



Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

January 27, 2006

Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

SUMMARY

On March 13, 2004, a 55-year-old male career Battalion Chief (Victim #1) and a 51-year-old male career master fire fighter (Victim #2) were fatally injured during a structural collapse at a church fire. Victim #1 was acting as the Incident Safety Officer and Victim #2 was performing overhaul, extinguishing remaining hot spots inside the church vestibule when the bell tower collapsed on them and numerous other fire fighters. Twenty-three fire fighters injured during the collapse were transported to area hospitals. A backdraft occurred earlier in the incident that injured an additional six fire fighters. The collapse victims were extricated from the church vestibule several hours after the collapse. The victims were pronounced dead at the scene.

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

- *ensure that an assessment of the stability and safety of the structure is conducted before entering fire and water-damaged structures for overhaul operations*
- *establish and monitor a collapse zone to ensure that no activities take place within this area during overhaul operations*
- *ensure that the Incident Commander establishes the command post outside of the collapse zone*
- *train fire fighters to recognize conditions that forewarn of a backdraft*
- *ensure consistent use of personal alert safety system (PASS) devices during overhaul operations*
- *ensure that pre-incident planning is performed on structures containing unique features such as bell towers*



Church involved in the incident

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/fire/ or call toll free 1-800-35-NIOSH



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

- **ensure that Incident Commanders conduct a risk-versus-gain analysis prior to committing fire fighters to an interior operation, and continue to assess risk-versus-gain throughout the operation including overhaul**
- **develop standard operating guidelines (SOGs) to assign additional safety officers during complex incidents**
- **provide interior attack crews with thermal imaging cameras**

Additionally,

- **municipalities should enforce current building codes to improve the safety of occupants and fire fighters**

INTRODUCTION

On March 13, 2004, a 55-year-old male career Battalion Chief (Victim #1) and a 51-year-old male career master fire fighter (Victim #2) were fatally injured during a structural collapse of a bell tower following a church fire. Twenty-nine other fire fighters were injured during the incident. On March 14, 2004, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of these fatalities. On April 28, 2004, two occupational safety and health specialists and a safety engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program conducted an investigation into this incident. The NIOSH team met with the Chief of the department, Assistant Chief of Operations, and the department's arson investigator. The NIOSH team examined photographs of the fire ground, and reviewed witness statements and other documents. The incident site was visited and photographed by the NIOSH team. On May 17-19, 2004, three safety and occupational health specialists and a

safety engineer conducted further investigation into this incident. The NIOSH team met with officials of the department, representatives from the local International Association of Fire Fighters (IAFF), and interviewed fire fighters and officers involved in the incident. The team examined additional photographs of the fireground and reviewed additional witness statements and other pertinent documents including the department's investigative report.

Structure

The church was a National Historic Landmark that was built in 1875 (Diagram 1). The building was still in use as a house of worship and school at the time of this incident. The exterior construction was masonry with several courses of red brick covered with stone. The building foundation was approximately 120 x 70 feet and approximately 50 feet to the roof line. The pitched roof was covered with asphalt shingles and supported by heavy timber roof trusses. The stone façade exterior of the structure was added during a renovation in the 1930s. This renovation also included the addition of a 115 foot bell tower capped with four spires. The bell tower was not a stand-alone structure, but was supported by steel I-beams with a brick and stone façade that was connected into the southwest corner of the original church.

The church had four levels. The entry level or 'Cay Cee Level' had the main assembly area with a performance stage, a kitchen and two bathrooms. The top floor was the 'Sanctuary Level' which contained the pulpit, choir section, baptismal pool, and balcony. The basement or 'King Level' had several meeting rooms, three bathrooms, a computer room, a boiler room, and an electrical room. (*Note: An unfinished sub-basement was also present with three rooms*).



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

The church had an attached annex added to the eastern side of the original structure in 1994. The annex was approximately 60 x 45 feet in size and the three story addition contained an elevator that served the entire church. The annex was attached to the original structure via hallways on each floor with a central elevator shaft. On the first floor was a chapel, five offices and a bathroom. The second floor had nine meeting rooms. The third floor contained a fellowship hall, a kitchen and bathrooms.

The fire occurred on a Saturday morning as parishioners were preparing to have breakfast. The church staff noticed smoke coming from an electrical outlet. When the pastor went to investigate in the electrical room located in the basement, he found heavy smoke. Building occupants called 911 and reported an electrical fire. Building occupants had evacuated the church prior to the arrival of fire fighters.

The origin of the fire was in the basement ceiling located in the front southwest corner of the church within an electrical/computer room. The actual ignition mechanism of the fire was unable to be determined. The fire spread horizontally through the concealed space between the basement ceiling and first floor. The fire then spread vertically via concealed wall spaces to the structural members, framing and interior furnishings.

Department

The metropolitan department involved in this incident has 869 career fire fighters and operates out of 26 fire stations. The fire department serves a daytime population of approximately 653,000 and a nighttime population of 328,000, in a geographic area of 55.3 square miles. Each engine and truck company responds with a minimum of one officer and three fire fighters.

Training and Experience

Victim #1 had 31 years of experience as a career fire fighter and held the rank of Battalion Chief. He had extensive training which included ladders, aerial operations, tools and equipment, hose practices, driver training, ventilation, rope practices, incident command, communications, hydrant inspection, foam training, forcible entry, fire prevention inspections, extinguishers, hazardous materials at the operations level, rapid intervention team (RIT), engine company pump operations, and SCBA upgrade training.

Victim #2 had 30 years of experience as a career fire fighter and held the rank of master fire fighter. He also had extensive training which included ladders, aerial operations, tools and equipment, hose practices, driver training, ventilation, rope practices, incident command, communications, safety, hydrant inspection, foam training, forcible entry, fire prevention inspections, extinguishers, hazardous materials at the operations level, rapid intervention team (RIT), engine company pump operations, and SCBA upgrade training.

Although both victims had graduated from the department's training academy in the early 1970s, training records were only available from about 1985.

Equipment and Apparatus

There were approximately 70 fire fighters and 13 apparatus on scene during the 4th alarm response when the bell tower collapse occurred at 1213 hours. Additional units were dispatched in a 5th alarm; however, only those units directly involved in operations preceding the fatal events are discussed in the investigation section of this report.



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

The initial dispatch was at 0846 hours. Units and apparatus listed in order of arrival on the scene included:

First Alarm at 0846 Hours:

- Engine 4 (Officer and three fire fighters)
- Truck 4 (Officer, three fire fighters and volunteer ride-along fire fighter)
- Battalion Chief (Victim #1), initial Incident Commander (IC), via staff car
- Engine 5 (Officer and three fire fighters)
- Engine 10 (Officer and three fire fighters)
- Acting Battalion Chief as the initial Incident Safety Officer (ISO) via staff car
- Engine 6 as the Rapid Intervention Team (Officer and three fire fighters)
- Safety Unit (Officer and three fire fighters) via sport utility vehicle (SUV)
- Air Truck (one fire fighter)

Second Alarm at 0900 Hours:

- Deputy Chief as the IC via staff car
- Engine 11 (Officer and three fire fighters)
- Engine 12 (Officer and three fire fighters)
- Truck 14 (Officer and three fire fighters)

Third Alarm at 0911 Hours:

- Engine 18 (Officer and three fire fighters)
- Engine 3 (Officer, Victim #2, two fire fighters)
- Engine 29 (Officer and three fire fighters)
- Arson Investigators via two staff cars
- Assistant Chief via staff car

Fourth Alarm at 0931 Hours:

- Engine 24 (Officer and three fire fighters)
- Engine 32 (Officer and three fire fighters)
- Additional Arson Investigators via staff cars
- Captain as the Communications Officer via staff car
- Training Academy Battalion Chief as an additional ISO via staff car
- Chief via staff car

Fifth Alarm at 1214 Hours:

- Truck 6 (Officer and three fire fighters)
- Engine 22 (Officer and three fire fighters)
- Engine 21 (Officer and three fire fighters)
- Engine 8 (Officer and three fire fighters)
- Truck 33 (Officer and three fire fighters)

All fire fighters were equipped with a full array of bunker gear, portable radios and SCBAs with integrated personal alert safety system (PASS) devices.

Weather

At the time the fire occurred the weather was partly cloudy and cold with a temperature of approximately 25°F. During the fire, the wind was from the north-northwest and averaged 8-13 mph, with gusts of 22 mph.

INVESTIGATION

Activities of fire fighters during the 1st Alarm (0845-0900 hours)

At 0845 hours, an alarm was received for an electrical fire at a church. The 1st Alarm



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

assignment included three engine companies, a truck company, another engine company to serve as the RIT team, an acting Battalion Chief as the IC, a Battalion Chief as the Incident Safety Officer (ISO), a Mobile Air Truck used to fill SCBA air tanks and a Safety Unit that maintains command status and fire fighter accountability boards.

Victim #1, a Battalion Chief, was dispatched on the 1st alarm as the ISO and arrived on scene at 0850 hours via a staff car. Since Victim #1 arrived on scene prior to the arrival of the acting Battalion Chief, he assumed Incident Command.

Engine 4 (E4) was the first company on scene at 0850 hours. The apparatus was positioned in front of the church and the crew reported seeing light to moderate smoke inside the church. The church pastor told the crew that the building had been evacuated and that the smoke was coming from the electrical room in the basement. The crew advanced a 1 ¾-in hand line through the front southeast entrance and down the stairs to the basement. Once in the basement, the crew was met with intense heat and thick black smoke. The crew could not see any flame but heard crackling sounds that they localized to the ceiling above them. The crew then attempted to open the ceiling, but heavy plaster and lathe construction hindered their efforts.

Truck 4 (T4) also arrived on scene at 0850 hours and positioned the apparatus in the parking lot. The crew was preparing to raise the aerial ladder to the roof and begin ventilation when the IC ordered them to open the floor on the first floor above the fire. Once on the first floor, the crew started using a chainsaw and immediately began to experience problems with the saw stalling. (*Note: It is believed that the interior smoke conditions and a lack of oxygen caused the gas-*

powered saw to stall out rendering it unusable.) The crew switched to axes and started chopping the floor. The E4 crew could hear the axe strikes above them from the basement below.

Engine 5 (E5) arrived on scene at 0851 hours and established water supply to E4. The crew advanced another 1 ¾-in hand line to the basement to back up the E4 crew. Engine 10 (E10) arrived on scene at 0852 hours and established a second water supply. The crew advanced a 1 ¾-in hand line to the first floor to back up the T4 crew and assisted in opening the floor. Both crews experienced heavy smoke conditions upon entering the church.

The acting Battalion Chief arrived on scene at 0854 hours and was briefed by Victim #1. (*Note: The acting Battalion Chief was originally dispatched as the Incident Commander.*) After conferring with Victim #1, the acting Battalion Chief assumed the role of ISO and Victim #1 remained in command as IC.

Engine 6 (E6) arrived on scene at 0854 hours and the crew acting as the RIT team assembled in front of the church along with their equipment.

Activities of fire fighters during the 2nd Alarm (0900-0911 hours)

A 2nd Alarm was requested for additional manpower by Victim #1 at 0900 hours and the assignment included two engine companies, a truck company and the Deputy Chief.

Prior to the 2nd Alarm being dispatched, the Deputy Chief was already en-route and upon arrival at 0900 hours conducted a size-up and was briefed by Officers. The Deputy Chief assumed IC while the Acting Battalion Chief became the Operations Chief and Victim #1 became the ISO.



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

(Note: Although department SOPs call for the Assistant Chief to assume command on the 3rd Alarm and the Chief to assume command on the 4th Alarm, this current command structure was maintained until the fatal events occurred during the collapse.)

Engine 11 (E11) arrived at 0902 hours and reported to command for assignment. The IC ordered the crew to the basement to make entry to the electrical room from the stairs in the southwest corner. Prior to making entry, the crew had to force the door and they ventilated a small basement window at ground level. The crew noted that the smoke that came out the window was an unusual dark yellow color and "did not look right." The crew then entered the church and vented another basement window while searching for the stairwell to the basement.

Engine 12 (E12) arrived at 0907 hours and the crew was ordered to back-up the E4 and E5 crews already operating in the basement. The crew followed the hoseline down the stairs into the basement. Once in the basement, the crew began to search for the seat of the fire. The E4 crew soon withdrew from the basement to change their SCBA tanks. The truck company (T4) operating above on the first floor began to break through the floor, exposing fire to the crew operating below. The E12 crew began to apply water to the fire with the handline that E4 had advanced.

Activities of fire fighters during the 3rd Alarm (0911-0931 hours)

A 3rd Alarm was requested by the IC at 0911 hours and the assignment included three additional engine companies and the Assistant Chief. Since the exact seat of the fire was still not located, the IC made a special request for Engine 29 (E29) to bring a thermal imaging camera (TIC) to the

scene. *(Note: At the time of this incident, the department had only one TIC, a unit that was on loan from the manufacturer.)*

Truck 14 (dispatched on the 2nd Alarm) arrived at 0914 hours. They reported to command and were ordered to assist T4 operating on the first floor.

Engine 18 (E18) arrived on scene at 0914 hours and reported to command. The crew was ordered to ventilate the church. Based on the volume of smoke, the IC ordered horizontal ventilation through the first floor windows. *(Note: The large stained glass windows were covered with thick plexiglass, which served to protect the glass from vandals. The plexiglass hampered ventilation efforts. The plexiglass was fastened to the window frame perimeter with Phillips screws and fire fighters did not have a power screwdriver to remove the protective covering).* The company later operated a hand line from the street applying water on the western exterior side of the church.

Engine 3 (E3) arrived on scene at 0917 hours with Victim #2. The crew reported to command and was ordered to establish water supply on the western side of the church. The crew experienced a water supply problem with the hydrant from gravel that blocked the pump inlet screen. The crew quickly cleared the blockage and water supply was established. The E3 crew set up and operated their master stream appliance and operated a 2 ½-in hand line on the western exterior for about three hours.

At 0919 hours (approximately 30 minutes into the incident), the IC called for an evacuation and an accountability check based on the deteriorating interior conditions. All firefighters on the interior attack crews reported outside to the Safety Unit for the accountability check. After all personnel



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

were accounted for at 0925 hours, the IC continued the interior attack with crews located in the basement and on the first floor.

The E12 Officer reported to command that they had located the fire in the basement prior to the accountability check; they were ordered to continue fire suppression with E4 acting as back-up. Both crews re-entered the basement and began to extinguish the fire. The E12 Officer reported that soon after they began to spray water, the basement went "black, totally black, like the fire left." He immediately yelled for everyone to back out. Some fire fighters reported hearing a "big, loud whistle" followed by a bang.

At 0928 hours, a major backdraft occurred that injured six fire fighters. The E4 Officer who was standing at the top of the stairwell was blown out of the building into the street by the force of the backdraft. The E4 Officer suffered bruises and facial burns. The E12 crew in the basement was beginning to back out when roaring fire rolled over top of them knocking them down. They quickly climbed the steps and exited the church with their bunker gear smoldering. The E12 Officer received burns on his back, hands and face; an E12 fire fighter received hand and facial burns and another E12 fire fighter received facial burns. The E11 Officer and E11 fire fighter were venting windows from a ground ladder against the wall on the western exterior when they saw that smoke was puffing in and out of the windows. They heard a load roar and started to run, but the force of the backdraft blew them across the street. The E11 Officer suffered a broken wrist and the fire fighter was slightly injured.

Fire fighters immediately began administering first aid to the injured and the IC ordered an evacuation and accountability check. The

accountability check was quickly conducted by the Safety Unit and all fire fighters were accounted for by 0929 hours. Five of the injured fire fighters were transported by ambulance to a metropolitan trauma/burn center; the E11 fire fighter was treated on the scene. (*Note: The five transported fire fighters were treated and later released from the emergency department.*)

Fire fighters from Truck 14 did not reenter the church but were ordered to set up a positive pressure ventilation fan in a window in the front of the church. (*Note: This task was not completed prior to the backdraft.*)

E29 arrived on scene at 0927 hours just prior to the backdraft. The IC had the crew on standby for approximately 15-20 minutes after the evacuation and accountability check. The crew attempted to take the TIC to the basement to locate the fire, but they were backed out when the IC had E29 reposition their apparatus to help E3 with their water supply problems. The crew then operated a 1 ¾-in hand line in the rear of the structure for about 2 hours.

Activities of fire fighters during the 4th Alarm (0931-1214 hours)

A 4th Alarm was requested by the IC at 0931 hours and the assignment included two additional engine companies, the Chief, a Communications Officer, and another Battalion Chief as an additional ISO.

Engine 24 (E24) arrived on scene at 0938 hours and established water supply to E10. They advanced a 1 ¾-in hand line into the church annex to check for fire extension. Engine 32 (E32) arrived at approximately the same time and set up a master stream appliance in the church



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

parking lot on the eastern side. This appliance was in operation for the duration of defensive operations that followed.

The Training Academy Battalion Chief (TABC) arrived on scene at 0944 hours, reported to the IC, and was assigned to gather information on the fire fighters injured in the backdraft. After determining the status of the injured fire fighters and collecting their gear for later impoundment because of the injuries sustained during the backdraft, the TABC met with Victim #1 to discuss fire ground safety. They decided to sector the fire ground into two zones. Victim #1 would act as the ISO in the northeast sector while the TABC would act in the southwest sector. For the next several hours, both ISOs were working their sectors and updating the IC with progress reports.

At 0948 hours (approximately 1 hour into the incident), heavy smoke was reported throughout the church and the IC changed tactics to a defensive attack and removed all personnel from the building. Numerous master steam appliances and hand lines were operated from all exposure sides in an attempt to extinguish the fire in the church and protect the annex.

At 0949 hours, fire was present throughout the western side of the church. At 1007 hours, heavy black smoke was observed in the eastern side and at 1009 hours, fire was breaking through the roof (Photo 1). At 1031 hours, there was heavy fire throughout the church and at 1048 hours (approximately 2 hours into the incident), the roof was completely burnt away and companies were continuing with "surround and drown" operations (Photo 2).

At 1148 hours, the IC ordered all exterior hose streams shut down (Photo 3). One ISO left the

immediate scene as instructed by the Assistant Chief to impound the fire gear of the fire fighters injured in the back draft. The IC met with company officers and discussed overhaul operations to extinguish the remaining pockets of fire. (*Note: It is unclear as to who was involved in this meeting; no radio transmissions were reported as to the updated action plan.*) Victim #1 went to the front entrance vestibule where fire fighters were setting up stationary hoselines to douse pockets of fire still burning in the debris; however, it remains unclear who assigned Victim #1 to this task as it was never transmitted by radio. The IC used the TIC to determine the location of the hot spots. Victim #1 was ensuring that fire fighters did not fall through a hole in the floor and Victim #2 was manning a 1 ¾-in hand line.

The crews from E24 and E32 were ordered to make entry into the annex to check for fire extension. They advanced 2 ½-in and 1 ¾-in hand lines to the third floor of the annex then proceeded into the second floor sanctuary of the church. E24 was extinguishing the burning roofing debris on the pews within the sanctuary and E32 was extinguishing fire on the collapsed balcony.

At 1213 hours (approximately 3½ hours into the incident), the church bell tower collapsed sending large chunks of stone, brick, heavy wooden timbers, and other debris crashing through the vestibule trapping both victims under debris. (*Note: At the time of the collapse Victim #1 was not wearing a SCBA and therefore did not have an activated PASS device.*) Other fire fighters operating in the vestibule recall that heavy timbers and wood boards broke through the ceiling and then the entire ceiling came down. Several fire fighters reported narrowly escaping from the collapse.



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

Fire fighters standing outside of the church were showered with falling debris that injured numerous fire fighters. The IC recalled looking up as the collapse occurred, and was hit in the face with falling stone and severely injured. At this point in the incident, command suffered a serious lapse with the IC and numerous officers incapacitated. E24 and E32 fire fighters on the second floor of the church were operating their hand lines when the bell tower collapsed (Photo 4). The collapse caused some of the heavy timber roof trusses to fail. Falling roof trusses struck several fire fighters and one fire fighter became trapped. The fire fighters made an urgent radio transmission for assistance and requested rescue equipment. Their call went unanswered due to command being incapacitated.

Activities of fire fighters during the 5th Alarm

At 1214 hours, an arson Officer radioed to dispatch that a major collapse had occurred and requested a 5th alarm for additional manpower to assist with rescue efforts. The 5th alarm assignment included three additional engines and two additional truck companies. Fire fighters immediately began administering first aid and transporting injured fire fighters to ambulances. Upon hearing of the collapse over the radio, the other ISO returned to the immediate scene from impounding the fire gear from injured fire fighters. The ISO, assisted by an officer of the Safety Unit, conducted an accountability check a short time after the collapse and verified that Victim #1 and Victim #2 were missing. Twenty three fire fighters were injured during the collapse and transported to area hospitals.

Fire fighters could hear a PASS alarm but were unable to extricate the victims from the large amount of debris trapping them. (*Note: The alarm that fire fighters heard was from Victim*

#2's integrated SCBA PASS alarm). The severe magnitude of the collapse prompted the activation of an Urban Search and Rescue (USAR) team that arrived on scene at 1520 hours. The USAR team consisted of two strike teams and a building structural specialist. The team monitored the stability of the remaining church structure to detect any potential secondary collapses. Fire fighters on scene in conjunction with the USAR team extricated both victims by 1700 hours. The victims were pronounced dead at the scene.

CAUSE OF DEATH

The county coroner's office report listed the cause of death of Victim #1 as asphyxiation due to compression of the body by building debris. Blunt force trauma of the head, neck, pelvis and extremities were contributory causes of death.

The county coroner's office report listed the cause of death of Victim #2 as asphyxiation due to compression of the body by building debris with blunt force trauma of the head and extremities.

RECOMMENDATIONS AND DISCUSSION

Recommendation #1: Fire departments should ensure that an assessment of the stability and safety of the structure is conducted before entering fire and water-damaged structures for overhaul operations.

Discussion: Due to the destructive powers of fire, most structures that have been involved in fires are structurally weakened. In this incident, the structural integrity of the bell tower was weakened by a fire of several hours duration, the addition of thousands of gallons of water, and possibly the destructive effect of the backdraft. Analysis of the exterior of the structure should be performed continuously while conducting interior operations. Similarly, before overhaul operations are begun, the structure should be determined



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

safe to work in by the IC and a designated Safety Officer. If necessary, the IC should seek the help of qualified structural experts or other competent persons to assess the need for the removal of dangerously weakened construction, or should make provisions for shoring up load-bearing walls, floors, ceilings, roofs, or as in this case, the bell tower.¹

Recommendation #2: Fire departments should establish and monitor a collapse zone to ensure that no activities take place within this area during overhaul operations.

Discussion: During fire operations, two rules exist about structural collapse: (1) the potential for structural failure always exists during and after a fire, and (2) a collapse danger zone must be established. A defensive attack was declared within an hour after fire suppression activities began. Part of a defensive strategy is establishing and moving fire fighters outside of the collapse zone.¹⁻⁴ A collapse zone is an area around and away from a structure in which debris might land if a structure fails. Immediate safety precautions must be taken if factors indicate the potential for a building collapse. All persons operating inside the structure must be evacuated immediately and a collapse zone should be established around the perimeter. The collapse zone area should be equal to the height of the building plus an additional allowance for debris scatter and at a minimum should be equal to 1½ times the height of the building. For example, since the bell tower was 115 feet high, the collapse zone boundary should be established at least 173 feet away from the church. Once a collapse zone has been established, the area should be clearly marked and monitored, to make certain that no fire fighters enter the danger zone.

Recommendation #3: Fire departments should ensure that the Incident Commander establishes the command post outside of the collapse zone.

In this incident, command suffered a serious lapse after the Incident Commander and several company officers were injured in the collapse. The command post from which the IC manages the fireground must be located in an area outside of the collapse zone. The IC must ensure that the command post is protected from danger so that an effective command structure is maintained throughout the incident.^{1,5}

Recommendation #4: Fire departments should train fire fighters to recognize conditions that forewarn of a backdraft.

In this incident, several fire fighters were injured in a backdraft prior to the fatal events. Fire fighters should be trained in the recognition signs of possible backdraft conditions, which include the following:

- Smoke puffing in and out of the building (appearance of breathing)
- Smoke coming from small cracks
- Black smoke turning grayish yellow in color
- Little visible flame from the exterior
- Confined fire with excessive heat
- Smoke stained windows

If any of these warning signs are present, fire fighters should immediately relay the information to the IC, move away from doors and windows, and immediately exit the structure. Training on fire behavior should be provided to all fire fighters on a regular basis or as needed to ensure that effective recognition skills are maintained.⁴



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

Recommendation #5: Fire departments should ensure consistent use of personal alert safety system (PASS) devices even during overhaul operations.

Discussion: PASS devices are electronic devices worn by the fire fighter that emit a loud and distinctive sound (alarm) if the fire fighter is motionless for more than 30 seconds. There are several types of PASS devices available. One type is integrated into the SCBA and is activated when the SCBA air cylinder is turned on. Manual or secondary PASS devices are also used throughout the fire service. The latter devices require the fire fighter to actively turn on the device as needed. All fire fighters should be equipped with a PASS device and instructed to activate the device immediately upon entering any hazardous area.⁶ In this incident, Victim #2 had a PASS device integrated into his SCBA, but Victim #1 was not wearing a PASS device. Departments and arson investigators should consider utilizing manual PASS devices when tasks are to be performed in hazardous areas where SCBAs (with integrated PASS devices) are not needed. A sounding PASS alarm may have assisted in locating the exact position of Victim #1 sooner.

Recommendation #6: Fire departments should ensure that pre-incident planning is performed on structures containing unique features such as bell towers.

Discussion: 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, maze-like conditions, or structural damage from a previous

fire. Preplans should be conducted by first due companies. NFPA 1620 *Recommended Practice for Pre-incident Planning* outlines the steps involved in developing, maintaining, and using a pre-incident plan and covers factors such as construction, site and occupant considerations, protection systems and water supply, and special hazards (e.g., presence of skylights that are boarded over).⁷ Fire fighters thought that the church construction was solid stone, but the stone was only a façade over the original brick. Building construction could have been determined with a pre-incident inspection on church occupancies.

Recommendation #7: Fire departments should ensure that incident commanders conduct a risk-versus-gain analysis prior to committing fire fighters to interior operations, and continue to assess risk-versus-gain throughout the operation including overhaul.

Discussion: Size-up includes a continual evaluation of the risk versus gain during fire operations.^{8,9} Factors to consider for fire suppression operations include characteristics of the structure (e.g., type of construction, age, type of roof system), time considerations (time of day, amount of time fire was burning before and after arrival), contents of the structure, potential hazards such as fuels or explosive materials, life safety hazards, and exposures. The level of risk to fire fighters must be balanced against the potential to save lives or property. Whenever there is a potential for collapse, overhaul should be conducted defensively or until after the building has been inspected and secured by structural experts.



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

Recommendation #8: Fire departments should develop standard operating guidelines (SOGs) to assign additional safety officers during complex incidents.

Discussion: Complex incidents may require the IC to assign assistant safety officers to safely manage the fireground.⁸ Assistant safety officers will assist the ISO in covering the geographic area of the incident. Assistant safety officers, under the direction of the ISO, can also be assigned to functional positions such as division, group, or sector supervisor. Fire departments should develop SOGs which address the response of the ISO and the role of assistant safety officers assigned during extended incidents. In this incident, an ISO was assigned other duties, including securing gear from the fire fighters injured in the backdraft, prior to the scene being secured.

Recommendation #9: Fire departments should provide interior attack crews with thermal imaging cameras.

Discussion: Thermal imaging cameras (TICs) are used by the fire service in size-up to locate the fire or heat source. Additionally, "Infrared thermal imagers assist fire fighters in quickly getting crucial information about the location of the source (seat) of the fire from the exterior of the structure, so they can plan an effective and rapid response with the entire emergency team. Knowing the location of the most dangerous and hottest part of the fire helps fire fighters determine a safe approach and avoid structural damage in a building that might have otherwise have been undetectable. Ceilings and floors that have become dangerously weakened by fire damage and threaten to collapse can frequently be spotted with a thermal imaging camera. A fire

fighter about to enter a room filled with flames and smoke can judge whether or not it will be safe from falling beams, walls, or other dangers."¹⁰ The use of a thermal imaging camera may provide additional information the Incident Commander can use during the initial size-up, fire attack and later during overhaul.

Additionally,

Recommendation #10: Municipalities should enforce current building codes to improve the safety of occupants and fire fighters.

Discussion: The NFPA Fire Protection Handbook 25 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."¹¹ 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." 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. Sprinkler systems are one example of a safety feature that can be retrofitted into older structures. Such systems have been shown to reduce loss of life and property. Sprinkler systems can reduce fire fighter fatalities since such systems contain and can extinguish fires prior to the arrival of the fire department. In this incident, the building was not equipped with sprinklers.



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania

REFERENCES

1. Dunn V [1988]. Collapse of burning buildings, a guide to fireground safety. Saddle Brook, NJ: PennWell.
2. Dodson D [1999]. Fire department incident safety officer. New York: Delmar Publishers.
3. NIOSH [1999]. Preventing injuries and deaths of fire fighters due to structural collapse. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99-146.
4. Delmar Publishers [2000]. Fire fighter's handbook: essentials of fire fighting and emergency response. New York: Delmar Thomson Learning.
5. Brunacini AV [1985]. Fire command. Quincy, MA: National Fire Protection Association.
6. NFPA [1998]. NFPA 1982: Standard on personal alert safety systems (PASS). Quincy, MA: National Fire Protection Association.
7. NFPA [2003]. NFPA 1620: Recommended practice for pre-incident planning. Quincy, MA: National Fire Protection Association.
8. NFPA [2002]. NFPA 1561: Standard on emergency services incident management system. Quincy, MA: National Fire Protection Association.
9. NFPA [2002]. NFPA 1500: Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.
10. Norman J [2004]. Fire Officer's handbook of tactics. Saddle Brook, NJ: Fire Engineering Books and Videos.
11. NFPA [1997]. Fire protection handbook. 18th ed. Quincy, MA: National Fire Protection Association.

INVESTIGATOR INFORMATION

This investigation was conducted by Steve Berardinelli, Bruce Oerter, and Jay Tarley, Safety and Occupational Health Specialists and Tim Merinar, Safety Engineer with the Fire Fighter Fatality Investigation and Prevention Team, Fatality Investigations Team, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. A technical review was provided by Deputy Chief William Goldfeder, Loveland-Symmes Fire Department and editor of



**Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire
Fighters are Injured during a Five Alarm Church Fire - Pennsylvania**

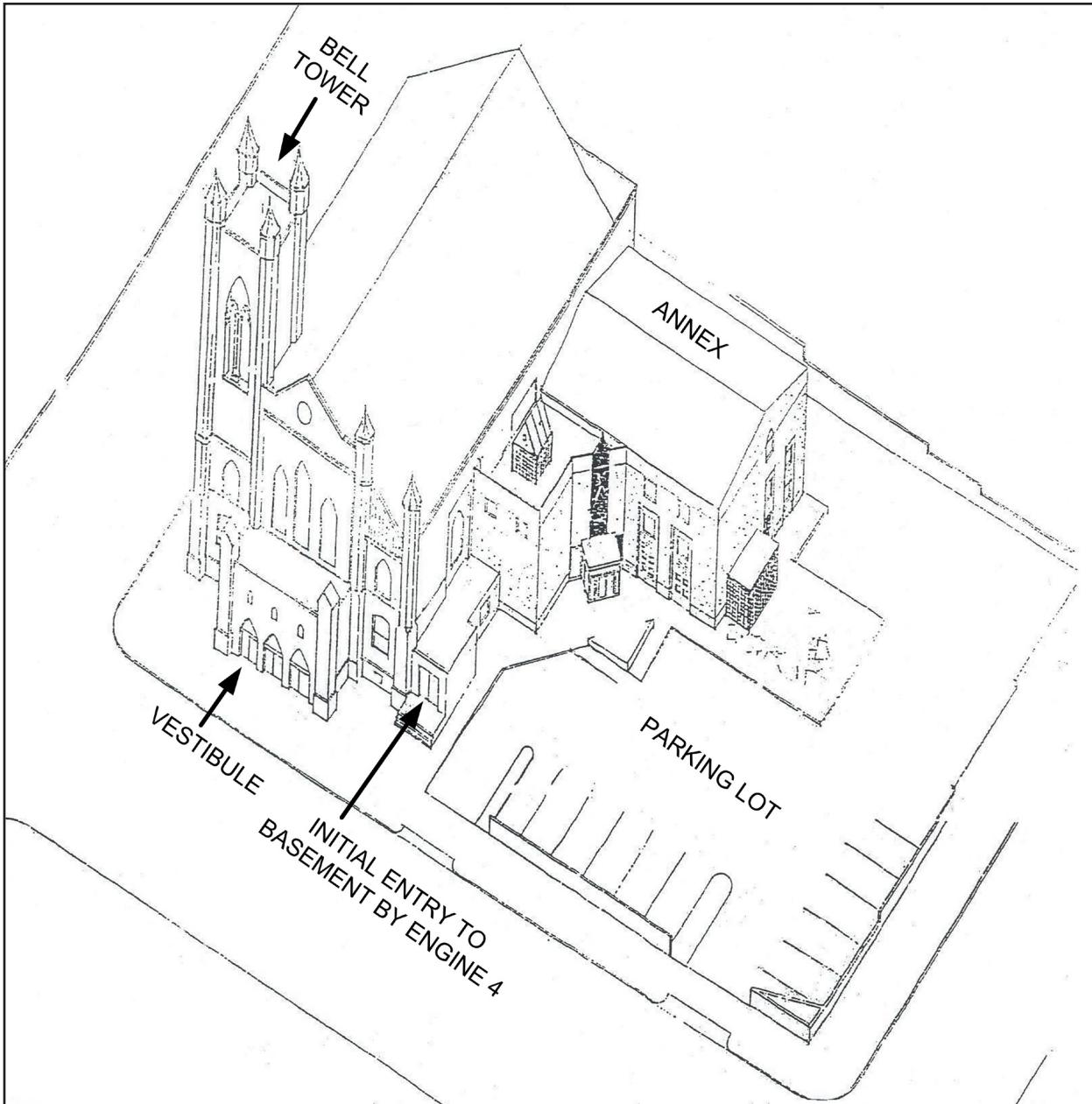


Diagram 1. Church involved in incident



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania



Photo 1. Fire breaking through roof of incident structure



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania



Photo 2. Incident structure prior to overhaul



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania



Photo 3. Incident structure prior to collapse



Career Battalion Chief and Career Master Fire Fighter Die and Twenty-Nine Career Fire Fighters are Injured during a Five Alarm Church Fire - Pennsylvania



Photo 4. Incident structure after collapse

U. S. Department of Health and Human Services

Public Health Service

Centers for Disease Control and Prevention

National Institute for Occupational Safety and Health

4676 Columbia Parkway, MS C-13

Cincinnati, OH 45226-1998

OFFICIAL BUSINESS

Penalty for private use \$300



**Delivering on the Nation's promise:
Safety and health at work for all people
through research and prevention**