

LINE OF DUTY DEATH REPORT

2018-12 • 7/1/2021

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One Firefighter Dies and Another Injured in Natural Gas Line Explosion— Wisconsin

Executive Summary

On July 10, 2018, a 34-year old paid-on-call/volunteer fire Captain died, and another firefighter was injured in a building explosion while responding to a report of a natural gas leak. At 1820 hours the local combination fire department was dispatched for a report of gas odor at an intersection approximately 1 block away from the fire station. The initial arriving crew immediately began evacuating the surrounding buildings. Meeting resistance from civilians who were unwilling to evacuate businesses in the area, the Incident Commander called for additional personnel to respond to the station. A Captain with the fire department arrived following the staffing request, along with several other firefighters. After checking in with the Incident Commander, the Captain, along with firefighters from the initial responding crew, entered a building near the suspected leak to control utilities in the basement. As the crew was exiting, the building exploded. One firefighter walked away from the blast with minor injuries. Firefighters on-scene searched for the Captain and the other firefighter in the pile of rubble from the building. The injured firefighter was found buried up to his face, conscious and moving. He was transported to the hospital in critical condition having sustained multiple fractures to his jaw and head. The Captain was found face down in the rubble. Crews worked to extract the Captain, loaded him into a waiting Advanced Life Support (ALS) staffed ambulance, and performed cardiopulmonary resuscitation until they reached the hospital where he later passed away from his injuries.



Site of Natural Gas Explosion
(Fire Department Photo)

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Contributing Factors

- *Sub-contractor performing unpermitted directional boring for underground utility*
- *Natural gas leak caused by directional boring*
- *Natural gas line explosion*
- *Responders working in blast radius to evacuate civilians lingering in the area*
- *Captain and crew entered building previously evacuated during primary search to attempt to control utilities*

Key Recommendations

- *Fire departments should refer to the 2020 Emergency Response Guidebook [USDOT 2020] and operate outside of the hot zone once civilians are evacuated*
- *Fire departments should ensure that Incident Commanders continuously evaluate the risk versus gain when making operational decisions during evacuation operations.*
- *Fire departments should ensure that firefighters are trained in situational awareness, personal safety, and accountability.*
- *Fire Departments should ensure that their members (and specifically their hazardous materials teams) are provided and trained in the latest tactics and equipment for detecting and responding to hazardous materials situations, including gas leaks.*

Additionally, governing municipalities (federal, state, regional, and local) should:

Work with civilians to educate them on the hazards of gas leaks and the need to immediately evacuate when public safety workers (fire and police) direct them to do so

The National Institute for Occupational Safety and Health (NIOSH) initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

For further information, visit the program Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On July 10, 2018, a 34-year old paid-on-call/volunteer Captain died and another firefighter was injured in a building explosion while responding to a report of an outside odor of natural gas. The Captain had arrived on-scene in response to a second call-back for additional resources following the need for a rapid evacuation spanning several blocks. The Captain and a crew of two firefighters went to control utilities in the basement of a building that had undergone a primary search and evacuation. As the crew was leaving the building, an unknown ignition source caused an explosion of the building, partially burying the Captain and one firefighter in the rubble. The buried firefighter was located, removed from a debris pile, and taken by EMS to a local hospital with significant injuries. The Captain was located with a pulse, which was lost upon loading him into an awaiting ambulance. Crews transported the Captain to a local hospital where he was later pronounced deceased. The third firefighter from the crew sustained minor injuries and was treated and released. The Chief remained on-scene until the Captain was transported, and he was treated at the hospital for a concussion sustained from falling debris down the street from the blast.

On July 29, 2018, a Safety Engineer and two Safety and Occupational Health Specialists from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Wisconsin to investigate the incident. Photographs of the incident scene post clean-up were taken (See Photos 1 and 2). NIOSH investigators met with representatives from the City Police Department, City Building Officials, and Officers from the Fire Department. Interviews were conducted with fire department personnel who responded to the incident, as well as emergency medical personnel and the medical examiner assigned to the case. NIOSH investigators reviewed the department's standard operating procedures (SOPs), the victim's training records, and police photographs of the scene. NIOSH investigators were accompanied by the Chief, Fire Marshall, and Building Official to inspect the incident scene.

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**Photo 1. Side Alpha of Pub prior to explosion.
(Photo from Google Maps)**



**Photo 2. Site of explosion. Note the building/origin of the explosion was destroyed during the
blast
(NIOSH Photo)**

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Fire Department

The combination department involved in this incident has two fire stations serving a primary geographical response area of 94 square miles and responds to approximately 1700 emergency incidents per year. A total of 45 volunteer members, 13 career firefighters, and 6 part-time firefighters serve a population of about 43,000 residents.

The department owned the following apparatus at the time of the incident:

- 2001 Engine 1 pumper
- 2013 Engine 3 with 776-gallon water capacity and 1500 GPM pumping capacity
- 2007 Engine 8
- 2017 E-One Typhoon
- 2007 Ladder 2
- 1999 Squad 5
- 1999 Brush Truck
- 1992 Brush Truck
- 1997 Tender
- 2017 Ladder 1
- 2016 SUV
- 2017 SUV
- 2006 SUV

Among many other topics, the department's extensive Standard Operating Procedures included sections on Radio Communications, National Incident Management System/Incident Command System (NIMS/ICS), Gas Meters, Incident Response, Mayday, Structure Fire Procedures, and Training.

Training and Experience

To become a volunteer member, applicants submit a written application and photocopy of their personal identification. Applicants spend 2 nights at the fire department as an observer watching drills. Following a background check, applicants are required to get medical clearance via a physical, as well as pass a physical agility test. Mandatory training within the first year includes Bloodborne Pathogen training, Basic Life Support CPR for the healthcare provider, NIMS/ICS Series Courses (100, 200, 300 and 400), and training on radio operations.

Probationary members are assigned a mentor for a minimum of 1 year. The state of Wisconsin requires 60 hours of entry level training. After entry level training, probationary members obtain SCBA training. Members must obtain state certification as Fire Fighter I and advance to Fire Fighter II before the individual can go interior or be "on-air" at a fire incident. These courses meet NFPA 1001 Standard for Fire Fighter Professional Qualifications. All firefighters with this department are at least Fire Fighter I certified [NFPA 2019].

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Firefighter/Rank	Years of Experience	Training/Certification
Chief	30 years	Entry Level Firefighter, Firefighter I, Firefighter II, Driver Operator Pumper, Fire Inspector, Fire Instructor, Fire Instructor EXP, Safety Officer, Fire Officer I, Fire Officer II, NIMS 100, 200, 300, 400, 700, and 800, HAZMAT Operations, Chief Fire Officer Certified Bachelor's Degree in Fire Science, NFPA 1670 Technical Rescue Technician
Assistant Chief/Incident Commander	45 years	Entry Level Firefighter, Firefighter I, Firefighter II, Fire Inspector, Safety Officer, NIMS 100, 200, 300, 400, 700, and 800, HAZMAT Operations
Captain (deceased)	15 years	Entry Level Firefighter, Firefighter I, Firefighter II, Driver Operator-Pumper, Driver Operator-Aerial, Fire Instructor, Safety Officer, Fire Officer 1, NIMS 100, 200, 300, 400, 700, and 800, HAZMAT Operations
Fire Fighter 1 (injured)	5 years	Entry Level Firefighter, Firefighter I, Firefighter II, Driver Operator-Pumper, Fire Inspector, NIMS 100, ICS 700, HAZMAT Operations
Fire Fighter 2 (minor injuries)	10 months	Firefighter I, NIMS 100 & 200, ICS 700 & 800

Equipment and Personnel

The fire department responded with one engine (Engine 3) staffed with 5 firefighters and one command vehicle (Car 2) staffed by an Assistant Chief.

While the initial responding crew began evacuating the buildings in the area surrounding the gas leak, the Assistant Chief/Incident Commander requested a call back for any available firefighters to respond to the station. Ladder 1 responded once a crew assembled at the fire department after the explosion. While this crew was assembling, the Captain grabbed his gear and walked from the firehouse to the intersection where the gas leak was occurring.

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The fire department is located approximately 2 blocks northeast of the site of the gas leak/explosion. Several firefighters responded to the scene on foot due to the proximity. The apparatus was initially parked within steps of the leak, then rapidly moved back when the location of the gas leak was established.

Structure/Blast Area

The initial report of gas odor came from a pizza parlor at the intersection of two city roads, approximately 1 block down from where underground boring was taking place. The pizza parlor was directly across the street from the building that exploded. The area is a main street in a historic city, consisting of older, multi-story brick buildings (ordinary type 3 structures) which housed restaurants and businesses on the first floor, and many with apartments or additional business offices on the upper floors. To the northwest side of the intersection, there was a bar/pub (explosion site). Across the street from the explosion site to the east is a multipurpose building that houses a confection restaurant and apartments. To the southeast of the intersection where the explosion occurred is a building shared by the Department of Corrections and a Mexican restaurant. To the west on the other side of the street was the pizza parlor. Given the time of day, the restaurants in the area were full of patrons during the “dinner rush.”

The building that exploded was a 2-story brick structure built in 1883. The building was 4,222 sq. ft above grade with a 2,257 sq. ft footprint including porches, entries, and garages. The building also had a below grade cellar with access directly inside the side Delta entryway.

The explosion occurred during business hours. Prior to evacuation, there were approximately 40 civilians inside of the structure

Personal Protective Equipment

The Detective Sergeant investigating the incident reported to the NIOSH investigators that the Captain (victim) was wearing his issued structural firefighting coat, pants, boots, and helmet when he was found at the scene of the incident. Both the Captain and injured firefighter were wearing an SCBA at the time of the explosion, but neither were “on air” during the response/explosion. NIOSH investigators examined and photographed all available structural firefighting clothing being held at the city evidence department under custody of the Police. The PPE were not determined to be a contributing factor in this incident

Weather

At the time of the report of gas odor in the area, the temperature was around 74 degrees and sunny with a 4-mph breeze from the north. Weather does not appear to be a contributing factor in this incident [Weather Underground, 2018].

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Directional Boring

A 5-inch gas main was punctured by a sub-contractor during unpermitted underground boring to locate underground utilities, causing natural gas to collect in the sewers and basements of the surrounding buildings. An unknown ignition source caused the trapped gas to ignite and explode in the building while the firefighters were exiting.

Timeline

This timeline is provided to set out, to the extent possible, the sequence of events according to the recorded radio transmissions. Times are approximate and were obtained from review of the dispatch records, witness interviews, and other available information. Times have been rounded to the nearest minute. This timeline is not intended, nor should it be used, as a formal record of events.

1820 hours

Gas line hit. Gas leak reported at a pizza parlor at the main intersection in the downtown area.

1821 hours

Fire department dispatched.

1822 hours

Engine 3 with 5 firefighters and Car 2 with an Assistant Chief arrived on-scene. The Assistant Chief established incident command on the east side of the scene. Firefighters noticed a heavy odor of gas in the area and immediately got readings of 6-7% of lower explosive level (LEL) on gas monitors as they exited the fire apparatus.

The driver of Engine 3 moved the apparatus east, away from the intersection. The rest of the crew broke into 2 teams and immediately began to evacuate civilians from businesses and apartments. The Incident Commander requested a staffing call-back for any available firefighters to respond

1824 hours

IC called the gas company who gave him a 30 minute estimated time of arrival (ETA) for the response crew.

Police were requested to assist with traffic control.

Fire crews continued to evacuate civilians and check gas levels in the surrounding building, noting high readings coming from the sewers along the streets. Crews reported being able to hear hissing out of the sewer grates.

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1835 hours

The Fire Chief arrived on-scene. Command remained with the Assistant Chief. The Fire Chief switched up crews, putting one experienced firefighter with each newer firefighter (3 teams of 2) and they continued evacuating buildings. The Chief met with the Detective Sergeant on scene and had him move a perimeter 5 blocks out and moved Command back to the firehouse

1845 hours

The Captain arrived at the fire department, grabbed his gear, pulled a gas meter from Truck 2, and walked down to the intersection. The Captain teamed up with a 2-man crew from Engine 3 to control utilities in the basement of a building consisting of a bar on the first floor with apartments above.

1905 hours

A power utility company representative arrived on-scene as the Captain and 2 firefighters were exiting the building.

The building exploded, and structure fires ignited.

Gas leak continued.

1906 hours

Assistant Chief/Incident Commander called for a personnel accountability report (PAR).

A firefighter who rushed to the pile of rubble radioed the Chief that he saw a firefighter buried in the rubble. A second firefighter who came to the call back helped uncover the buried firefighter, then helped him to his feet and moved him about 1 block north away from the pile towards the fire department. The second firefighter met with a third firefighter from the basement crew and transferred patient care to him. The second firefighter returned to the pile.

MABAS box alarm was called for structure fire. (Fire and EMS mutual aid)

1912 hours

The Advanced Life Support EMS crew on-scene took over care of the injured firefighter and transported him to the hospital with serious injuries.

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Firefighters continued arriving on scene and began digging through the pile searching for the Captain. An Assistant Chief who took over operations on the pile told crews to drop their SCBA to expedite the search.

Two fire fighters moved from the pile to drop their SCBA and spotted the Captain face down in the rubble near the edge of the pile. One of the firefighters felt a carotid pulse prior to the crew securing the Captain to a backboard and moving him to a waiting ambulance. The pulse was lost before the ambulance was in-route to the hospital and the ALS crew began cardiac arrest protocol.

Unified Command established.

1927 hours

1 block radius evacuation completed. 2 block radius evacuation initiated.

1951 hours

Evacuation area expanded to 5-block radius.

2005 hours

The Captain was pronounced deceased at the hospital

2042 hours

Evacuation area expanded to ½ mile radius.

2135 hours

5th MABAS box alarm called.

0245 hours

Gas shut off. All clear issued for firefighters to work hand lines at the explosion site/city road intersection. Utility company continued to purge additional gas lines.

0621 hours

All first due Fire Department personnel fully withdrawn from the response

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Investigation

On July 10, 2018, a 34-year old paid, on-call Captain died and another firefighter was injured in a building explosion while responding to a report of a natural gas leak. The deceased Captain was responding to a call-back to re-staff the fire station during a gas leak response. At 1821 hours, dispatch was notified of a possible gas leak at the intersection of 2 city roads approximately 2 blocks from the fire station. At 1825 hours, Engine 3 responded with 5 firefighters, along with Car 2 driven by the Assistant Chief on shift at that time.

The initial report of gas odor came from a pizza parlor at the intersection of two city roads approximately 1 block down from where underground boring was taking place. The area is a main street in a historic city, consisting of older, multi-story brick buildings which housed restaurants and businesses on the first floor, and many with apartments or additional business offices on the upper floors. To the northwest side of the intersection, there was a bar/pub (explosion site). Across the street to the east is a multipurpose building that houses a confection restaurant and apartments. To the southeast of the intersection is a building shared by the Department of Corrections and a Mexican restaurant. To the west on the other side of the street was the pizza parlor (see Diagram). Given the time of day, the restaurants in the area were full of patrons during the “dinner rush.”

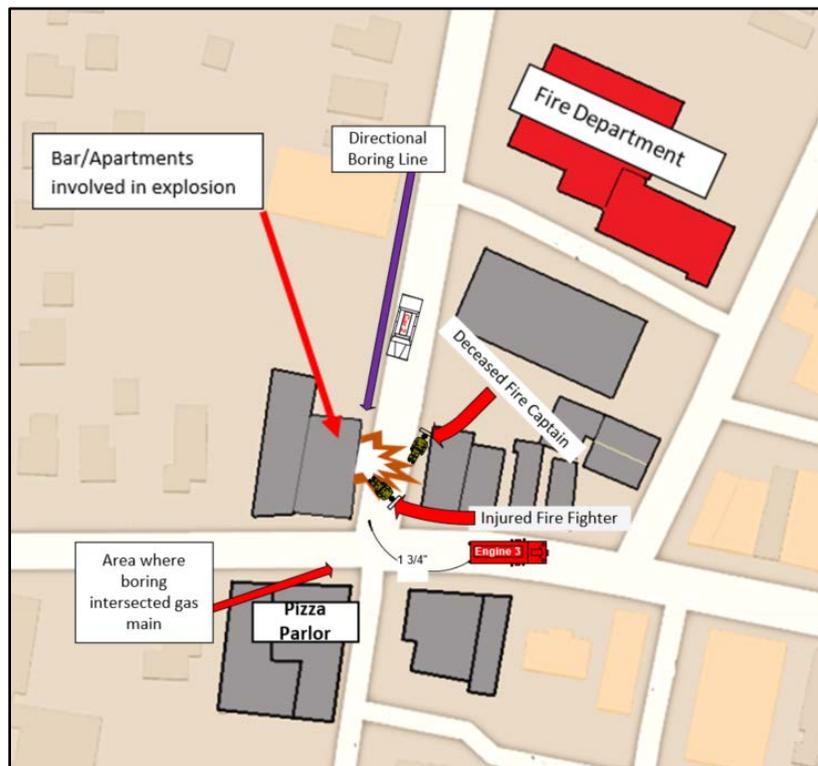


Diagram. Overview of intersection where explosion occurred. Depicts site of explosion, area where boring line pierced gas main, and the direction of the boring line

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Upon arrival, firefighters noticed a heavy odor of natural gas in the area. The Assistant Chief established incident command towards the east side of the scene. When getting off the engine, firefighters reported gas meter readings of 6-7% LEL. The driver of Engine 3 moved the apparatus east from the intersection and the suspected source of the leak. The rest of the crew divided into 2 crews and immediately began evacuating civilians from the businesses and apartments surrounding the intersection. Crews reported elevated gas readings in all the buildings in a two-block radius of the intersection.

At 1825 hours over the radio, the Assistant Chief requested a staffing call-back for any available firefighters to respond. The Assistant Chief/IC then called the gas company and was given a 30-minute estimated time of arrival for a gas utility crew to respond. At this time, city police officers were on-scene providing traffic control and helping keep civilians out of the area. The first responding fire crews continued to evacuate civilians and check gas levels in the buildings, noting high readings coming from the sewers along the streets. Crews reported that they were able to hear hissing out of the sewer grates.

At approximately 1835 hours, the Fire Chief arrived on scene and made adjustments to the evacuation crews in order to keep one experienced firefighter with each lesser experienced firefighter. After a brief discussion with a police department Sergeant, the decision was made to expand the evacuation area and continue evacuating civilians from all buildings. Evacuations were difficult due to civilians lingering in dining establishments and refusing to evacuate. Crews also encountered multiple individuals walking into the hot zone via side streets and alleyways. This forced crews to remain in the hot zone longer. The fire department in this incident effectively evacuated the buildings within the hot zone, preventing more casualties that could have resulted from the blast.

At approximately 1845 hours, the Captain arrived at the fire department. One firefighter was preparing to bring a ladder truck down to the scene. The Captain had a brief conversation with him, then grabbed a gas meter and walked to the scene on foot. When the Captain arrived on scene, he checked in with the Assistant Chief/IC and discussed going back into one of the previously evacuated buildings in which he was a commercial tenant, to control utilities in the basement. The Captain stated he was familiar with the utilities in the structure. Along with two other firefighters, he re-entered and went to the basement. They discussed shutting off the power in the building, and the Captain expressed concern that the gas meter was alarming at 100%. The crew decided to exit the structure. One firefighter headed around the back of the building's exterior to look for a gas shut off valve. As the Captain and the other firefighter were stepping out of the threshold on Side Delta, the building exploded (approximately 1905 hours).

The Chief, who was approximately 1 block down from the blast, immediately called for a PAR. He suffered a concussion and mild hearing loss following the blast. Another firefighter, who was standing on the sidewalk up from the building when the explosion occurred, turned to the pile of burning rubble and saw the firefighter (who was with the Captain in the basement) partially buried. At approximately 1906 hours, he radioed to the Chief that there was a firefighter down. The injured firefighter slowly sat up and was assisted away from the pile. The injured firefighter was medically evaluated by a third

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firefighter who had also been in the basement with the Captain. Patient care was then transferred to the first arriving EMS ALS crew.

At this time, other firefighters began searching the pile of rubble for the missing Captain. Engine 3 began flowing water on what was left of the building, which was becoming more involved in fire. Engine 3 utilized a deck gun to put water on the fire. As the search continued, an Assistant Chief who had responded to the station call-back, and was operating on the pile, instructed the crews to remove their Self-Contained Breathing Apparatus (SCBA) because it was slowing down the search operation. The firefighter who had found the first downed firefighter and the firefighter who was part of the Captain's basement crew went to drop their SCBA when they saw the reflective trim of the Captain's boot in the rubble. The Captain was found lying face down, with his right boot and head visible in the debris. The rest of his body was covered in rubble.

A firefighter reported feeling a faint carotid pulse on the Captain as they were removing him from the pile. The Captain was loaded onto a backboard and transferred to a waiting ALS crew. No pulse was detected in the ambulance and the crew immediately began resuscitative efforts. The Captain was pronounced dead at the hospital at 2005 hours.

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:

- *Sub-contractor performing unpermitted directional boring for underground utility*
- *Natural gas leak caused by directional boring*
- *Natural gas line explosion*
- *Responders working to evacuate lingering civilians within blast radius at time of explosion*
- *Captain and crew entered building previously evacuated during primary search to attempt to control utilities*

Cause of Death

According to the Medical Examiner's report, the Captain's cause of death was multiple blunt impact injuries.

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Recommendations

Recommendation #1: Fire departments should use the 2020 Emergency Response Guidebook and ensure that collapse/explosion control zones are established when dealing with a potential explosion hazard.

Discussion: During operations dealing with a gas leak and the possibility of an explosion, apparatus should be positioned outside the hazard area (330 feet/100 meters per the fire department's SOP and the Department of Transportation Emergency Response Guidebook [USDOT 2020]). Positioning should include a barrier, if possible, and water supply considerations.

Once a building within the hazard area has been evacuated, firefighters should not re-enter until it has been cleared as safe to do so. All efforts to evacuate immediate hazard areas should be performed swiftly and efficiently to limit first responder exposure to potential explosions.

In this incident, the Captain and two firefighters re-entered a previously evacuated structure within the hot zone to turn off utilities in the building. The explosion occurred just as the decision was made to expand the already established hot zone, and as the Captain and firefighters were exiting the structure.

Recommendation #2: Fire departments should ensure that Incident Commanders continuously evaluate the risk versus gain when making operational decisions during evacuation operations.

Discussion: The initial size-up conducted by the first arriving officer allows the officer to assess the conditions and to assist in planning the response strategy. The following general factors are important considerations during a size-up: occupancy type involved, potential for civilians in the structure, hazardous conditions, exposures, and time considerations such as the time of the incident, length of time before arrival, and time elapsed [IFSTA, 2013]. The Incident Commander must perform a risk analysis to determine what hazards are present, what the risks to personnel are, how the risks can be eliminated or reduced, and the benefits to be gained from interior or offensive operations [Kipp and Loflin 1996]. The size-up must include continued assessment of risk versus gain during incident operations. According to NFPA 1500 A.8.3.3, "The acceptable level of risk is directly related to the potential to save lives or property. Where there is no potential to save lives, the risk to the fire department members must be evaluated in proportion to the ability to save property of value. When there is no ability to save lives or property, there is no justification to expose fire department members to any avoidable risk, and defensive fire suppression operations are the appropriate strategy" [NFPA 2018a].

In this incident, the building that the Captain and 2 firefighters re-entered had already undergone a primary search and evacuation. The decision to expand the hot zone was made while the Captain and firefighters were exiting, and the building exploded.

Recommendation #3: Fire departments should ensure that firefighters are trained in situational awareness, personal safety, and accountability.

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One of the most critical responsibilities firefighters face on an emergency scene is maintaining situational awareness. All firefighters operating at an incident should maintain situational awareness and conduct a continuous risk assessment throughout the incident. The opposite of situational awareness is tunnel vision where the firefighters become so focused on a task, firefighting, or other operational assignments that they fail to sense changes in their environment. Firefighters can maintain their situational awareness by training with and trusting their tools and detection instruments, communicating with fellow crew mates and command, and continuously looking, listening, and feeling around for new or unusual sounds or vibrations.

Essentials of Fire Fighting and Fire Department Operations defines situational awareness as an awareness of the immediate surroundings. On an emergency scene, every firefighter should be trained to be constantly alert for changing and unsafe conditions, regardless of whether a safety officer has been designated for that incident [*Essentials of Fire Fighting and Fire Department Operations* 2008].

To assist with “go or no-go” decision making, the International Association of Fire Chiefs, Safety, Health and Survival section developed the “Rules of Engagement for Structural Fire Fighting.” While this incident was not initially a structure fire, the Rules can be applied to a variety of scenarios to assist both the firefighter and the Incident Commander in risk assessment.

One principle applied in the Rules is that firefighters and the company officers are the members most at risk for injury or death and will be the first to identify unsafe conditions and practices. The Rules integrate the firefighter into the risk assessment decision making process. Where it is not safe to proceed, the rules allow a process for that decision to be made while still maintaining command unity and discipline [IAFC 2016].

In this incident, the IC and Fire Chief working with the Police supervisor continued to reevaluate conditions. Due to migrating natural gas in the 150-year-old infrastructure “Hot Zones” were difficult to establish due to elevated readings in multiple buildings. Additionally, police and fire crews having to deal with breaches from curious residents entering the area from alleyways and other locations that could not be controlled. Police perimeters were moved out three blocks from the initial response location. Command Location was moved five times during the operation.

The Captain was assigned to utilities due to his knowledge of the buildings in the area which housed his restaurant/pub business. Although the building had previously been evacuated by the first responding crew, the Captain requested to re-enter the structure to control utilities as called for in the department’s SOPs. The IC utilized an accountability board upon arrival, and regained control of accountability post explosion.

Recommendation #4: Fire Departments should ensure that their members (and specifically their hazardous materials teams) are provided and trained in the latest tactics and equipment for detecting and responding to hazardous materials situations, including gas leaks.

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Discussion: While gas meter training was not determined to be a contributing factor in this incident, it is an industry best practice to remain up to date on the latest technology, knowledge, and tactics when responding to highly technical emergencies.

Regarding natural gas emergencies, firefighters must be thoroughly trained in the use of their combustible gas indicators and/or 4 gas meters. Training must include information on understanding cross sensitivities, alarm points, proper sampling techniques, and limitations of the specific instrument. Fire departments often respond to natural gas leaks, and LEL monitors are an essential tool for helping establish whether it is safe to enter a structure when a natural leak is suspected.

LEL monitors require maintenance (including frequent calibration) and proper training in their use to be accurate and effective in the field. Manufacturer guidelines should be followed in maintaining and calibrating these technical devices. Understanding the proper use and reading requires routine training by qualified personnel. Inadequate training and maintenance will put firefighters at risk.

New technologies emerge frequently, and it is up to the fire department to determine if they are applicable to their response area. For example, fire departments could consider using laser based natural gas detectors. This type of gas detector allows firefighters to greatly speed up their size-up and increases safety because it has a 100-foot range with sensitivity in the ppm range keeping them out of an Immediately Dangerous to Life and Health (IDLH) area.

When conducting natural gas emergency training, the implementation of action levels built into the training SOP is important. Once a firefighter is proficient with use of the department's chosen gas meter, training can then move on to what tactics they are supposed to implement based on the readings they obtain. This includes understanding how to interpret the data they are gathering and making responsive tactical decisions.

Recommendation #5: Cities and municipalities should work with civilians to educate them on the hazards of gas leaks and the need to immediately evacuate when public safety officials direct them to.

Discussion: Time is of the essence when conducting an evacuation during a natural gas leak, or any hazardous situation. The occurrence of a natural gas leak is a low frequency event civilians encounter. This means that many may not understand the urgency to evacuate when there is no visible indication of danger, such as with a fire. It is crucial that public education programs are developed, tailored to, and distributed to residents of communities serviced by natural gas.

Focus areas of such programs could include:

- Identifying and reporting signs of a natural gas leak
- What to do in the event of a gas leak
- How to prevent natural gas leaks from occurring in your home or business

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City officials play a critical role in emergency management. Preparing communities for a disaster or major emergency event takes careful planning and a thorough account of resources immediately available. By taking these things into consideration and developing protocols for mandatory compliance during an emergency, first responders will be able to conduct efficient operations that have the potential to save lives. The task of developing ordinances that communities are both aware of and responsible to uphold falls to the city officials and public health leaders in communities.

In this incident, the first responding crews from both the fire and police departments did an outstanding job conducting an efficient evacuation prior to the explosion. There is no doubt that dozens of lives were saved due to their efforts. It was reported that some crews were met with resistance when asking patrons to evacuate businesses in the hot zone. This resistance, along with individual civilians re-entering the evacuation zone via back alleyways and side streets, forced the decision of Incident Command to remain in the hot zone until the all clear was given. City Emergency Managers and Fire Departments should take every opportunity to educate the public and encourage civilians to comply with directions from first responders. The quicker crews and civilians can get out of the immediately hazardous area, the less likely it will be that anyone is injured in the event of an explosion.

NOTE: The following recommendations are not considered to be contributing factors for this incident, but they are good practices to include in fireground operations.

Recommendation #6: Fire departments should ensure an effective personnel accountability system is used to account for all firefighters and first responders assigned to any incident.

Discussion: Personnel accountability on a fireground means identifying and tracking all personnel working at the incident. A fire department should develop its own system and standardize it for all incidents. Accountability on the fire ground can be maintained by several methods: a passport system, a system using individual tags assigned to each firefighter, a riding list provided by the company officer, an SCBA tag system, or an incident command board [IFSTA 2013]. Some personal alert safety system (PASS) devices incorporated into SCBA can communicate automatically with a command/control module at the incident command post, establishing an automatic accountability system. NFPA 1500 and NFPA 1561 contain guidelines for the development of an accountability system for fireground and other emergency operations [NFPA 2014, 2018a].

As an incident escalates, additional staffing and resources will be needed, adding to the burden of tracking personnel accountability. At this point a tactical worksheet should be established with an assigned accountability officer or chief's aide. In large incidents, this can also be used at the division level, with resources being assigned and tracked at the division level.

An important aspect of a personnel accountability system is the personnel accountability report (PAR). A PAR is an organized on-scene roll call in which each supervisor reports the status of their crew when requested by the Incident Commander. The use of a personnel accountability system is recommended by NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* and NFPA

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1561 *Standard on Emergency Services Incident Management System*. A functional personnel accountability system requires the following:

- development of a departmental SOP
- training all personnel
- strict enforcement during emergency incidents [NFPA 2014, 2018a]

The control of the personnel accountability system should be assigned to an individual responsible for maintaining the location and status of all assigned resources (resource status) at an incident. This is a separate role from the duties of the Incident Commander. The Incident Commander is responsible for overall command and control of the incident. Due to the importance of responder safety, this function would be assigned to a personnel accountability officer or resource status officer. This function can be staffed by the chief's aide, staff assistant, field incident technician, chief officer, or other responder familiar with the department's accountability system [NFPA 2014].

There are many different methods and tools for accounting resources. Some examples are as follows:

- command boards,
- tactical worksheets,
- apparatus riding lists,
- electronic bar-coding systems,
- accountability tags or keys (e.g. PASSPORT System) [NFPA 2014]

Different methods and tools for resource tracking and accountability can be used in conjunction with one another to facilitate the tracking of responders by both location and function. The components of the personnel accountability system should be modular and expand with the size and complexity of the incident [NFPA 2014].

With an accountability system in place, the Incident Commander may readily identify the location and time of all firefighters on the fireground. A properly initiated and enforced personnel accountability system that is consistently integrated into fireground command and control enhances firefighter safety and survival by helping to ensure a more timely and successful identification.

There has been much technological advancement in accountability systems. There are currently available PASS systems that have the capacity to act as a standard PASS device but also transmit a signal to the command console when the fire fighter has gone into alarm. Additionally, the Incident Commander can signal any and all fire fighters through their PASS device when there is a need to evacuate a structure.

In this incident, command initially set up an accountability system to which firefighters checked in at the command vehicle as they arrived on scene. Prior to the explosion, there was a functional accountability system in place with Incident Command, and the span of control was adequate. After the explosion occurred and rescue operations began, firefighters arrived on foot to the scene and

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headed straight for the pile. It was noted that it was unclear who all had responded until after the recovery was made. Once recovery was accomplished, accountability was regained, and command boards immediately came into play. Accountability is not considered a contributing factor to this fatality. However, when effective accountability is established early and maintained throughout the incident it can lead to an organized response.

Recommendation 7: Fire departments should consider developing Flammable Gas Response SOPs jointly with utility experts and conduct annual joint training with utility companies to maintain familiarity with protocols.

Discussion: When dealing with flammable gas emergencies (i.e. natural gas, propane gas), the responding fire department has the responsibility for protecting the emergency responders as well as civilians in cooperation with the local utilities. It is imperative that fire department procedures, training, and equipment all support this mission. Operational procedures that are standardized, clearly written, and mandated to each department member establish accountability, increase command, and improve effectiveness.

It is important to understand the difference between a policy and a procedure. A department policy is a guide to decision-making that originates with or is approved by top management in a fire department. Policies define the boundaries within which the administration expects department personnel to act in specified situations. A procedure is a written communication closely related to a policy. A procedure describes in writing the steps to be followed in carrying out organizational policies. SOPs are standard methods or rules in which an organization or a fire department operates to carry out a routine function. Usually these procedures are written in a policies and procedures handbook and all fire fighters should be well versed as to their content. [IFSTA 2013]

When developing new SOPs or re-visiting established SOPs, consider including outside organizations who would also be involved in the response. In the case of a flammable gas leak, Fire Department procedures should consider and mirror utility best practices for response and control, as these may very well be similar both tactically and strategically. By including local utility experts, the outcome will be a well-rounded SOP that clearly outlines the roles and responsibilities for firefighters and utility workers on the scene of a gas emergency. Fire department operational plans, trainings, strategies, and tactics should anticipate firefighters being on scene without utility assistance for extended periods of time and utilize utility professional guidance for how to proceed in these circumstances.

As with any new or updated SOP, fire departments should conduct annual training to ensure fire fighters are familiar with the various responder roles outlined in the procedure. Utility technicians, fire department officers, and frontline firefighters should train on common techniques/procedures to ensure good on scene effectiveness and cooperation ensuring a unified effort. Training should be classroom based *and* hands-on using common/realistic natural gas emergency scenarios the fire department is expected to mitigate before utility assistance arrives.

In this incident, the fire department had SOPs in place for responding to natural gas emergencies. While SOPs are not considered a contributing factor to this fatality, co-development of technical SOPs

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with utility experts is considered an industry best practice and would be beneficial to fire departments nationwide.

Recommendation #8: Fire departments should ensure that firefighters wear a full array of turnout clothing and personal protective equipment, including Self-Contained Breathing Apparatus (SCBA), appropriate for the assigned tasks.

Discussion: While PPE is not considered a contributing factor to this incident, it is notable in this discussion. NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* contains the general recommendations for firefighter protective clothing and protective equipment [NFPA 2018a]. Chapter 7.1.2 states “protective clothing and protective equipment shall be used whenever the member is exposed or potentially exposed to the hazards for which it is provided.” Chapter 7.2.1 states “members who engage in or are exposed to the hazards of structural firefighting shall be provided with and shall use a protective ensemble that shall meet the applicable requirements of NFPA 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* [NFPA 2018b].

The fire department in this incident provides members with a full array of turnout gear and SCBA that are in accordance with NFPA 1971. During the search and rescue operation of this incident, firefighters were instructed to remove their SCBA while searching on the burning pile of rubble to speed up recovery efforts. The fire Captain was in full structural turnout gear.

Recommendation #9: Fire departments should provide manual personal alert safety system (PASS) or tracking devices to locate potentially missing firefighters when Self-Contained Breathing Apparatus (SCBA) are not utilized.

Discussion: While this is not considered a contributing factor to the Captain’s death, often firefighters can and do carry out their duties at a hazard scene without donning or activating their SCBAs. In this scenario, an SCBA with the integrated PASS device would not be activated since the SCBA would not be turned on. If an unexpected explosion or collapse occurs, there may not be an indication that a firefighter is down because the PASS would not be activated. The use of a manually activated device in these types of situations may be helpful to pinpoint a firefighter’s location.

In this incident, the Captain was missing, and firefighters were looking for him in the rubble. He was found when members from the search crew saw the reflective portion of his right boot. An active PASS alarm may have alerted search crews to his location more effectively.

Recommendation #10: Building officials should be included in emergency management services planning committee drills.

Discussion: Disaster preparation does not solely fall on the shoulders of first responders and emergency managers. Building and code officials can have a major role to play in pre-incident planning. Emergency management services planning committees should include fire, police, EMS, and building officials. Knowledge of current and past construction permits, changes to major structures,

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utility work, and city records can help enhance preparations and pave the way to a smooth emergency operation.

Building officials should be encouraged to participate in pre-incident planning committees and be involved during inter-operational drills. By doing so, weaknesses may be identified, such as the inability to quickly pull building blueprints or building permits due to old or outdated filing systems, and then be improved for better access. This will provide first responders important building information quicker and allow the Incident Commander to make well informed operational decisions.

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Investigator Information

This incident was investigated by Karis Kline, Safety and Occupational Health Specialist, Timothy R. Merinar, Safety Engineer and Steve Miles, Safety and Occupational Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, West Virginia. An expert technical

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review was provided by Chief Jerry Knapp. A technical review was also provided by the National Fire Protection Association, Emergency Response and Responder Safety (ERRS) Division.

Additional Information

[Rules of Engagement for Firefighter Survival](#)

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