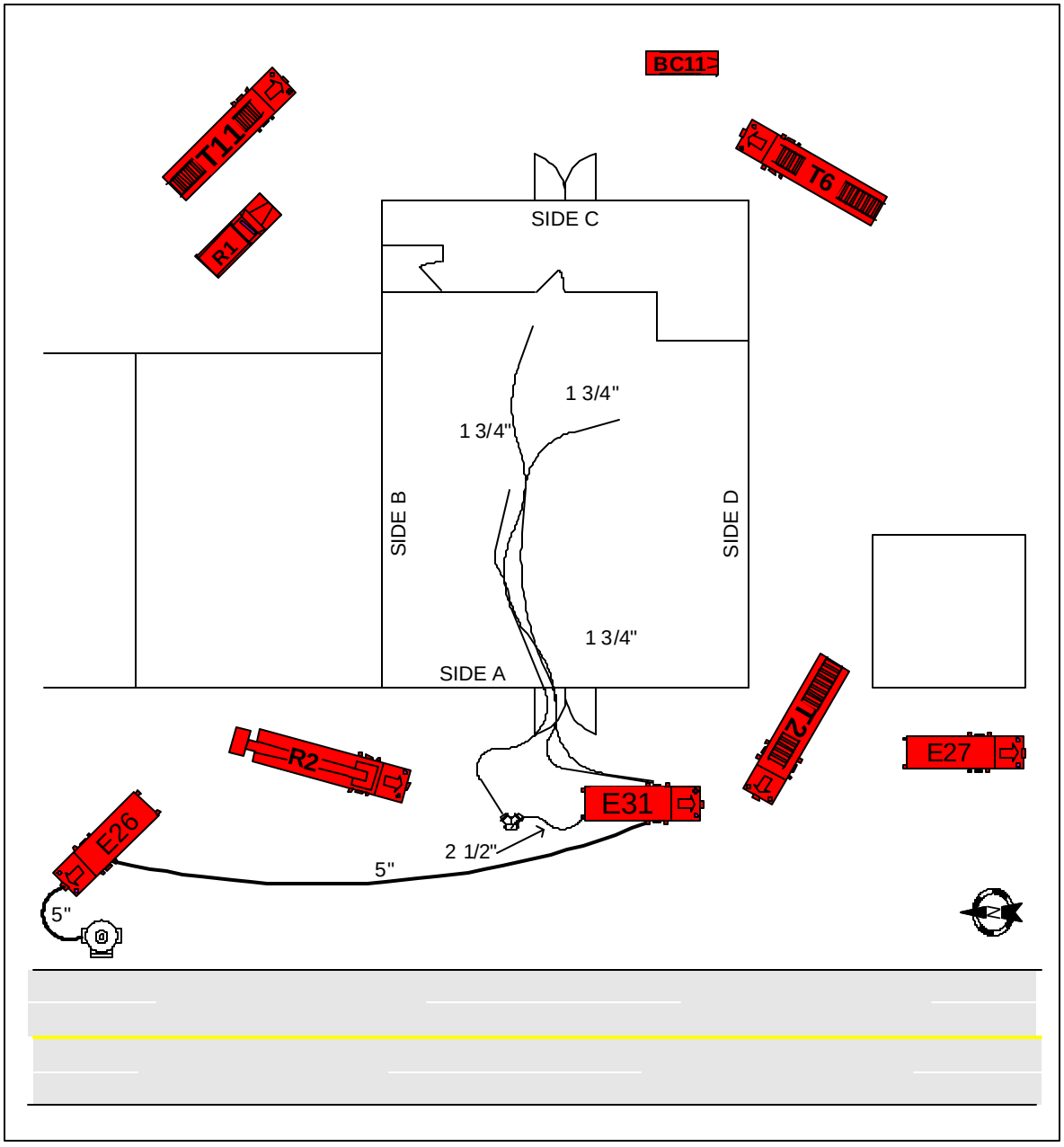

Diagram 1. Incident scene aerial view

Partial Roof Collapse in Commercial Structure Fire Claims the Lives of Two Career Fire Fighters - Tennessee

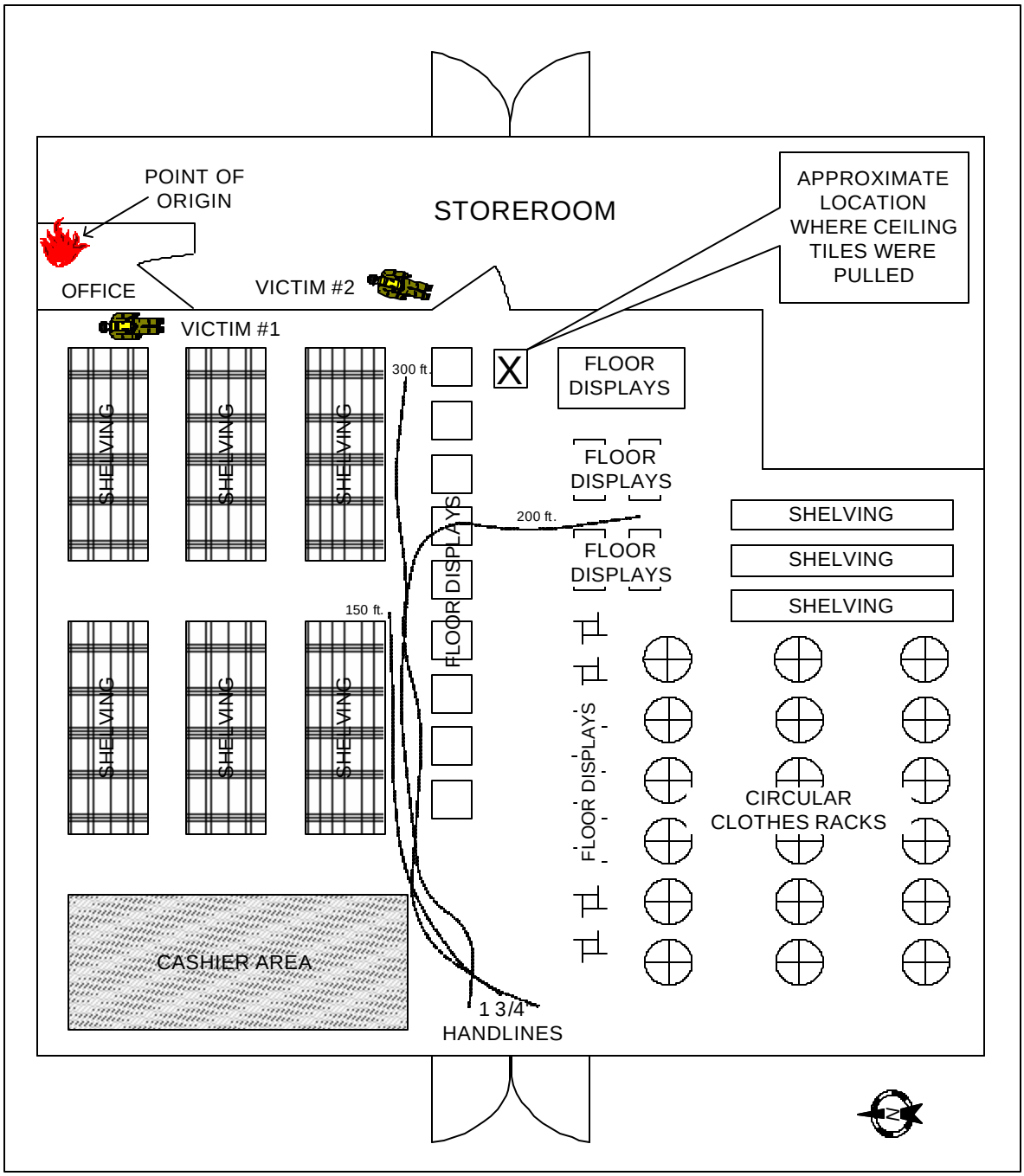

Diagram 2. Building layout aerial view

Partial Roof Collapse in Commercial Structure Fire Claims the Lives of Two Career Fire Fighters - Tennessee

Photo 1. Void space between the corrugated metal roof sheeting and suspended ceiling where the unprotected open-web steel trusses are located. This photo was taken from a building similar in construction to the building involved in this incident.

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Photo 2. Roof collapse B-Side

Photo 3. Extrication point B-Side

APPENDIX I

Partial Roof Collapse in Commercial Structure Fire Claims the Lives of Two Career Fire Fighters - Tennessee

NIOSH Reference: TN-12993

Phone: (412) 386-4000
Fax: (412) 386-4051
December 31, 2003

The National Institute for Occupational Safety and Health (NIOSH or the Institute) has concluded its investigation conducted under NIOSH Task Number TN 12993. This investigation consisted of the inspection and testing of three Dräger Safety 2216 psi, 30-minute, self-contained breathing apparatus (SCBA). The SCBA, sealed in corrugated cardboard boxes, were delivered to the NIOSH facility in Bruceton, Pennsylvania on July 1, 2003. Upon arrival, the sealed packages were taken to the Firefighter SCBA Evaluation Lab (Building 108) and stored under lock until the time of the evaluation.

SCBA Inspection

The first package from the fire department was opened, and the SCBA inspection was initiated on August 5, 2003. Inspection of the three SCBA was completed on August 8, 2003. The SCBA were examined, component by component, in the condition as received to determine their conformance to the NIOSH-approved configuration. The entire inspection process was videotaped. The SCBA were identified as the Dräger AirBoss model.

The complete SCBA inspection is summarized in Appendix II of the Status Investigation Report. The condition of each major component was also photographed with a digital camera. Images of the SCBA are contained in Appendix IV of the report.

One of the SCBA, Unit #3, has been severely damaged by fire. It is unlikely that any of its components could be returned to use. The other two SCBA both appear to have seen heavy use. Most of the components are worn and scratched, and to varying degrees have spots of what appears to be molten plastic adhered to them. Some rust is present on the cylinder sealing nipple of Unit #1, indicating that water may have been introduced into the high-pressure connection. The waistbelt buckle and demand valve storage point on Unit #1 are damaged and should be replaced. On Unit #2, the hydrostatic retest label is obscured and the cylinder should be taken to a certified retester for requalification. Visibility through the facepiece lenses of both units is impaired and they should be replaced.

Personal Alert Safety System (PASS) Devices

A Personal Alert Safety System (PASS) device was incorporated in the remote air pressure gauge of each SCBA. During the inspection, an attempt was made to activate each PASS device both manually and automatically. Only the device on Unit #2 could be activated; the other two were not functional. The PASS on Unit #2 appeared to function normally, but it was not tested against the requirements of NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*, 1998 Edition. Because NIOSH does not certify PASS devices, no further testing or evaluations were conducted on the PASS unit.

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). Unit #3 was too heavily damaged to be tested.

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)]

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

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

Testing of Units #1 and #2 was performed on August 6 and 8, 2003, respectively. All testing was videotaped with the exception of the Exhalation Resistance Tests and Static Pressure Tests.

Both SCBA allowed the facepiece pressure to drop below ambient during the Positive Pressure Test. Unit #1 also failed the Gas Flow Test by a narrow margin. The low-air alarm whistle on Unit #1 activated at a pressure higher than the acceptable range (510-598 psig) and the electronic low-air alarm did not function at all. This caused the unit to fail the Remaining Service Life Indicator Test and NFPA Air Flow Performance Test. Unit #2 had excessive exhalation resistance during the NFPA Air Flow Performance Test.

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

Summary and Conclusions

The SCBA submitted to NIOSH by the fire department for evaluation were delivered to NIOSH on July 1, 2003 and inspected on August 5 and 8, 2003. The units were identified as Dräger AirBoss 30-minute, 2216 psi SCBA (NIOSH approval number TC 13F 377). Units #1 and #2 were determined to be in a condition safe for testing; Unit #3 had suffered extensive fire damage.

The units were subjected to a series of seven performance tests. Testing was performed on August 6 and 8, 2003. Neither SCBA was able to meet the requirements of all tests. No maintenance or repair work was performed on the units at any time.

Following inspection and testing, the SCBA were returned to the packages in which they were received pending return to the fire department.

If Units #1 and #2 are to be placed back in service, they must be thoroughly inspected, repaired, and tested by a qualified service technician. The cylinder of Unit #2 must be qualified by a certified retester as the latest test date is not visible. It is recommended that the Unit #1 cylinder also undergo visual inspection and hydrostatic retest. The damaged components of each SCBA must be replaced and its proper performance verified before being returned to use. It is unlikely that any part of Unit #3 can be salvaged.

In light of the information obtained during this investigation, the Institute has proposed no further action on its part at this time. The investigation under task number TN 12993 will be considered closed. If you have any questions or require additional information, please contact me at 412 386 4029.

Sincerely yours,

Vance Kochenderfer
Quality Assurance Specialist
Respirator Branch
National Personal Protective Technology Laboratory

Enclosure

cc: T. Merinar, NIOSH Division of Safety Research
R. Sell, Dräger Safety

U. S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway, MS C-13
Cincinnati, OH 45226-1998

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