2008 07
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty…

A summary of a NIOSH fire fighter fatality investigation **August 17, 2009**

Two Career Fire Fighters Die and Captain is Burned When Trapped during Fire Suppression Operations at a Millwork Facility – North Carolina

SUMMARY

On March 7, 2008, two male career fire fighters, aged 40 and 19 (Victims #1 and #2 respectively) were killed when they were trapped by rapidly deteriorating fire conditions inside a millwork facility in North Carolina. The captain of the hoseline crew was also injured, receiving serious burn injuries. The victims were members of a crew of four fire fighters operating a hoseline protecting a firewall in an attempt to contain the fire to the burning office area and keep it from spreading into the production and warehouse areas. The captain attempted to radio for assistance as the conditions deteriorated but fire fighters on the outside did not initially hear his Mayday. Once it was realized that the crew was in trouble, multiple rescue attempts were made into the burning warehouse in an effort to reach the trapped crew as conditions deteriorated further. Three members of a rapid intervention team (RIT) were hurt rescuing the injured captain. Victim #1 was located and removed during the fifth rescue attempt. Victim #2 could not be reached until the fire was brought under control. The fourth crew member had safely exited the burning warehouse prior to the deteriorating conditions that trapped his fellow crew members. Key contributing factors identified in this investigation include radio communication problems (unintelligible transmissions in and out of the fire structure that may have led to misunderstanding of operational fireground communications), inadequate size up and incomplete pre-plan information, a deep-seated fire burning within the floor of the office area that was able to spread into the production and warehouse facility, the procedures used in which operational modes were repeatedly changed from offensive to defensive, lack of crew integrity at a critical moment in the event, and weather which restricted fireground visibility.

Two Career Fire Fighters Die and Captain is Burned When Trapped during Fire Suppression Operations at a Millwork Facility – North Carolina

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***ensure that detailed pre-incident plan information is collected and available when needed, especially in high risk structures***
- ***limit interior offensive operations in well-involved structures that are not equipped with sprinkler systems and where there are no known civilians in need of rescue***
- ***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***
- ***ensure that Rapid Intervention Crews (RIC) / Rapid Intervention Teams (RIT) have at least one charged hose line in place before entering hazardous environments for rescue operations***
- ***ensure that the incident commander establishes the incident command post in an area that provides a good visual view of the fire building and enhances overall fireground communication***
- ***ensure that crew integrity is maintained during fire suppression operations***
- ***encourage local building code authorities to adopt code requirements for automatic protection (sprinkler) systems in buildings with heavy fire loads.***

Additionally, manufacturers, equipment designers, and researchers should:

- ***continue to develop and refine durable, easy-to-use radio systems to enhance verbal and radio communication in conjunction with properly worn self-contained breathing apparatus (SCBA)***
- ***conduct research into refining existing and developing new technologies to track the movement of fire fighters inside structures***

INTRODUCTION

On March 7, 2008, two male career fire fighters, aged 40 and 19 (Victims # 1 and # 2 respectively) were killed when they were trapped by rapidly deteriorating fire conditions inside a millwork and manufacturing facility in North Carolina. The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) learned of the incident through the national media the same day. On March 8, 2008, the U.S. Fire Administration notified NIOSH of the fatalities. The fire department temporarily suspended operations and requested that NIOSH delay its investigation until after the funerals and memorial services were completed. On March 17, 2008, a safety engineer, general engineer and an occupational safety and health specialist with the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to North Carolina to investigate the incident. The NIOSH investigators met with representatives of North Carolina OSHA and the facility owner and inspected and photographed the site. On March 18, 2008, the NIOSH investigators met with representatives of the fire department, the city risk management office, North Carolina OSHA and the North Carolina state fire marshal's office. The NIOSH investigators remained in North Carolina through March 22nd and met with representatives of the city police, the public utility board (water department) and both the city and county telecommunications departments. The personal protective clothing, equipment, and self-contained breathing apparatus worn and used by the two victims and the injured captain were inspected and photographed. Interviews were conducted with the fire fighters involved in the incident including the municipal fire department, the combination fire department providing rapid-intervention team (RIT) support and two mutual aid departments. Other sources of information used in this investigation include state and federal OSHA regulations, National Fire Protection Association (NFPA) standards, fire department records (including standard operating procedures, training records, self-contained breathing apparatus (SCBA) and personal protective equipment (PPE) inspection records, pre-plan information and records), copies of the fireground radio transmissions, the fire department's post incident report, and media reports.

Note: Some photographs used in this NIOSH report have been altered to remove names, faces and other identifiers.

FIRE DEPARTMENTS

The municipal fire department involved in this incident serves a population of approximately 31,000 in a geographic area of approximately 21.6 square miles. At the time of the incident, the fire department employed 67 uniformed fire fighters. The fire department operated three working shifts with typical staffing of 20 fire fighters per shift. Each shift worked 24 hours on and 48 hours off. The city is bi-sected by a major north-south interstate highway. The city also has regular daily Amtrak service to all major eastern cities in the United States.

The fire department had a health and safety program aimed at meeting the requirements of NFPA 1500 Standard for a Fire Department Occupational Safety and Health Program.[1] The fire department utilized written standard operating procedures (SOPs) that covered a wide range of departmental operations including incident command organization, transfer of command, incident safety officer, rapid intervention crew deployment, emergency evacuation and Mayday procedures.

The fire department did pre-planning at commercial and large structures at least biannually to keep pre-plan information up to date. Crews identified specific hazards and then developed various fire suppression scenarios as part of the pre-plan process. The fire department did hydrant flow testing and used a color coded system to identify each hydrant's available output. The fire department employed two fire marshals who conducted building inspections and enforced code violations. The fire marshals usually returned 30 days after an inspection to evaluate whether cited violations had been corrected. The fire marshals also taught annual safety classes throughout the area, including at the facility where the fire and fatalities occurred. The department also employed 3 shift safety officers who worked a 24/48 hour shift. Each shift safety officer conducted inspections and responded to structure fires and other incidents as the scene safety officer.

The fire department maintained good working relationships with a number of local combination and volunteer fire departments that operated on an automatic mutual-aid basis within the county. One particular combination department, Station 62, provided automatic mutual aid for Rapid Intervention Team (RIT) support to the municipal fire department at all confirmed structure fires including this incident. Another volunteer department, Station 45, was called upon to initiate Class-A foam operations in the basement of the involved structure.

Note: Many of the fire fighters working at the municipal fire department are also volunteer fire fighters at a number of surrounding communities; some being ranking officers at their respective volunteer departments.

TRAINING and EXPERIENCE

The state of North Carolina, Fire and Rescue Commission requires fire fighters to be trained to NFPA Fire Fighter Level I and II based on the requirements of *NFPA 1001, Standard for Fire Fighter Professional Qualifications*.[2] The municipal fire department requires new recruits to have training that meets at a minimum, the North Carolina Fire and Rescue Commission, Live Fire Qualifications[a] prior to being hired. Once hired, fire fighters have 18 months to advance to the NFPA Fire Fighter II level. The municipal fire department requires each fire fighter to pass a modified fitness challenge test twice per year and to pass an annual physical. Fire fighters employed by the municipal fire department are also required to complete a minimum of 240 hours of refresher training each year.

The Deputy Chief serves as the department training officer. Each shift also has a designated training officer. The training officers meet and plan out training exercises for 3 months in advance. Training is usually 8 hours long with some training lasting up to 12 hours. Monday, Tuesday and Wednesday are designated training days. Specialized training on topics such as hazardous materials, heavy rescue, trench rescue, etc. is provided annually. Fire fighters can request off-site training through official channels. Once approved by the department, the fire fighter can travel to attend training on department time with all expenses paid by the department.

[a] The North Carolina Fire and Rescue Commission Live Fire Qualifications consist of 111 hours of training in 10 areas based upon the requirements found in NFPA 1001.

Victim #1 had been employed by the fire department since June 2007 and had over 15 years of total experience. He had previously worked as an emergency medical technician (EMT) at a major metropolitan fire department in the northeast and had been the valedictorian of his medic class at that fire department. Records provided by the fire department showed Victim #1 had completed 477 hours of training since June 2007.

Victim #2 had been employed by the fire department since June 2007 and had been a volunteer fire fighter with a neighboring volunteer department since joining as a junior member at age 14. Records provided by the fire department showed Victim #2 had completed 121 hours of training since June 2007. He was attending a local community college working toward a fire science degree.

The injured captain had been employed by the fire department since November 1987 and had over 21 years of total experience. Training records provided by the fire department showed the injured captain had completed 3,190 hours of training from January 2003 until the time of the incident.

EQUIPMENT and PERSONNEL

At the time of the fire, the fire department operated a fleet of Quint pumpers out of 4 station houses. Central Station # 1 housed Quint 1 with a minimum crew of 3 fire fighters, Squad 1 with a crew of 2 fire fighters, and Rescue 1 with a minimum crew of 3 fire fighters. Each shift was supervised by a Battalion Chief stationed at Central Station. Each shift had an on-duty Safety Officer. The administrative functions were also housed at Central Station. Three outlying stations each housed a Quint apparatus staffed by a minimum of 3 fire fighters. Each shift had a Division Chief who worked a day time schedule Monday thru Friday. The fire department's standard operating procedures dictated that all on-duty fire fighters and all apparatus respond to a confirmed working fire within the city. On a typical shift, 20 fire fighters were available to respond to a structure fire. The department also maintained procedures for calling off-duty personnel back to work as needed. Off-duty officers were placed on a rotating on-call roster for support roles at major incidents such as Operations Chief, Sector Officers and other support tasks. Specific departmental standard operating procedures for a confirmed structure fire are summarized in Appendix I.

TIMELINE and RESPONDING APPARATUS

The municipal fire department was dispatched at approximately 0705 hours for a structure fire at a local industrial park. Per departmental procedures, all apparatus and all on-duty fire fighters were dispatched, including the following:

Central Station
Quint 1 (acting captain, acting engineer / operator and fire fighter)

Rescue 1 (captain, engineer / operator, fire fighter)
Squad 1 (2 fire fighters - Victim # 1 and Victim # 2)
Battalion Chief (BC)
Safety Officer (ISO)
Division Chief (DC-30)

Station 2
Quint 2 (captain, engineer / operator and fire fighter)

Station 3
Quint 3 (captain, engineer / operator and fire fighter)

Station 4
Quint 4 (captain – injured, engineer / operator and fire fighter)

Crews began arriving on-scene at 0710 hours and immediately confirmed a working fire. The initial offensive fire suppression efforts by the Quint 2 and Rescue 1 crews focused on the basement under the office area that was attached to the rest of structure (see Diagram 1). The municipal fire department called a number of off-duty fire fighters back for staff support including an Operations Chief and Sector Officers. A second and third alarm dispatched a number of combination and volunteer fire departments from the surrounding area for mutual aid support. Responding mutual aid fire departments that are mentioned in this report include Station 45 (Class A foam operations), Station 57 (RIT # 1) and Station 62 (RIT # 2).

Approximately 20 minutes after the initial crews arrived on-scene, heavy fire and smoke conditions forced the attack crews out of the basement and the incident commander declared a change to defensive operations to protect exposures. The next hour focused on attempts to reach the deep-seated fire. Multiple crews made entry into the basement from both the B-side and D-side basement doors, as well as the first floor office area through the front entrance and the warehouse. Operations switched back and forth between offensive and defensive tactics. A mutual aid department initiated Class A foam suppression operations in the basement in an attempt to reach the seat of the fire approximately one hour after the initial crews began offensive operations. Multiple personnel accountability reports (PAR) were taken to track fire fighters moving in and out of the structure. As the fire continued to spread and conditions deteriorated, operations again switched back to defensive tactics with the focus on containing the fire to the office area (preventing its spread into the production and warehouse facilities) approximately 90 minutes after the first crews arrived on-scene. The Quint 4 and Squad 1 crew that had previously advanced a 2 ½" hose line into the office area through the warehouse was sent back into the warehouse to protect the fire wall separating the office area from the warehouse. Approximately 2 hours after the initial fire dispatch, rapidly deteriorating conditions in the warehouse trapped the crew members operating in the warehouse.

A detailed timeline summarizing the sentinel events in this incident is included as Appendix II. The times are approximate and were obtained by studying the dispatch records, witness statements, and other available information. In some cases, the times are rounded to the nearest minute. The times listed in this report have been extrapolated from the electronic dispatch audio file records. The timeline is not intended, nor should it be used, as a formal record of events.

Note: NIOSH investigators reviewed the Fireground Channel 2 audio recordings. NIOSH investigators noted 1,043 transmissions were recorded from 0710.33 until 1041.03 hours. Out of these 1,043 transmissions, 101 transmissions were cut off and 323 (31%) were unintelligible. During the critical part of the incident from 0825 hours until 0925 hours, NIOSH investigators identified over 420 radio transmissions on Fireground Channel 2 with at least 125 transmissions that were partially or completely unintelligible (30%) and another 18 that were cut off.

PERSONAL PROTECTIVE EQUIPMENT

At the time of the incident, each victim was wearing a full array of personal protective clothing consisting of turnout gear (coat and pants), Nomex® hood, helmet, gloves, boots and a self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS) and in-mask heads-up display (HUD). The municipal fire department utilizes 45-minute SCBA air cylinders. Every fire fighter carries a 50 ft rescue rope attached to their SCBA backframe. Every fire fighter carries a radio assigned to the riding position on each apparatus. Every company has a thermal imaging camera (one carried on each apparatus).

Following the inspection by NIOSH investigators, the SCBA worn and used by Victim # 1 was sent to the NIOSH National Personal Protective Technology Laboratory (NPPTL) for additional evaluation and testing. As a result of erratic performance of the heads-up display in the SCBA facepiece during the NIOSH testing, it failed to meet the requirements of the Remaining Service Life Indicator Test and NFPA Air Flow Performance Test. The SCBA worn and used by Victim # 2 was too badly damaged by fire and heat exposure to be tested. The NIOSH SCBA post-incident test results did not suggest any contributing factor to the incident (see Appendix III.) It is likely that the damage to both SCBA occurred post-mortem. Investigation information does not suggest that SCBA performance was a contributing factor to the fatalities. The integrated PASS devices worn by both victims and the injured captain were reported to have been heard sounding during the incident.

STRUCTURE

The structure involved in this incident was a commercial building of ordinary construction that housed a millworks manufacturing facility that produced laminated cabinets, molding and wood trim products. The site had housed a number of businesses over the years, mostly involved in lumber and wood products manufacturing and sales. A number of fires have occurred at the site over the years including major fires in 1939 and 1959 that totally destroyed the facility, and a smaller fire in 1998. The facility was totally rebuilt following the 1959 fire and had been in continuous operation since then. The structure has remained basically the same with only minor renovations since 1959. The fire department was dispatched to the site in February 2008 for a small fire that started near a band saw with concern for fire spread into the wood dust collection / ventilation system. *Note: The February 2008 fire was contained to the immediate area and no structure damage occurred.*

The structure was made of brick and masonry walls with heavy timber beams supporting wooden floor joists. The flat roof was constructed of wooden roof decking supported by steel I-beams. Photos taken after the incident show the roof over the office area consisted of roof decking covered by layers of waterproof composite membrane and asphalt (see Photo 1). The 79,000 square foot main building consisted of a basement and ground levels divided into office space, production and warehouse facilities. The office area was approximately 7,500 square feet on two levels and was separated from the production and warehouse facility by masonry walls on the ground level. Masonry walls also divided the office area separating the administrative and accounting area.

Railroad tracks ran parallel to the front (A-side) of the structure. An access road that provided access to the businesses within the industrial park ran between the railroad tracks and the structure (see Diagram 1).

According to the Department of Alcohol, Tobacco and Firearms (ATF), the March 7, 2008 fire, of "undetermined cause," originated above the drop ceiling in the basement under the office area.[3] The fire was discovered burning in the basement by employees reporting for work on the morning of March 7th. The room of origin was used as a training / classroom and employee break area. The wiring in the basement was believed to have been installed in 1959 following the last major fire at the site. The structure did not contain a sprinkler system.

The fire department had conducted a pre-plan inspection at the facility in December 2006 and city fire marshals conducted an annual inspection with the most recent inspection occurring in December 2007. The pre-plan form included a hand sketch of the millwork facility, listed the probable strategy as an aggressive fire attack, noted hazards as cluttered aisles, production machinery and an open elevator shaft in the production area, and predicted rapid fire growth due to the heavy fuel load. The hand drawn sketch did not identify the location of fire walls or provide detailed locations of doors, windows, offices, hallways or other distinguishing features.

The fatalities occurred inside the loading dock at the warehouse in an area where finished products were staged ready for shipment.

WEATHER

Changing weather conditions may have contributed to the incident. Rain began falling sometime after fire fighters arrived on-scene to begin initial fire suppression activities. During the incident, changing weather conditions and shifting winds caused heavy dark smoke to bank down and cover the incident scene (see Photo 2). This smoke severely restricted fireground visibility and forced pump operators to don SCBA while working around their apparatus, interfered with the designated fireground rehab area and forced the designated RIT Team to change their staging area in front of the structure. The smoky conditions obscured the vision of the incident commander and the crews working in the area. At the time of the initial fire dispatch, weather conditions were overcast, approximately 45 degrees Fahrenheit, 82 percent relative humidity, and east / northeast winds at approximately 9 miles per hour. Weather conditions at 0800 hours were approximately 46 degrees Fahrenheit, 93 percent relative humidity, east winds at approximately 4 miles per hour and rain. At the approximate time of the fatalities, winds of approximately 10 miles per hour were blowing from the east / northeast.[4]

INVESTIGATION

On March 7, 2008, the municipal fire department was dispatched at 0705 hours for a structure fire in the basement of a millworks facility in a local industrial park. Per department procedures, all on-duty fire fighters were dispatched from the four stations (B-shift was just completing their 24-hour shift).

Quint 1 responded with an acting captain, engineer/operator and fire fighter and positioned near the front corner of the office area (A-D corner along the D-side) assuming truck company operations.

Rescue 1 responded with a captain, engineer/operator and a fire fighter on-board. The fire fighter was responding to his first major working fire so the captain talked to him about fireground procedures as they traveled to the fire. Rescue 1 was the second unit on-scene and parked along the fence on the B-side separating the millworks facility from an adjoining business to the north. They observed flames shooting out the basement door on the B-side of the millworks structure.

Quint 2 responded with a captain, engineer/operator and a fire fighter and arrived first on-scene at approximately 0710 hours. They confirmed a major working fire with fire and heavy brown smoke visible in the basement under the office area (see Diagram 2).

The on-duty safety officer (Safety 1) arrived on-scene at 0711 hours and assumed Incident Safety Officer (ISO) duties. The on-duty Battalion Chief (BC) arrived on scene at 0712 hours, directed all units to switch to fireground channel 2 and assumed Incident Command (IC) at 0713 hours. His vehicle was positioned in front of the warehouse near the A-D corner (south of the office area) and was used as a stationary command post throughout the incident. *Note: Changing weather conditions, shifting winds, and rain caused smoke to bank down to ground level, at times obstructing the view of* *the structure (see Photo 2). Company vehicles and a semi trailer at the loading dock and a large tree also interfered with a clear view of the incident scene (see Diagrams 1 – 5).*

Squad 1 responded with Victim # 1 and Victim # 2 on-board. Quint 4 responded with a captain, engineer and fire fighter and arrived on-scene at approximately 0713 hours and began second engine company operations. They laid a 5" supply line from a hydrant located south of the millworks facility, then positioned in front of the loading dock (A-side, see Diagram 1).

Quint 3 responded with a captain, engineer / operator and a fire fighter and arrived on-scene at approximately 0715 hours. The crew connected to a hydrant at the highway east of the structure and laid a 5" supply line to the D-side of the warehouse where Quint 3 was positioned (see Diagram 1). After positioning Quint 3, the crew walked to Quint 1 and began second truck company operations. At approximately 0718 hours, the Squad 1 crew was assigned to team up with the engineer from Quint 1 to begin vertical roof ventilation on the office roof. The Quint 1 aerial ladder was raised to the office roof and used for roof access.

An off-duty, on-call captain arrived on-scene at approximately 0730 hours, reported to the command post and was assigned as Operations Chief to manage fire suppression operations. The Operations Chief was first heard in radio transmissions at approximately 0757 hours.

An off-duty, on-call safety officer (Safety 2) reported to the command post and was assigned to assess the interior conditions and report back to the IC. Safety 2 was later assigned as the Sector B Chief to aid in the Incident Management System command. A captain working an 8-hour shift conducting inspections reported to the IC and was assigned as the Sector C (basement) Chief.

A rehab area was established near the railroad tracks in front of the millwork facility. This area was used by fire fighters as a resting area between assignments and for changing out SCBA air cylinders.

Fireground operations 0710 to 0725 hours

Quint 2 arrived first on-scene at approximately 0710 hours. Quint 2 passed a hydrant along the main highway and dropped 1200 feet of 5-inch supply line to the front of the millworks (front A-B corner). The Quint 2 captain quickly sized up the A and B-sides of the structure and took a bundle of 2 ½ inch hose-line to the basement door located on the B-side (see Diagram 3 and Photo 3) while the engineer established water supply. The Quint 2 captain instructed the Quint 2 fire fighter to bring a 2 ½" nozzle to the basement door. The Quint 2 captain notified dispatch that a working fire was present in the basement and requested that the utility companies be notified. The fire fighter grabbed the nozzle and also pulled a 1 ¾" preconnected hand line as a backup line. Once the 2 ½" hoseline was charged, the Quint 2 captain and fire fighter could not drag the hose around the corner to enter the basement door so they began to advance the 1 ¾" hand line. Fire was blowing out the open doorway and extending up the side of the brick exterior wall 10 or 12 feet above the door. The Rescue 1 crew (captain and fire fighter) arrived on scene next at 0711 hours and provided assistance to the Quint 2 crew. The basement area under the ground level offices appeared to be fully involved and the crews had to knock down fire at the doorway in order to enter the basement. The Quint 2 crew was able to advance the 2 ½" hoseline into the basement backed up by the Rescue 1 crew with the 1 ¾" hoseline. The fire burning around the doorway burned through the 1 ¾" hand line less than a minute after the crews entered the basement (at approximately 0720 hours).

The Quint 2 captain radioed the Quint 2 engineer to shut down the 1 ¾" hose line. The Rescue 1 crew backed out and the Quint 2 engineer pulled a second 2 ½" hoseline down to the basement doorway and the Rescue 1 crew re-entered the basement with the 2 ½ inch hoseline. They advanced about 20-30 feet inside the basement. The second 2 ½" hoseline had a fog nozzle and the fog pattern did not have the desired effect on the fire. The fog pattern just pushed the fire around (did not knock down the fire) so they called for the Quint 2 engineer to bring them another 2 ½ inch hoseline with a smoothbore nozzle. The crew backed out, got the third 2 ½" hoseline and re-entered the basement again. They were able to advance the 2½" hoseline inside the basement a short distance (about 10-15 feet) into the training room located under the first-floor office area (see Diagram 3). The Rescue 1 captain radioed the IC that it appeared they had knocked down the fire in the basement. The ISO confirmed smoke was turning from grey to white in the basement indicating good steam conversion and also the smoke on first floor was beginning to turn.

While enroute, the Quint 1 crew heard the Quint 2 captain radio that the Quint 2 crew was connecting to the hydrant at the highway and would lay supply line to the front of the structure. The Quint 1 acting captain knew another hydrant was located near the A-B corner in front of the structure so Quint 1 proceeded to that hydrant. When Quint 1 arrived at the front of the structure, the captain observed that Quint 2 was blocking the hydrant he wanted to connect to. The Quint 1 acting captain instructed the acting engineer on where to position Quint 1 at the A-D corner. The Quint 1 acting captain and fire fighter then pulled a preconnected 1 ¾" hand line off Quint 2 and pulled it to the front entrance to the office area (A-side at ground level). The acting captain and fire fighter forced the front door open and entered the office area. *Note: The acting captain dropped his rope-bag at the front door while forcing it open. He carried the Quint 1 thermal imaging camera (TIC) inside.* They observed heavy smoke and moderate heat but did not observe any fire. Visibility was near-zero. The acting captain radioed the Incident Commander (IC) and reported the interior conditions.

The Quint 1 acting captain and fire fighter proceeded straight down the center hallway (deeper into the office area). They checked each office door with the TIC as they came to it, trying to locate the seat of the fire. They advanced about 50 feet down the hallway on their hands and knees. They began to feel heat transmitting thru the floor and the floor felt sticky to the touch (probably due to paint or lacquer on the floor being heated by the fire). At approximately 0725 hours, the Quint 1 acting captain radioed from inside the office area that fire had broken through the floor of an office to their left (on the B-side of the office area). Their hand line was hung up and they had to stretch out the hose to advance the nozzle into the office where they began to cool down the fire. *Note: The IC and command staff had previously considered venting the first floor but decided against it as they did not want to draw the fire up to the first floor. The original goal was to contain the fire to the basement.* After knocking down the fire in the office, they returned to the hallway and advanced to the end of the hallway. They observed heat in every office they checked, but only observed fire in the one office.

While enroute, the Quint 4 crew heard radio traffic from Quint 2 confirming the working fire and also radio traffic about approaching the structure from the street to the south-west of the structure. They connected to a hydrant located in front of a grocery distribution center located south of the millworks facility. The fire fighter dismounted Quint 4 at the hydrant and Quint 4 proceeded to position in front of the loading dock area (see Diagram 4) near the middle of the structure (A-side). The Quint 4 fire fighter connected the 5-inch supply line to the hydrant, charged the hydrant, and then walked to Quint 4 to meet his crew.

Squad 1 responded with two fire fighters (Victim # 1 and Victim # 2). They arrived on-scene and were assigned to ventilate the roof over the office area along with the engineer / operator from Quint 1. *Note: Per departmental SOPs, the Squad 1 crew and the engineer / operator from the first truck company form the roof ventilation crew.* The Quint 1 ladder was used to access the roof.

<u>Fireground Operations – 0726 hours to 0743 hours</u>

At 0726 hours, the IC ordered the roof crew off the office roof as fire had broken through a first floor window and was impinging upon the Quint 1 aerial ladder. Soon after, the Rescue 1 captain radioed the IC that the Rescue 1 crew was backing out of the basement due to high heat and deteriorating conditions. The Quint 2 crew also exited the basement. The crews worked their hoselines through the basement door from the outside for several minutes.

At 0727 hours, the IC requested a personnel accountability report (PAR) which confirmed accountability for all crews. At 0729 hours, the IC radioed to all crews that they were now in a defensive mode and were going to work to protect exposures. During this time period, the Quint 4 captain met with the IC and ISO face-to-face and discussed the conditions inside the loading dock / warehouse area. The ISO had just completed an interior size-up in the warehouse area and described a doorway leading into the office area. *Note: There were two doorways leading from the warehouse / production area to the office area. One was located near the front A-side wall. The other was located about halfway back (marked by red arrows on Diagram 4).* The Quint 4 captain was assigned to take a 2 ½" hose line inside the loading dock to protect the warehouse area. The Squad 1 crew (Victim # 1 and Victim # 2) who had come down from the roof were teamed up with the Quint 4 crew to assist with the hose line.

The Quint 1 crew backed out and changed out their SCBA cylinders. They observed heavy smoke outside that obscured their view of the apparatus in front of the structure when they got outside. After changing their air cylinders, the Quint 1 crew went around to the D-side of the office area to knock out windows in an attempt to release the heat and smoke. The IC asked the Quint 1 crew to go back inside the office area to pull ceiling and assess the need for vertical ventilation.

At approximately 0735 hours, the Quint 2 captain had a crew of three fire fighters from a mutual aid volunteer department assist his crew in pulling a 2 ½" hoseline from Quint 1 to the office area D-side basement door. They advanced the hoseline a short distance into the basement and began to knock down the fire burning at ceiling level. They encountered good conditions with good visibility and little heat. They lost pressure on the hose line so the Quint 2 captain went back outside and returned to Quint 1 to check on the water pressure. When water pressure was restored, the Quint 2 captain re-entered the basement through the D-side door.

The Quint 4 and Squad 1 crews donned their SCBA and pulled an uncharged 2 ½ inch preconnected hose line through the loading dock door into the warehouse area of the structure. The Quint 4 captain carried a thermal imaging camera (TIC). The Quint 4 fire fighter was instructed to bring extra sections of hose to the loading dock door and to stay outside until all hose connections were made and the line was charged. At approximately 0738, the Quint 4 captain radioed the IC that he was advancing the 2 ½" hose line into the warehouse with a crew of four. The crew tied a rope line to a bench on the loading dock before entering The Quint 4 captain and the Squad 1 crew went on-air as they entered the warehouse area. Visibility was good and no heat was detected. They made their way through the warehouse turning left past stacks of 4 X 8 sheets of laminated sheeting to advance toward the office area. The Quint 4 captain and the Squad 1 fire fighters (the two victims) advanced through a door into the office area while the Quint 4 fire fighter pulled slack through the warehouse and fed the hose for the crew. The Quint 4 fire fighter ran low on air and told the Squad 1 FF # 1 (Victim # 1) he was going outside to change his air cylinder (he could not see his captain at this point).

The crew forced opened the door to the office area and the captain used the TIC to check the offices and overhead areas for heat. The captain radioed for the hoseline to be charged as they advanced into the office area. They encountered grey smoke banked about halfway down from ceiling to floor and also could feel an increase in heat. At this point, the TIC was showing heat at floor level. The crew crawled forward on their hands and knees. The Quint 4 crew entered an office to their left to search for fire extension. The TIC indicated heat in a ceiling vent so water was flowed toward the ceiling vent. A pike pole was used to pull some ceiling tiles, but the crew did not observe any fire overhead.

The Quint 4 fire fighter reentered the warehouse after changing his air cylinder and followed the hoseline to his crew in the office area. The captain observed that both the Quint 4 fire fighter and the Squad 1 fire fighter # 2 (Victim # 2) were breathing heavily and consuming a lot of air. He talked to them about calming down and conserving their air supply. The Quint 4 fire fighter and Victim # 2 had to go outside, change their air cylinders (the second cylinder change for the Quint 4 fire fighter). When the two fire fighters went outside to change their air cylinders, the Quint 4 captain decided to stay with Victim # 1 in the office area while the other two went to change their air cylinders. The captain and Victim # 1 advanced and encountered the Quint 1 crew in the office hallway. The Quint 4 captain met the Quint 1 captain and gave his rope bag to the Quint 1 captain and asked him to tie off the rope outside the door (this established two escape routes for the Quint 4 crew – follow their hoseline or rope line back or the second rope line forward). The Quint 1 crew was low on air and had to go outside to change their SCBA air cylinders.

The Quint 3 crew relieved the Quint 2 crew at the B-side basement door. At approximately 0739 hours, the Rescue 1 and Quint 3 crews re-entered the basement after discussing the basement conditions with the IC.

0744 hours to 0843 hours

At approximately 0744 hours, the Incident Commander radioed the Rescue 1 captain and asked what would be needed to contain the fire to the basement area. The Rescue 1 captain requested to switch back to offensive operations to re-enter the basement area to get a better angle to flow water on the fire. *Note: The B-side basement doorway limited the angle at which water could be flowed into the basement from the exterior. Since this door actually faced the front of the structure, water was mainly being directed toward the front of the basement area below the offices (toward the A-side). Water could not be flowed directly toward the C-D corner and the D-side of the basement area (see Diagrams 1 – 3).*

At 0746 hours the ISO radioed the IC that he had talked with the Quint 1 and Rescue 1 captains and they were in agreement that the roof over the office should be re-evaluated to resume ventilation to vent the office to release smoke and heat building up inside. A crew of off-duty fire fighters who were called back for extra staffing was sent to the roof.

At 0754 hours, the Quint 2 crew pulled a second 2 ½" hoseline from Quint 1 and had it positioned at the basement door on the D-side for entry into the basement. They were unable to enter the basement because of the opposing hose stream from the Rescue 1 crew operating in the basement through the B-side door. A few minutes later, the Operations Chief synchronized the Quint 2 and Rescue 1 hoseline operations so that both crews could operate inside the basement.

At approximately 0756 hours, the IC and the ISO discussed over the radio that they believed the fire was contained to the office area of the structure with no extension into the rest of the facility. They discussed that the fire was deep-seated and difficult to extinguish, but they believed it was contained.

At approximately 0800 hours, the IC assigned mutual aid department Station 45 to report to the B-side with their engine to initiate Class-A foam operations in the basement.

After tying off the Quint 4 captain's rope line at the front entrance to the office area, the Quint 1 crew re-entered the front door and advanced down the hallway. They met the Quint 4 captain near the end of the hallway and discussed the interior conditions. They discussed the possibility of venting the roof overhead to release the smoke and heat that was building up inside the office area. The floor was beginning to feel spongy. They could hear the fire suppression operations going on in the basement beneath them and could feel the water streams hitting the floor beneath their feet. The Quint 4 captain radioed the IC and reported the interior conditions. The IC instructed them to start backing out. The Quint 4 captain took his crew (the Quint 4 and Squad 1 fire fighters had returned from changing their air cylinders) out the way they had entered, following their 2 ½" hoseline, while the Quint 1 crew returned to the front entrance of the office area. The Quint 4 crew backed out to the warehouse. The smoke in the accounting area was getting noticeably thicker (see Diagram 4). They had to crawl on their hands and knees until they backed out to the doorway and made the turn into the warehouse, then they were able to stand upright. They left their hoseline nozzle in the office area hallway and a large amount of hoseline slack at the door to the accounting area.

At approximately 0814 hours, the ISO attempted to contact the Quint 1 crew inside the office area but the radio transmission was garbled and no response was heard. The RIT 1 team was activated to find the Quint 1 crew. Shortly after entering the office area, the Quint 1 crew was found and the RIT 1 team radioed the IC that Quint 1 was okay. The IC radioed the ISO to pull everyone out of the structure and for all command officers to report to the command post to re-assess the fireground conditions. At 0816 hours, the IC called CODE RED[b] to signal all fire fighters to exit the structure. Roof ventilation operations were continued.

At approximately 0820 hours, Station 45 (mutual aid department) was positioned near the basement door on the B-side and water supply was established from Quint 2 using the 2 ½" hoseline with the fog nozzle that had previously been deployed to the basement door (as the supply line to the Station 45 engine). The Rescue 1 and Station 45 crews entered the basement through the B-side door and began foam operations. *Note: Offensive interior tactics to extinguish the fire were resumed but not formally announced over the radio.* Crews again entered the basement through the D-side door. Visibility was limited in the basement and heat was beginning to build up. The Quint 4 and Squad 1 crews (including the two victims) were assigned to relieve the Quint 2 crew in the basement so they proceeded to the office area when the captain remembered that he had left the TIC at the rehab area where they had changed out their air cylinders so the Quint 4 fire fighter went back to retrieve the TIC. The captain and two fire fighters from Squad 1 followed the hoseline to a door on the D-side of the office area that led into the basement. They were unable to make entry into the basement because the nozzle on the 2 ½" hoseline was inaccessible. The Quint 4 captain directed his crew to pull a 1 ¾" hand line from Quint 1 to the basement doorway.

At approximately 0831 hours, fire flared up in the office area and was visible from the outside through the B-side office windows. Following discussions about opening the office area floor to release the smoke and heat from the basement, the Operations Chief radioed the IC that the crews were again pulling out and going defensive. At 0833 hours, the IC radioed the ISO to activate the RIT team, make sure everyone was outside and conduct a PAR. The order to go defensive was given before the Quint 4 / Squad 1 crew could place the 1 ¾" hoseline into operation in the basement. At 0836, the IC radioed the ISO to put the Quint 1 and Quint 2 master streams into operation. The Operations Chief radioed that the roof ventilation crew was still in the process of removing their tools from the roof.

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[b] The fire department utilizes a standardized "CODE RED" system of notifying fireground personnel to imminent dangers requiring immediate withdrawal from a structure or hazardous area. Upon noticing any condition warranting emergency evacuation, a fire officer will announce the CODE RED via portable radio on the fireground channel. Fire fighters are trained to evacuate when a CODE RED is announced.

Command officers were again summoned to the command post for a face-to-face meeting to update the incident action plan and to review the facilities' pre-plan information (including the location of firewalls and doors) with the command staff and the building owner. *Note: A number of garbled radio communications are recorded on the fireground audio recordings. From approximately 0825 hours to 0845 hours, these garbled radio communications appeared to impact fireground communications.*

At approximately 0843 hours, the IC radioed "Division C" and discussed the fire conditions on the C-side. The IC stated that the main focus was to be defensive and that Quint 4 was going to "be the exposure truck to keep the fire out of the warehouse."

<u>0844 hours to 0915 hours</u>

The foam operation in the basement was shut down. Quint 1 and Quint 2 were repositioned for master stream operation over the office area (at the A-side). The IC radioed the Operations Chief to have another aerial ladder set up at the C-side. Ladder 64 in the staging area was designated to move to the C-side for master stream operation.

After returning to the rehab area, the Quint 4 captain discussed the fire suppression activities with the Operations Chief. They discussed the need to contain the fire to the office area and to protect the rest of the structure from fire spread. It was decided that the Quint 4 crew would return to the warehouse area and protect the masonry wall dividing the office area from the warehouse area.

The Quint 4 captain had everyone check their SCBA air cylinders and determined that everyone had at least 4000 psi remaining. The crew returned to the loading dock and followed the 2 ½" hoseline that they had previously left inside the warehouse. They followed the hoseline to the office door and turned left into the hallway. At this point, there was a lot of thick gray smoke but not a lot of heat in the office hallway. As they crawled down the hallway, they began to encounter heat on their left. The captain instructed Victim #1 to pull the hoseline back so they could reach the nozzle as he didn't want the crew to advance any further. The captain opened the nozzle and flowed water into an office to their left and then gave the nozzle to Victim #1 while he used the TIC to scan for the seat of the fire. At this point, he still could not detect any fire and water from their hoseline was dripping from the ceiling down onto them (indicating that there was no fire overhead as the water was not turning into steam).

At approximately 0853 hours, the Operations Chief attempted to radio the Quint 4 captain (inside the office area) multiple times without receiving a response. The Quint 2 engineer observed heavy fire blowing out the B-side window of the office and radioed the Incident Commander. At approximately 0857, the ISO attempted to radio the Quint 4 captain, without receiving a response. The ISO radioed the IC that the RIT Team was being activated to locate the Quint 4 / Squad 1 crew.

The Quint 4 fire fighter ran low on air and had to follow the hoseline through the warehouse to the outside. At this point, the captain heard someone attempting to radio him, but the message was unintelligible. The captain turned to Victim #1 and asked him to send Victim #2 outside to tell the ISO that the Quint 4 crew was okay. The Quint 4 captain and Victim #1 pulled the hoseline back to the warehouse doorway as the conditions were deteriorating in the office / accounting area with thickening dark smoke and increased heat (see Diagram # 5). *Note: The Quint 4 captain reported attempting to radio outside crews for assistance in pulling back the 2 ½" hoseline, but the request was not received or understood.*

When the Quint 4 fire fighter reached the outside, the ISO told him he needed to tell the captain to answer the radio. The Squad 1 fire fighter #2 (Victim #2) also followed the hoseline to the loading dock where he talked with the ISO about the interior conditions and location of the crew. Shortly after that, the Quint 4 captain heard a radio transmission telling the RIT team to stand down because Quint 4 was okay, so the captain knew that Victim #2 made it safely outside. At approximately 0900 hours, the ISO radioed the IC to tell him that he had face-to-face contact with one of the Quint 4 crew and that the crew was experiencing radio problems but they were okay. *NOTE: There were multiple garbled radio communications during this time period.*

After talking with the ISO, Victim #2 re-entered the warehouse to rejoin his crew. *Note: This was the last known location of Victim #2 and the investigation was unable to identify any information on his path back into the warehouse.* Soon after, the Quint 4 fire fighter re-entered the warehouse following the 2 ½" hose line. The ISO told the Quint 4 fire fighter to tell the captain that the fire was starting to work its way overhead.

At approximately 0902 hours, the crew operating in the basement radioed that they were going to lose the stairwell to the warehouse if they did not get water. *Note: Water to the 2 ½" hose lines deployed to the basement was shut down while Quint 1 and Quint 2 were repositioned for master stream operation. After the apparatus were repositioned, it is possible that not all the hose lines were immediately charged.* Soon after this radio transmission, the stairwell began to collapse, driving the hoseline crew out of the basement.

Soon after hearing the radio transmission for the RIT team to stand down, the captain heard Victim #1 yell that the fire was breaking out overhead. Almost immediately, Victim #1 yelled that the fire was all around them. The captain attempted to radio Mayday but he was not able to transmit outside. *Note: A review of the fireground audio transcripts showed a number of unintelligible radio transmissions during the time period 0900 hours to 0915 hours. Also, a number of fire fighters interviewed by NIOSH investigators reported observing fire race from one end of the structure to the other (B-side to D-side) in a matter of seconds at about this same time frame. Others reported thickening dense black smoke building up inside the warehouse area. The collapsing stairwell likely pushed ignition source(s) into the smoke-filled warehouse resulting in a rapid fire progression throughout the rest of the structure.*

The captain talked to Victim #1 to reassure him and attempted to pull some slack in the hose back to their position in the warehouse so they could use the nozzle to protect themselves. The captain told Victim #1 to follow the hoseline out and he would follow behind. After going some distance, Victim #1 told the captain he thought they were going the wrong way. They reversed direction and the captain followed Victim #1 back to the nozzle. The captain then told Victim #1 to stay in contact with him and he (the captain) would lead the way out. The captain again attempted to radio Mayday, but could not tell if anyone heard him or not. The captain and Victim #1 followed the hoseline to the loops of slack in the hoseline. At this point, the heat inside the warehouse was beginning to become unbearable. The captain told Victim #1 to stay calm while he sorted out the loops of hoseline. The captain did not observe the other two crew members in the area at this point. During this time period, the Quint 4 fire fighter reported he was only able to follow the hoseline a short distance into the warehouse before intense heat forced him to turn around and exit the warehouse. The Quint 4 fire fighter attempted to radio his captain but was unable to make contact. The Quint 4 fire fighter reported feeling intense heat on his left side as he tried to enter following the hoseline and feeling intense heat on his right side after turning around.

The captain yelled for Victim #1 to follow him, but did not get an answer. He yelled again and also attempted to radio Mayday again. The captain observed an orange glow all around him and felt intense heat as he began to crawl along the hoseline. He was not sure whether Victim # 1 was following him at this point or not. The captain crawled along the hoseline until he came to where the hoseline was leaking (about 30 feet from the loading dock door). He laid down on the leaking hoseline in an attempt to cool off and rolled over in an attempt to allow the leaking water to cool his back (see Photo 4 and Diagram # 4) . He attempted to radio another Mayday and heard a radio transmission deploying the RIT team into the warehouse. *Note: During this timeframe, several fire fighters working outside the structure reported seeing fire race throughout the structure, fully engulfing the structure in a matter of seconds.*

RIT Team Activities

A neighboring combination fire department (Department 62) had a standing mutual aid agreement with the municipal fire department to provide rapid intervention team (RIT) support at confirmed working fires within the city's jurisdiction. This department also provided mutual aid RIT support to a number of surrounding fire departments.

A four-person crew including the Chief of volunteer Department 62 responded to the structure fire. While enroute, they were told by the municipal Fire Chief to report to the A-side of the structure. They should have been dispatched on the second alarm but were not (due to an oversight). Another mutual aid department was designated as the RIT # 1 Team. Once on-scene, the Department 62 crew was designated as the RIT #2 Team and was assigned to the A-sector while the RIT # 1 Team was re-assigned to the C-sector. The Chief of Department 62 (RIT # 2 Chief) walked to the B-side of the office area and sized up the structure and the fire conditions. He walked back around the A-side to the

D-side of the office area and observed the basement door at the A-D corner (where the office area connected to the warehouse and production area) was locked and the glass window in the door was safety glass reinforced with wire mesh inside the glass. He reported this to the municipal Fire Chief and the RIT # 2 team was advised to go ahead and force open the door in case it was needed for entry or egress later. After forcing open the door and two adjoining windows, the RIT # 2 team continued their size-up and observed the 2 ½" hoseline being used by the Quint 4 crew running through the loading dock door. One of the RIT # 2 team members placed a metal garbage can under the open roll-up door to keep the doorway open in case the door should come down. The RIT # 2 team then returned to their staging area in front of the structure. *Note: The windows and door forced open by the RIT # 2 team provided an open path for fire to penetrate the common fire wall between the office and warehouse area. This provided a potential path for the fire to advance into the warehouse and production areas (see Photo 5).*

At approximately 0814 hours, command officers attempted to contact the Quint 1 crew that was operating inside the first floor of the office area via radio. The Quint 1 crew did not receive the radio transmission so they did not respond. The RIT # 1 team was activated and entered the front door of the office area. They soon encountered the Quint 1 crew and determined that the Quint 1 crew was okay.

At approximately 0853 - 0857 hours, command officers attempted to contact the Quint 4 crew who had gone back into the warehouse area to protect the masonry wall dividing the office area from the rest of the structure. The Quint 4 crew did not respond so the RIT # 2 team was activated and told to report to Quint 4. There they met with the ISO who reported that he had talked with Victim # 2 face-to-face at the loading dock and that the Quint 4 crew appeared to be okay. The RIT # 2 team was told to stand down so they returned to the staging area near the railroad tracks.

About 10 minutes later (approximately 0906), the RIT # 2 team heard a Mayday broadcast over the radio. The RIT team immediately proceeded to Quint 4, then to the loading dock and again met with the ISO. They observed the Quint 4 fire fighter (who had just exited the warehouse due to the extreme heat) at the loading dock. The RIT # 2 team asked for another hoseline to protect the RIT team and also another crew to open the loading dock door. *Note: By this time, the warehouse was full of fire but visibility was reportedly still good inside the warehouse. The heat and fire had caused the roll-up door at the loading dock to drop, which was now supported by the metal garbage can, leaving approximately 2 feet of space under the door to access the warehouse.* Two members of the RIT # 2 team immediately entered the warehouse by crawling under the loading dock door. They observed stacks of 4 X 8 foot laminated sheeting to the left of the loading dock door that were burning freely on top. They reported high heat, but it was not unbearable, so they continued to advance along the hoseline. The warehouse interior began getting darker and visibility decreased as they advanced into the warehouse. The RIT # 2 Chief and the other RIT team member waited a short time for the back-up hoseline, but one was not brought to the loading dock, so the RIT # 2 Chief crawled under the door into the warehouse. The first two RIT # 2 team members heard a PASS device sounding in front of them just after passing the stacks of burning laminate sheeting. They soon encountered the Quint 4 captain lying on the leaking hoseline. They also heard two other PASS devices sounding further inside the warehouse. One RIT # 2 team member (RIT captain # 1) immediately began dragging the Quint 4 captain outside while the other RIT # 2 team member (RIT captain # 2) advanced along the hoseline in the direction of the other sounding PASS devices. RIT captain # 2 had advanced only a few feet when the structure was rocked by an explosion and the heat inside the warehouse immediately intensified. He turned around, followed the hoseline back and helped RIT captain # 1 drag the injured Quint 4 captain outside. About the same time, the municipal Fire Chief came to the loading dock and ordered everyone outside. The RIT # 2 team was able to get the Quint 4 captain under the loading dock door and then crawled under themselves. As they assisted in getting the Quint 4 captain off the loading dock, they relayed the information about hearing other PASS devices. Both RIT team captain # 1 and captain # 2 suffered burn injuries to their hands and head, so they were sent back to the staging area for medical attention. The RIT # 2 Chief was also injured when he rolled under the door and rolled off the loading dock, dropping onto the ground.

The Rescue 1 crew (captain, engineer and fire fighter) were sent inside to search for the two missing fire fighters. They advanced along the hoseline to the point where the hose was leaking (where the captain had been found), but were driven back by intense heat and fire conditions in the warehouse.

Two additional attempts were made to follow the hoseline back inside the warehouse, but both attempts were stopped by the intense heat and fire conditions. Rescuers reported the water that was accumulating on the warehouse floor was near boiling hot. One last attempt was made by two municipal fire fighters (two off-duty captains) who were sent inside to search for the missing fire fighters. They encountered intense heat as they followed the 2 ½" hoseline inside the warehouse area. When they came to the area where the hose was leaking, they could hear a PASS device ahead and to the right. They advanced a short distance further and encountered Victim #1 laying face down. The victim was dragged by his SCBA shoulder straps back to the loading dock (approximately 40 feet) and taken outside. At this point, the smoke in the warehouse was beginning to clear out and visibility began to improve. Fire was burning freely throughout the warehouse and debris was beginning to fall from overhead. Victim #1 was transported by ambulance to the local trauma hospital but died shortly after.

Due to the deteriorating conditions, rescue attempts were halted. Hose lines were put into operation to protect the location where Victim #2 was believed to be. Victim #2 was located and removed at approximately 0945 hours. Victim #2 was transported to the local trauma hospital where he was pronounced dead.

CONTRIBUTING FACTORS

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

- Intermittent radio communication problems (unintelligible transmissions in and out of the fire structure) led to RIT teams being activated multiple times prior to the actual Mayday event and the potential misunderstanding of operational fireground communications at various points in the incident.
- Inadequate size-up and incomplete pre-plan information may have contributed to a misunderstanding in the location of the doorways connecting the warehouse to the office area.
- The deep-seated fire burning within the floor of the office area that was able to spread to the rest of the production and warehouse facilities. The concealed space between the basement ceiling and office floor contained solid wood floor joists representing a large concealed fuel load.
- The procedures used in which operational modes were repeatedly changed from offensive to defensive.
- Lack of crew integrity at a critical moment in the event.
- Weather conditions and the location of the command post contributed to poor visibility of the fire scene from the command and impacted accessibility of the command post by command and general staff.

CAUSE OF DEATH

The county medical examiner's office listed the cause of death for both victims as heat exposure and carbon monoxide poisoning.

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that detailed pre-incident plan information is collected and available when needed, especially in high risk structures.

Discussion: In this incident, arriving crews concentrated on the A and B-sides of the structure. The Incident Commander arrived on-scene, assumed command, established a stationary command post, obtained interior condition reports from company officers, and designated sector officers and an Operations Chief early into the incident. Pre-plan information was available and utilized by the fire department early into the incident as well. However, the pre-plan form did not contain detailed construction information or an accurate floor plan for the facility. Attempts were made to contain the fire to the office area but the deep-seated fire proved difficult to extinguish as the seat of the fire could not be reached. Masonry walls dividing the office area and separating the office area from the rest of the facility were thought to be fire walls and efforts were made to protect these walls. However, the firewalls and accurate locations of openings were not clearly identified on the pre-plan drawing.

National Fire Protection Association (NFPA) 1620 *Recommended Practice for Pre-Incident Planning, 2003 Edition*, § 4.4.1 states "the pre-incident plan should be the foundation for decision making during an emergency situation and provides important data that will assist the Incident Commander in developing appropriate strategies and tactics for managing the incident." This standard also states that "the primary purpose of a pre-incident plan is to help responding personnel effectively manage emergencies with available resources. Pre-incident planning involves evaluating the protection systems, building construction, contents, and operating procedures that can impact emergency operations." [5] A pre-incident plan identifies deviations from normal operations and can be complex and formal, or simply a notation about a particular problem such as the presence of flammable liquids, explosive hazards, modifications to structural building components, or structural damage from a previous fire. [5, 6, 7]

In addition, NFPA 1620 outlines the steps involved in developing, maintaining, and using a pre-incident plan by breaking the incident down into pre-, during- and post-incident phases. In the pre-incident phase, for example, it covers factors such as physical elements and site considerations, occupant considerations, protection systems and water supplies, hydrant locations, and special hazard considerations. Building characteristics including type of construction, materials used, occupancy, fuel load, roof and floor design, and unusual or distinguishing characteristics should be recorded, shared with other departments who provide mutual aid, and if possible, entered into the dispatcher's computer so that the information is readily available if an incident is reported at the noted address. Since many fire departments have tens and hundreds of thousands of structures within their jurisdiction, making it impossible to pre-plan them all, priority should be given to those having elevated or unusual fire hazards and life safety considerations. The structure involved in this incident was known to have a heavy fuel load and the fire department had conducted several pre-plan inspections in the past. If possible, fire departments should obtain engineering drawings or detailed floor plans to be made part of the pre-plan record.

Fire fighters and chief officers need to understand that fires in commercial structures are 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.[7]

Recommendation #2: Fire departments should limit interior offensive operations in well-involved structures that are not equipped with sprinkler systems and where there are no known civilians in need of rescue.

Discussion: In this incident, fire fighters were on-scene and engaged in fire suppression operations from 0710 to 0906 hours (1 hour and 56 minutes) prior to the first confirmed Mayday transmission. Fire suppression tactics were switched from offensive to defensive and back to offensive several times. Life safety of civilians was not a consideration in determining what strategy to use as fire fighters were not searching for occupants within the structure and the fire department conducted regular personal accountability reports (PAR) to account for all fire fighters on-scene. As noted earlier, fires in commercial structures are typically more dangerous than residential building fires.[7] 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.[8] In this incident, there were no indications of civilians in danger inside the commercial structure that was not required to be equipped with a sprinkler system.

Recommendation #3: 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. While it is recognized that fire fighting is dangerous and involves some risk, 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.[9] During this incident, the operational mode was changed from offensive to defensive and back to offensive several times, including changes made just minutes apart. In some instances, whenever actions were taken to switch the fireground operations to a defensive mode, various units requested to remain in an offensive mode. There were also instances in which orders to withdraw from the structure were not communicated to all units or coordinated with the operations chief. The book *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*[9] 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*, 2008 Edition,[10] Chapter 5.3.18 states "In situations where the risk to emergency services responders is excessive, as defined in 5.3.19, 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 Quint 4 / Squad 1 fire fighters were trapped by the rapidly deteriorating conditions inside the millwork facility, the intended strategy was to contain the fire to the office area and protect the production and warehouse areas. There was no life safety hazard (other than the fire fighters inside the warehouse area) and the fire had been burning for over two hours, resulting in substantial damage to the office area.

Recommendation #4: Fire departments should ensure that Rapid Intervention Crews (RIC) / Rapid Intervention Teams (RIT) have at least one charged hose line in place before entering hazardous environments for rescue operations.

Discussion: Charged hose lines are necessary to provide protection to RIT team members as they initiate search and rescue operations in burning structures. The RIT team must be ready to enter the burning structure at a moments notice for rescue operations.[1, 11] NFPA 1500 *Standard for a Fire Department Occupational Safety and Health Program*, Chapter 8, Section 8.8.2.1 states "each RIC shall be fully equipped with protective clothing, protective equipment, SCBA, and any specialized rescue equipment that could be needed given the specifics of the operation under way."[1]

In this incident, the RIT # 2 team members searched for and rescued the Quint 4 captain without a charged hoseline, and were injured in the process. A charged hoseline may have potentially facilitated searching for the two victims prior to retreating because of the intense heat and deteriorating conditions. The RIT # 2 Chief requested a back-up hand line and another crew to open the roll-up door that had dropped down and was resting on the garbage can (previously placed under the door in the event it came down). The backup hose line was not brought to the loading dock. As mentioned above, two of the RIT # 2 team members suffered burn injuries while removing the Quint 4 captain. It is good practice to pull a backup line whenever a hose line is put into operation so that the backup line is readily available if needed.

Recommendation #5: Fire departments should ensure that the incident commander establishes the incident command post in an area that provides a good visual view of the fire building and enhances overall fireground communication.

Discussion: The location of the command post should provide a vantage point from which to view the incident and that enhances communications between the incident commander and fire fighting forces.[10] Ideally, the command post location should provide the IC with the ability to observe fire conditions, building conditions, and the progress or lack of progress on containing and extinguishing the fire (i.e. changes in smoke color, density, velocity, changes in amount of fire, etc.) A good location would be in front of the fire structure with a view of the two most critical sides of the structure or the direction toward which a fire may spread.[12] However, the command post cannot always be located in a position to observe all of these factors. When the command post is located in less than an ideal location, the incident command structure must effectively communicate fireground conditions to the command post on a regular basis. The expansion of the Incident Management System, through the use of divisions and groups, aids the IC in managing the incident. The safety officer, operations chief, division and group leaders become additional "eyes" for the IC at the different fronts where they operate.[9, 10]

First arriving crews encountered a well-established and deep-seated basement fire and initially accessed the basement through a B-side basement door. The Incident Commander established the command post near the A-D corner of the 79,000 square foot commercial structure. This location provided a view of the front (A-side) of the structure, but the B-side was not visible (where most of the initial offensive operations were taking place). During the incident, heavy dark smoke banked down and covered the incident scene, due to changing weather conditions. This smoke severely restricted fireground visibility and forced pump operators to don SCBA while working around their apparatus, interfered with the designated fireground rehab area and forced the designated RIT Team to change their staging area in front of the structure. The IC's view of the fire structure was also partially blocked by a large tree in front of the loading dock, company vehicles and a semi-trailer parked at the loading dock, as well as the position of Quint 4. If the command post had been staged near the A-B corner or further upwind, a more comprehensive view of the fire structure and exposures may have been possible. However, active railroad tracks in front of the industrial park complicated the positioning of the command post.

The Incident Commander stayed in radio contact with the Incident Safety Officer, the Operations Chief and designated Sector Officers throughout the incident, but had limited visual contact with a large amount of on-going fireground operations. The changing fire suppression tactics employed as the incident escalated and crews were unable to reach the seat of the fire, along with the lack of visual oversight may have led to misunderstandings in locations dictated during operational assignments. For example, there were two access doors dividing the warehouse from the office area. The door closest to the office area was bypassed and access to the office area was made through the door that was furthest from the loading dock door. When rapidly deteriorating conditions caught the Quint 4 / Squad 1 crew off-guard, they had further to travel during their escape attempt to reach the outside.

Recommendation #6: Fire departments should ensure that crew integrity is maintained during fire suppression operations.

Discussion: Fire fighters should always work and remain in teams whenever they are operating in a hazardous environment.[13] Team continuity means team members knowing who is on their team and who is the team leader; team members staying within visual contact at all times (if visibility is low, teams must stay within touch or voice distance of each other); team members communicating needs and observations to the team leader; and, team members rotating together to rehabilitation, staging as a team, and watching out for each other (practicing a strong buddy system). Following these basic rules helps prevent serious injury or even death by providing personnel with the added safety net of fellow team members. Teams that enter a hazardous environment together should leave together to ensure that team continuity is maintained.[8, 10] In this incident, Victim #2 was sent outside to relay the message that the Quint 4 / Squad 1 crew was okay, since the Quint 4 captain was experiencing problems with his radio transmitting outside the structure. A safer action of the entire crew exiting the structure to report radio communication problems may have led to a different outcome in this incident. Another crew member exited on his own to change his air cylinder. Working alone increases the risk for individuals, and possibly to others during search and rescue efforts. Federal regulations [the OSHA 2-in-2-out rule, 29 CFR 1910.134 (g)(4)(i)] states "…at least two employees enter the immediately-dangerous-to-life-or-health (IDLH) atmosphere and remain in visual or voice contact with one another at all times."[11] NFPA 1500 *Standard for a Fire Department Occupational Safety and Health Program*, Chapter 8, Section 8.5.4 states Members operating in hazardous areas at emergency incidents shall operate in crews of two or more. [1]

Recommendation #7: Fire departments should encourage local building code authorities to adopt code requirements for automatic protection (sprinkler) systems in buildings with heavy fire loads.

Discussion: This recommendation focuses on fire prevention and minimizing the impact of a fire if one does start. The NFPA *Fire Protection Handbook* states "throughout history there have been building regulations for preventing fire and restricting its spread. Over the years these regulations have evolved into the codes and standards developed by committees concerned with fire protection. The requirements contained in building codes are generally based upon the known properties of materials, the hazards presented by various occupancies, and the lessons learned from previous experiences, such as fire and natural disasters."[14] Although municipalities have adopted specific codes and standards for the design and construction of buildings, structures erected prior to the enactment of these building laws may not be compliant. Such new and improved codes can improve the safety of existing structures.[14] Sprinkler systems are one example of a safety feature that can be retrofitted into older structures. Sprinkler systems can reduce fire fighter fatalities since such systems can contain and may even extinguish fires prior to the arrival of the fire department, thus reducing fire fighter exposure. The structure involved in this incident was a one-story commercial structure of ordinary construction with a partial basement containing approximately 79,000 square feet and housed a millwork facility that produced laminated cabinets, molding and wood trim products. The contents represented a heavy fire load. However, the structure was rebuilt in 1959, and was not required to have an automatic sprinkler system.

Recommendation #8: Manufacturers, equipment designers, and researchers should continue to develop and refine durable, easy-to-use radio systems to enhance verbal and radio communication in conjunction with properly worn SCBA.

Discussion: Recent testing of portable radios in simulated fire fighting environments by the National Institute for Standards and Technology (NIST) has identified that radios are vulnerable to exposures to elevated temperatures. Some degradation of radio performance was measured at elevated temperatures ranging from 100^{O}C to 260^{O}C, with the radios returning to normal function after cooling down. Additional research is needed in this area.[15, 16] Fire service radios also need to be waterproof as normal fireground conditions dictate that radios are frequently exposed to excessive amounts of water during routine use through exposure to hose streams, overspray, water dripping from overhead, etc.

The use of Personal Protective Equipment (PPE) and an SCBA make it difficult to communicate, with or without a radio.[16, 17] Faced with the difficult task of communicating while wearing an SCBA, fire fighters sometimes momentarily remove their face pieces to transmit a message directly or over a portable radio. Considering the toxic and oxygen-deficient hazards posed by a fire and the resulting products of combustion, removing the SCBA face piece, even briefly, is a dangerous practice that should be prohibited. Even small exposures to carbon monoxide and other toxic agents present during a fire can affect judgment and decision making abilities. To facilitate communication, equipment manufacturers have designed face piece-integrated microphones, intercom systems, throat mikes and bone mikes worn in the ear or on the forehead.[17, 18]

During this incident fire fighters experienced intermittent radio communication problems and interruptions. Audio transcripts of the fireground channel recorded multiple instances where fire fighters inside the structure (including the injured captain), attempted to transmit over the radio, but the transmissions were not heard or not understood. Garbled and unintelligible radio transmissions were recorded on Fireground Channel 2 throughout the incident with over 10% of the transmissions cut off and 30% unintelligible. During the critical time period from approximately 0825 hours until after the fatalities occurred, at least 125 of 420 radio transmissions were unintelligible. This time period coincides with the escalation of the fire, changing fire suppression tactics, and reduced visibility due to dense smoke banking down over the fireground. While it is unclear what caused the radio communication problems, effective radio communication is an important part of safe fireground operations.

Recommendation #9: Manufacturers, equipment designers, and researchers should conduct research into refining existing and developing new technologies to track the movement of fire fighters inside structures.

Discussion: Fire fighter fatalities often are the result of fire fighters becoming lost or disoriented on the fireground. The use of systems for locating lost or disoriented fire fighters could be instrumental in reducing the number of fire fighter deaths on the fireground. The National Institute for Standards and Technology (NIST) has been evaluating the feasibility of real-time fire fighter tracking and locator systems for some time.[15, 19] Research into refining existing systems and developing new technologies for tracking the movement of fire fighters on the fireground should continue. While it is not clear that the use of this technology in this incident would have prevented the fatalities, such technology could potentially have reduced the search time by aiding rescue teams in pin-pointing the location of the missing fire fighters. This new technology must function properly in the severe fire conditions often encountered during rescue operations.

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INVESTIGATOR INFORMATION

This investigation was conducted by Timothy Merinar, Safety Engineer, Matt Bowyer, General Engineer, and Jay Tarley, Occupational Safety and Health Specialist, with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research. Vance Kochenderfer, NIOSH Quality Assurance Specialist, National Personal Protective Technology Laboratory, conducted an evaluation of Victim # 1's self-contained breathing apparatus. This report was authored by Timothy Merinar. Steve Miles, Occupational Safety and Health Specialist with NIOSH and retired Battalion Chief of Safety with the Virginia Beach Fire Department, reviewed the fireground radio recordings and provided assistance in the development of the final recommendations. An expert technical review was conducted by I. David Daniels, Fire Chief / Emergency Services Administrator, Renton Washington, and member of the International Association of Fire Chiefs, Executive Board of Directors.

ADDITIONAL INFORMATION

For additional information on the events of this incident, refer to the fire department post incident report https://www.salisburync.gov/IncidentReport/Incident1.pdf

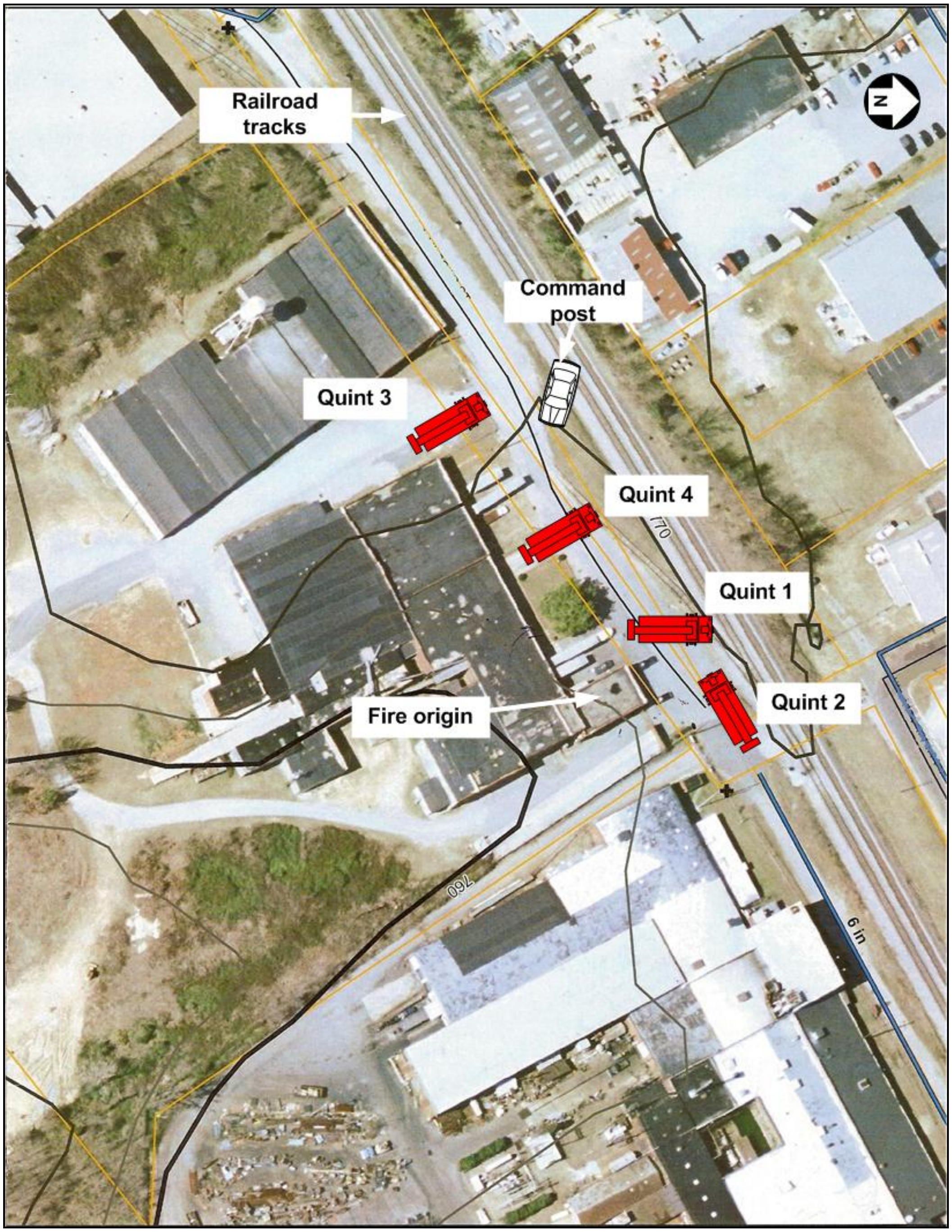

Diagram 1. Overhead view of incident site. Diagram adapted from aerial photograph taken in March 2006. Diagram not to scale.
***GIS aerial photograph provided by city water department*.**

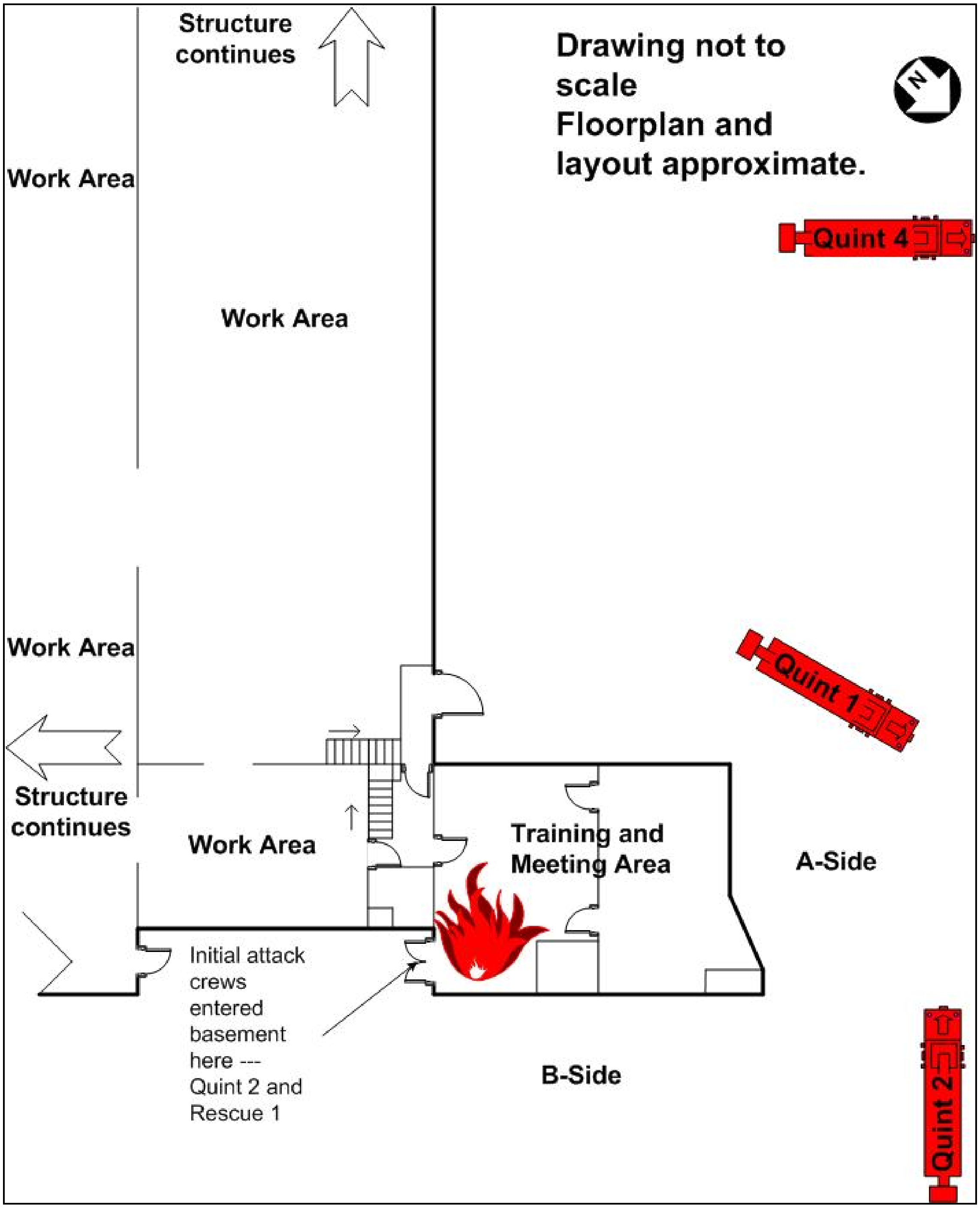

Diagram 2. Incomplete diagram of structure showing only the effected areas at the basement level of the A and B-sides

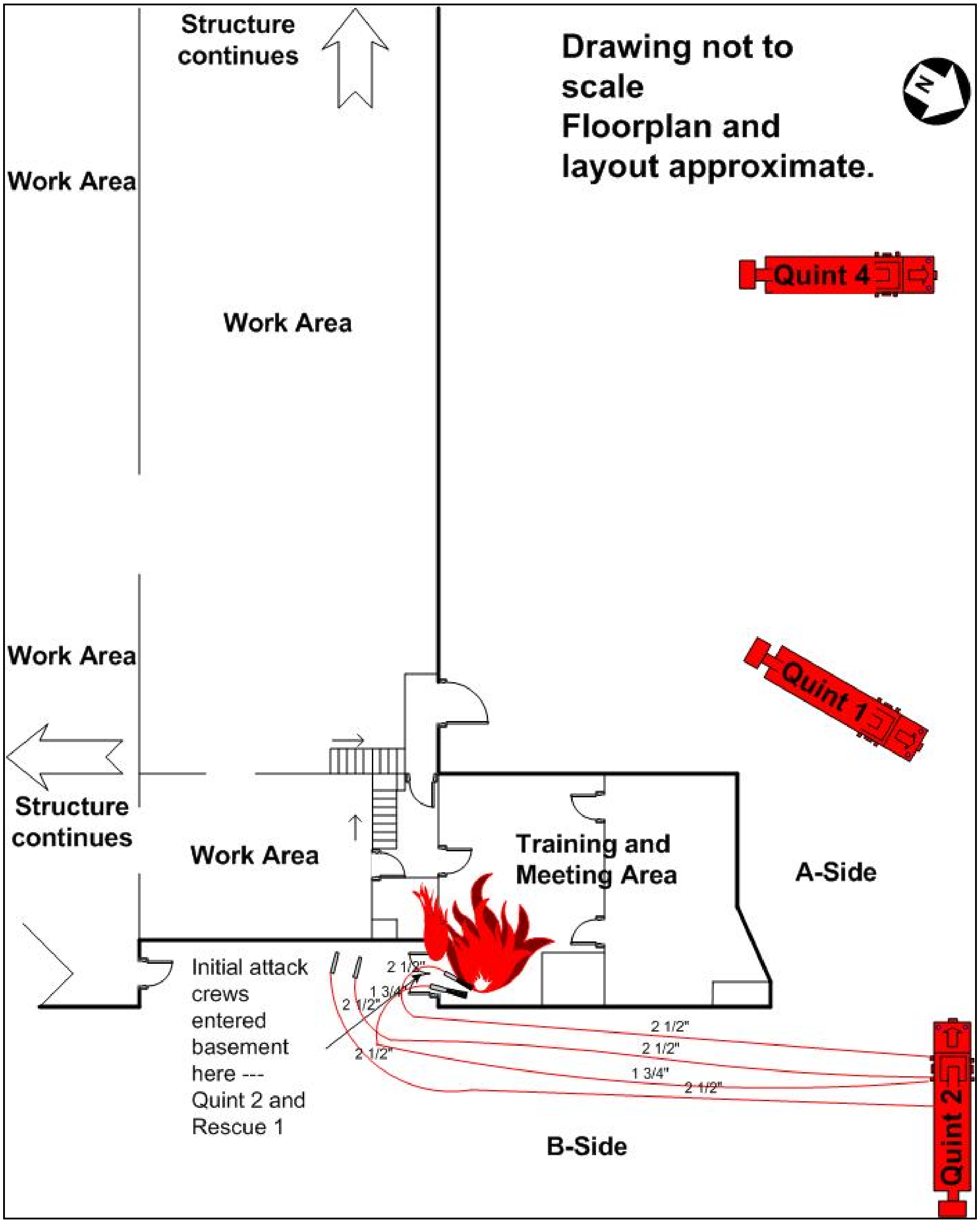

Diagram 3. Diagram shows location where initial attack lines were pulled from Quint 2 to the B-side basement door. Incomplete diagram of structure showing only the effected areas in the basement at the A and B-sides

Photo 1. Overhead view of office area. Front entrance (A-side) is at the upper left. Note steel I-beams that supported roof along with recessed pockets in masonry walls for joists.
Photo from ATF – provided by fire department

Photo 2. Photo shows an example of the limited visibility in front of the fire structure. Photo shows Quint 1 positioned near the A-D corner of the office area.
Photo provided by fire department.

Photo 3. B-side of millwork facility showing location of basement door. Time approximately 0830-0840 hours after Class A foam operations in basement had been suspended. Note that Quint 2 shown in background is not yet set up for master stream operation.
Photo from fire department

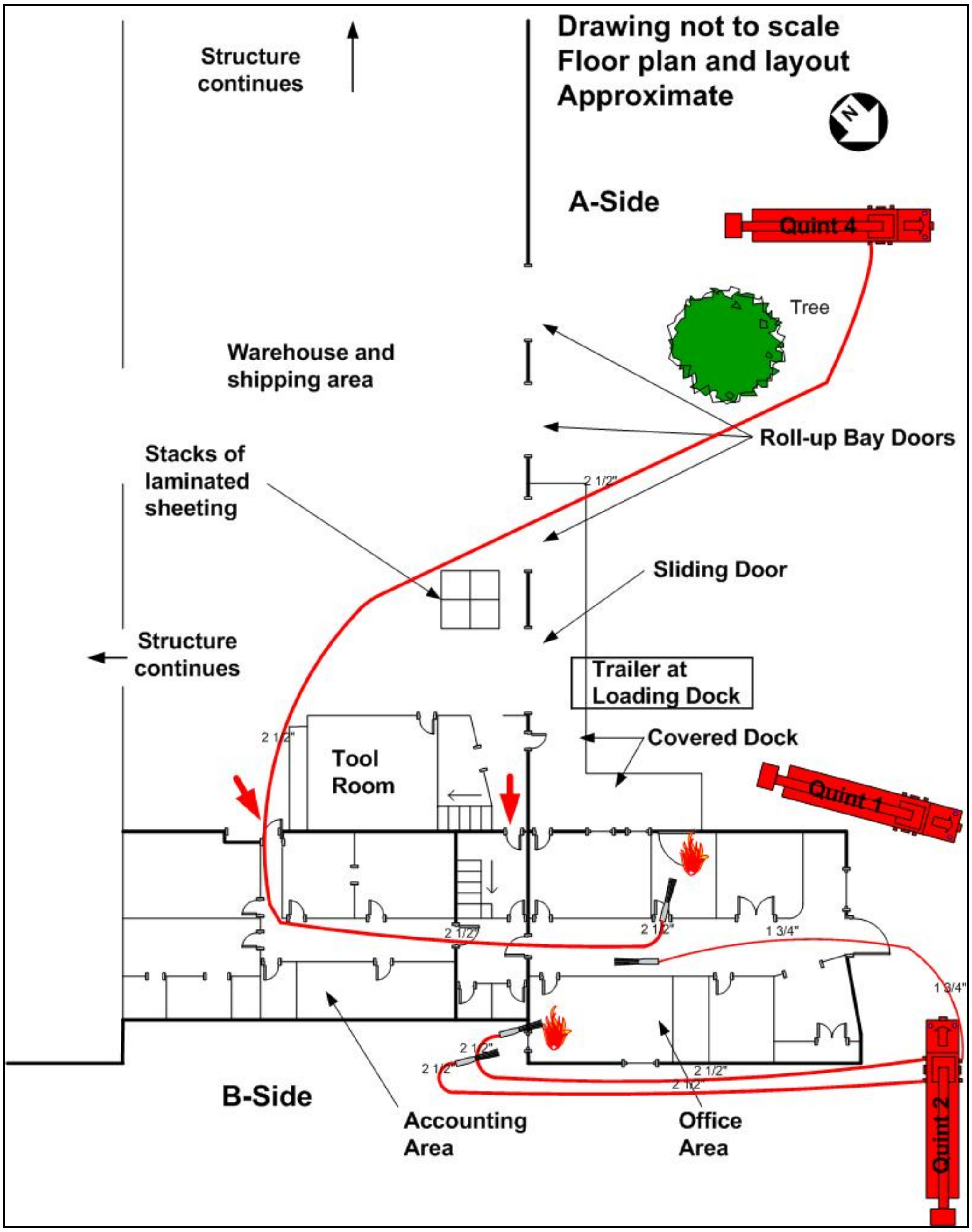

Diagram 4. Hoselines pulled by Quint 1 and Quint 4 Crews into ground floor. Diagram also shows 2 ½" hoselines pulled from Quint 2 to basement door on B-side. Bold lines indicate masonry firewalls. Red arrows indicate location of doors located between warehouse and office areas.

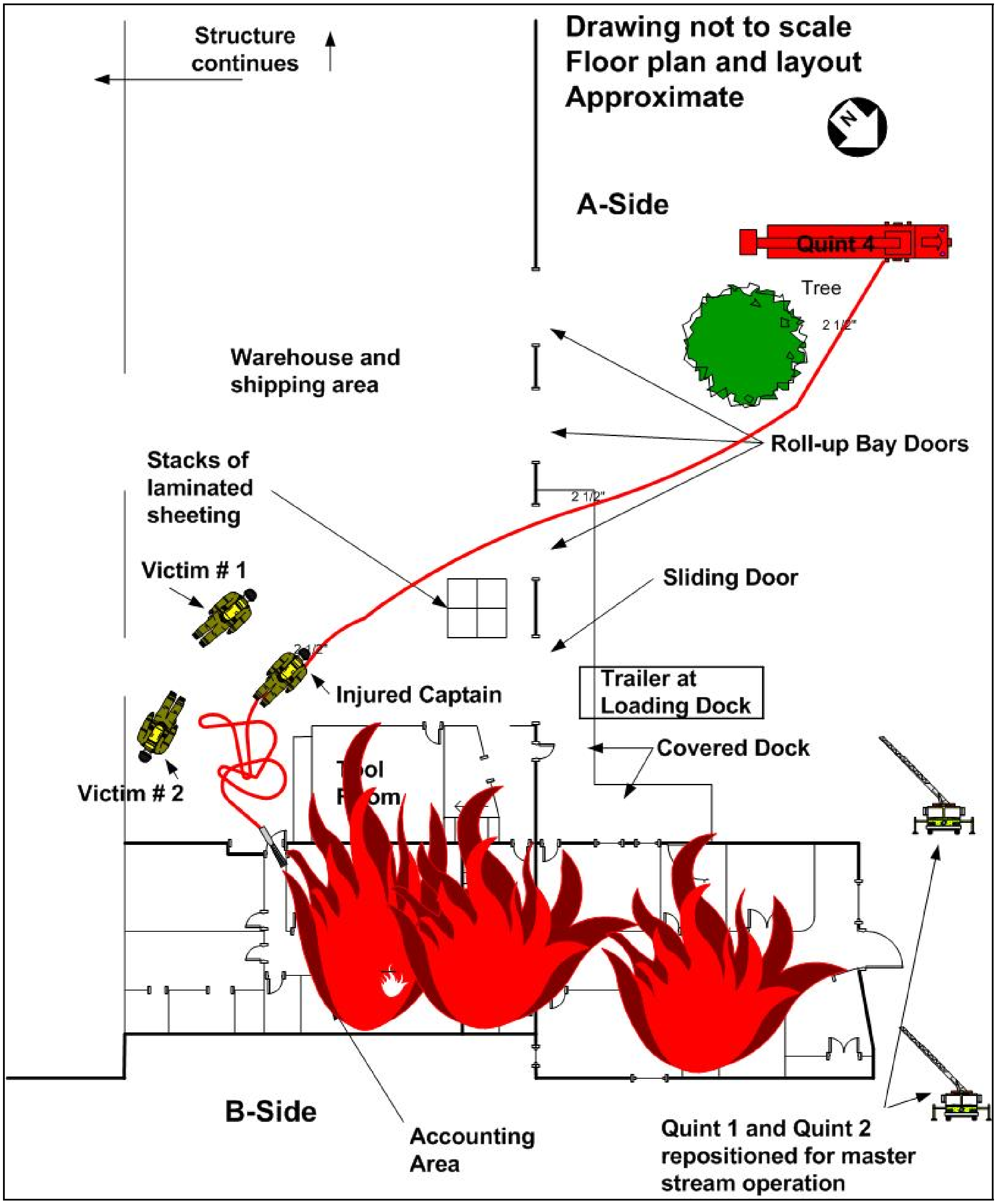

Diagram 5. Location of Quint 4 captain and Squad 1 fire fighters during and after Maydays Bold lines indicate masonry firewalls.

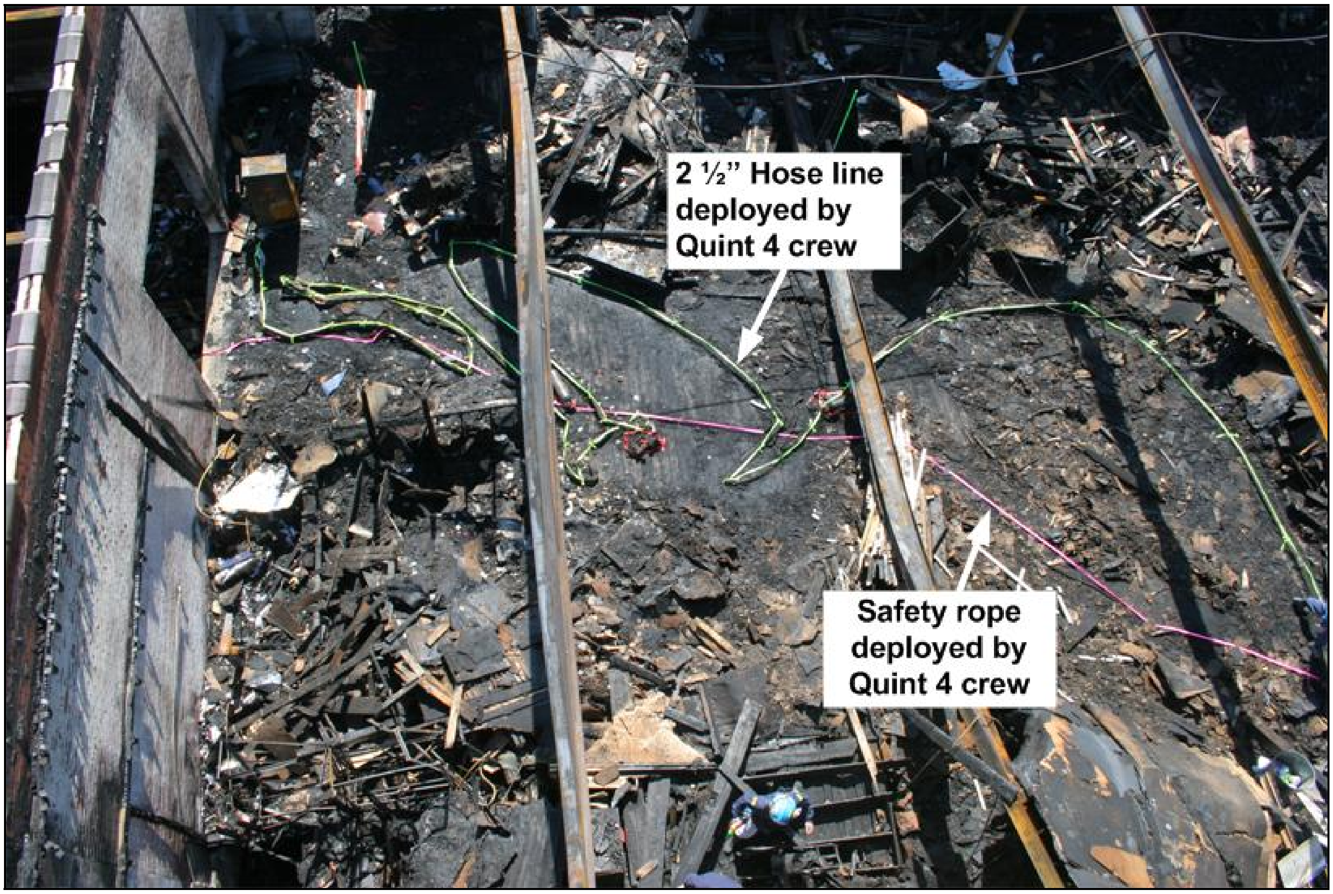

Photo 4. Overhead view of the area where the injured captain and two victims were located. The yellow line marks the location of the 2 ½" hose line following the incident. The pink line marks the location of safety rope deployed by the Quint 4 captain when the crew initially entered the office area through the warehouse.
Photo from ATF – provided by the fire department.

Photo 5. Photo shows basement door on A-D corner of office area where office area connects to the warehouse and loading dock. Also note the door and two windows in the D-side of the office area that were forced open by the RIT # 2 crew. Note the proximity to the window in the warehouse and the potential for flame spread from the office area to the warehouse area.
Photo from ATF – provided by fire department

Appendix I

Summary of Departmental Standard Operating Procedures for Structure Fires

The fire department standard operating procedures for confirmed structure fires:

- All stations are emptied – all on-duty fire fighters and all apparatus are dispatched.
- The first arriving Quint operates as an engine company. The officer and fire fighter pull the initial attack lines. The engineer works to establish water supply via 5" supply hose.
- The first arriving Quint is supported by the crew on Rescue 1.
- The second arriving Quint functions as a truck company.
- The second arriving Quint crew teams up with Squad 1 so that a minimum of 5 fire fighters are available for initial truck company operations. The Quint officer will take a fire fighter inside for search and rescue operations. The other 3 fire fighters will set ground ladders, secure utilities, perform vertical or horizontal ventilation and other outside truck company operations as needed.
- The third-arriving Quint crew functions as the second engine company. They help establish water supply, pull additional attack hose lines, back up the first attack line, etc.
- The fourth-arriving Quint functions as the second truck company. The crew usually goes inside and performs search and rescue operations or may assist as an additional hoseline crew.

Additional fire department SOPs are as follows:

- The initial arriving officer is the incident commander. The initial arriving officer conducts the initial size-up while water is being established.
- The Battalion Chief (BC) assumes command upon arrival and remains in command until relieved by a Division Chief.
- The on-duty Safety Officer responds and becomes the Incident Safety Officer (ISO). The ISO can go inside the structure to evaluate conditions.
- Each arriving company officer and the incident commander (IC) should get a 3-sided view of the structure upon arrival
- First due captain does an initial size up while water is being established.
- A typical operation would not advance an un-charged hoseline.
- All commercial and large structures should receive pre-plan inspections at least bi-annually to keep the pre-plan information up-to-date.

The incident commander can initiate call-back procedures when necessary to bring off-duty fire fighters for additional staffing needs when required.

APPENDIX II

Timeline

Note: This timeline is a summary of events that occurred as the incident evolved. Not all events are included in this timeline. The times are approximate and were obtained by studying the dispatch records, witness statements, and other available information. In some cases, the times are rounded to the nearest minute. The times listed in this report have been extrapolated from the electronic dispatch audio file records. The timeline is not intended, nor should it be used, as a formal record of events.

The response, listed in order of arrival (all times are approximate) and sentinel events, include:

- **0705 Hours:**
  911 dispatches the local municipal fire department for a structure fire at a local industrial park
  Central Station
  Quint 1 (acting captain, acting engineer / operator and fire fighter)
  Rescue 1 (captain, engineer / operator, fire fighter)
  Squad 1 (2 fire fighters - Victim # 1 and Victim # 2)
  Battalion Chief (BC-1)
  Safety Officer (ISO)
  Division Chief (DC-30)

  Station 2
  Quint 2 (captain, engineer / operator and fire fighter)

  Station 3
  Quint 3 (captain, engineer / operator and fire fighter)

  Station 4
  Quint 4 (captain – injured, engineer / operator and fire fighter)

- **0710 Hours:**
  Quint 2 on-scene, confirms working fire, begins first engine operations

- **0711 Hours:**
  Safety Officer (ISO) on-scene, begins safety operations
  Rescue 1 on-scene, assists Quint 2 crew

- **0712 Hours:**
  Battalion Chief 1 (BC-1) on-scene
  Quint 1 on-scene, begins first truck operations

- **0713 Hours:**
  BC-1 assumes Incident Command
  Quint 4 on-scene, begins second engine operations, lays second 5" supply line

- **0714 Hours:**
  BC-1 calls for second and third alarms

- **0715 Hours:**
  Quint 3 on-scene, begins second truck operations

- **0718 Hours:**
  Squad 1 crew (two victims) are assigned to ventilate roof over office area

- **0725 Hours:**
  Quint 1 interior crew advises Command that fire has broken thru the floor (in office area)

- **0726 Hours:**
  Rescue 1 radios Command that Quint 2 and Rescue 1 crews have backed out of the basement due to high heat. They have not been able to get to seat of the fire. Crews still attacking fire (flowing water) through basement door
  Squad 1 crew is ordered off the roof

- **0727 Hours:**
  Command calls for PAR[c]

- **0727 – 0728 Hours:**
  All crews report PAR. Quint 1 reports they are still interior on first floor of office area.

- **0729 Hours:**
  Command announces over radio that "We are in a defensive mode at this time; we're going to start protecting exposures."

- **0730 Hours:**
  On-call captain arrives on-scene, assigned Operations Chief by IC.

- **0733 Hours:**
  Quint 4 and Squad 1 crews advancing uncharged 2 ½" hose line through warehouse.

[c] PAR is the common acronym for Personnel Accountability Report.

- **0735 Hours:**
  Quint 2 and mutual aid crews advancing hose line into basement through D-side door

- **0738 Hours:**
  Quint 4 and Squad 1 crews have advanced into office area (interior)

- **0739 - 0740 Hours:**
  Quint 3 and Rescue 1 radio that they are entering basement
  Command radios for crews not to enter the involved area (transmission cut off)

- **0742 Hours:**
  Quint 3 and Rescue 1 radio there is still heavy fire involvement in basement (B-side door)
  Quint 4 captain radios for 2 ½" hose line to be charged – confirms water flowing

- **0744 Hours:**
  Command radios Rescue 1 and asks what is needed to contain fire in basement
  Rescue 1 requests to switch to interior offensive operations to enter basement a short distance to get better angle on the visible fire (enter through B-side door)

- **0746 Hours:**
  ISO radios Command that he has talked with Quint 1 and Rescue 1 captains face-to-face and they all agree the roof should be evaluated for the possibility of resuming roof ventilation operations to release smoke from the office area.

- **0748 Hours:**
  ISO attempts to contact both Quint 2 and Quint 4 captains. Radio transmissions garbled.

- **0751 - 0752 Hours:**
  Quint 1 crew re-enters ground floor office area
  Rescue 1 and Command discuss basement conditions over radio
  Quint 1 captain and ISO discuss first floor conditions over radio. ISO reports he is seeing clean white smoke that is not pushing.

- **0754 Hours:**
  Quint 2 has 2 ½" hoseline in place at basement door D-side: they cannot enter basement because of opposing hose stream from Rescue 1 on B-side. ISO discusses coordinating shutting down the Rescue 1 hoseline after Quint 2 crew changes air cylinders.

- **0756 Hours:**
  Command and ISO discuss over radio that they believe fire is contained to the office area with no extension to the rest of the facility. Fire is deep-seated in the basement but they believe it is contained.

- **0757 Hours:**
  Operations Chief heard on radio for first time. ISO radios for Operations and Operations Chief reports he is "getting an air tank"

- **0759 Hours:**
  Mutual aid crew sent to D-side basement door to assist Quint 2 with 2 ½" hose line for entry into basement

- **0800 - 0801 Hours:**
  Rescue 1 crew reports they are operating 2 – 2 ½" hose lines in basement on the B-side as Quint 3 crew has gone to change their air cylinders. Rescue 1 crew requests relief. Command radios that mutual aid 45 crew is on its way with Class A foam; should arrive in 15 minutes.

- **0808 Hours:**
  Fire flares up in first floor office area

- **0809 Hours:**
  Operations asks Command to activate RIT at front door of office area since Quint 1 crew cannot be contacted via radio.

- **0811 Hours:**
  Quint 4 captain radios Operations that crew of 4 (Quint 4 and Squad 1) are exiting the office area and that Quint 1 crew needs help with fire suppression in office area.

- **0814 Hours:**
  ISO attempts to contact Quint 1 captain (interior) via radio but transmissions are cut off so RIT is activated to find Quint 1 crew

- **0815 Hours:**
  RIT Team radios to Command that they have found Quint 1 crew and crew is OK
  Command radios ISO to pull everyone outside and for all command officers to meet at the command post to re-assess the fireground situation

- **0816 Hours:**
  Command calls CODE RED to signal all fire fighters to exit the structure

- **0817 Hours:**
  ISO radios to the Engine 3 crew located on the roof of office building, discusses the stability of the roof, and instructs the crew to continue with vertical ventilation activities
  2 ½ hose line running from Quint 2 to B-side basement door is shut down so that it can be used as a water supply line to feed the Station 45 engine located on the B-side for Class-A foam operation in basement.

- **0820 Hours:**
  Water supply is established to Engine 45 for foam operation in basement

- **0822 Hours:**
  Engine 3 crew on office roof calls for another K-12 saw – experiencing mechanical problems with the original saw

- **0823 - 0824 Hours:**
  IC radios Basement Division and asks for status of foam operation
  Rescue 1 and Engine 45 (crew of 3) make entry into basement through B-side door to begin foam operation
  IC radios for another PAR

- **0825 - 0829 Hours:**
  Much garbled radio communication
  IC radios for a report on the effectiveness of the foam (in the basement)
  Radio discussions about opening the floor in office area to ventilate the basement
  Crews on C-side of basement report lots of heat and low visibility in basement

- **0831 Hours:**
  Radio traffic to IC stating that flames have flared up in the office and are visible through the C-side, ground floor windows above where the basement crews are working
  Additional radio traffic to IC correcting the location of the flames to the B-side above the basement door

- **0832 Hours:**
  Operations Chief radios IC and requests a crew to go interior and open the floor in the office area to ventilate the basement
  Operations Chief radios IC and reports that “we just had a light off of the whole first floor on the rear of the structure” and crews are pulling out, going defensive

- **0833 Hours:**
  IC radios the ISO to activate the RIT, make sure everyone is out and take another PAR

- **0834 - 0835 Hours:**
  Crews confirm PAR
  Engine 3 crew reports they are exiting the roof

- **0836 Hours:**
  IC radios ISO to put aerial ladders in service for master stream operations.
  Operations Chief radios the IC that the Engine 3 crew is still on roof finishing ventilation cuts
  IC radios the ISO to get everyone off roof and out of the building
  Engine 3 radios the Operations Chief that they are exiting the roof

- **0837 – 0842 Hours:**
  Many garbled radio transmissions
  Operations Chief summoned to command post
  Engine 3 crew retrieving tools from roof at 0838 hours
  Quint 1 master stream put into operation at 0839 hours
  Quint 4 captain is summoned to command post

- **0843 Hours:**
  IC radios Division C and discusses conditions at C-side
  IC states the main focus is now defensive with Quint 4 to be exposure truck to keep fire out of the warehouse

- **0844 - 0850 Hours:**
  Engine 45 foam operation is shut down
  Quint 1 and Quint 2 are repositioned for master stream operation, shutting down water to 2 ½" hose lines in operation at basement door
  IC radios Operations Chief to have another aerial ladder set up at rear of structure (C-side)
  Ladder 64 in staging area is designated to be moved to rear of structure
  Quint 4 and Squad 1 crews (total of 4) go inside the warehouse following the 2 ½" hoseline they previously took inside to office area

- **0853 - 0856 Hours:**
  Operations Chief radios to Quint 4 captain multiple times – no response
  Quint 2 engineer radios IC that heavy fire is now coming out window on B-side of office
  IC radios Operations Chief and asks if he copies the report of fire coming out window

- **0857 Hours:**
  ISO radios for Quint 4 captain multiple times with no response
  Operations Chief radios RIT Team to report to Quint 4
  ISO radios IC that the RIT Team is being activated to locate the Quint 4 / Squad 1 crew

- **0857 - 0859 Hours:**
  Many garbled radio transmissions
  Quint 4 captain radios for Operations Chief
  Operations Chief radios IC and requests additional crews to pull additional hand lines for exposure protection

- **0900 – 0901 Hours:**
  ISO radios the Operations Chief and IC and tells them he has made face-to-face contact with the Quint 4 crew (probably Victim # 2) and that they are having radio problems
  Several garbled radio transmissions

- **0902 Hours:**
  Radio traffic from basement C-Sector about losing stairwell.

- **0903 Hours:**
  Several garbled radio transmissions
  Urgent radio request to C-Sector that water is needed (on hand line)

- **0904 Hours:**
  Broken transmission of fire fighter screaming over radio (through SCBA mask)

- **0905 – 0906 Hours:**
  Several more garbled radio transmissions
  ISO attempting to radio Quint 4 about 2 ½” hose line
  ISO attempting to radio Operations Chief

- **0906 Hours:**
  “Mayday, Mayday, Mayday, Quint 4”
  ISO radios all units to clear channel
  Quint 4 captain states the hose line has gone dead – repeats “Mayday, Mayday, Mayday”
  Someone asks for identification of unit calling Mayday
  Quint 4 captain replies – “Quint 4, we’re burning up”
  RIT # 2 Team is activated to find Quint 4 crew

- **0907 Hours:**
  Operations Chief radios IC that RIT Team is being activated
  RIT 2 Team confirms the activation
  Quint 4 radios – "I got fire overhead, I'm on the hose line but the hose line's gone dead"
  Fireground operations are switched to channel 3

- **0908 Hours:**
  More garbled radio transmissions

- **0909 Hours:**
  "RIT 2 back out, RIT 2 back out, charge the second line, 620 to RIT 2 back out"

- **0910 Hours:**
  ISO radios – "need EMS behind Quint 4, fire fighter down" as Quint 4 captain is brought outside
  Many garbled radio transmissions

- **0911 - 0913 Hours:**
  Several screams at 0911 hours
  Many garbled radio transmissions

- **0914 Hours:**
  RIT 1 directed to report to Quint 4

- **0915 - 0934 Hours:**
  Several garbled radio transmissions on Fireground Channel 2
  Victim # 1 located and extricated by off-duty captain at approximately 0933 hours
  Additional rescue attempts are suspended for fire suppression efforts

- **0936 Hours:**
  Deputy Chief takes another search crew into warehouse

- **0946 Hours:**
  Deputy Chief advises IC that Victim # 2 has been removed and structure is starting to collapse

Appendix III

Status Investigation Summary of One Self-Contained Breathing Apparatus NIOSH Task Number 15681

Background

As part of the ***National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program***, the Technology Evaluation Branch agreed to examine and evaluate one Scott Air-Pak Fifty 4.5, 4500 psi, 45-minute, self-contained breathing apparatus (SCBA).

This SCBA status investigation was assigned NIOSH Task Number 15681. The SCBA, sealed in a corrugated cardboard box, was delivered to the NIOSH facility in Bruceton, Pennsylvania on April 10, 2008. After its arrival, the sealed package was taken to the Firefighter SCBA Evaluation Lab (building 108) and stored under lock until the time of the evaluation.

SCBA Inspection

The package was opened and a complete visual inspection conducted on May 7, 2008. The SCBA was examined, component by component, in the condition as received to determine its conformance to the NIOSH-approved configuration. The visual inspection process was videotaped. The SCBA was identified as the Scott Air-Pak Fifty 4.5 model.

The SCBA is quite dirty and appears to have seen considerable wear and use overall but generally remains in good condition. The cylinder was required to be hydrostatically retested in December 2007, but no test marking is visible.

Personal Alert Safety System (PASS) Device

A Personal Alert Safety System (PASS) device was incorporated into the pneumatics of the SCBA. During the inspection, the PASS device was activated both manually and automatically. Although the unit appeared to function normally, it was not tested against the specific performance 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). Further testing was conducted to provide an indication of the SCBA's conformance to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services*, 2002 Edition.

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

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

National Fire Protection Association (NFPA) Tests (in accordance with NFPA 1981, 2002 Edition):

7. Air Flow Performance Test [Chapter 7, 7.1.1]

Testing was conducted on May 15 and August 8, 2008. All testing was videotaped with the exception of the Exhalation Resistance Test and Static Pressure Test. The SCBA failed to meet the requirements of the Remaining Service Life Indicator Test and NFPA Air Flow Performance Test; however, this was due to the erratic illumination of the heads-up display which may be the result of a damaged wire or similar electrical fault. Had the heads-up display remained lit throughout testing, the unit would have met the requirements of all tests.

Summary and Conclusions

An SCBA was submitted to NIOSH on April 10, 2008 for evaluation and inspected on May 7, 2008. The unit was identified as Scott Air-Pak Fifty 4.5, 4500 psi, 45-minute, SCBA (NIOSH approval number TC-13F-212). The unit was judged to be in a condition safe for testing. Testing was conducted on May 15 and August 8, 2008. As a result of erratic performance of the SCBA's heads-up display, it failed to meet the requirements of the Remaining Service Life Indicator Test and NFPA Air Flow Performance Test. No maintenance or repair work was performed on the unit at any time.

In light of the information obtained during this investigation, NIOSH has proposed no further action on its part at this time. Following inspection and testing, the SCBA was returned to the package in which it was shipped to NIOSH and placed in storage pending return.

If the SCBA is to be placed back in service, it must be repaired, tested, and inspected by a qualified service technician. The cylinder must be requalified by an authorized DOT retester before being refilled.