2015
21

Death in the line of duty...

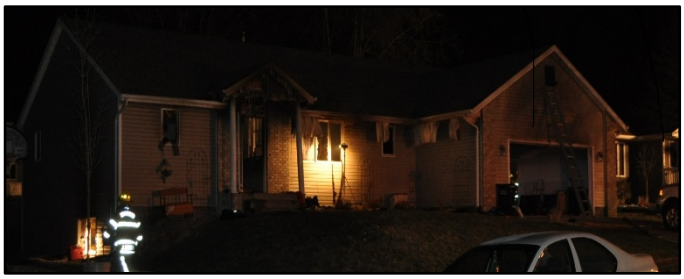
National Institute for Occupational Safety and Health NIOSH

A report from the NIOSH Fire Fighter Fatality Investigation and Prevention Program November 1, 2017

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Executive Summary

On April 12, 2015, a 38-year-old male volunteer fire fighter died in a floor collapse while working above a residential basement fire. At 22:09 hours, the local volunteer fire department, neighboring mutual aid volunteer fire department, county emergency management, and a medic unit were dispatched to a residential house fire with an occupant inside. The caller reported to Dispatch that the fire was in the basement. Due to the similarity in street names, the address was corrected a minute later by Dispatch. The fire chief was first on-scene and was informed that the male homeowner would be near the master bathroom. The chief reported smoke coming from the garage and requested mutual aid from two other volunteer departments. The first engine on-scene took a 1¾-inch hoseline and forced the front door. Heavy, brown smoke was banked to the floor. The crew searched the bathroom then heard erratic breathing and located the homeowner on the floor near the bed. The homeowner was stuck on something but they moved him toward the bedroom double doors. After approximately 20 minutes on-scene, a third crew was able to get him out. A crew with a 1¾-inch hoseline from the neighboring department made entry on the first floor through the garage. They went through the laundry room, across the hallway, and into the kitchen where they encountered heavy heat, smoke, and fire. The third fire fighter on the line yelled to get out, then the other two fire fighters heard a loud explosion and were surrounded by fire. They backed out, following the hoseline. Once outside, they thought the third fire fighter was already out. An evacuation order was given and a personnel accountability report was called. Responding companies all gave a positive report, including the neighboring department. Finally, it was realized that the third fire fighter was missing**.** A crew made entry down to the basement via the interior stairs and were searching for the fire but was driven back by heat, smoke, and water that had collected in the basement. Crews searched and noticed that the floor had collapsed in an area in the hallway on Side D and in the kitchen. A hole was cut in the exterior wall on Side D above the collapsed floor in the hallway, exposing a view into the basement. The crew noticed the reflective trim on the downed fire fighter's turnout gear in the debris in the basement. A recovery was made at 09:37 hours, after the local urban search and rescue team arrived to shore up the structure so the fire fighter could be safely removed.



Fire structure.
(*Courtesy of Fire Marshall.*)

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Contributing Factors

- *Delay in notification to the fire department*
- *Delay in fire suppression*
- *Blood alcohol level above the legal limit*
- *Concealed basement fire*
- *Crew integrity*
- *Self-contained breathing apparatus operation/maintenance*
- *Fireground communications*

Key Recommendations

- *Fire departments should ensure that a fire attack is conducted concurrently with rescue operations and a risk-versus-gain analysis is done after the rescue is completed.*
- *Fire departments should ensure that officers and fire fighters are trained in current basement fire strategies and tactics.*
- *Fire departments should ensure that a zero-tolerance alcohol policy is established and enforced.*
- *Fire departments should ensure that an accountability system is established prior to entry and personnel accountability reports are accurate.*
- *Fire departments should ensure that a respiratory protection program is established and maintained.*
- *Fire departments should ensure that SCBAs are functional and maintained in accordance with manufacturer guidelines.*
- *Fire departments should ensure that fire fighters wear proper personal protective equipment on the fireground.*
- *Fire departments should ensure that a staging area manager is assigned to the staging area to release crews once assignments are given.*

Additionally, local governments should:

- *Consider requiring fire fighters be trained to state minimum training requirements.*

2015
21

Death in the line of duty...

National Institute for Occupational Safety and Health NIOSH

A report from the NIOSH Fire Fighter Fatality Investigation and Prevention Program November 1, 2017

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Introduction

On April 12, 2015, a 38-year-old male volunteer fire fighter died in a floor collapse while working above a residential basement fire. On March 18, 2016, the county emergency management director, the county fire chiefs association, and the chief from the fallen fire fighter's volunteer fire department sent a letter to the National Institute for Occupational Safety and Health (NIOSH) requesting an investigation. On April 24–28, 2016, a general engineer and a safety engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to South Dakota to investigate this incident. The NIOSH investigators conducted an opening meeting with the county emergency management director, the investigating deputy state fire marshal, and the president of the county fire chiefs association. The NIOSH investigators visited the incident scene and conducted interviews with fire chiefs, officers, and fire fighters who were at the incident. The NIOSH investigators reviewed the two primary fire departments' standard operating guidelines, officers' and fire fighters' training records, dispatch audio tapes, the county medical examiner's autopsy report, and the state fire marshal's report.

Fire Department

The county's fire service consists of 13 volunteer fire departments, 1 career fire department, and 3 public service organizations. The Office of Emergency Management (OEM) assists the response and recovery activities of these departments and organizations involved in providing emergency services. The OEM is the principal source of information on emergency management, including the identification of training needs and developing and providing training programs. The OEM also assists all county agencies in obtaining surplus governmental equipment (vehicles, tools, etc.). The county's fire chiefs association was created in 1968 to coordinate and assist the efforts of the fire departments across the county. The association coordinates the initial fire service training for new members and provides a dedicated training officer to assist the departments in finding and establishing training programs. The county's fire service serves a population of approximately 185,000 in an area of 814 square miles. Mutual aid agreements are a key component to the success of the county's fire service. The county has been progressive in establishing radio policies, training opportunities, and financial support.

The district volunteer fire department where the fire occurred was established in 1958 and currently has about 25 active members but is set up to have 40 certified fire fighters on their roster, of which, about a third are EMTs. They serve a community of approximately 9,000 people, which covers 5.37 square miles. They operate out of one station with two rescue trucks, two engines, two wildland trucks, two tenders, a command vehicle, and a fire all-terrain vehicle. The department trains the first and third

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Monday of every month. They attend state fire schools and have been the host site for the state fire school. They provide mutual aid for five other fire departments in the area.

The mutual aid volunteer fire department that had the fatality was established in 1898 and operates out of one station with 30 active members. They serve a population of 1,700 people, covering 56 square miles. They operate two engines, two tenders, two wildland trucks, and a rescue truck.

Training and Experience

The state of South Dakota does not have prerequisite training or education requirements for an individual to become a fire fighter. The state Fire Marshal's Office assists fire departments via the State Fire Service Training Program, which coordinates training for the state fire school, district fire schools, National Fire Academy courses, and other special training classes. The program provides for the certification of fire fighters, fire instructors, fire apparatus drivers/operators, and fire officers through certified training programs. The Fire Service Training Program is also a resource for training materials.

Table 1 summarizes the documented training of the Engine 1 fire fighter (Mutual Aid) and the fire chief (incident commander).

Table 1. Training records for the Engine 16 fire fighter (Mutual Aid) and fire chief (incident commander)

Fire Fighter	Training Courses	Years of Experience
Fire Fighter (Engine 1 Mutual Aid)	Basic Fire Fighting (Fire Fighter I and Fire Fighter II), Introduction to the Incident Command System (IS-100), ICS for Single Resources and Initial Action Incidents (IS-200), Intermediate ICS for Expanding Incidents (ICS-300), Hazardous Materials Awareness Level, various fire-fighting procedures, and various other administrative and technical courses.	14

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Fire Fighter	Training Courses	Years of Experience
Fire Chief (Incident Commander)	Fire Fighter I, Emergency Medical Technician-Basic, Introduction to the Incident Command System (IS-100), ICS for Single Resources and Initial Action Incidents (IS-200), National Incident Management System (NIMS) an Introduction (IS-700), Leadership Command Presence, Incident Safety Officer, State Certified Fire Officer, State Certified Fire Instructor, Fire Attack-Strategy and Tactics of Initial Company Response, Firefighter Survival and Rapid Intervention, Basic Wildland Firefighter (S-130), Introduction to Wildland Fire Behavior (S-190), Engine Boss (Single Resource)(S-231), Interagency Incident Business Management (S-260), and various other administrative and technical courses.	22

Structure

The incident involved a ranch style, single-family home with a two-car, attached garage, which was built in 1994. The ground floor accounted for 1,759 square feet of living space, and most of the basement had been finished to add another 1,500 square feet. The home was wood frame construction on a concrete block foundation. The exterior was vinyl siding with brick and brick veneer. The roof was gabled 2 inch x 6 inch rafters with OSB sheathing covered with asphalt shingles (see Photos 1 and 2). The interior was drywall with carpet and vinyl flooring. Natural gas was used for the forced air furnace and hot water heater, which shared a single-walled metal chimney pipe. The basement area contained an unfinished utility room area on Side D of the home (see Diagrams 1 and 2). The basement had no exterior man door. Side B had a window near the A/B corner and there were several small windows on Side C.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Photo 1. Front, side A, view of fire structure.
(*Courtesy of the Fire Marshall's Office.*)

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Photo 2. Partial Side C view of fire structure.
(*Courtesy of the Fire Marshall's Office.*)

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

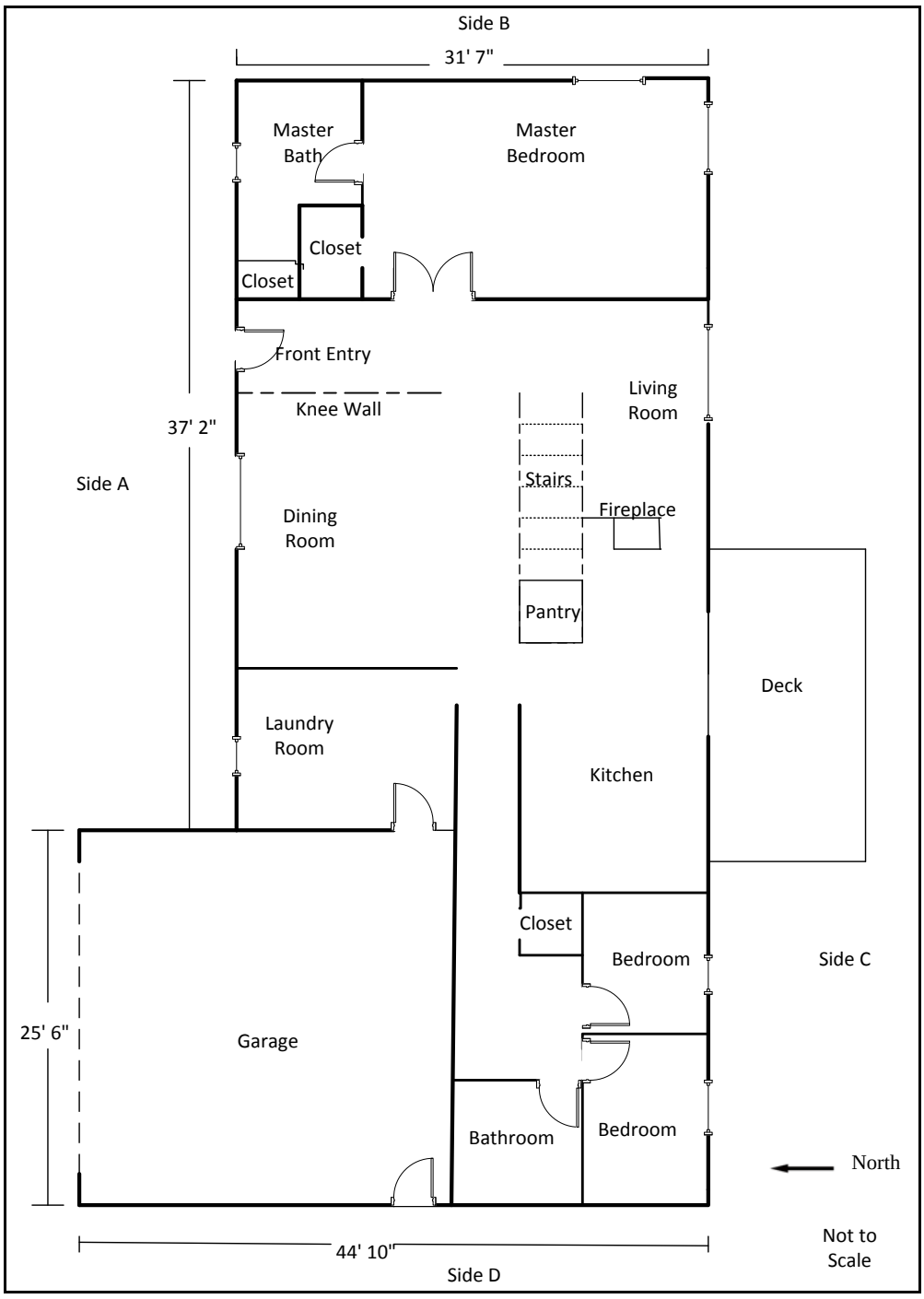


Diagram 1. First floor of fire structure.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

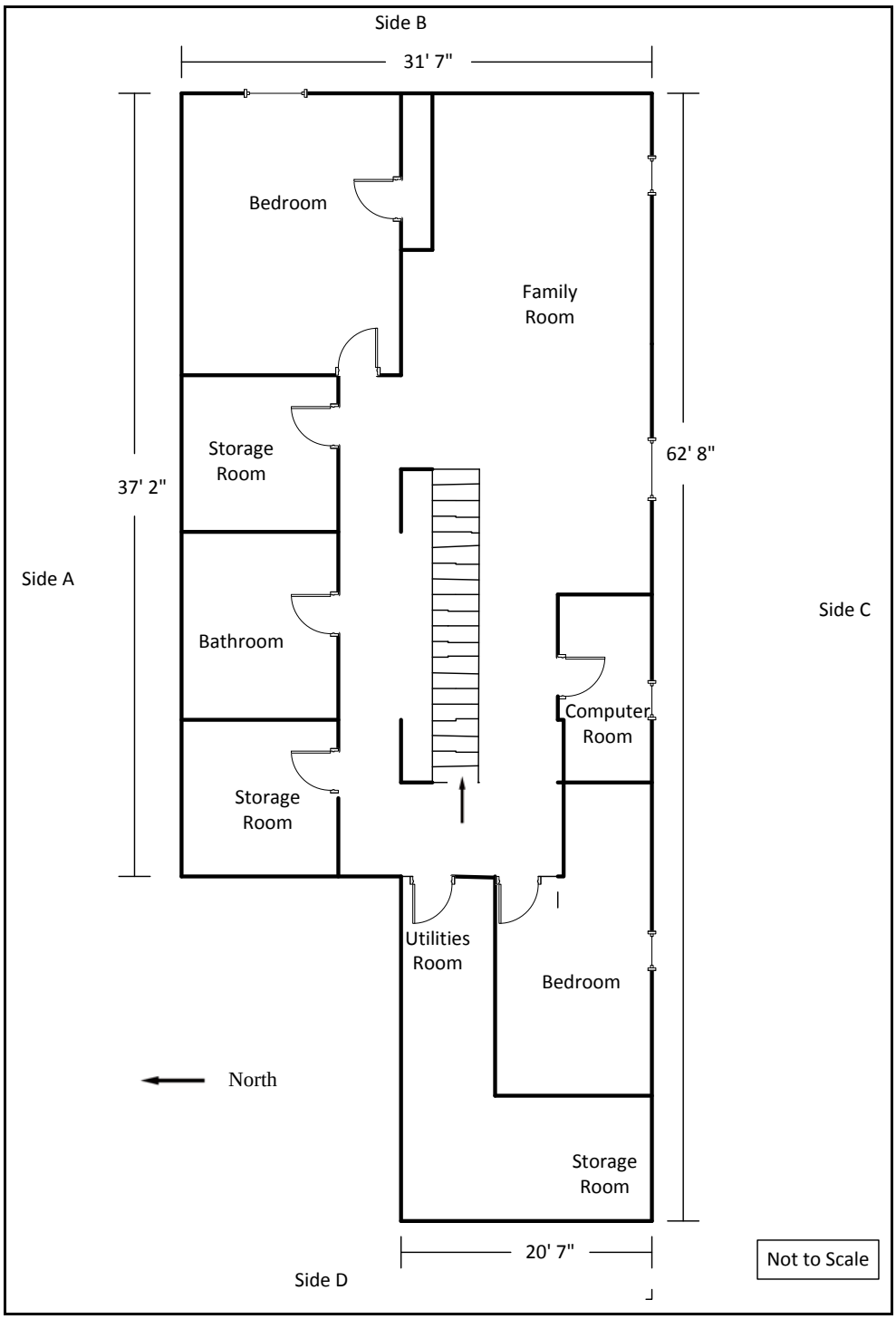


Diagram 2. Finished basement floor plan.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Equipment and Personnel

On April 12, 2015, the county dispatched the local volunteer fire department, a neighboring volunteer fire department, county emergency management, and a medic unit for a residential structure fire with a person trapped inside. Nine minutes later from time of dispatch, the incident commander requested two additional mutual aid volunteer fire departments. Table 2 identifies the apparatus and staff dispatched on the first-alarm assignment, along with their approximate dispatch times and on-scene arrival times rounded to the nearest minute.

Table 2. First-alarm equipment and personnel dispatched

Resource Designation	Staffing	Dispatched (rounded to minute)	On-scene (rounded to minute)
Engine 2	lieutenant, engine operator, and 3 fire fighters	22:09 hrs	22:15 hrs
Fire Chief (incident commander)	fire chief	22:09 hrs	22:14 hrs
Engine 1	lieutenant, engine operator, 2 fire fighters, and 2 probationary fire fighters	22:09 hrs	22:17 hrs
Rescue 1	4 fire fighters	22:09 hrs	22:19 hrs
Wildland 2	2 fire fighters	22:09 hrs	22:21 hrs
Wildland 1	2 fire fighters and 2 probationary fire fighters	22:09 hrs	22:21 hrs
Mutual Aid Tender1	2 fire fighters	22:09 hrs	22:35 hrs
Mutual Aid Tender2	2 fire fighters	22:09 hrs	22:35 hrs
Mutual Aid Engine 1	2 fire fighter	22:09 hrs	22:17 hrs

Resource Designation	Staffing	Dispatched (rounded to minute)	On-scene (rounded to minute)
Mutual Aid Rescue	3 fire fighters	22:09 hrs	Unknown
Mutual Aid Grass Rig	2 fire fighters	22:09 hrs	Unknown
Medic 931	2 paramedics	22:09 hrs	22:15 hrs
EMR	supervisor	22:09 hrs	22:46 hrs

Timeline

An approximate timeline summarizing the significant events of the incident is listed below. The times are approximate and were obtained by studying available dispatch records, photos, run sheets, witness statements, and fire department records. The times are rounded to the nearest minute. The timeline is not intended, nor should it be used, as a formal record of events.

- **22:09 Hours**
  County Dispatch paged the local volunteer fire department, a mutual aid volunteer fire department, an emergency medical unit, and county emergency management to a residential structure fire with occupant trapped inside.

- **22:14 Hours**
  Fire Chief arrived on-scene.

- **22:15 Hours**
  Engine 2 and Medic 931 arrived on-scene after a brief address correction. Occupants informed the chief that an occupant was nonresponsive in the master bedroom.

- **22:17 Hours**
  Engine 1 and Mutual Aid Engine 1 arrived on-scene.

- **22:19 Hours**
  Rescue 1 arrived on-scene.

- **22:21 Hours**
  Wildland 1 and 2 arrived on-scene.

- **22:32 Hours**
  Second mutual aid fire department arrived on-scene.

- **22:35 Hours**
  Mutual Aid Tenders 1 and 2 arrived on-scene. The male occupant had been removed from the structure and taken to Medic 931.

- **22:37 Hours**
  County Emergency Management EMR arrived on-scene. The first mutual aid company made entry through the garage with a 1¾-inch hoseline into the kitchen where the they encountered fire and flowed water. The second mutual aid company had been assigned exterior attack and may have flowed water at this time.

- **22:38 Hours**
  Third mutual aid fire department arrived on-scene.

- **22:41 Hours**
  Medic 931 was en route to hospital with the male occupant. Fire Chief called for evacuation of the fire structure.

- **22:43 Hours**
  Fire Chief ordered a defensive fire attack and called for a PAR.

- **23:01 Hours**
  Reports of missing fire fighter. Mutual Aid Fire department requested to report to their apparatus for count.

- **23:04 Hours**
  Suppression operations stopped to look for fire fighter. Fire Chief activated RIC for missing fire fighter.

- **23:08 Hours**
  Fire Chief called for second evacuation and resumed exterior attack.

- **01:30 Hours**
  Missing fire fighter's body was found in the basement.

- **09:37 Hours**
  Missing fire fighter's body was recovered.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Personal Protective Equipment

During the initial entry into the structure, the fire fighter was wearing his bunker coat and pants, gloves, hood, boots, helmet, self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS), and a radio. The fire fighter was found with his facepiece slightly misaligned on his face and his air cylinder empty. His gloves were not on his hands but were found near him and his helmet was off his head with the chin strap underneath his chin. The NIOSH National Personal Protective Technology Laboratory (NPPTL) evaluated the SCBA and the summary evaluation report is included as Appendix 1. The full report can be found at: https://www.cdc.gov/niosh/npptl/ppe-fireservice/default.html .

Weather Conditions

At the time of the incident, the sky conditions were clear with 10-mile visibility. The temperature was 53 degrees F. Dew point was 27 degrees F. Relative humidity was 35%. Wind speed was 16.1 mph and wind direction was northwest. Since the wind speed was greater than 10 mph, it may have assisted in the rapid fire growth once a flow path via horizontal ventilation was provided to the main living area of the residence. Barometric pressure was 29.88 [Weather Underground 2015].

Investigation

On April 12, 2015, a 38-year-old male volunteer fire fighter died in a floor collapse while working above a residential basement fire. At 22:09 hours, two engines and the fire chief from the local volunteer fire department, five apparatus from the neighboring volunteer fire department, county emergency management, and a medic unit were dispatched to a residential house fire with an occupant trapped inside. The caller reported to Dispatch that her father was inside the house and the fire was in the basement. The caller stated her father had taken sleeping pills and she wasn't able to get him out of the house. The original address was misunderstood due to the similarity in street names but was corrected a minute later by Dispatch. (The street was "Fir" but understood as "First.")

At 22:14 hours, the fire chief arrived on-scene with Medic Unit 931 and Engine 2 a minute later. They were informed that the male homeowner would be near the master bathroom, which was through the front door and first door on the left. The chief assigned Engine 2 as search and rescue. The fire chief reported smoke coming from the garage and requested mutual aid from two additional volunteer departments. The Engine 2 officer told the three Engine 2 fire fighters to mask-up. A local policeman was trying to force the door, and the Engine 2 officer had an axe and a halligan and forced the door. Heavy, brown smoke was banked to the floor. The Engine 2 officer had pulled a 1¾-inch hoseline to the door and ordered the operator to charge the line (see Diagram 3).

At 22:17 hours, Engine 1 and mutual aid Engine 1 arrived as the Engine 2 crew made entry with the hoseline. The fire chief had assigned Engine 1 as the rapid intervention crew (RIC) while en route. Engine 2 had problems with the initial hydrant, so the Engine 2 officer drove Engine 1 to the next hydrant but had issues getting the cap off. Then Engine 2 got water established at the initial hydrant.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

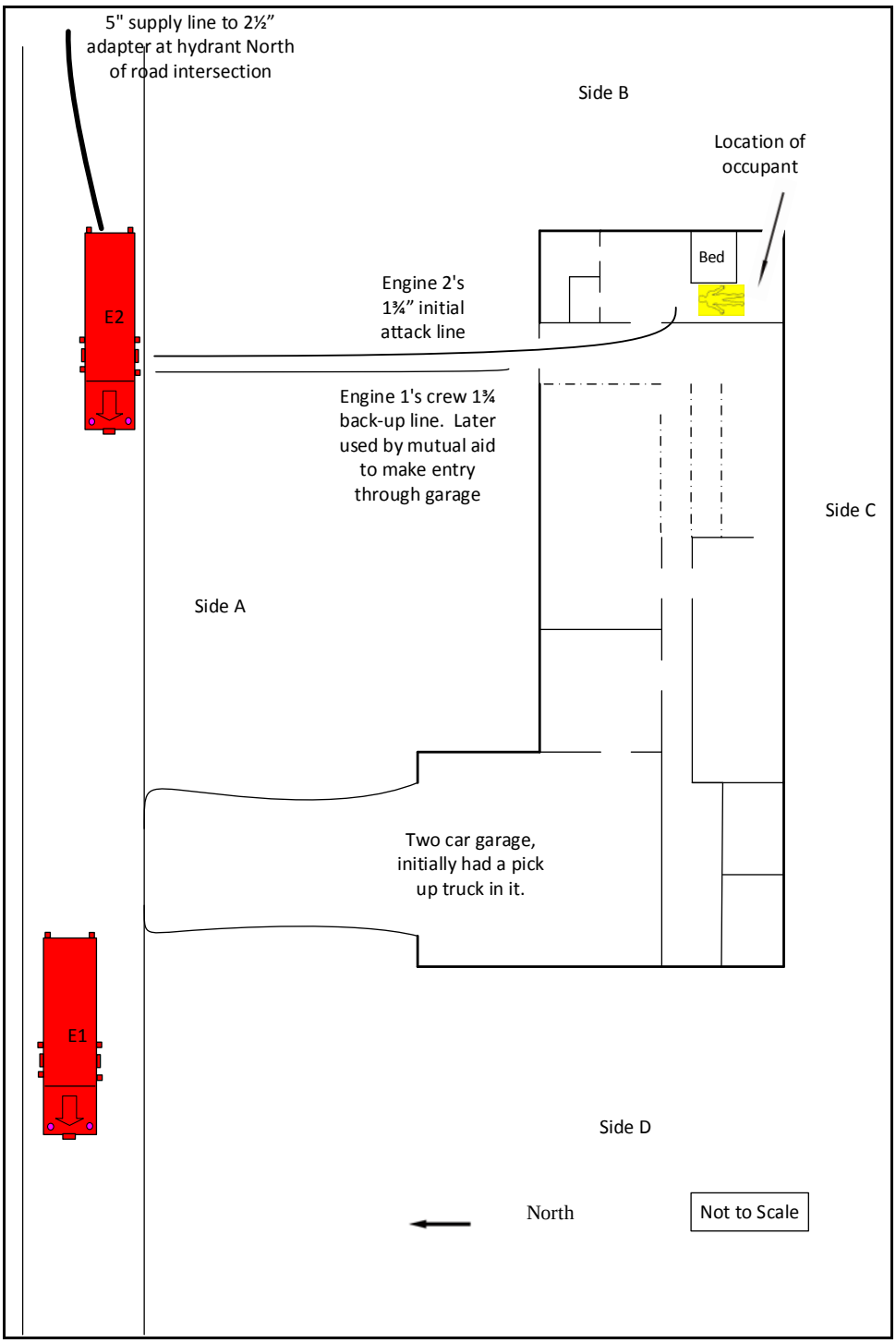


Diagram 3. Placement of initial hoselines and location of male occupant.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

At 22:19 hours, Rescue 1 arrived on-scene. The Engine 2 crew searched the bathroom then heard erratic breathing and located the homeowner on the floor near the bed (see Diagram 3). The crew tried to move him but he was stuck and their low-air alarms were going off. The crew left the nozzle near the victim, and as they met the Engine 1 crew at the door, they told the Engine 1 crew to follow the hoseline to the occupant.

The Engine 1 officer had two Engine 1 fire fighters deploy another 1¾-inch hoseline from Engine 2 as back-up at the door. The Engine 1 crew made entry doing a left-hand search in zero visibility. The Engine 1 officer yelled to his crew to see if they were with him; the crew was not, so the Engine 1 officer returned to the front door. One Engine 1 fire fighter had a regulator issue so the officer had them wait at the master bedroom door before completing the search. The crew fixed the regulator issue and started a left-hand search ending up in the bathroom. He made a second pass in the bathroom and crawled into the bathtub, he then started a left-hand search. He made entry into the bedroom but didn't feel anybody so he stopped and listened. He heard erratic breathing. Then an Engine 1 fire fighter felt an arm and started pulling, but the occupant was stuck. He radioed Command and said he found the occupant but was low on air and needed assistance. The low-air alarm sounded and the Engine 1 crew exited the front door.

Rescue 1 had established a third crew at the door as the second crew exited. A positive pressure ventilation (PPV) fan had been placed at the front door. The Rescue 1 crew followed the hoseline in and moved the occupant to the front door. Several fire fighters carried the male occupant to the medic unit to continue CPR.

At 22:32 hours, the second mutual aid volunteer fire department arrived with an officer and two fire fighters as the occupant was being taken to the medic unit. They noticed a PPV fan at the door and that the windows on Side A had been ventilated. Fire had vented out the C/D corner of the structure and the fire chief requested an interior attack crew. The first mutual aid volunteer fire department crew with a 1¾-inch hoseline made entry through the dark, smoke-filled garage and crawled into the laundry room (see Photo 3). The second mutual aid fire department crew was assigned exterior suppression at the Side A dining room windows. The second mutual aid fire department officer used a thermal imager through the windows and could see the dining and kitchen area.

At approximately 22:37 hours, County Emergency Management arrived on-scene. The interior three-man crew made their way into the kitchen about 5 feet when the third fire fighter on the line yelled to get out. The room seemed to flash, causing a loud explosion with fire all around and ceiling material coming down on them. The third fire fighter on the line jumped up and went left, down the hallway out of sight of the other two fire fighters. The second fire fighter switched with the nozzleman and hit the ceiling with water (see Photo 4). The fire fighters then followed the hoseline out past the pick-up truck, which was still in the garage. The third fire fighter told the fire chief that he needed to get the pick-up out of the garage. The two interior fire fighters thought the third fire fighter who yelled get out had made it out and thought they noticed his gear in the yard.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Photo 3: View from laundry room across hallway into the kitchen.
(*Courtesy of the Fire Marshall's Office.*)

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Photo 4. View from rear sliding doors looking into the kitchen and the floor collapse in the kitchen area. The entry into the kitchen is just to the right of the refrigerator. (*Courtesy of the Fire Marshall's Office.*)

At 22:38 hours, the third mutual aid fire department arrived at the staging area and started walking to the fire scene. At 22:41 hours, the medic unit departed for the hospital with the occupant. The third mutual aid fire department reported to Command and were told to have three of their fire fighters operate the hoseline on Side C and two fire fighters (the mutual aid chief was one of the two) on a hoseline on Side A for defensive operations. At approximately 22:43 hours, the fire chief ordered an evacuation and called for a personal accountability report (PAR). The two interior crew members who exited the garage grabbed a 2½-inch hoseline and flowed water through the laundry room window into the kitchen for about 5 minutes. PARs had been called and everyone, including the initial mutual aid fire department's chief, reported everyone was accounted for, even though no one was able to positively locate the third fire fighter. Defensive operations continued on Side A and on Side C by several mutual aid fire departments.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

After several fire fighters tried locating the missing fire fighter (one even drove back to the station), he could not be accounted for. A crew had even made entry down to the basement via the interior stairs and were searching for the fire but were driven back by heat, smoke, and water that had collected in the basement. At 23:04 hours, the fire chief stopped suppression operations to look for the missing fire fighter. The initial mutual aid fire department members grabbed a chainsaw and cut a triangular hole in the Side D wall up from the C/D corner to look for and possibly locate the missing fire fighter (see Photo 5). Fire was present in the collapsed floor joists and basement area. A hoseline was used to knock down the fire. The Engine 1 officer had been doing a 360, searching the exterior and asking questions on the whereabouts of the missing fire fighter. After the initial attack, crew members had finished cutting the exterior hole, and the Engine 1 officer inquired how far they made it into the kitchen. The officer and two other fire fighters formed a RIC, and with the fire chief's concurrence, they made entry through the garage. They advanced into the hallway looking into the kitchen and could see fire in the collapsed area of floor. The second mutual aid fire department officer, using a thermal imager through the dining room window, observed the RIC making entry near the kitchen. Heat was building up in the southwest corner of the structure, and the Engine 1 officer was concerned about a flashover, so the RIC backed out through the garage.

At 23:08 hours, the fire chief called for a second evacuation and resumed exterior attack. A second hole was cut on the Side D exterior bathroom wall. The floor collapse and the basement were visible through this hole. The fire was knocked down, and water pumps were set up on Side B and Side C to pump water out of the basement. At approximately 01:30 hours, a fire fighter from the missing fire fighter's department was using a pole through the Side D hole to move debris and noticed reflective trim on the missing fire fighter's turnout gear (see Diagram 4). The local urban search and rescue team arrived on-scene to shore up the structure so the fire fighter could be safely removed. At approximately 09:37 hours, the fire fighter's body was recovered.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Photo 5. Initial hole cut on Side D to look for the missing fire fighter.
(*Courtesy of the Fire Marshall's Office.*)

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

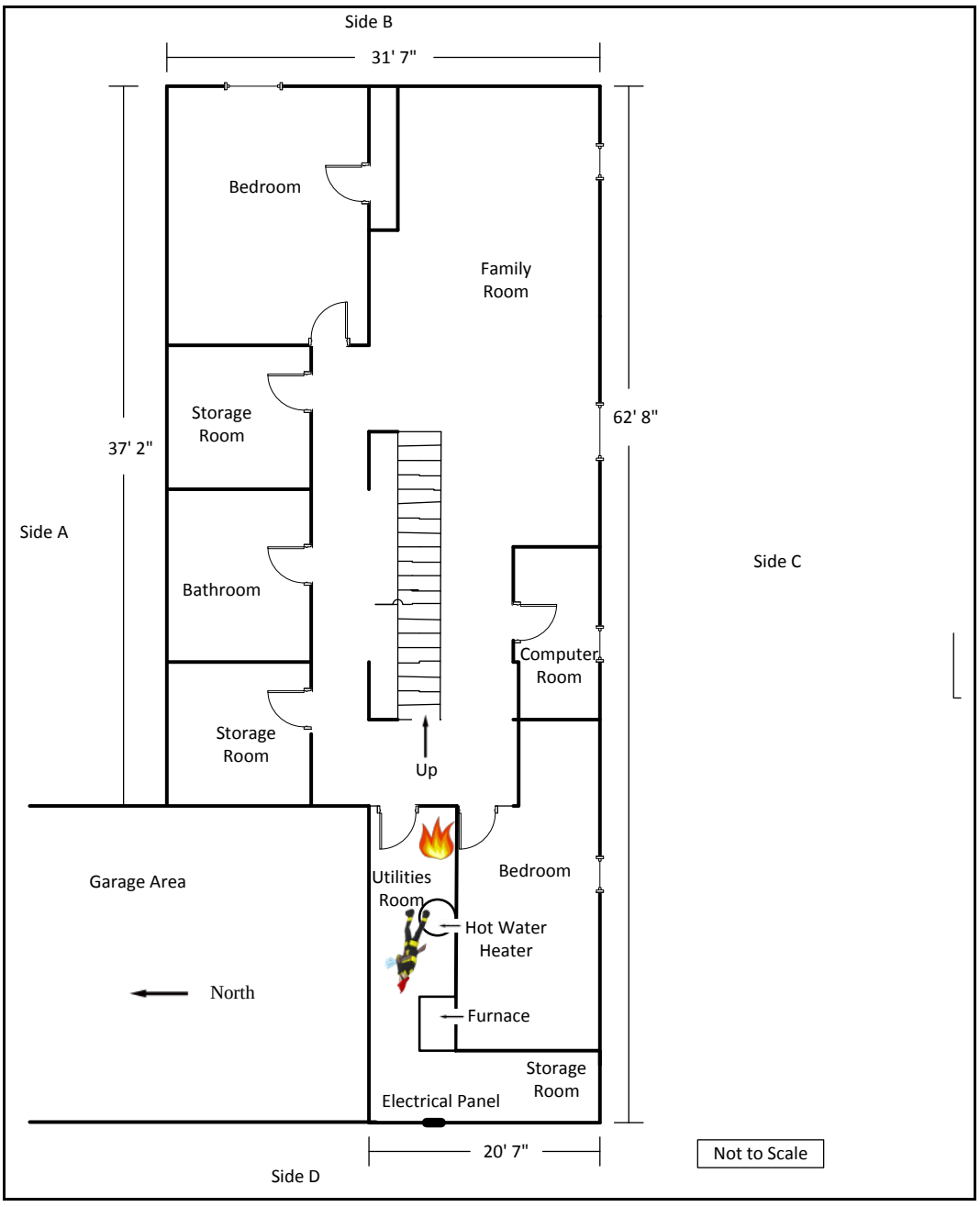


Diagram 4. Approximate location of fire fighter found in basement.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Fire Behavior

According to the state fire marshal's office, the cause of the fire was accidental. The origin of the fire was in the basement's utility room near the ceiling around the exhaust vent pipe that served both the furnace and water heater.

Indicators/contributors of significant fire behavior were:

- Occupant reported another occupant trapped and fire in the basement.
- Occupant delayed calling 911 by trying to get other occupant out.
- Upon arrival, heavy smoke coming out of garage.
- Multiple attempts were made to locate nonresponsive occupant in dark smoke with no water on the fire.
- It took twenty minutes getting the occupant out of the structure while the fire continued to grow.
- PPV fan placed at front door and windows vented at B/C corner with winds of 16 mph, possibly providing a low pressure vent for fire in basement.
- Fire vented at southwest corner (Side C/D) of structure.
- Flash-over-type fire seen in middle of structure with crews inside.
- Evacuation order given.
- Defensive operations.

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:

- Delay in notification to the fire department
- Delay in fire suppression
- Blood alcohol level above the legal limit
- Concealed basement fire
- Crew integrity
- Self-contained breathing apparatus operation/maintenance
- Fireground communications

Cause of Death

According to the coroner's report, the cause of death was listed as asphyxia due to smoke inhalation. Soot was present in his airway with a minimal carbon monoxide level. Thermal injuries consisted of generalized second-degree burns with third-degree burns on his face, hands, and lower left leg. Acute ethanol intoxication was present in his blood stream, with a blood alcohol content of 0.189.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Recommendations

Recommendation #1: Fire departments should ensure that a fire attack is conducted concurrently with rescue operations and a risk-versus-gain analysis is done after the rescue is completed.

Discussion: At any incident, life safety (of civilians and fire fighters) is always the first priority, followed by incident stabilization and then property conservation. Fire fighters are tasked with saving lives as their first priority when they arrive on the fireground. The primary search is a fundamental skill fire fighters perform. Thus, ensuring the safety of fire fighters is a continuous process throughout the incident. A sound risk management plan ensures that the risks are evaluated and matched with actions and conditions. The following risk management principles should be used by incident commanders:

- Activities that present a significant risk to the safety of fire fighters should be limited to situations that have the potential to save endangered lives.
- Activities that are routinely employed to protect property should be recognized as inherent risks to the safety of fire fighters, and actions should be taken to reduce or avoid these risks.
- No risk to the safety of fire fighters should be acceptable where there is no possibility to save lives or property [Brunacini 2002].

The strategy and tactics of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. The priority is to get a fire department unit to the rear of the structure on Side Charlie. However, unless an obvious life safety issue exists (e.g., victims requiring immediate assistance), interior fire-fighting operations should not commence until a report from Side Charlie is received. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Bravo, Side Charlie, and Side Delta may be delegated to another engine company on the first alarm. Even if a 360-degree size-up can be conducted, the second-due engine company or third-due engine company and the second-due truck company should be assigned to Side Charlie.

A radio report of conditions, including those on Side Charlie, should be transmitted over the assigned tactical channel to the incident commander and the dispatch center. The transmission should include the following:

- Smoke and fire conditions, with an emphasis on identifying the seat of the fire. The initial radio report from the first arriving unit for a structural fire should include the signal for a working fire, the number of stories, type of occupancy, and location of fire. This lays the foundation for additional reports and serves as notification to responding units as to the type of standard operating procedure (SOP) to implement.
- If critical building description information for the address is transmitted through the critical incident dispatch system (CIDS), then this information would aid in implementing or adjusting SOPs. CIDS could contain information that would necessitate alternative action to fulfill operational goals.
- Building features—e.g., number of stories (particularly if there is a difference between Sides Alpha and Charlie).

- Basement access and type.
- Other life or safety hazards.

Any change to operational priorities or responsibilities based on the above size-up should be clearly communicated to Command, all responding units, and the dispatch center via the assigned tactical radio channel [Township of Spring Fire Rescue 2013; ULFSRI and FirefightersCloseCall.com, no date]. Command is then obligated to re-broadcast and receive acknowledgement from all operating companies.

Stretching and operating hoselines is the primary function of an engine company. All members must realize the importance of the initial line stretched at a structural fire. More lives are saved at a fire by the proper positioning and operating of hoselines than by all other life-saving techniques available to the fire-fighting forces [NIOSH 2009a]. The majority of structural fires are controlled and extinguished by this initial line. The **first line** is placed between the fire and any persons endangered by it. This is accomplished by stretching the hoseline via the primary means of egress, usually the main stairway. This tactic:

- Provides a base for confining and controlling the fire.
- Allows occupants to evacuate via the stairs.
- Allows fire fighters to proceed above the fire for search operations [FDNY 2013].

In most cases, the first line is stretched via the interior stairs to the location of the fire. The purpose of this line is to protect the primary means of egress for occupants evacuating the building and to confine and extinguish the fire. Prior to opening the door to the fire area for advancement of the line, the engine company officer **must** ensure that no fire fighters will be exposed in the hallway or on the stairs above as the fire attack is initiated. This can be done via portable radio or in person [FDNY 2013].

When the fire attack is being initiated, the engine company officer shall announce via portable radio to Command that "water is on the fire." This is a significant incident benchmark that must be met. If the engine company officer can't get water or there is a delay of getting water on the fire, this must be communicated to Command as well [Brunacini 2002].

All members must be alert to fireground communications concerning hoseline placement and the commencement of fire-fighting operations so that crews can avoid opposing hoselines and getting hit with high-pressure water and debris.

At any fire, there are tasks that need to occur regardless of the occupancy: initial on-scene report upon arrival; initial risk assessment; situational report; water supply; deployment of handlines and back-up handlines; search and rescue, ventilation, and rapid intervention crews; ground and aerial ladder placement; fire attack and extinguishment; and salvage and overhaul. Over the past few years, fire fighters have adopted an acronym that details the steps to take when confronted with a fire: *SLICERS*.

- **S**ize up all scenes.
- **L**ocate the fire.

- **I**dentify and control the flow path (if possible).
- **C**ool the heated space from a safe location.
- **E**xtinguish the fire.
- **R**escue and **S**alvage are actions of opportunity that may occur at any time [ULFSRI and FirefightersCloseCall.com, no date].

The "flow path" of a fire is the movement of a fire determined by incoming and outgoing vents for air, since air is what allows a fire to burn. Identifying and controlling the flow path is about knowing where the air comes from and where it's headed. The importance of identifying and using flow path information cannot be underestimated. The identification of flow path is an item that should find its way into every after-action review. While trying to locate the fire, cooling the heated space from a safe location while ensuring for the safety of the fire fighters is important. Once the fire is under control, the fire can be completely extinguished.

The rescue and salvage operations are self-explanatory—if anything can be saved, save it. These two actions are always active, right from sizing up to extinguishment.

Procedures developed for fireground operations should be flexible enough to allow the change in the incident action plan due to:

- Life hazard (must be given first priority).
- Problems with water supply and water application.
- Volume and extent of fire, requiring large-caliber streams.
- Location of the fire, inaccessible for hand-line operations.
- Materials involved in the fire and explosion potential compounding the problem.
- Exposure problems where further fire spread would be a major concern.
- Stability of the structure, which would be dependent on the condition of the structural components of the building and the intensity and duration of the fire [Brunacini 2002].

At this incident, the incident commander was informed that a civilian was in the home and of his general location. A resident stated that there was fire in the basement. The initial efforts were in rescuing the civilian before water suppression efforts were initiated. The rescue was hindered by heavy, dark smoke and the victim being caught on a piece of furniture. Use of a thermal imager may have assisted in locating the civilian. Additionally, the deployed hoseline could have been used to cool the atmosphere, improving fire fighter operations, while searching for the civilian. The initial RIC was deployed to help rescue the victim. Once the civilian was brought outside, an updated risk assessment needed to be done and a RIC needed to be re-established.

Recommendation #2: Fire departments should ensure that officers and fire fighters are trained in current basement fire strategies and tactics.

Discussion: Basement fires can be taxing and test a fire fighter's knowledge and skill on how to combat them safely and effectively. Fire burning underneath floors can significantly degrade the floor system with little indication to fire fighters working above [NIOSH 1999, 2009b]. Fire fighters need to

be aware of rapid heat buildup, little or no ventilation, limited accessibility, and the potential storage place for unknown hazards (e.g., combustibles, hazardous materials, and flammable liquids). Also of concern for fire departments is how to determine how long a fire has gone undetected. Fire fighters should be aware of what is stored on the floor directly above a basement fire, what the finished floor is comprised of (e.g., terrazzo, plywood, tongue-and-groove, or tile), and what the floor's structural members are comprised of (e.g., engineered wood floor joists, concrete, or steel). Structural support members may be directly exposed to fire, causing them to weaken and increase the likelihood of an above-floor collapse. Interior crew(s) intending to operate on the floor above a basement fire should limit their operating time, especially if ventilation, suppression, and accessibility are not progressing. The floor's structural members will continue to weaken as fire and heat intensify. Specifying an exact length of time for how long suppression crew(s) should operate above a basement fire is difficult, and incident commanders should make that determination by performing a hazard analysis/risk assessment. In this incident, the fire department did not have an SOP specifically addressing strategies and tactics when combating basement fires. SOPs should be developed to address structural fire-fighting operations specific to basement fires, as these types of fires present a complex set of circumstances, and following established SOPs will minimize the risk of serious injury to fire fighters.

During this incident, fire fighters were unable to access the basement, opted not to ventilate the basement fire, and were unaware of the fire load found within the basement. The use of a cellar nozzle, like a Bresnan distributor, or by putting hoselines through the basement windows during the initial stages of the basement fire may have assisted in containing the fire and/or allowing better operating conditions for fire fighters to access the basement [IFSTA 2013]. Attempts were made to flow water on the first floor where fire had vented, but this effort was not successful. Fire fighters should also recognize that fire venting through a floor is a late indication of a weakened floor system.

Recommendation #3: Fire departments should ensure that a zero-tolerance alcohol policy is established and enforced.

Discussion: Fire departments should strictly prohibit any member of the fire department from responding to a call if they have been drinking. According to the International Fire Chiefs Association (IAFC) position statement on drug and alcohol awareness, "If someone has consumed alcohol within the previous 8 hours, or is still noticeably impaired by alcohol consumed previous to the 8 hours, they must voluntarily remove themselves from the activities and function of the fire or emergency services agency/organization, including all emergency operations and training." In addition, the IAFC policy states, "No member of a fire and emergency services agency/organization shall participate in any operational or support aspect of the organization while under the influence of alcohol, including but not limited to, any fire and emergency operations, fire-police, training, administrative functions, rehab, etc." [IAFC 2012].

Fire departments should adopt the International Association of Fire Chief's Zero-Tolerance Policy for Alcohol and Drinking to prohibit the use of alcohol by members of any fire or emergency services agency/organization at any time when they may be called upon to act or respond as a member of those

departments. Fire departments should develop written policies and have procedures in place to enforce this policy.

In this line-of-duty death, the fire fighter was found to have an acute level of ethanol intoxication in his blood stream. This may have impaired his judgment and his motor skills.

Recommendation #4: Fire departments should ensure that an accountability system is established prior to entry and personnel accountability reports are accurate.

Discussion: The personnel accountability system was designed and is operated to ensure that fire fighters do not become lost or missing in the hazard zone. The system tracks fire fighters by location and function. An integral part of the accountability system is to make sure that the fire fighters who are assigned and operating in the hazard zone are accounted for, starting with the initial operations and throughout the entire incident. Also, a process must be in place to periodically check to make sure that all members operating in the hazard zone are accounted for.

A personnel accountability system readily identifies both the location and function of all members operating at an incident scene [Bachrach and Egstrom 1987; Corbin 2000]. The philosophy of the personnel accountability system starts with the same principles of an incident management system—company unity and unity of command. Unity can be fulfilled initially and maintained throughout the incident by documenting the situation status and resource status on a tactical worksheet.

One of the most important functions of command safety is for the incident commander to initiate an accountability system that includes the functional and geographical assignments at the beginning of operations and until the termination of the incident. It is very important for the first on-scene resource to initiate an accountability system. This initial system allows the passing or transfer of information to the next officer who assumes command upon his/her arrival [Bachrach and Egstrom 1987].

A functional personnel accountability system requires the following:

- Development and implementation of a departmental standard operating procedure.
- Necessary components and hardware.
- Training all members on the operation of the system.
- Strict enforcement during emergency incidents.

Some methods and tools for resource accountability are:

- Tactical worksheets
- Command boards
- Apparatus riding lists
- Company responding boards
- Electronic bar-coding systems
- Accountability tags or keys (e.g., PASSPORT System) [Bachrach and Egstrom 1987]

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Resource accountability should be assigned to personnel who are responsible for maintaining the location and status of all assigned resources at an incident. As the incident escalates, resource status would be placed on the implemented accountability system. This function is separate from the role of the incident commander. The incident commander is responsible for the overall command and control of the incident. Due to the importance of responder safety, resource status should be assigned to a dedicated member as the size and complexity of the incident dictates. A number of positions could function in this role, including an incident command technician, staff assistant, chief officer, or other designated member. As the incident escalates and tactical-level management components (e.g., divisions or groups) are assigned, the resource status officer (accountability officer) works with the division or group supervisors to maintain on-going tracking and accountability of members. A properly initiated and enforced personnel accountability system enhances fire fighter safety and survival. It is vital that resources can be identified and located in a timely manner.

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 [Bachrach and Egstrom 1987]. The PAR should be conducted every 15–20 minutes or when benchmarks are met.

In order for the personnel accountability system to function, it must include a standard operating procedure that defines each function's responsibility in making this process successful on the fireground. Also, a training component—both classroom and practical—must occur to ensure this process operates properly during emergency incidents.

During this incident, the fire fighter was unaccounted for and his location was unknown. The fire fighter had yelled get out and got out of the kitchen before his crew. When the rest of the crew got outside they saw gear and a pack in the yard thinking it was their member's gear. It was later determined that they did not have an accurate PAR check. Crew integrity was lost when the crew separated in the kitchen area.

Recommendation #5: Fire departments should ensure that a respiratory protection program is established and maintained.

Fire fighting is a physically and psychologically demanding occupation that requires strength, physical agility, and endurance as well as the ability to operate effectively with the limitations from self-contained breathing apparatus (SCBA) and other personal protective equipment. The fact that a fire fighter may have the physical ability to perform functions such as hose advancement or rescuing victims with their vision un-obscured, does not mean that the fire fighter can perform any of those functions while using required personal protective equipment such as SCBA. Fire departments should recognize and implement SCBA best practices such as described by the minimum requirements outlined in [NFPA 2013a].

During the interview process, it was established that many of the volunteer fire departments did not have the funding or resources to adequately establish or maintain a respiratory protection program.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Recommendation #6: Fire departments should ensure that SCBAs are functional and maintained in accordance with manufacturer guidelines.

Discussion: The following standards address the maintenance and use of self-contained breathing apparatus (SCBA) and personal alert safety system (PASS) devices:

- NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus for Emergency Services [NFPA 2013d]
- NFPA 1852 Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus [NFPA 2013c]
- NFPA 1500 Standard on Fire Department Occupational Safety and Health Program [NFPA 2013b]
- NFPA 1989 Standard on Breathing Air Quality for Emergency Services Respiratory Protection [NFPA 2013e]

The SCBA is an integral part of the fire fighter's protective ensemble, and fire fighters cannot safely enter hazardous environments requiring respiratory protection without a properly functioning SCBA. Fire departments need to ensure that all respiratory protection equipment is appropriate for the task and is in proper working order with no defects. All needed repairs must be completed thoroughly or proper replacements provided. Fire fighters need to be instructed in the proper use, care, and inspection of personal fire-fighting gear. Department SOPs need to emphasize and officers need to enforce the proper inspection procedures for all respiratory protection equipment including SCBA and PASS devices. Department SOPs should include procedures to remove from service and replace defective respiratory protection equipment including PASS devices. According to NFPA 1852, when a SCBA is assigned to an individual user for a duty period, the individual user shall inspect the SCBA at the beginning of each duty period [NFPA 2013c]; when the SCBA has an integrated PASS, the inspection shall include the following assessments:

- Wear and damage
- Covers/compartments for secure attachment
- All operating modes for proper function
- Low-battery warning signal

NFPA 1500 states that each PASS device shall be tested at least weekly and prior to each use and shall be maintained in accordance with the manufacturer's instructions [NFPA 2013b]. It is vital that departments have a systematic routine that requires the SCBA and all of its components (including the PASS device) be examined for readiness at the beginning of each tour of duty. In this incident, had the victim discovered that this component of the SCBA was not operational at the start of the tour, the unit could have been placed out-of-service and another functional unit placed in-service.

In this incident, it was reported to NIOSH investigators that PASS devices may have been nonoperational due to batteries not being replaced when needed. Due to the extreme heat conditions the fallen fire fighter's SCBA encountered, it is uncertain whether this was a contributing factor in the incident.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Recommendation #7: Fire departments should ensure that fire fighters wear proper personal protective equipment on the fireground.

Discussion: A fire fighter's responsibility is to maintain physical and mental readiness to handle situations that often are inherently dangerous. A fire fighter's situational awareness and ability to apply the training they received leads to a successful outcome. Properly wearing personal protective equipment (PPE) on the fireground is critical to a fire fighter's safety. Not properly protected means not wearing gloves, not using the helmet strap, and not donning their hood because they want to use their ears to sense heat among other things. It also means not ensuring the lining of their coat and pants are properly in place and secured, not having their collar up and deployed with their helmet ear covers down, not completely closing their gear so there's no exposed skin, and finally, not wearing and using their SCBA [NFPA 2013b].

There are several reasons why fire fighters don't properly wear their gear, and none of them are justifiable. The reasons can be traced back to lack of training, lack of policy and procedures, lack of enforcement by fire officers, lack of example by fire officers and other fire fighters, and overconfidence [Grilliot 2007]. A recent study suggests that pressure at the peer and organizational levels appears to be essential considerations fire fighters undertake when choosing whether or not to engage in safety behavior [Maglio et al. 2016].

In this incident, fire fighters were fighting fire outside the structure without their full ensemble of PPE and SCBA.

Recommendation #8: Fire departments should ensure that a staging area manager is assigned to the staging area to release crews once assignments are given.

Discussion: During fireground operations, the incident commander may need a resource(s) beyond those resources that are already operating on the fireground. When Command identifies a task that needs to be done, Command chooses the proper resources, confirms their availability, and then orders them into action. Managing incident operations in this fashion is how the incident management system coordinates and incorporates all of the efforts of multiple units into a single, cohesive operation [MABAS 2017].

Staging is the function/location designated at the incident that is used to position uncommitted resources that are immediately available for assignment (within 3 minutes). The incident scene can quickly become congested with personnel and equipment if not managed effectively. During incidents when companies are involved in investigative operations or when companies have not yet been assigned, additional responding equipment will normally stage one block from the incident in the direction of travel. This will provide more flexibility in the use/clearing of resources at an incident. When additional resources or alarms are requested, incident commanders should establish a staging area and designate a location as soon as possible. A separate tactical channel should also be requested for staging so that the tactical channel used by on-scene resources does not become overrun with radio traffic. The first uncommitted company arriving at the staging area will be responsible for staging (staging area manager). Staging reports to the incident commander until such time as Operations is

established. In the expanded organizational structure, all resources within Staging will be under the direct control of the operations section chief [VBFD 2011].

The following major responsibilities of the staging area manager should apply to any incident:

- Establish layout of staging area.
- Post areas for identification and traffic control.
- Provide check-in for incoming resources.
- Determine required resource reserve levels from the incident commander or the operations section chief.
- Contact the operations section chief or incident commander when reserve levels reach minimum.
- Maintain and provide status to resource unit of all resources in staging area.
- Respond to the incident commander or operations section chief requests for resources.
- Request logistical support for personnel and/or equipment as needed.
- Maintain staging area in an orderly condition.
- Demobilize or move staging area as required.
- Maintain unit log [NFPA 2014].

NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety* Paragraph 5.10.1.8.1 states, "The incident management system shall provide a standard system to manage reserves of responders and other resources at or near the scene of the incident." Additionally, NFPA 1561 Paragraph 5.10.1.8.2 states, "When emergency activities are being conducted in a location where there would be a delay in activating staged resources, the incident commander shall establish staging areas close to the area where the need for those resources is anticipated" [NFPA 2014].

Staging provides a standard method to keep reserves of responders, apparatus, and other resources ready for action close to the scene of an incident. Staging also provides a standard method to control, record, and account for the arrival of such resources and their assignment to specific activities. When resources are dispatched to assist at working incidents, they should be dispatched to a designated staging or base area where they can be ready for assignment when required by the incident commander. This process helps the incident commander to keep track of the resources that are on the scene and to know which are available for assignment, where they are located, and where specific units have been assigned.

Incident commanders should attempt to keep reserves of responders, equipment, and supplies available to rotate assignments with fatigued crews. Equipment failures should be anticipated and supplies should be ordered to the scene in time and in sufficient quantities to provide a safe margin over anticipated needs. The ability to provide these reserves is dependent on the amount of resources that are available. Every fire department should have plans to utilize its available resources to maximum advantage and have contingency plans to obtain resources from other departments that might be available [NFPA 2014].

It is generally desirable to keep staged resources in locations where they can be ready for action within 3 minutes. In some cases, particularly where imminent hazards exist, it is advisable to keep an immediate response capability in a state of readiness in a safe location that provides immediate access to the area.

The term **Base** is often used to refer to a more remote location where standby resources are gathered but are not available for immediate action. As needed, resources can be moved up to a staging location where they are ready for immediate action. An example is a high-rise building where apparatus are parked at a safe distance from the building and responders and equipment are moved in to stand by in Staging on a safe floor below the fire level. Base is the location at which primary support activities are performed, including all equipment and personnel support operations. It is also designated as the initial gathering point for resources not immediately available for assignment. Base will most commonly be used during incidents involving high-rise structures, hazardous materials, and wildland incidents. The fire officer or fire fighter managing Base, reports to Command unless the Logistics Section has been established. The term "Base" is used for its radio designation [VBFD 2011].

At this incident, companies that were requested on additional alarms reported to the staging area and staged their apparatus. Companies walked directly to the scene, reported to Command, and then without an assignment started performing fireground tasks.

Recommendation #9: Local governments should consider requiring fire fighters be trained to state minimum training requirements.

Discussion: State training standards have been established to increase competency and reliability of fire service personnel; improve and expand the professional training available to fire service personnel by developing uniform minimum standards for basic, in-service, advanced in-service, and promotional supervisory training programs, with emphasis on proper subject content and better instruction; encourage the active participation of local governments in the fire service training standards process; and develop training criteria that will enhance each local government's fire prevention and life safety activities.

The South Dakota Fire Marshal Office oversees and coordinates the Fire Service Training Program. The State Fire School offers Firefighter I and II pre-certification training that most local departments always require.

In this incident, 48 of the 53 firefighters were state certified to the IFSTA FF I and FF II Standard. The county fire chief's association was helping to provide formal training to the IFSTA FFI & FFII Standards, but there was no county or municipality regulatory requirement at the time of this incident.

References

Bachrach A, Egstrom G [1987]. Stress and performance in diving. San Pedro, CA: Best Publishing.

Brunacini AV [2002]. Fire command. Quincy, MA: National Fire Protection Association.

Corbin DE [2000]. Seeing is believing. Occupational Safety and Health *69*(8):60–67.

FDNY [2013]. Taxpayer fires. In: Firefighting procedures. Vol 1. Book 4. New York, NY: Fire Department of New York, http://sageauthoring.com/fdny/construction/tp01.pdf.

Grilliot W [2007]. To keep safe, wear your PPE. Fire Apparatus and Emergency Equipment Magazine, April, http://www.fireapparatusmagazine.com/articles/print/volume-12/issue-4/features/to-keep-safe-wear-your-ppe.html.

IAFC [2012]. Position statement: drug and alcohol-free awareness. Fairfax, VA: International Association of Fire Chiefs, http://iafc.cms-plus.com/files/1ASSOC/IAFCposition_DrugAlcoholFreeAwareness.pdf.

IFSTA [2013]. Essentials of fire fighting. 6th ed. Stillwater, OK: Fire Protection Publications, International Fire Service Training Association.

MABAS [2017]. MABAS Division 201: operations manual. Version 1.1. Mishawaka, IN: Mutual Aid Box Alarm System, https://www.dropbox.com/s/eo9j9emwafj770u/MABAS%20Ops%20Manual.pdf?dl=0.

Maglio MA, Scott C, Davis AL, Allen J, Taylor JA [2016]. Situational pressures that influence firefighters' decision making about personal protective equipment; a qualitative analysis. Am J Health Behav *40*(5):555–567.

NFPA [2013a]. NFPA 1404 Standard for fire service respiratory protection training. Quincy, MA: National Fire Protection Association.

NFPA [2013b]. NFPA 1500 Standard on a fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

NFPA [2013c]. NFPA 1852 Standard on selection, care, and maintenance of open-circuit self-contained breathing apparatus (SCBA). Quincy, MA: National Fire Protection Association.

NFPA [2013d]. NFPA 1981 Standard on Open-circuit Self-contained Breathing Apparatus for the Fire Service. Quincy, MA: National Fire Protection Association.

NFPA [2013e]. NFPA 1989 Standard on breathing air quality for emergency services respiratory protection. Quincy, MA: National Fire Protection Association.

NFPA [2014]. NFPA 1561 Standard on emergency services incident management system and command safety. Quincy, MA: National Fire Protection Association.

NIOSH [1999]. NIOSH alert: Preventing injuries and deaths of fire fighters due to structural collapse. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH) Publication No. 1999-146, https://www.cdc.gov/niosh/docs/99-146/pdfs/99-146.pdf.

NIOSH [2009a]. Nine career fire fighters die in rapid fire progression at commercial furniture showroom—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services,

Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2007-18, http://www.cdc.gov/niosh/fire/pdfs/face200718.pdf.

NIOSH [2009b]. NIOSH workplace solutions: preventing deaths and injuries of fire fighters working above fire-damaged floors. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH) Publication No. 2009-114, http://www.cdc.gov/niosh/docs/wp-solutions/2009-114/default.html.

Township of Spring Fire Rescue [2013]. Initial fireground assessment standard operating procedure, section 3: response to alarms, subsection 3.00.01. Township of Spring, PA: Township of Spring Fire & Rescue.

ULFSRI, FirefightersCloseCall.com [no date]. *S.L.I.C.E. – R.S.* Columbia, MD: Underwriters Laboratory Fire Safety Research Institute. FirefightersCloseCall.com, http://modernfirebehavior.com/s-l-i-c-e-r-s/.

VBFD [2011]. Incident command system. Virginia Beach, VA: Virginia Beach Fire Department, SOP FS 5.01.

Weather Underground [2015]. Weather history for KFSD—April 2015. Atlanta, GA: The Weather Channel Interactive, Inc., https://www.wunderground.com/history/airport/KFSD/2015/4/12/DailyHistory.html?req_city=Sioux+Falls&req_state=SD&req_statename=&reqdb.zip=57101&reqdb.magic=1&reqdb.wmo=99999.

Investigator Information

This incident was investigated by Matt E. Bowyer, General Engineer, and Tim Merinar, Safety Engineer and Project Officer, with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, located in Morgantown, West Virginia. An expert technical review was provided by Kevin D. Quinn, Deputy Chief, Union Fire District, South Kingston, Rhode Island, and Chairman, National Volunteer Fire Council Executive Committee. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

Disclaimer

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Appendix I

Self-Contained Breathing Apparatus

National Personal Protective Technology Laboratory
Technology Evaluation Branch

Disclaimer

Investigator Information
The SCBA inspection and this report were written by Thomas D. Pouchot, General Engineer, Technology Evaluation Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Bruceton, Pennsylvania.

The purpose of Respirator Status Investigations is to determine the conformance of each respirator to the NIOSH approval requirements found in Title 42, *Code of Federal Regulations*, Part 84. A number of performance tests are selected from the complete list of Part 84 requirements and each respirator is tested in its "**as received**" condition to determine its conformance to those performance requirements. Each respirator is also inspected to determine its conformance to the quality assurance documentation on file at NIOSH.

In order to gain additional information about its overall performance, each respirator may also be subjected to other recognized test parameters, such as National Fire Protection Association (NFPA) consensus standards. While the test results give an indication of the respirator's conformance to the NFPA approval requirements, NIOSH does not actively correlate the test results from its NFPA test equipment with those of certification organizations which list NFPA-compliant products. Thus, the NFPA test results are provided for information purposes only. Selected tests are conducted only after it has been determined that each respirator is in a condition that is safe to be pressurized, handled, and tested.

Respirators whose condition has deteriorated to the point where the health and safety of NIOSH personnel and/or property is at risk will not be tested.

Volunteer Fire Fighter Dies in a Floor Collapse While Working Above a Residential Basement Fire—South Dakota

Status Investigation Report of a
Self-Contained Breathing Apparatus
Submitted by the
NIOSH Division of Safety Research for the Fire Department

NIOSH Task Number 20855

Investigator Information

The SCBA performance tests were conducted by Jeremy Gouzd, Karis Kline, Angie Andrews, and Jay Tarley of the Morgantown Testing Team (MTT), Evaluation and Testing Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Morgantown, West Virginia.

Background

As part of the ***National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program***, the National Personal Protective Technology Laboratory (NPPTL) agreed to examine and evaluate a self-contained breathing apparatus (SCBA) identified as a Dräger ND2 PSS100 30 minute, 2216 psi unit.

This SCBA status investigation was assigned NIOSH Task Number 20855. The Fire Department and the NIOSH Division of Safety Research (DSR) were advised that NPPTL would provide a written report of the inspection and any applicable test results.

The SCBA unit was sealed as delivered to DSR at the NIOSH facility in Morgantown, WV on April 29, 2016. The unit was transported to Lab H1513, for secured storage. The SCBA unit was removed from secured storage for inspection on July 5, 2016 and was placed back into secured storage until the day of performance testing on July 7, 2016.

SCBA Inspection

The unit was removed from its packaging in Lab H1513 and inspected on July 5, 2016 by Jay Tarley, Karis Kline, Angie Andrews, and Jeremy Gouzd of the MTT at NPPTL. The unit was identified as a Dräger ND2 PSS100 30 minute, 2216 psi unit with NIOSH Approval Number TC-13F-512CBRN and as the unit submitted by the NIOSH Division of Safety Research for the Fire Department. The SCBA unit was visually examined, component by component, in the condition received to determine the conformance of the unit to the NIOSH-approved configuration. The

visual inspection process was documented by photographs. Once the inspection was completed the SCBA unit was repackaged and placed back in the secured storage.

SCBA Testing

The purpose of the testing was to determine conformance of the SCBA to the approval performance requirements of Title 42, *Code of Federal Regulations*, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the conformance to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, 1997 Edition.

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

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

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

7. Airflow Performance Test [Chapter 5, 5.1.1]

Summary and Conclusions

The SCBA unit was submitted to NIOSH NPPTL by the Fire Department for evaluation. The SCBA unit was delivered to NIOSH on April 29, 2016 and extensively inspected on July 5, 2016. The unit was identified as a Dräger ND2 PSS100 30 minute, 2216 psi unit with NIOSH Approval Number TC-13F-512CBRN. The unit worn by the victim was provided with its corresponding cylinder and facepiece which were used for all testing. The unit suffered some heat damage and was in overall poor condition. Burns were found on all of the straps, the pressure reducer, and the console. The hose leading to the PASS was burned through the rubber casing, exposing the inner liner. The facepiece lens was burned and melted.

In light of the information obtained during this investigation, NIOSH has proposed no further action on its part at this time. The SCBA unit was returned to secured storage pending return to the Fire Department.

If the unit is to be placed back in service, the SCBA must be repaired, tested, cleaned and any damaged components replaced and inspected by a qualified service technician, including testing and

other maintenance activities as prescribed by the schedule from the SCBA manufacturer. A flow test is required on an annual basis, at a minimum.

Actions to be taken by the Fire Departments with SCBAs Involved in an Incident

- Any SCBA unit involved in an incident should not be placed back in service until the SCBA has been repaired, tested, cleaned, and any damaged components replaced and inspected by a qualified service technician, including such testing and other maintenance activities as prescribed by the schedule from the SCBA manufacturer.
- For all SCBA units, even those not involved in an incident, must undergo a flow test on at least an annual basis.