



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

April 11, 2001

Structure Fire Claims the Lives of Three Career Fire Fighters and Three Children—Iowa

SUMMARY

On December 22, 1999, a 49-year-old Shift Commander (Victim #1) and two Engine Operators, 39 and 29 years of age respectively (Victim #2 and Victim #3), lost their lives while performing search-and-rescue operations at a residential structure fire. At approximately 0823 hours, the three victims and two additional fire fighters cleared the scene of a motor-vehicle incident. One of the fire fighters (Fire Fighter #1) riding on Engine 3, joined the ambulance crew to transport an injured patient to the hospital. At approximately 0824 hours, Central Dispatch was notified of a structure fire with three children possibly trapped inside. At approximately 0825 hours, Central Dispatch notified the fire department, and a Shift Commander and an Engine Operator (Victim #1 and Victim #2) were

dispatched to the scene in the Quint (Aerial Truck 2). At 0827 hours, Engine 3 (Lieutenant and Victim #3) responded to the scene. At 0829 hours as Aerial Truck 2 approached the scene, they radioed Central Dispatch, reporting white to dark brown smoke showing from the residence, and requested six additional fire fighters. Aerial Truck 2 arrived on the scene at 0830 hours. The crew of Aerial Truck 2 witnessed a woman and child trapped on the porch roof, and they were informed that three children were trapped inside the house. A police officer who was already on the scene positioned a ladder to the roof and removed the woman and child as Victim #1 proceeded into the house to perform a search-and-rescue operation. Engine 3 arrived on the scene shortly after, and the Lieutenant connected a supply line to the hydrant as Victim #3 pulled the Engine into position. The Lieutenant and Victim #3 stretched a 5-inch supply line and connected it to Aerial Truck 2. At approximately 0831 hours, the Chief and Fire Fighter #1 arrived on the scene, and the Chief assumed Incident Command (IC). Fire Fighter #1 pulled a 1½-inch handline off Aerial



Photo courtesy of Cindy Iutzi,
Daily Gate City, Iowa

Incident Site

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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Truck 2, through the front door and placed it in the front room. The IC instructed Victim #2 and Victim #3 to don their protective gear and proceed into the house to assist in the search-and-rescue operations. Fire Fighter #1 went back to Aerial Truck 2 to gear up. At this time, one of the victims removed the first of the three children from the structure, handed the child to a police reserve officer near the front entrance of the structure, and returned to the structure to continue search-and-rescue operations. The police reserve officer transported the child to a nearby hospital. The IC charged the handline from Aerial Truck 2 and went to the structure. At this time one of the victims removed a second child. The IC grabbed the child and began cardiopulmonary resuscitation (CPR). Due to limited personnel on the fireground, the IC directed a police officer on the scene to transport him and the child to the hospital. After donning her gear, Fire Fighter #1 approached the front door and noticed that the 1½-inch handline (previously stretched) had been burned through and water was free-flowing. It is believed that the three victims were hit with a thermal blast of heat before the handline burned through. The three victims failed to exit as 12 additional fire fighters arrived on the scene through a call-back method and began fire suppression and search-and-rescue operations. Victim #2 was located, removed, and transported to a nearby hospital, where he was pronounced dead. Victim #1 and Victim #3 were later found and pronounced dead on the scene. NIOSH investigators concluded that to minimize the risk of similar occurrences, fire departments should

- ***ensure that adequate numbers of staff are available to immediately respond to emergency incidents***
- ***ensure that Incident Command conducts an initial size-up of the incident before***

initiating fire fighting efforts, and continually evaluates the risk versus gain during operations at an incident

- ***ensure fire fighters are trained in the tactics of defensive search***
- ***ensure that fire command always maintains close accountability for all personnel at the fire scene***
- ***ensure that fireground communication is present through both the use of portable radios and face-to-face communications***
- ***ensure that a trained Rapid Intervention Team (RIT) is established and in position immediately upon arrival***
- ***ensure that fire fighters wear and use PASS devices when involved in interior fire fighting and other hazardous duties***

INTRODUCTION

On December 22, 1999, fire fighters from a career fire department responded to a structural fire at a local residence. The fire was started when a stove turned on shortly after 0800 hours, ignited the materials setting on the stove top. A 49-year-old Shift Commander (Victim #1), a 39-year-old Engine Operator (Victim #2) assigned to drive Aerial Truck 2, and a 29-year-old Engine Operator (Victim #3) assigned to drive Engine 3 lost their lives while performing search-and-rescue operations for three children who were trapped inside the burning structure. These fire fighters were part of a five-person crew who were on duty at the time of the alarm.

On December 22 and 23, 1999, the International Association of Fire Fighters (IAFF) and the United States Fire Administration (USFA), respectively,



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notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On January 18-21, 1999, a Fire Protection Engineer, a Senior Investigator, an Occupational Safety and Health Specialist, and the Chief of the Surveillance and Field Investigations Branch, Division of Safety Research, investigated this incident. Interviews and meetings were conducted with the Chief of the department, fire fighters from the department who were on the scene of this incident, a representative from the Local IAFF, and a representative from the State Fire Marshal's Office. Additionally, NIOSH held meetings with representatives from the Bureau of Alcohol Tobacco and Firearms (ATF), the National Institute of Standards and Technology (NIST), and the National Fire Protection Association (NFPA), who were also conducting investigations. The incident site was visited and the fire scene was photographed. Copies of witness statements, training records, standard operating procedures (SOPs), pathology reports, and a map of the fire scene were reviewed. An inspection of the victims' Self-Contained Breathing Apparatus (SCBA) and turnout gear was conducted.

On October 23, 2000, an Occupational Safety and Health Specialist, the Chief of the Surveillance and Field Investigations Branch, Division of Safety Research, and an Engineer with the National Institute of Standards and Technology met with the Chief of the department to assist in the development of a fire dynamics model for this incident (see section titled FIRE MODEL INFORMATION).

This career department consists of 18 uniformed fire fighters and a Chief. The department serves a population of 13,500 in an area of approximately 10 square miles. The department operates on a three-shift rotation with five to six fire fighters per shift.

The incident occurred in a balloon-framed structure built in the 1870s as a single-family residence. In the 1970s the structure was remodeled and divided into three separate apartment units. The apartment in which the incident occurred was a single unit which occupied both floors of the structure. The attic and basement did not receive fire damage. Minimal fire stops in the walls and ceiling cavities were created from heavy timber construction. The attic was common to the entire area above the second-floor ceiling.

The State of Iowa requires all fire fighters to be NFPA Fire Fighter I certified. The department requires all fire fighters to attain their certification as Fire Fighter I 18 months from their date of hire. All three victims were certified at the Fire Fighter I level. Regularly scheduled in-house training is conducted by shift officers and documented by certified instructors (State of Iowa) on the department's staff. The fire department periodically sends fire fighters to the Iowa State University Fire Service Institute for fire training. Victim #1 had 25 years of experience, Victim #2 had 4 years of experience, and Victim #3 had 5 years of experience.

At the time of the incident, all of the victims were wearing a full array of personal protective clothing and equipment, consisting of turnout gear (coat and pants), helmet, gloves, boots, Nomex® hoods, a Self-Contained Breathing Apparatus (SCBA) with an integrated Personal Alert Safety System (PASS) device, and a Manual Personal Alert Safety System (PASS) device secured to each fire fighters' turnout coat. *Note: The victims' manual PASS devices were checked and found to be severely damaged, but in working condition. It is unknown if the PASS devices were turned off after the victims' removal from the structure or were never turned on before entering the structure.*



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INVESTIGATION

At approximately 0823 hours, the three victims and two additional fire fighters had cleared the scene of a motor-vehicle incident. One of the fire fighters (Fire Fighter #1) riding on Engine 3 joined the ambulance crew to transport an injured patient to the hospital. At approximately 0824 hours, Central Dispatch received a call from a neighbor, about a structure fire with the possibility of children trapped inside. Central Dispatch notified the fire department and at approximately 0825 hours dispatched Aerial Truck 2 with the Shift Commander (Victim #1) and an Engine Operator (Victim #2). Aerial Truck 2 proceeded to the scene. At 0827 hours, Engine 3 was dispatched and responded to the scene with a Lieutenant and an Engine Operator (Victim #3). The Chief responded by Car 5661 to the hospital to pick up Fire Fighter #1 and continue to the scene. At approximately 0829 hours, the Shift Commander (Victim #1) radioed the hydrant position at the scene to Engine 3 who was approximately 1 minute behind Aerial Truck 2. As Aerial Truck 2 approached the location of the structure, the Shift Commander (Victim #1) radioed Central Dispatch and requested that 6 additional fire fighters be called in due to the severity of the situation. Aerial Truck 2 reported white to dark brown smoke showing from the residence.

Aerial Truck 2 arrived on the scene at approximately 0830 hours. A woman and a child were trapped on a porch roof at the front of the residence. The fire fighters were informed that three children were trapped inside the house. Victim #1 proceeded into the house through the front door to perform a search-and-rescue operation (Photo 1). A police officer, who arrived on the scene before Aerial Truck 2, positioned a ladder to the porch roof and removed the mother and child. The Lieutenant from Engine 3 connected a line (200 feet of a 5-inch supply line)

to the hydrant as the Engine Operator (Victim #3) pulled the engine into position. After connecting the line, the Engine Operator (Victim #3) and the Lieutenant from Engine 3 connected the supply line to Aerial Truck 2.

At approximately 0831 hours, the Chief and Fire Fighter #1 arrived on the scene. The Chief assumed duties as the Incident Commander (IC). Through face-to-face contact the IC instructed Victim #3 to finish hooking the supply line to Aerial Truck 2, then “gear up” and proceed into the house to assist in the search-and-rescue operation. *Note: In this incident only fireground officers were equipped with portable radios, thus only certain members on the fireground receive their instructions over their portable radios. Other fireground personnel are forced to rely on face-to-face communications from the IC or their crew leader.* Fire Fighter #1 stretched 200 feet of a 1½-inch handline through the front door of the structure into the front downstairs room, noting smoky conditions with little heat. Fire Fighter #1 then went back to Engine 3 to finish donning her protective gear.

At this time, one of the victims handed a child to a police reserve officer near the front door of the structure. The police reserve officer transported the child to a nearby hospital. As the first child was removed, the IC charged the handline and went back up to the structure. At this time, a second child was brought to the door. The IC ran to the door and grabbed the child from one of the victims and began cardiopulmonary resuscitation (CPR). The IC then looked for someone to give the child to; however, there were no other fire fighters or emergency medical service personnel on the scene. A second police officer transported the IC and the child to the hospital. *Note: Both children removed from the structure were pronounced dead at the hospital.*



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At approximately 0835 hours, Fire Fighter #1 went up to the front of the structure to begin an active fire fight and noticed that the hoseline was free-flowing. As Fire Fighter #1 continued toward the structure she discovered that the hoseline had burned through and flames were protruding from the entrance. *Note: It is believed, through interviews conducted, evidence at the scene, and a fire model developed by NIST, that the dining room flashed, causing secondary flashovers in the living room, and ventilation conditions created a path of least resistance up the stairs, injuring and disorienting the three fire fighters enough to prevent their escape from the structure. Please see section titled FIRE MODEL INFORMATION.*

Noting that the hose was free-flowing, the Lieutenant from Engine 3 shut the line down. He then charged a second line that was stretched into the house for Fire Fighter #1 and proceeded to his engine to “gear up.” At this time, Fire Fighter #1, standing inside the doorway of the structure, was yelling that they were out of water. The Lieutenant then proceeded to the pump panel of Aerial Truck 2 and opened the wheel valve, recharging the line for Fire Fighter #1. Fire Fighter #1 then initiated suppression activities in the living room (Figure 1). *Note: Due to the extreme heat Fire Fighter #1 would advance the hoseline into the room and then retreat. This sequence was repeated several times.*

At approximately 0839 hours, the Chief returned to the scene and continued his role as IC. Shortly after the Chief returned to the scene, Engine 6 arrived with an Assistant Chief (Assistant Chief #1) and a Lieutenant. As the Lieutenants from Engines 3 and 6 and Assistant Chief #1 finished donning their protective gear, they were told by onlookers that there was the possibility of a civilian in the upstairs apartment on the non-fire

side of the building (Photo 2). *Note: The neighbor’s car was parked in front of the house, causing concern among onlookers that he was still inside the structure.* At this time the IC ordered the Lieutenant from Engine 3, the Lieutenant from Engine 6, and Assistant Chief #1 to form a three-man search-and-rescue team to search the apartment located on the top floor of the non-fire side.

The search-and-rescue team proceeded through the front door (non-fire side) to the upstairs apartment. As they reached the landing at the top of the stairs, the search-and-rescue team split up in their search efforts. Assistant Chief #1 went off to the left to search, the Lieutenant from Engine 3 went straight ahead toward the back of the structure, while the Lieutenant from Engine 6 stayed near the entrance of the structure. At this point, there was zero visibility in this side of the structure due to thick smoke.

Note: Through interviews conducted it was determined that the Fire Department had not completed any type of ventilation at this time. However, it is believed that horizontal ventilation took place in the rear of the structure by a police officer. Both rear first floor windows of the structure were cleared in both the fire and non-fire sides of the structure. Photographs reviewed by investigators show that the fire department was possibly on the scene conducting search-and-rescue operations when the horizontal ventilation was conducted; however, an exact time of the horizontal ventilation could not be determined, due to insufficient fireground communication between the fire department and the police officers on the scene. The window cleared on the fire side of the structure was the bathroom window near the kitchen. ATF agents, who conducted a post-fire investigation of the structure, and the engineers from NIST, who developed the fire



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model, concluded that the door leading from the bathroom to the kitchen area was closed and intact when the window was cleared. Consequently, it is believed that the clearing of this window had little impact on ventilation or fire growth.

After conducting their searches, the search-and-rescue team met on the upstairs landing to decide what their next move should be. At approximately 0848 hours, they heard the IC yelling for Victim #1, so the search-and-rescue team exited the structure and proceeded to the IC to get their next assignment. *Note: After returning from the hospital, the IC (Chief) regained command and started to account for all fire fighters on the scene. He realized that he was now missing three fire fighters (Victims #1, #2, and #3).* At approximately 0850 hours, Aerial Truck 1, consisting of a four-man crew (Lieutenant, Engine Operator, and Fire Fighters #2 and #3), arrived on the scene. At the same time, an Assistant Chief (Assistant Chief #2) and a fire fighter (Fire Fighter #4) arrived on the scene in a privately owned vehicle (POV). Assistant Chief #1 from Engine 6, the Lieutenant from Engine 6, and the Engine Operator from Engine 3 were ordered to continue as a Rapid Intervention Team (RIT) and search the fire side of the structure (Photo 2). Assistant Chief #2 and Fire Fighter #4 donned their SCBA, pulled an additional line off Aerial Truck 2, and went into the structure to assist in suppression activities. Assistant Chief #2, the nozzleman, and Fire Fighters #2 and #4 manned the hoseline inside the doorway, spraying water into the living room. Fire Fighter #1 was also near the entrance of the structure performing suppression activities. The Engine Operator from Aerial Truck 1 went into the hallway, then heard Assistant Chief #2 ask for a positive pressure ventilation fan (PPV) to be placed in the front doorway. Fire Fighter #2 took the nozzle from Fire Fighter #4, and Assistant

Chief #2 acted as additional backup as they continued spraying water into the living room. At this time, Fire Fighter #2 noticed a helmet lying on the floor in the front right room, then saw one of the victims lying on the floor (Figure 1). *Note: It is undetermined why the victims' integrated and manual PASS devices were not heard sounding in this incident.* The interior suppression crew's (Fire Fighter #2, Fire Fighter #4, and Assistant Chief #2) low-air alarms sounded, and they were forced to exit the structure.

Fire Fighter #4 was ordered by the IC to go to the rear of the structure and aid in suppression activities. *Note: Two lines were taken to the rear of the structure; however, through interviews conducted, it is undetermined who pulled these lines to the rear of the structure.*

The interior suppression crew changed their air bottles and reentered. At this time the Engine Operator from Aerial Truck 1 placed a PPV fan in the front doorway. Upon entry, Assistant Chief #2, Fire Fighter #2, and the Engine Operator from Aerial Truck 1 removed who was thought to be Victim #1 from the structure. Upon exiting the structure, they realized it was Victim #2. Victim #2 was transported to the hospital where he was pronounced dead.

Due to the extreme heat inside the structure, the IC made the call to switch from a search-and-rescue operation to a defensive attack. The IC assigned Assistant Chief #1 the responsibility of keeping fire fighters out of the structure until it was deemed safe. At this time three additional fire fighters (Fire Fighters #5, #6, and #7) were transported to the scene by a police officer. Fire Fighter #7 was assigned to the rear of the structure with the Lieutenant from Engine 6 and Fire Fighter #2, to control the fire extension from the rear of the structure (Photo 3). Fire Fighter #5 was



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ordered to man a hoseline with the Lieutenant from Aerial Truck 1 on the side and rear of the structure to control fire extension and assist in suppression activities. Fire Fighter #6 was assigned with Assistant Chief #1 to man a hoseline from the main entrance of the structure to aid in the cool down.

After approximately 4 minutes of defensive fire fighting, search-and-rescue operations resumed. The Lieutenant from Engine 6 and Fire Fighter #3 formed a RIT and entered the fire side of the structure to search for the two missing fire fighters. However, they had to exit the structure due to problems with Fire Fighter #3's personal protective equipment. At this time, Assistant Chief #1 and Fire Fighter #7 entered the structure to search for the two missing fire fighters and the third child. Approximately 1030 hours, as crews continued to suppress the fire inside the structure, Assistant Chief #1 and Fire Fighter #7 located Victim #1 and the third child at the top of the stairs on the second-floor landing (Figure 2). Assistant Chief #1 radioed the IC asking EMS personnel to proceed to the front of the structure to aid in the removal of the third child from the structure. After the third child was removed, Assistant Chief #1 and Fire Fighter #7 proceeded back up the stairs to the landing, and with help from Fire Fighter #6, they removed Victim #1 from the structure. Assistant Chief #1 and Fire Fighter #7 then located Victim #3 in the master bedroom and removed him from the structure. Fire Fighter #8 arrived on the scene by POV and assisted in fire suppression activities. Victims #1 and #3 and the third child were pronounced dead at the scene.

Fire Fighters #5 and #8 and the Engine Operator from Aerial Truck 1 received an order from the local Fire Marshal to ventilate the structure in preparation for a post-fire investigation. *Note:*

At approximately 1012 hours the local Fire Marshal arrived on the scene. At this time Fire Fighters #5 and #8 and the Engine Operator from Aerial Truck 1 ventilated the roof to aid in suppression activities. The remaining crews were relieved from the scene at approximately 1530 hours. At this time, mutual-aid companies arrived on the scene and took over the suppression and overhaul activities.

CAUSE OF DEATH

The pathology reports list the causes of death for the victims as follows: Victim #1-Smoke inhalation (15% Carboxyhemoglobin level) and sudden exposure to intense heat, Victim #2-Smoke inhalation (25% Carboxyhemoglobin level) and sudden exposure to an extremely hot environment, and Victim #3-Sudden exposure to intense heat (1.0 % Carboxyhemoglobin level).

RECOMMENDATIONS AND DISCUSSION

Recommendation #1: Fire departments should ensure that adequate numbers of staff are available to immediately respond to emergency incidents.¹

Discussion: As stated in NFPA 1500

“(6-4.3) Members operating in hazardous areas at emergency incidents shall operate in teams of two or more. Team members operating in hazardous areas shall be in communication with each other through visual, audible, or physical means or safety guide rope, in order to coordinate their activities. Team members shall be in close proximity to each other to provide assistance in case of emergency.”

“(6-4.4) In the initial stages of an incident where only one team is operating in the hazardous area at a working structural fire, a minimum of four individuals is required, consisting of two



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individuals working as a team in the hazard area and two individuals outside this hazard area for assistance or rescue at emergency operations where entry into the danger area is required. The staged members shall be responsible for maintaining a constant awareness of the number and identity of members operating in the hazardous area, their location and function, and time of entry. The standby members shall remain in radio, visual, voice, or signal line communications with the team.”

“(6-4.4.2) One standby member shall be permitted to perform other duties outside of the hazardous area, such as apparatus operator, incident commander, or technician or aide, provided constant communication is maintained between the standby member and the members of the team. The assignment of any personnel, including the incident commander, the safety officer, or operators of fire apparatus, shall not be permitted as standby personnel if by abandoning their critical task(s) to assist or, if necessary, perform rescue, they clearly jeopardize the safety and health of any fire fighter working at the incident. No one shall be permitted to serve as a standby member of the fire-fighting team when the other activities in which he/she is engaged inhibit his/her ability to assist in or perform rescue, if necessary, or are of such importance that they cannot be abandoned without placing other fire fighters in danger.”

Additionally, “when members are performing special operations, the highest available level of emergency medical care shall be standing by at the scene with medical equipment and transportation capabilities. Basic life support shall be the minimum level of emergency medical care.”

The small size of the initial responding crew could not appropriately and safely respond to the

necessary fireground operations—e.g. incident command, scene size-up, search-and-rescue, a staged Rapid Intervention Team (RIT), hydrant connections, ventilation, and medical aid and transport.

Recommendation #2: Fire departments should ensure that Incident Command conducts an initial size-up of the incident before initiating fire fighting efforts, and continually evaluates the risk versus gain during operations at an incident.^{2,3,4,5}

Discussion: One of the most important size-up duties of the first-in officers is locating the fire and determining its severity. This information lays the foundation for the entire operation. First, it determines the number of fire fighters and the amount of apparatus and equipment needed to control the blaze. Second, it assists in determining the most effective point of fire extinguishment attack and the most effective method of venting heat and smoke.

A proper size-up begins from the moment the alarm is received, and it continues until the emergency is under control. Several factors must be evaluated in conducting the size-up—e.g., type of structure, time of day, contents of the structure, potential hazards, etc. The size-up should also include risk versus gain during incident operations.

The following general factors are important considerations:

Occupancy type involved. The type of occupancy can have a great effect on the aspects of the fire attack. The type of occupancy could assist in determining the structure’s layout, hazardous materials, and the possibility of civilians.



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Smoke conditions. The smoke conditions can provide the Incident Commander additional information about the fire.

Type of construction. The type of construction will be one of the most important areas to identify. The type of structure could provide information such as how the building will hold up under fire conditions or if the building is generally subject to collapse under fire conditions.

Type of roof system. The roof system should be one of the first things that is determined before fire fighters enter a burning structure.

Age of structure. The Incident Commander should acknowledge the age of the building when determining strategy or tactics. The age of the structure can provide the Incident Commander with information to determine the building's integrity or other areas previously mentioned.

Exposures. The Incident Commander should evaluate the whole picture. The protection of exposures near or connected to a burning building should be included in the strategic plan.

Time considerations. Information such as time of incident, time fire was burning before arrival, time fire was burning after arrival, and type of attack are some of the most important information the Incident Commander should have.

As the Chief (IC) arrived on the scene, while positioning his car, he drove on the road that the house faced, seeing primarily the front of the structure. The IC could see a second side of the structure when charging a handline. The IC was then handed a child from the structure whom he transported to the hospital. A complete walk-around of the structure may have allowed the initial responding crew and/or the IC to locate

the seat of the fire in the rear of the structure, assess the degree of the involvement of the fire and hazards to fire fighters, and to identify where fire suppression activities should be initiated.

Additionally, fire departments should ensure that the first officer or fire fighter inside evaluates interior conditions and reports them immediately to the Incident Commander.

Interior size-up is just as important as exterior size-up. Since the IC is staged at the command post, the interior conditions should be communicated to him or her. Interior conditions could change the IC's strategy or tactics. For example, if heavy smoke is emitting from the exterior roof system, but fire fighters cannot find any fire in the interior, it is a good possibility that the fire is above them in the roof system. It is important for the Incident Commander to immediately obtain this type of information to make the proper decisions.

Recommendation #3: Fire departments should ensure fire fighters are trained in the tactics of defensive search.

As stated in *Command and Control of Fires and Emergencies*, "There are two warning signs that may precede flashover: heat mixed with smoke and rollover. When heat mixes with smoke, it forces a fire fighter to crouch down on his hands and knees. If you are forced down to the floor by intense heat, consider the possibility of flashover. As mentioned above, rollover presages flashover."

Whenever one of these danger signs exists, you must use defensive search tactics. Three defensive search tactics are as follows:

1. At a door to a burning room that may flashover, fire fighters should check behind the door to the



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room and sweep the floor near the doorway. Fire fighters should not enter the room until a hoseline is in position.

2. When there is a danger of flashover, fire fighters should not go beyond the “point of no return.” The point of no return is the maximum distance that a fully equipped fire fighter can crawl inside a superheated, smoke-filled room and still escape alive if a flashover occurs. The point of no return is five feet inside a doorway or window.

3. “When searching from a ladder tip placed at a window, look for signs of rollover if one of the panes has been broken. If rollover is present, do not go through the window. Instead, crouch below the heat and sweep the interior area below the windowsill with a tool. If a victim has collapsed there, you may be able to crouch below the heat enough to pull him to safety.”⁶

Additionally, fire departments should ensure fire fighters are trained to recognize the danger of searching above a fire.⁷

The danger of being trapped above a fire is greatly influenced by the construction of the burning building. Of the five basic building construction types (fire resistive, noncombustible, ordinary construction, heavy timber, and wood-frame) the greatest danger to a fire fighter who must search above the fire is posed by wood frame construction. Vertical fire spread is more rapid in this type of structure. Flames may spread vertically and trap fire fighters searching above the fire in four ways: up the interior stairs, through windows (autoexposure), within concealed spaces, or up the combustible exterior siding.

Recommendation #4: Fire departments should ensure that fire command always maintains

close accountability for all personnel at the fire scene.^{8,9,10}

Discussion: Accountability on the fireground is paramount and may be accomplished by several methods. It is the responsibility of every officer to account for every fire fighter assigned to his or her company and relay this information to the Incident Commander. Fire fighters should not work beyond the sight or sound of the supervising officer unless equipped with a portable radio. The crew leader should communicate with the supervising officer by portable radio to ensure accountability and indicate completion of assignments and duties. When the assigned duties are completed, the crew should radio this information to the supervisor then return to the supervisor for additional duties. As a fire escalates and additional fire companies respond, a communication assistant with a command board should assist the Incident Commander with accounting for all fire fighter companies at the fire, at the staging area and at rehabilitation. One of the most important aids for accountability at an incident is an Incident Management System (IMS). The IMS is a management tool that defines the roles and responsibilities of all units responding to an incident. It enables one individual to have better control of the incident scene. This system works on an understanding among the crew that the person in charge will be “standing back” from the incident, focusing on the entire scene.

Recommendation #5: Fire departments should ensure that fireground communication is present through both the use of portable radios and face-to-face communications.^{3,9}

Discussion: During the course of the fireground operations, the Incident Commander must be heard and also must hear everyone on the scene. All members should follow radio communications



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guidelines, keeping transmissions short, specific, and clear. However, this cannot be achieved if electronic problems occur, or not all fire fighters are equipped with portable communication equipment. Therefore, fire departments should implement a backup communications plan to avoid a communication breakdown on the fireground. The plan should include backup electronic equipment, additional channels, training, and consideration of face-to-face communications, or the utilization of runners to communicate an important message if radio communication fails.

Recommendation #6: Fire departments should ensure that a trained Rapid Intervention Team is established and in position immediately upon arrival.¹

Discussion: A Rapid Intervention Team (RIT) should respond to every major fire. The team should report to the officer in command and remain at the command post until an intervention is required to rescue a fire fighter(s) or civilians. The RIT should have all tools necessary to complete the job—e.g., a search rope, first-aid kit, and a resuscitator—to use if a fire fighter becomes injured. Many fire fighters who die from smoke inhalation, from a flashover, or from being caught or trapped by fire actually become disoriented first. They are lost in smoke and their SCBAs run out of air, or they cannot find their way out through the smoke, become trapped, and then fire or smoke kills them. The primary contributing factor, however, is disorientation. The RIT will be ordered by the IC to complete any emergency searches or rescues. They will provide the suppression companies the opportunity to regroup and take a roll call instead of performing rescue operations. When the RIT enters to perform a search-and-rescue, they should have full cylinders on their SCBAs and be physically prepared. When a RIT team is used in an emergency situation, an

additional RIT team should be put into place in case an additional emergency situation arises. This additional RIT team should be comprised of fresh, well-rested fire fighters. The limited size of the department made it difficult to establish a Rapid Intervention Team (RIT) with the initial responding crews, and to establish additional RITs comprised of fresh, well-rested fire fighters.

Recommendation #7: Fire departments should ensure that fire fighters wear and use PASS devices when involved in interior fire fighting and other hazardous duties.^{1,3}

Discussion: A PASS device should be part of every fire fighter's equipment. The PASS is an electronic device which will emit a loud and distinctive audible alarm if a fire fighter becomes motionless after a minimal period of time, frequently 30 seconds. Fire fighters can also activate the alarm manually if needed. Although the victims were equipped with both PASS devices integrated into their SCBAs and a manual PASS device attached to their turnout coats, none of the devices were heard sounding in this incident. The victims' SCBAs were examined by the NIOSH investigators and were deemed to be unfit for testing. Extreme heat and direct flame impingement may have affected the operation of the integrated PASS devices.

REFERENCES

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INVESTIGATOR INFORMATION

The lead investigator of this report is Thomas P. Mezzanotte, Safety and Occupational Health Specialist. The following NIOSH staff participated in the site visit: Eric Schmidt, Fire Protection Engineer; Ted Pettit, Senior Investigator; and Dawn Castillo, Chief, Surveillance and Field Investigations Branch, Division of Safety Research.

Expert review was provided by the following: Vincent Dunn, Deputy Chief FDNY (ret); Dan Madrzykowski, NIST; and Bob Duval, NFPA.

FIRE MODEL INFORMATION

Upon a request from NIOSH, the National Institute of Standards and Technology (NIST) completed a fire model of this incident. The fire model demonstrates growth and the fire's reaction when different variables are introduced. The complete fire model will be available for viewing online in the Summer of 2001 at www.fire.nist.gov.

Structure Fire Claims the Lives of Three Career Fire Fighters and Three Children—Iowa



Photo courtesy of Cindy Iutzi, Daily Gate City, Iowa.

Photo 1. Front of Structure Where Fire Fighters Entered

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Photo courtesy of Cindy Iutzi, Daily Gate City, Iowa.

Photo 2. Doors in Which Fire Fighters Entered

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Photo courtesy of Cindy Iutzi, Daily Gate City, Iowa.

Photo 3. Rear of Structure Note: Arrow indicates origin of the fire.

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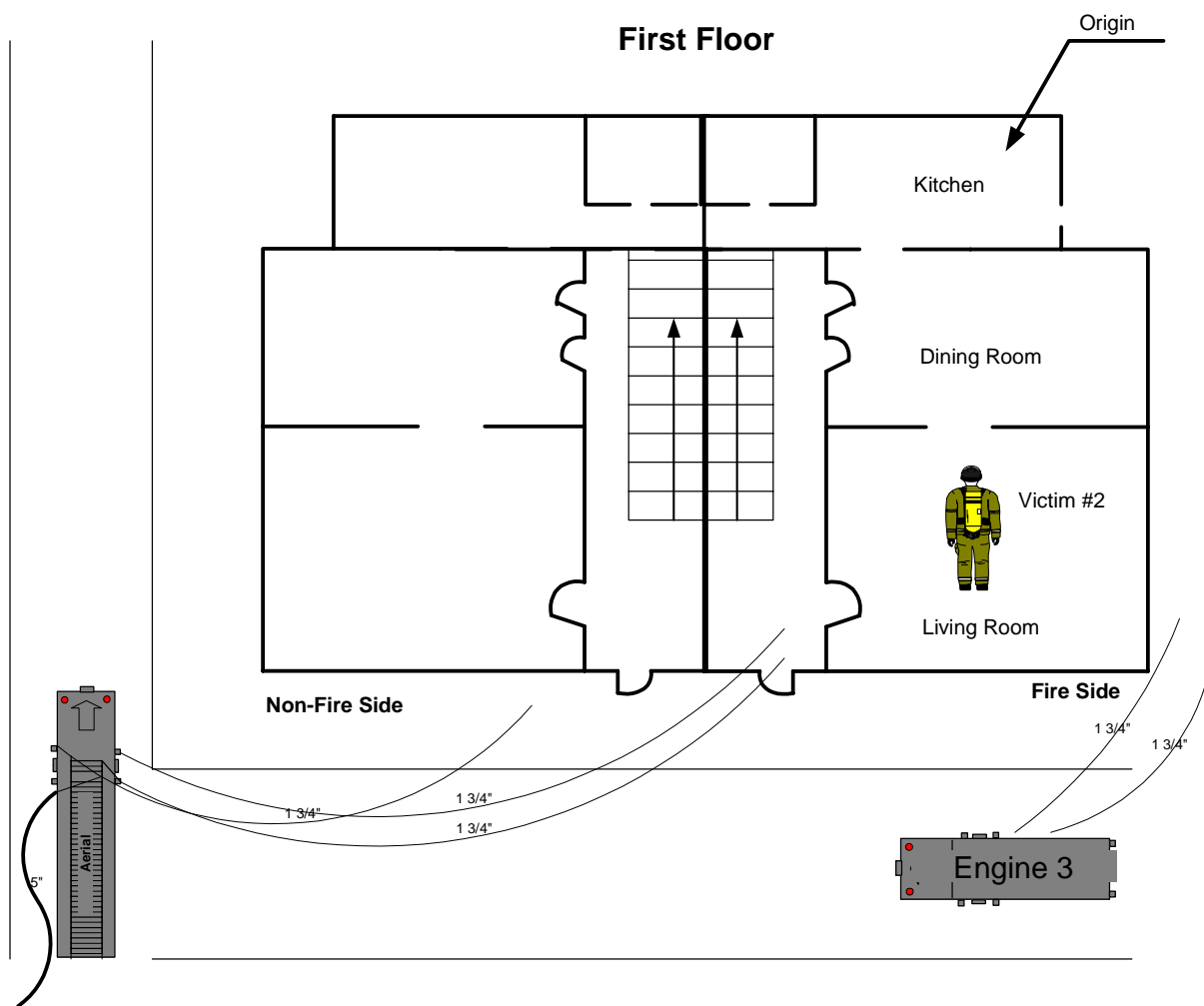


Figure 1. Overview of Incident Site: First Floor



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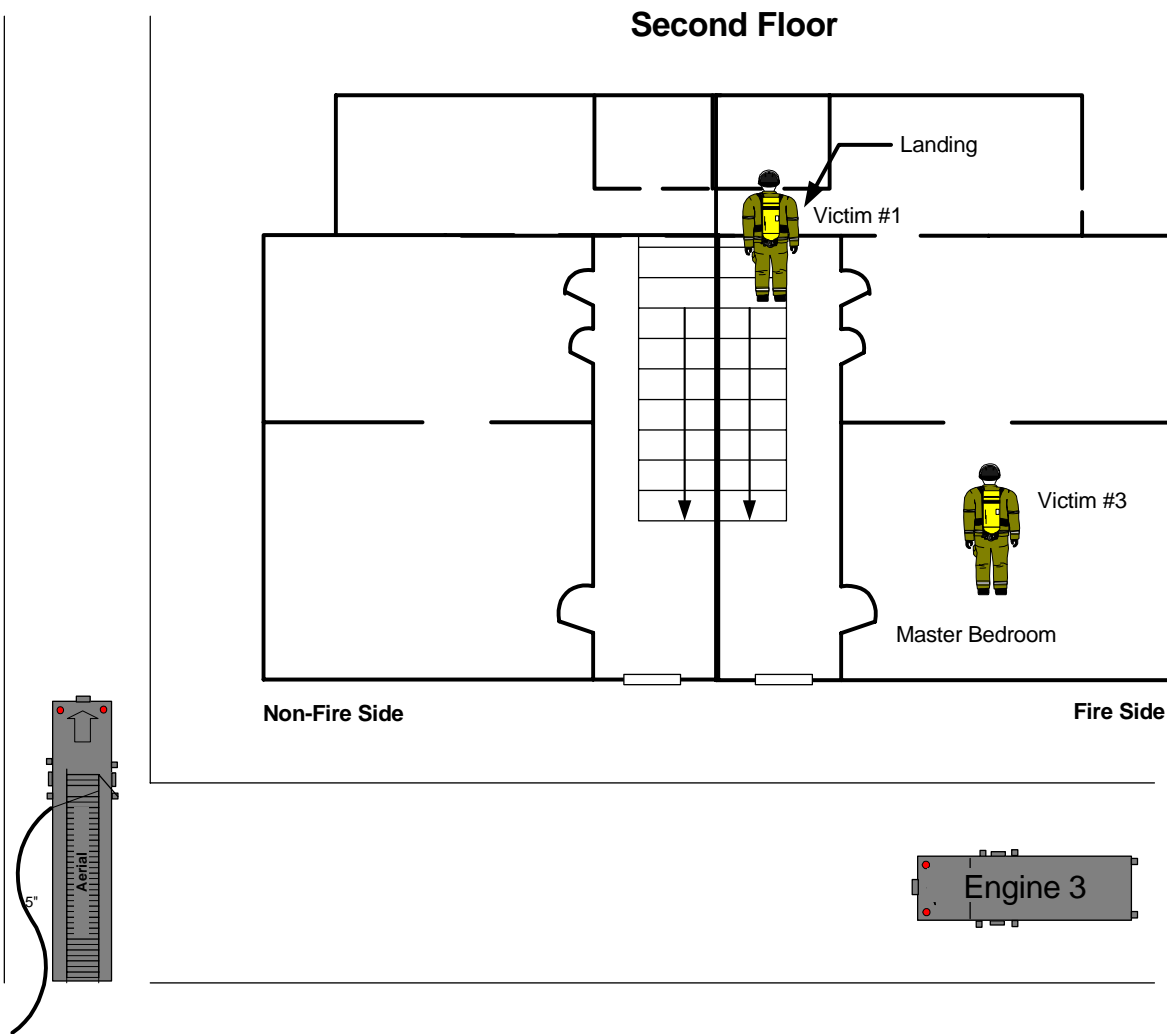


Figure 2. Overview of Incident Site: Second Floor