



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

SUMMARY

On January 20, 2005, a 39-year-old male career Captain (the victim) died after he ran out of air, became disoriented, and then collapsed at a residential structure fire. The victim and a fire fighter made entry into the structure with a handline to search for and extinguish the fire. While searching in the basement, the victim removed his regulator for 1 to 2 minutes to see if he could distinguish the location and cause of the fire by smell. While searching on the main floor of the structure, the fire fighter's low air alarm sounded and the victim directed the fire fighter to exit and have another fire fighter working outside take his place. The victim and the second fire fighter went to the second floor without the handline to continue searching for the fire. Within a couple of minutes, the victim's low air alarm started sounding. The victim and the fire fighter became disoriented and could not find their way out of the structure. The victim made repeated calls over his radio for assistance but he was not on the fireground channel. The second fire fighter "buddy breathed" with the victim until the victim became unresponsive. The second fire fighter was low on air and exited. The fire intensified and

had to be knocked down before the victim could be recovered. NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- *enforce standard operating procedures (SOPs) for structural fire fighting, including the use of self-contained breathing apparatus (SCBA), ventilation, and radio communications*
- *ensure that the Incident Commander completes a size-up of the incident and continuously evaluates the risk versus benefit when determining whether the operation will be offensive or defensive*
- *ensure that adequate numbers of staff are available to immediately respond to emergency incidents*
- *use defensive fire fighting tactics when adequate apparatus and equipment for offensive operations are not available*



Front of Structure

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

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Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

- ***ensure that ventilation is closely coordinated with the fire attack***
- ***ensure that team continuity is maintained during fire suppression operations***
- ***ensure those fire fighters who enter hazardous areas, e.g., burning or suspected unsafe structures, are equipped with two-way communications with Incident Command***
- ***instruct fire fighters on the hazards of exposure to products of combustion such as carbon monoxide (CO) and warn them never to remove their face pieces in areas in which such products are likely to exist***
- ***ensure that a Rapid Intervention Team is in place before conditions become unsafe***
- ***use guidelines/ropes securely attached to permanent objects and/or a bright, narrow-beamed light at all entry portals to a structure to guide fire fighters during emergency egress***
- ***use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area***
- ***train fire fighters on actions to take while waiting to be rescued if they become lost or trapped inside a structure***

Additionally

- ***Municipalities should establish dispatch centers that are integrated with fire response functions.***

INTRODUCTION

On January 20, 2005, a 39-year-old male career Captain (the victim) died after he ran out of

air, became disoriented, and then collapsed at a residential structure fire. On January 20, 2005, the International Association of Fire Fighters (IAFF) and the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of the fatality. On March 14 through March 16, 2005, a Safety and Occupational Health Specialist, a Safety Engineer, and a General Engineer from the NIOSH Division of Safety Research investigated the incident. Meetings were conducted with the State Police Fire Investigator, IAFF representative, and officers of the fire department. Interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's standard operating procedures (SOPs), the fire department's incident report, the victim's training records, the medical examiner's report, photographs, and drawings of the site. The incident site was visited and photographed.

Department

The combination department involved in this incident is comprised of 16 career and 12 volunteer fire fighters operating out of two stations. The department serves a population of approximately 22,000 residents in a geographic area of about 26 square miles.

Training

The State of Michigan requires that all fire fighters receive Fire Fighter I and Fire Fighter II training. The victim was National Fire Protection Association (NFPA) Level I- and Level II-certified, and he had also received training for fire officer, leadership, instructor orientation, and fire fighter health and safety. He had more than 20 years of fire fighting experience.

Structure

The structure was a tri-level, single family residence of ordinary construction which



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

encompassed approximately 4,000 square feet that was built in the 1950s. The room of fire origin was an addition to the original residence that was structurally completed in the summer of 2004. Interior finish work was still being completed in the addition. The smoke detectors were disabled by the homeowner during the new construction project.

Units for Initial Alarm

Multiple departments were dispatched to this incident; however, only those units directly involved in operations preceding the fatal event are discussed in the investigation section of this report:

- Engine 1 (Fire Fighter #1/driver, Captain/victim)
- Engine 2 (Fire Fighter #2/driver, fire fighter)
- Rescue 1(Incident Commander)
- Privately Owned Vehicle (volunteer fire fighter/pump operator)

Weather

The conditions were clear with light winds and temperatures averaging 16 degrees Fahrenheit. The average humidity was 70 percent.

INVESTIGATION

On January 20, 2005, a 39-year-old male career Captain (the victim) died when he ran out of air, became disoriented, and then collapsed at a residential structure fire. At 0704 hours Central Dispatch received a call of a possible garage fire and dispatched the local fire department at 0706 hours. *Note: Central Dispatch also received calls from neighbors reporting that they could see fire on the rear side of the structure from across the lake. This information was not relayed to the fire department.* The victim and Fire Fighter #1 arrived on the scene in Engine 1 at 0711 hours with little to no smoke showing from the front of the structure.

The owner met the victim and Fire Fighter #1 in his driveway and stated that the house was unoccupied with light smoke conditions. The owner opened the garage door which revealed light grey smoke conditions inside the garage. The victim opened a door leading to the interior and thick black smoke was banked down to the floor as the smoke pushed out into the garage. The victim radioed Central Dispatch to dispatch another engine and have them stand by at the closest hydrant. He also told Central Dispatch to advise the other responding units of the conditions. He then radioed the captain responding on Rescue 1 requesting him to assume Incident Command (IC) upon arrival. The victim and Fire Fighter #1 donned their self-contained breathing apparatus (SCBA) and made entry into the structure to search for the fire with a 1 3/4-inch handline.

The pump operator arrived in his POV at approximately 0713 hours without any bunker gear and was wearing the headset from E1 that only picks up the fireground channel. The IC arrived on the scene at approximately 0714 hours, and saw the victim and Fire Fighter #1 enter through the B-side man door inside the garage (Diagram 1). The IC immediately radioed and told all responding units to switch from the dispatch channel to the fireground channel upon arrival. He then radioed Central Dispatch to request a second alarm.

Engine 2 arrived on the scene at approximately 0721 hours and the two fire fighters were requested by the IC to force open the front door. The victim and Fire Fighter #1 continued searching the interior of the tri-level residence for the seat of the fire as the conditions worsened. The IC radioed the interior crew to see if they needed positive pressure ventilation (PPV). The victim replied that he did need ventilation and then radioed the pump operator regarding low



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

water pressure that was quickly restored. The IC had crew members start a PPV fan in the interior door from the garage (Diagram #1). The interior crew was experiencing difficulty managing the charged hoseline while searching between the different levels of the house. They reached the B-side wall of the family room inside the basement, but could not find the fire (Diagram #1). The victim told Fire Fighter #1 the fire wasn't in the current room and took out his regulator to see if he could distinguish the location and cause of the fire by smell. The victim called the IC to request assistance with the handline at 0723 hours and 23 seconds. The victim made two more transmissions to the IC with the last one stating that "it smells like food burning on the stove" at 0723 hours and 53 seconds. *Note: The victim's radio was no longer operating on the fireground channel. It is unknown how his radio got turned back to the dispatch channel. It is evident during these transmissions that the victim did not have his regulator in and was not on air.*

The victim put his regulator back in and told Fire Fighter #1 to find the kitchen. The victim and Fire Fighter #1 struggled to move the charged hoseline back up the stairs to the main level (Photo #1). They were searching the kitchen area for the fire when Fire Fighter #1's low air alarm started sounding (Diagram #2). The victim told Fire Fighter #1 to exit through the front door and send someone else in to take his place. *Note: The crew from Engine 2 had just opened the front door. Fire Fighter #1 exited and then assisted with replacing the PPV fan with one from Engine 2. The first PPV fan was flooded and running sporadically from its position inside the garage. The replacement PPV fan was operating through the man door on the B-side wall of the garage (see Diagram #1). The IC ordered the windows by the front door to be ventilated to assist with horizontal ventilation.*

Fire Fighter #2 entered the structure to assist the victim and the victim asked him to take out his regulator to see if he could distinguish what the smoke smell. Fire Fighter #2 told the victim he could not distinguish the smell and left his regulator in his facepiece. The victim proceeded to lead him in search of the fire. The crew went up the stairs to the second story without the hoseline searching for the fire. Within a couple of minutes, the victim's low air alarm started sounding.

Outside, in front of the structure, the homeowner approached the IC in the driveway and told him he thought the fire was in the furnace room. The IC sent two fire fighters into the structure to find the furnace room. The crew went in through the garage and down the stairs into the basement searching for the furnace room without a handline. They made it approximately 6 to 8 feet inside the family room with zero visibility. They could hear the fire in front of them and overhead with high heat conditions and were forced to exit.

At approximately the same time, the victim and Fire Fighter #2 became disoriented and could not find their way out of the structure. The victim called command at 0732 hours for assistance and reported that they were lost on the second floor. The victim called command two more times within a minute and gave a Mayday stating that they were lost, needed help, and ventilation. The victim made a final Mayday call at 0736 hours. *Note: The victim's calls were never heard by the IC because the victim was on the dispatch channel. Central Dispatch did not know the meaning or consequences of a Mayday. An off-duty fire fighter, monitoring the dispatch channel, called Central Dispatch to ask if they understood the severity of the situation and to urge the dispatcher to inform the IC of the Mayday.*



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

The victim became panicked and was yelling to Fire Fighter #2 to get him out of the structure. The victim went to his knees and took out his regulator stating that he couldn't breathe. Fire Fighter #2 began "buddy breathing" with the victim who was becoming more frantic. The victim collapsed on to the floor and became unresponsive. Fire Fighter #2 made his way to a window at the front of the structure and busted it out in an attempt to signal someone on the outside. He then went back to find the victim, but became disoriented and low on air. Fire Fighter #2 heard the PPV fan and moved down the hallway towards the sound. He stumbled on the stairs and found his way back out of the structure (Diagram #2).

The IC saw Fire Fighter #2 break the second-floor bedroom window on the A-side of the structure and sensed the crew was lost. He ordered the structure to be evacuated and for a fire fighter to put a ladder to the window. He then sent a crew inside to conduct a search, and ordered all of the windows to be broken to ventilate and possibly help the crew find their way out of the structure. *Note: The rescue crew entered the structure without any RIT gear, followed the hoseline, and found the abandoned nozzle on the first floor. No one on the fireground heard the evacuation order over the radio. The apparatus horns were not used to signal an evacuation.*

Fire conditions became untenable after the floor in the living room area collapsed, which was above the seat of the fire in the basement (Diagram #2). The rescue crew was forced to exit the structure due to the extensive fire conditions. Additional crew members operated a 2 1/2-inch handline from inside the front of the structure to knock down the fire before the search could resume. The victim was found at approximately 0758 hours in the bathroom of the master bedroom

on his left side (see Diagram 2). His alarming PASS device was muffled due to him lying on top of it. His face piece was on, with his regulator unhooked. He was removed through the master bedroom window and was transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner lists the cause of death as smoke and soot inhalation with a carboxyhemoglobin level of 22.7%.

RECOMMENDATIONS/DISCUSSIONS

Recommendation #1: Fire departments should enforce standard operating procedures (SOPs) for structural fire fighting, including the use of self-contained breathing apparatus (SCBA), ventilation, and radio communications.

According to the International Fire Service Training Association (IFSTA), fire fighters should never be inside a working structure fire with anything less than full protective clothing, SCBA, and a PASS device. . ." because of the possible presence of toxic products of combustion. Reactions to CO poisoning vary with individual and include headache, vertigo, difficulty breathing, confusion convulsions, and coma.¹⁻³

Ventilation and radio communications are also critical for fire fighter safety on the fire ground. Correct ventilation releases heat and gasses from the structure and improves fire fighter visibility. Two way communications must be maintained on the fireground to assist the IC in making tactical decisions base on information relayed from crew members or requests such as for ventilation. The department in this incident has SOPs regarding ventilation and communication procedures, and an SOP stating that SCBAs must be worn at all times while operating inside a structure on fire.

Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

Fire departments should conduct frequent training to ensure knowledge and compliance with their existing SOPs. ⁴⁻⁵

Recommendation #2: Fire departments should ensure that the Incident Commander completes a size-up of the incident and continuously evaluates the risk versus benefit when determining whether the operation will be offensive or defensive.

Discussion: One of the most important size-up duties of the first-in officer is locating the fire and determining its severity. This information lays the foundation for the entire operation. A proper size-up begins from the moment the alarm is received, and it continues until the fire is under control. Several factors must be evaluated in conducting the size-up, for example, type of structure and construction, time of day, contents of the structure, and potential hazards. ⁶ In recent years, thermal imaging cameras (TICs) have been used more frequently by the fire service for exterior size-up to locate the source as well as the hottest part of the fire and for search and rescue to locate victims. This knowledge may help fire fighters determine the safest approach and areas of the structure to avoid.

The size-up must include continued assessment of risk versus benefit during incident operations. According to NFPA 1500 §A-6-2.1.1, “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 fire department members must be evaluated in proportion to the ability to save property of value.” ⁷ As Dunn (1992, p.291) states “When no other person’s life is in danger, the life of the firefighter has a higher priority than fire containment.” ⁶

The fire department met with the owner upon arrival and was informed that the structure

was unoccupied at the time of this incident. A complete walk-around size-up could possibly have identified the fire location through the ground-level windows at the room of origin (Photo #2).

Recommendation #3: Fire departments should ensure that adequate numbers of staff are available to immediately respond to emergency incidents.

Discussion: For “low-hazard occupancies” (e.g., 1-, 2-, or 3- family dwellings), the NFPA recommends the following initial attack response: “At least two pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities), 1 chief officer, and other specialized apparatus as may be needed or available; not fewer than 12 fire fighters and 1 chief officer (p. 10-34).” ⁹

NFPA 1710 § 5.2.2 recommends that a minimum acceptable fire company staffing level should be four members responding on or arriving with each engine and each ladder company responding to this type of low-hazard fire. NFPA 1710 §5.2.1.1 states the following: “On-duty fire suppression personnel shall be comprised of the numbers necessary for fire-fighting performance relative to the expected fire-fighting conditions. These numbers shall be determined through task analyses that take the following factors into consideration:

1. Life hazard to the populace protected
2. Provisions of safe and effective fire-fighting performance conditions for the fire fighters
3. Potential property loss
4. Nature, configuration, hazards, and internal protection of the properties involved



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

5. Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene.”¹⁰

Recommendation #4: Fire departments should use defensive fire fighting tactics when adequate apparatus and equipment for offensive operations are not available.

Discussion: A trend in the fire service is that some smaller, combination and volunteer fire companies are adopting the aggressive fire fighting tactics of larger, career departments. Some of these smaller fire departments do not have the training, equipment and back-up personnel to safely accomplish these dangerous tactics.⁶ In this incident, an interior attack was initiated with the only two fire fighters with bunker gear on the scene. Operations should remain defensive until adequate resources arrive to assure interior fire fighter safety.

Recommendation #5: Fire departments should ensure that ventilation is closely coordinated with the fire attack.

Discussion: Chapter 10 of the *Essentials of Fire Fighting*, 4th edition, states that “ventilation must be closely coordinated with fire attack.”¹¹ To reduce vertical extension, direct ventilation of the basement during fire attack is necessary. This can be accomplished in several ways. Horizontal ventilation can be employed to vent heat, smoke, and gases through wall openings such as doors and windows, even if the windows are below ground-level in wells. Natural pathways such as stairways can also be used to vent the basement area provided the means used to ventilate the heat and smoke do not place other portions of the building in danger. As a last resort, the basement can be vented by cutting a hole in the floor near a

ground-level opening such as a door or window. The heat and smoke can then be drawn from the basement through the exterior opening using mechanical ventilation such as a smoke ejector. Forced ventilation, or positive pressure, introduces air at such great volumes that it can cause the fire to intensify or spread. Horizontal ventilation does not release the heat and smoke directly above the fire; therefore, it is imperative that horizontal ventilation is coordinated with the interior attack crew to ensure that it doesn’t block their escape routes.

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

Discussion: Fire fighters should always work and remain in teams whenever they are operating in a hazardous environment.¹¹ Team continuity relies on knowing your team members and the team leader, maintaining visual contact (if visibility is low, teams must stay within touch or voice distance of each other), communicating needs and observations to the team leader, rotating to rehabilitation, staging as a team, and watching team members (practicing a strong buddy system). To maintain team continuity, fire fighters working in teams should enter and exit the structure together.

Recommendation #7: Fire departments should ensure those fire fighters who enter hazardous areas, e.g., burning or suspected unsafe structures, are equipped with two-way communications with Incident Command.

The fireground communications process combines electronic communication equipment, a set of standard operating procedures, and the fire personnel who will use the equipment. To be effective, the communications network must



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

integrate the equipment and procedures with the dynamic situation at the incident site, especially in terms of the human factors affecting its use. Fire departments should review both operating procedures and human factors issues to determine the ease of use of radio equipment on the fireground to ensure that fire fighters consistently monitor radio transmissions from the IC and respond to radio calls.^{4,12} After standard operating procedures are developed, fire departments must train everyone on their use. In this incident, the victim's radio was somehow switched to the wrong channel. If the other fire fighters had been equipped with a portable radio, they possibly could have determined that the victim's radio was not on the correct channel. This could have helped to maintain communication with the IC and assist with rescue efforts.

Recommendation #8: Fire departments should instruct fire fighters on the hazards of exposure to products of combustion such as carbon monoxide (CO) and warn them never to remove their face pieces in areas in which such products are likely to exist.

Discussion: The toxicity of CO varies with the length of exposure, the concentration, breathing and heart rate, and the physical condition of the victim. Depending on the concentration, a single unprotected breath of an Immediately Dangerous to Life and Health (IDLH) atmosphere (e.g., products of combustion) may be enough to cause incapacitation.^{3,13} During this incident, the victim removed his regulator for 1 to 2 minutes in an attempt to locate the origin of the fire by smelling the smoke. The actions the victim made after removing his regulator (i.e not exiting with his partner, searching without a hoseline) suggests that his decision making may have been affected by breathing in the products of combustion.

Recommendation #9: Fire departments should ensure that a Rapid Intervention Team is in place before conditions become unsafe.

Discussion: A Rapid Intervention Team (RIT) should be positioned to respond to every fire. The team should report to the officer in command and remain at the command post or a designated area until an intervention is required to rescue a fire fighter(s). The RIT should have all the tools necessary to complete the job, e.g., a search rope, first-aid kit, and a resuscitator. The RIT team should be comprised of fresh, well-rested fire fighters, and be positioned and ready to respond when a fire fighter(s) is down or in trouble.¹⁴ Initially in this incident, there weren't enough equipped personnel to provide for a RIT when the victim and the fire fighter made entry as the IC arrived. When it was realized the victim was still inside the structure, fire fighters were chosen from other duties to conduct searches without any RIT equipment.

Recommendation #10: Fire departments should use guidelines/ropes securely attached to permanent objects and/or a bright, narrow-beamed light at all entry portals to a structure to guide fire fighters during emergency egress.

Discussion: When a structure is filled with smoke and visibility is poor, especially in large open areas or when there are maze-like conditions, fire fighters can become disoriented or lost, and thus, in need of a guideline to escape.^{8,15-16} For an engine crew, usually this guide is the hose line. For a search crew, it could be a hose from an engine crew or a guide rope. Another strategy is to use guide ropes securely attached to permanent objects outside of the structure or to place a person and/or a bright light at the entry portal as a guide. Illuminated search lines/ropes^a for fire

^aMention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health.



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

fighting operations also are available.¹⁷ Once these procedures are developed and outlined in SOPs, training in their use should be conducted on a regular basis.

Recommendation #11: Fire departments should use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area.

Evacuation signals are used when command personnel decide that all fire fighters should immediately be evacuated from a burning building or other hazardous area because conditions have deteriorated beyond the point of reasonable safety. All fire fighters should be familiar with their department's method of sounding an evacuation signal. There are several ways this communication can be done. The most common method is to (1) broadcast a radio message ordering all fire fighters to evacuate, AND (2) sound an audible warning device (air horn) on the apparatus at the fire scene for an extended period of time.¹² The message should be broadcast several times to make sure everyone hears it. Whenever communications or a key tactical operation cannot be completed that places the interior crew at a severe risk (i.e. ventilation), the structure should be evacuated.

Recommendations #12: Fire departments should train fire fighters on actions to take while waiting to be rescued if they become lost or trapped inside a structure.

Discussion: Fire fighters must act promptly when they become lost, disoriented, injured, low on air, or trapped.¹⁸⁻²² First, they must transmit a distress signal while they still have the capability and sufficient air. The next step is to manually activate their PASS device. To conserve air while waiting to be rescued, fire fighters should

try to stay calm and avoid unnecessary physical activity. If not in immediate danger, they should remain in one place to help rescuers locate them. They should survey their surroundings to get their bearings and determine potential escape routes, and stay in radio contact with Incident Command and rescuers. Additionally, fire fighters can attract attention by maximizing the sound of their PASS device (e.g., by pointing it up in an open direction), pointing their flashlight toward the ceiling or moving it around, and using a tool to make tapping noises. A crew member who initiates a Mayday call for another person should quickly try to communicate with the missing member via radio and, if unsuccessful, initiate a Mayday providing relevant information as described above. At the time of the Mayday, the victim's radio was not on the fireground channel.

Additionally,

Recommendation #13: Municipalities should establish dispatch centers that are integrated with fire response functions.

Discussion: An effective dispatch system is a key factor in fire department operations. The central dispatch center is used for receiving notification of emergencies, alerting personnel and equipment, coordinating the activities of the units engaged in emergency incidents, and providing non-emergency communications for the coordinating fire departments.⁹⁻¹¹ The dispatch system must be able to identify the type and number of units due to respond to the type of incident in advance based on risk criteria and unit capabilities.¹⁴ Because there were not pre-determined alarm assignments for specific situations and mutual aid, or an "alarm card," for the units dispatched, the Incident Commander had to decide which units and departments he wanted to respond to the incident. Having a pre-

Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

determined response for apparatus arranged by district, address, or type of incident, makes the Incident Commander's and the dispatcher's job much easier. The assignment lists the apparatus slated to respond to the incident and should take into account apparatus that are out of service by filling in for such units with similar units.

Central Dispatch should be staffed with operators who are familiar and trained with fire department operations and equipment. Central Dispatch could then also monitor fireground activity and inform command of time intervals and of possible missed transmissions, such as Maydays. A central dispatch center equipped with regional mutual aid channels could serve multiple jurisdictions. This type of system would provide operational advantages in the communication system, reflect a more functional mutual aid system, and reduce overall costs of operating centers in individual jurisdictions.²³⁻²⁴

In this incident, the victim ended up on the dispatch channel when he radioed a Mayday. The IC was calling Central Dispatch to request additional manpower from specific mutual aid companies when Central Dispatch told him that an ambulance was paged for his Mayday.

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Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

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INVESTIGATOR INFORMATION

This incident was investigated by Jay Tarley, Safety and Occupational Health Specialist; Matt Bowyer, General Engineer; and Tim Merinar, Safety Engineer, Division of Safety Research, NIOSH.



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

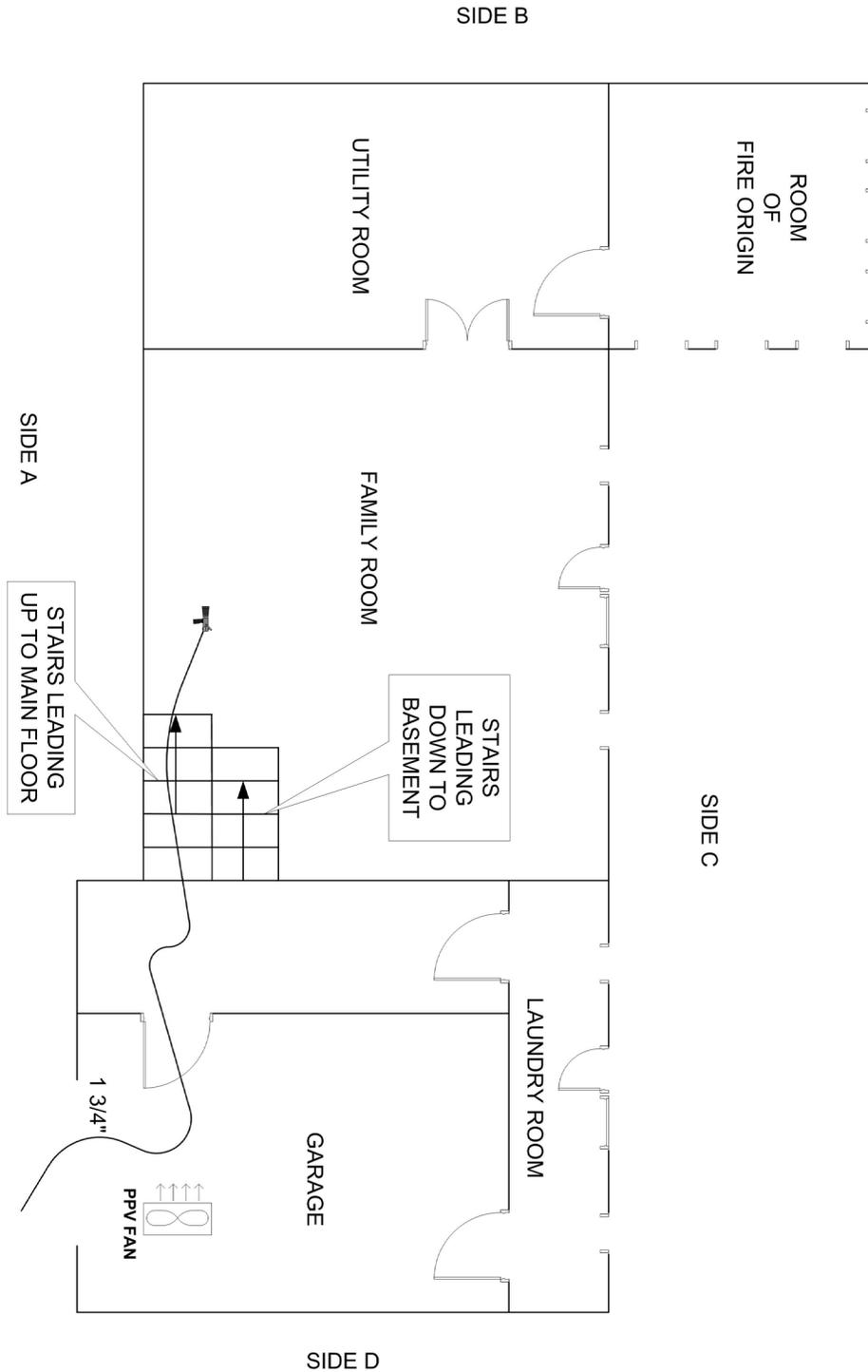


Diagram 1. Garage and basement layout; Aerial view



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan

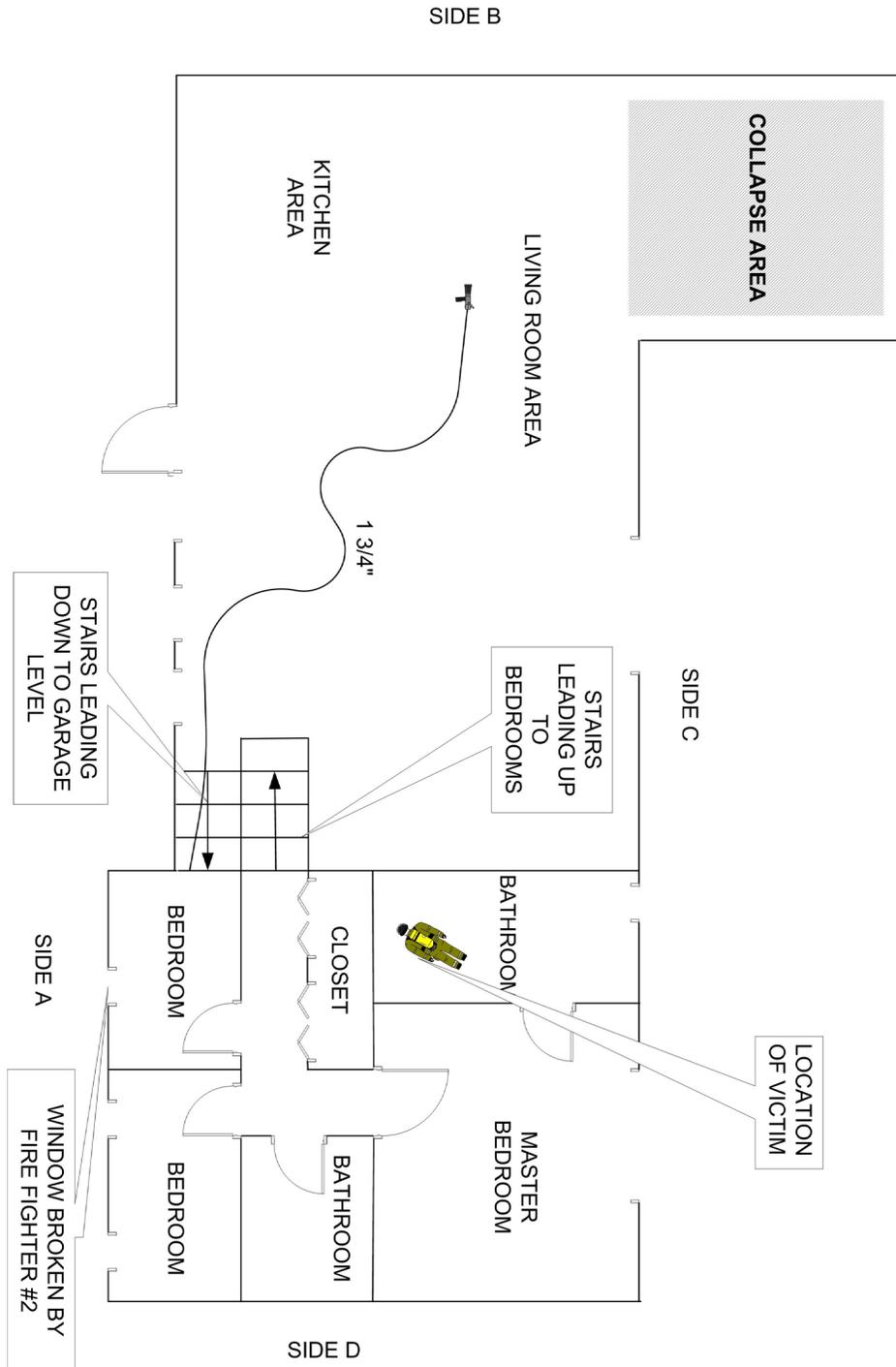


Diagram 2. Main floor and upper level; Aerial view



Career Captain Dies After Running Out of Air at a Residential Structure Fire - Michigan



Photo 1. Stairwell leading down to basement and up to second floor



Photo 2. Room of origin off of C-Side of structure at ground level

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