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NIOSH Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation *July 1, 2004*

Career Fire Fighter Dies Searching For Fire In A Restaurant/Lounge - Missouri

SUMMARY

On February 18, 2004, a 40-year-old male career fire fighter (the victim) was fatally injured in a commercial restaurant/lounge structure fire. The victim, providing mutual aid, had been searching for the seat of the fire with two volunteer fire fighters from another department, when one of these fire fighters lost the seal on his self contained breathing apparatus (SCBA) face piece. The fire fighter immediately abandoned the nozzle position and retreated out of the closest door. The backup fire fighter also retreated out of the building when his partner left. In the black smoke and zero visibility, the fire fighters were unaware that the victim was still inside the structure. Soon after, the Incident Commander (IC) ordered an emergency evacuation because of an imminent roof collapse, and an air horn signal was sounded. Personnel accounting indicated that a missing fire fighter (the victim) was still inside the building when the roof partially collapsed. After several search attempts, the victim was found in a face-down position with his mask and a thermal imaging camera cable entangled in a chair. His facemask was dislodged and not over his mouth. He was pronounced dead on scene.

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

- ***conduct pre-incident planning and inspections to facilitate development of a safe fire ground strategy***
- ***review, revise where appropriate, implement, and enforce written standard operating guidelines (SOGs) that specifically address: incident command (IC) duties, emergency evacuation procedures, personnel accountability, rapid intervention teams (RIT) and mutual aid operations on the fireground***
- ***train on the SOGs, the incident command system, and lost fire fighter procedures with mutual aid departments to establish interagency knowledge of equipment, procedures, and capabilities***
- ***ensure that the IC maintains the role of directing fireground operations for the duration of the incident or until the***

Incident scene

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

www.cdc.gov/niosh/firehome.html

or call toll free **1-800-35-NIOSH**

command role is formally passed to another individual

- ***ensure that the IC conducts a risk-versus-gain analysis prior to committing fire fighters to the interior and continually assesses risk versus gain throughout the operations***
- ***consider appointing a separate, but systematically integrated incident safety officer***
- ***ensure that all fire fighters are equipped with radios capable of communicating with the IC***
- ***ensure personnel accountability reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC***
- ***revise and enforce policies and guidelines regarding activation of personal alert safety systems (PASS) devices***
- ***ensure that fire fighters train with thermal imaging cameras (TIC) and they are aware of their proper use and limitations***
- ***ensure that individual fire fighters are trained and aware of the hazards of exposure to carbon monoxide and other toxic fire gases***

INTRODUCTION

On February 19, 2004, the U.S Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality. On March 9 and 10, 2004, three Safety and Occupational Health Specialists from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated the incident. The NIOSH team met with three chiefs of the involved departments and visited the site of the fatality. Fire-related reports, photos, written witness statements, personnel lists, SOGs, site plans, videos, dispatch radio tapes and the coroner's report were reviewed by the investigators. The victim's protective clothing, SCBA, PASS device, and the thermal imaging camera were examined and photographed.

Fire Department and Apparatus

There were seven separate fire departments involved in this incident operating under a mutual aid agreement. The victim's department is a full career department with 21 uniformed fire fighters serving a population of about 12,700. At the time of the incident, they were providing mutual aid to a neighboring volunteer department that consisted of 15 volunteer fire fighters serving a population of approximately 3,500. The victim responded on Engine 611 (E611). There were two other mutual aid engines (both designated Engine 1) on site and in operation preceding the fatal event (see Diagram) and, ultimately, more than 20 units responded.

Training/Experience

The victim had completed National Fire Protection Association (NFPA) Fire Fighter Level I and II training and had attended a basic course in the use of the department's model of thermal imaging camera. His records also indicated he had completed a personal safety training class within his department in November of 2002. The victim was a career and previously volunteer fire fighter with a total of more than 12 years fire fighting experience.

Building Information

The building was a one story, non-sprinklered commercial restaurant/lounge that was constructed of sheet metal walls and roof over wood frame and lightweight wood trusses (see Photo). In addition, the interior ceiling was metal decking attached to the

bottom of the trusses, suspended from the bottom chord. The building was approximately 5,000 sq ft, built in 1995. The structure consisted of a café, kitchen, bathrooms, and a 2,500 sq ft bar with a bandstand and dance floor. None of the responding departments had inspected the building or developed a pre-incident plan. The building was not covered by any building code jurisdiction since it was located in an unrestricted rural area.

Weather

Weather conditions at the time of the incident were sunny with a moderately strong wind of approximately 21 - 26 mph from the south-southwest. The temperature was approximately 64^0 F and humidity was about 30%.

INVESTIGATION

On February 18, 2004, five units from three separate departments were dispatched to a commercial restaurant/lounge fire. The initial alarm was dispatched at 1331 hours. At 1342 hours, the victim's engine arrived at the scene with three other career fire fighters. The structure fire was located in a mutual aid district, and the first arriving units were already on the scene for approximately one or two minutes when the victim's unit arrived. The victim was wearing full protective turnouts including a hood and a SCBA with an integrated PASS and a portable VHF radio. While responding to the scene, the integrated PASS had sounded in the jump seat of Engine 611 (E611). The victim reportedly silenced and reset the alarm. He was also wearing an additional PASS which was of the type that had to be manually turned on to operate. In addition, a thermal imaging camera was mounted on his helmet and connected to a side pouched battery pack.

When the victim's engine arrived on the scene, there were mutual aid units already in progress of organizing an interior attack. The substantial wind moved the heavy smoke in a general north and east direction. No flames were visible from the front at that time. The IC was a local volunteer district Fire Chief who had arrived prior to E611 and had maintained duties at an engine pump panel as the pump operator for the duration of the incident. Due to limited radio ground frequencies, the IC had no radio communications with E611. The IC also did not receive any interior condition reports from any crews for the duration of the incident.

E-611's crew leader, an acting officer (fire fighter #1), assigned the victim and another fire fighter (fire fighter #2) to assist a two person, mutual aid department crew that was getting ready to enter the front of the building with an 1¾ inch attack line to search for the seat of the fire. Three fire fighters entered the building with the victim in the lead followed by in-district volunteer fire fighters (fire fighters #3 and #4). Fire fighter #2 stayed at the door to feed the hose line. Their entry time is estimated to be 1343 hours. Since the fire was mostly confined to the space above the metal drop ceiling, there was light smoke and good visibility. Their initial entry was into the north part of the structure toward the café, to locate the seat of the fire. With no visible fire in this area, they reversed to the south part of the building in the bar area. At about 1346 hours, firefighter #2 was diverted to the rear of the building to join an attack line at the back door. He informed the victim of his reassignment and was given a "thumbs up" hand signal of acknowledgement. Fire fighter #2's relocation to the rear left three original fire fighters in the front door, the victim with the thermal imaging camera, and fire fighters #3 and #4 on the hoseline. When fire fighter #4 saw fire fighter #2 leave the building through the front door he mistakenly believed it to be the victim leaving. As the fire fighters entered the structure deeper into the south part of the building, the smoke became thick and black. Visibility dropped to zero and heat conditions worsened since the fire was rapidly spreading through the trusses above.

Fire fighter #3 was in the black smoke when he felt a sharp tug on his mask. He later told investigators he was unsure what caused the tug. He lost his facemask seal, dropped the nozzle and left the building through the front door after inhaling acrid smoke. Fire fighter #4, thinking he was alone, also exited through the front door.

In the meantime, fire fighter #1 entered the rear of the building with fire fighter #2 on an attack line around 1349 hours. At 1352 hours, another mutual aid Fire Chief observed part of the metal roof sagging down and advised the IC by radio of imminent structural collapse. He also advised emergency evacuation procedures. Almost simultaneously, the pump operator from E611, who was staged at the southwest corner of the building, noticed the same roof sagging and, with concern for the interior crew in the rear, sounded repeated air horn blasts from his engine until he could visibly see the rear attack crew exit the building.

The IC used his radio to order an "all out" emergency evacuation and a personnel accountability report (PAR). Individual groups of mutual aid departments took visual head counts of their people. Before there was a confirmation of all personnel outside and secure, the attack line in the front door was dragged out of the building. The roof partially collapsed at the south end of the structure around 1354 hours.

Soon, it was noticed that one of the fire fighters was missing. A couple of minutes later, there were several organized rapid intervention team (RIT) attempts to reenter the now partially collapsed building at different locations. Since no one was sure where the victim's last location was, initially the RIT entered through the rear. The result was withdrawals, regrouping, and another air-horn series signaling emergency evacuation. Except for defensive hoselines, the RIT brought no extra or special equipment. They heard no PASS alarms and there were no radio transmissions from the victim.

The victim was found along an east wall, about 25 ft. south of the front entrance at approximately 1437 hours, about 56 minutes after his initial entry. He was in a face-down position with his face mask partially removed and the cylinder to regulator hose tangled around a chair. A cable from the thermal imaging camera was also tangled in the chair. It appears that the entanglement with the chair would have inhibited exit but not trapped the victim. His helmet with the mounted thermal imaging camera was in place. His turnouts, hood, gloves, and SCBA were also in place. The integrated PASS alarm was not sounding, possibly due to the charred and melted condition of the unit. The other PASS unit was found on the victim but did not appear to have been activated. Even in a melted condition, the secondary manual PASS operated and alarmed at a low volume in a field test, post-incident.

A portable radio was found next to the victim. No individual traffic from the victim was recorded by central dispatch. The absence of a local fire ground channel and different radio frequencies precluded radio communication between the victim and the IC. A dent in the helmet of the victim appears to have been caused by a ceiling mounted television that had fallen post-mortem. It does not appear that the partial roof collapse directly struck the victim or obstructed his exit path. The victim was left in place until the local coroner pronounced him dead at the scene.

CAUSE OF DEATH

The coroner listed cause of death as smoke inhalation. An independent toxicology report listed the victim's carbon monoxide level at 51% saturation. There was no notable trauma.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Conduct pre-incident planning and inspections to facilitate development of a safe fire ground strategy[1-4]

Discussion: Even though fire department inspections may not be written into local ordinances, it could be critical to have prior knowledge of individual building construction and unique characteristics. NFPA 1500 considers building assessment a necessary component of a comprehensive risk management plan and Klaene and Sanders consider the identification of roof and floor trusses critical for developing a safe fire ground strategy. Since truss construction is common and requires special consideration in fire fighting operations, it is especially helpful to note their location or operate under the assumption that trusses are there unless confirmed otherwise. Besides the inherent heat distribution properties of metal walls, roofs and ceilings, the weight of a hanging metal ceiling should be a consideration when used in conjunction with light weight trusses.

In this case, the metal building, roof and ceiling, and lightweight wood roof truss construction created a dangerous fire environment conducive to early structural collapse. Concealed spaces above suspended ceilings allow flame spread to go undetected. The presence of concealed spaces can be noted in pre-incident visits and referenced. Also, a pre-incident inspection provides an opportunity to test radio transmission capabilities. In this case, it is unknown whether the metal building interfered with communications to the victim's designated radio channel. It was not tested before the building was razed. NFPA 1620 addresses the need for testing communications and interference of radio coverage during the pre-incident planning process.

Recommendation #2: Review, revise where appropriate, implement, and enforce written standard operating guidelines (SOGs) that specifically address: incident command (IC) duties, emergency evacuation procedures, personnel accountability, rapid intervention teams (RIT) and mutual aid operations on the fireground.[1,2,7]

Discussion: Written standard operating guidelines (SOGs) enable individual fire department members an opportunity to read and maintain a level of assumed understanding of operational procedures. Conversely, fire departments can suffer when there is an absence of well developed SOGs. The NIOSH Alert: "Preventing Injuries and Deaths of Fire Fighters" identifies a need to follow and establish fire-fighting policies and procedures. Guidelines should be reviewed, revised and fully implemented to be effective and enforceable. "All Out" type of emergency evacuations, personnel accountability, and rapid intervention teams are examples of critical operations that require specific written guidelines to assure mutual understanding. While SOGs should be written specific to each department, there is also a need to have regional planning. The complexities of a large scale incident are already difficult without the added confusion about differences in coordinating critical operations.

In an emergency evacuation, hoselines should not be removed until there is a full PAR completed, with all personnel accounted for. This excludes hose lines that are needed by interior crews to assist in the process of safe evacuation. In this situation, an interior hoseline was pulled back out through the front door before the PAR was completed. If the hoseline had not been pulled out, it may have served as a guide to the RIT on where to focus rescue efforts. Also, the victim may have had more opportunity to follow the hoseline out of the building. The victim's absence was eventually discovered and brought to the attention of an officer and the IC. The department SOGs addressed crew integrity but not guidelines or procedures for conducting a PAR .

Recommendation #3: Train on the SOGs, the incident command system, and lost fire fighter procedures with mutual aid departments to establish interagency knowledge of equipment, procedures and capabilities.[1,5,7]

Discussion: NFPA 1500 specifically refers to the importance of training in emergency operations based on standard operating procedures or guidelines. Training is the key to competency and is especially important when there is a gap in experience. Fire fighters should train on activation of PASS alarms and other life-saving activities when lost, trapped or disoriented. Basic activities such as emergency radio traffic, moving toward windows, breaching walls, and utilizing flashlights are just a few of the techniques that can save an individual or team. Fire fighters should be provided with the proper tools and special training to help facilitate search and rescue of lost fire fighters and individual or crew survival procedures. NFPA 1561 defines the essential elements of an incident command system.

While there were varying amounts of training within and between mutual aid departments, the victim's department had very little experience training with the department they were assisting. Cross training on SOGs and the incident command system helps to establish protocols or standards to maximize manpower efficiency and safety of mixed mutual aid crew assignments. Training for lost fire fighters is especially critical when required to work with mutual aid departments that have different staffing, equipment and procedures.

Recommendation #4: Ensure that the incident commander (IC) maintains the role of directing operations for the duration of the incident or until the command role is formally passed to another individual.[5]

Discussion: It is critical that a single individual assumes responsibility for overall control of an incident. While it is advisable to divide command positions into sectors or task groups, the authority and unification of command is the foundation of the system outlined in NFPA 1561. Section 3-1.1 states: "There should be one, clearly identifiable incident commander for the duration of the incident, from the arrival of the first unit until the incident is terminated." In this incident, the IC carried a dual role as pump operator for the duration of the fire operations. Many of the mutual aid fire fighters were not aware who the IC was and looked upon their regular chief officers as the unofficial commander of their department group actions.

Recommendation #5: Ensure that the IC conducts a risk-versus-gain analysis prior to committing fire fighters to the interior and continually assesses risk versus gain throughout the operations.[1]

Discussion: There was information provided by the building owner that the building was evacuated and completely unoccupied. This type of information should be a factor in consideration of a full interior attack or search for the seat of a fire. If an IC is directing the fire fighters to focus on aggressive interior offensive operations, there should also be additional parameters that include an organized retreat plan because of the high risk. An unknown layout, unknown construction, or an unknown source of the fire should be considered in all situations before committing interior crews deep into a structure. NFPA 1500 states in section 6-2.1.1: "No risk to the safety of the members shall be acceptable when there is no possibility to save lives or property."

A lack of preplanning and interior construction information created an environment of unknown,

potentially dangerous conditions. Interior crews did not pull ceilings or identify truss construction to the IC. Such information may have been critical for IC assessment of interior conditions and a decision of whether to go into defensive operations.

Recommendation #6: Consider appointing a separate, but systematically integrated incident safety officer [1,7]

Discussion: One of the key duties of an incident safety officer should be to assist the IC with risk management during emergency operations. While the IC continues to have ultimate responsibility for the safety of all fire department members operating at an incident, a designated safety officer can assist the IC in the analysis of critical risk factors. It is advisable that the IC appoints a safety officer that is not just playing a separate role, but rather is a part of the safety system that is an integral part of the whole incident management system. The appointment of a safety officer does not relieve the IC of safety functions but acts as a delegation of authority for scene safety management. In this sense, all fire fighters are part of that system and have a responsibility to report unsafe conditions to the designated safety officer or command. Safety officer duties are outlined in NFPA 1500 and NFPA 1521.

Recommendation #7: Ensure that all fire fighters are equipped with radios capable of communicating with the IC. [8,9]

Discussion: There were multiple radios utilizing multiple channels at this incident. While there was also a designated fire ground tactical channel assigned to units on the scene, the victim's department was incapable of using this channel because of technical limitations. It should be noted, however, that the victim was capable of communicating with his own department and the central dispatch. It is vital that an interior fire fighter have unrestricted communication with the IC for their own personal safety as well as the ability to advise command of interior conditions and special hazards. A designated emergency traffic channel or a procedure to take control of the assigned channel communications in an emergency situation should also be considered. NFPA 1221 addresses emergency communications needs.

Recommendation #8: Ensure that Personnel Accountability Reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC. [5,9]

Discussion: While there may be varying methods of accomplishing a PAR it is critical that all members report directly to the IC or an officer that reports directly to the IC. Officers should maintain a constant awareness of the position and function of all personnel assigned to operate under their supervision. Likewise, it is important for assigned teams to maintain integrity and awareness of each other's location and accountability unless reassigned. Then, if reassignment occurs, it should be understood by the whole team. In this situation, there was confusion about whether a fire fighter was actually missing or not.

When a PAR indicates a fire fighter is missing, directives by the IC become extremely critical and should encompass guidelines to the individuals in trouble as well as the coordination of other fire fighters, especially the rapid intervention team (RIT). An IC can also direct the RIT to bring special equipment, such as thermal imaging cameras, as needed for each unique situation. NFPA 1561 discusses the need for rapid and efficient personnel accounting.

Recommendation #9: Revise and enforce policies and guidelines regarding activation of personal alert safety systems (PASS) devices.[9,10]

Discussion: The operation of all PASS devices should be checked on a daily basis. When a PASS device is integrated into the SCBA, as in this situation, it should not preclude a need to activate the secondary device. In this case, however, the victim likely did not turn on his secondary PASS device. The SCBA integrated PASS was automatically activated when air was turned on. It is unknown whether the integrated PASS properly activated or alarmed. Interior rescue team fire fighters and other outside fire fighters were in positions where they probably should have heard the PASS alarm, if it was alarming. Yet, with the exception of an accidental activation in the jump seat of E611, neither PASS was heard for the duration of the incident.

Fire departments should maintain a policy of activation of all PASS devices on the fire ground and especially when conducting interior operations. Recognizing the problem of individuals not activating their PASS, many fire departments are utilizing automatic activating models. Because of the severely burned, deteriorated and melted condition of the integrated PASS when the victim was found, it will probably be undetermined whether the PASS was properly functioning. When investigators conducted a field test on the secondary PASS, it activated and alarmed, in spite of its melted condition.
NFPA 1982 outlines PASS standards.

Recommendation #10: Ensure that fire fighters train with thermal imaging cameras (TIC) and they are aware of their proper use and limitations.[11]

A thermal imaging device is a valuable tool, especially for size-up. However, fire fighters should be cautious about a false sense of security when using a TIC. Malfunctions may occur and sole reliance on the camera is not advisable. Fire fighters also need to train in the use of thermal imaging cameras so that they are able to recognize the key features of their proper use in locating the seat of a fire. In this case, the thermal image camera holder could have been behind the nozzle man to direct routes of entry and stream application. If the thermal image camera holder is in the lead, he or she may not recognize the poor visibility conditions of those that follow. In this case, the use of the second thermal imaging camera on scene may have helped the RIT locate the victim sooner.

Recommendation #11: Ensure that fire fighters are aware of the hazards of exposure to carbon monoxide and other fire gases.[12]

It is likely that the dislocation of the victim's mask, whether forced or voluntary, resulted in exposure to toxic gases that quickly overcame his ability to think or speak clearly. The effects of toxic smoke and carbon monoxide are frequently underestimated and may have rapidly affected the victim's judgment capabilities, muscular control or state of consciousness. In other words, because of his exposure to fire gases, he might not have had the opportunity to call for help on the radio, or activate his PASS alarm. Even moderate levels of carbon monoxide can produce symptoms like confusion, disorientation and physical incapacitation of muscular control. It is important for all fire fighters to understand that symptoms can appear in less than a minute and that they may have no time to react when a problem occurs. The victim's carboxyhemoglobin level was found to be 51% by official autopsy.

REFERENCES

1. NFPA [2002]. NFPA 1500: Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

2. 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, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99-146.

3. Klaene B. and Sanders R. [2002]. Structural fire fighting. Quincy, MA: National Fire Protection Association.

4. NFPA [2003]. NFPA 1620: Recommended practice for pre-incident planning. Quincy, MA: National Fire Protection Association.

5. NFPA [2002]. NFPA 1561: Standard on fire department incident management system. Quincy, MA: National Fire Protection Association.

6. NIOSH [1994]. NIOSH alert: preventing injuries and deaths of fire fighters. 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, DHHS (NIOSH) Publication No. 94-125.

7. NFPA [2002]. NFPA 1521: Standard for fire department safety officer. Quincy, MA: National Fire Protection Association.

8. NFPA [2002]. NFPA 1221: Standard for the installation, maintenance, and use of emergency services communication systems. Quincy, MA: National Fire Protection Association.

9. Dunn V. [1999]. Command and control of fires and emergencies. Saddle Brook, NJ. Fire Engineering publishing.

10. NFPA [1998]. NFPA 1982: Standard on personal alert safety systems (PASS). Quincy, MA: National Fire Protection Association.

11. Anonymous [2004]. Thermal imaging camera deployment: Phoenix Regional Standard Operating Procedures. Phoenix, AZ: Phoenix Fire Department.

12. Allen S. and Berkman B. [2002]. CO Rx : A Safety Prescription, WNYF (FDNY) magazine 4TH Edition, New York City, NY: FDNY Fire Zone.

INVESTIGATOR INFORMATION

This incident was investigated by Bruce Oerter, Mark McFall and Steve Berardinelli, Safety and Occupational Health Specialists with the Fire Fighter Fatality Investigation and Prevention Program, Division of Safety Research at NIOSH.

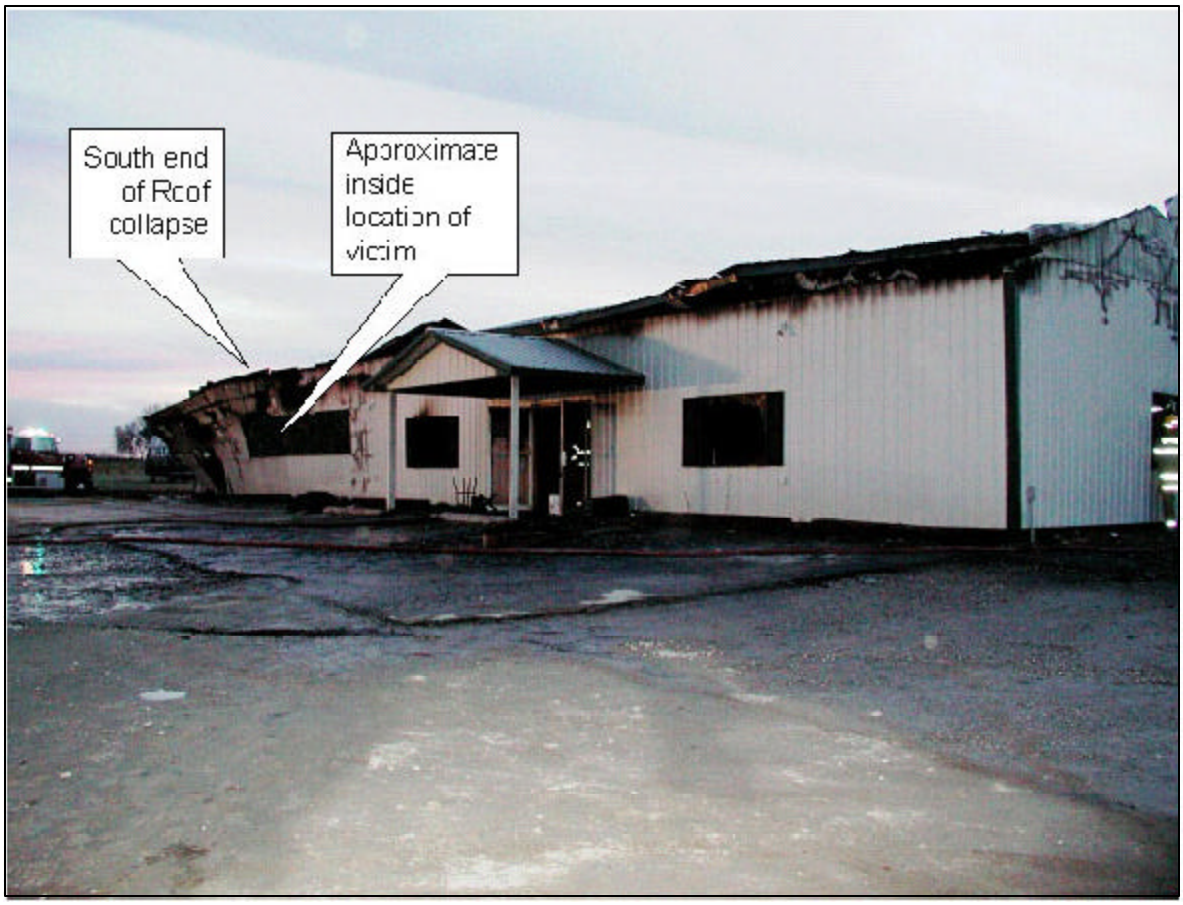

Photo. Front view (East side) of building

Career Fire Fighter Dies Searching For Fire In A Restaurant/Lounge - Missouri

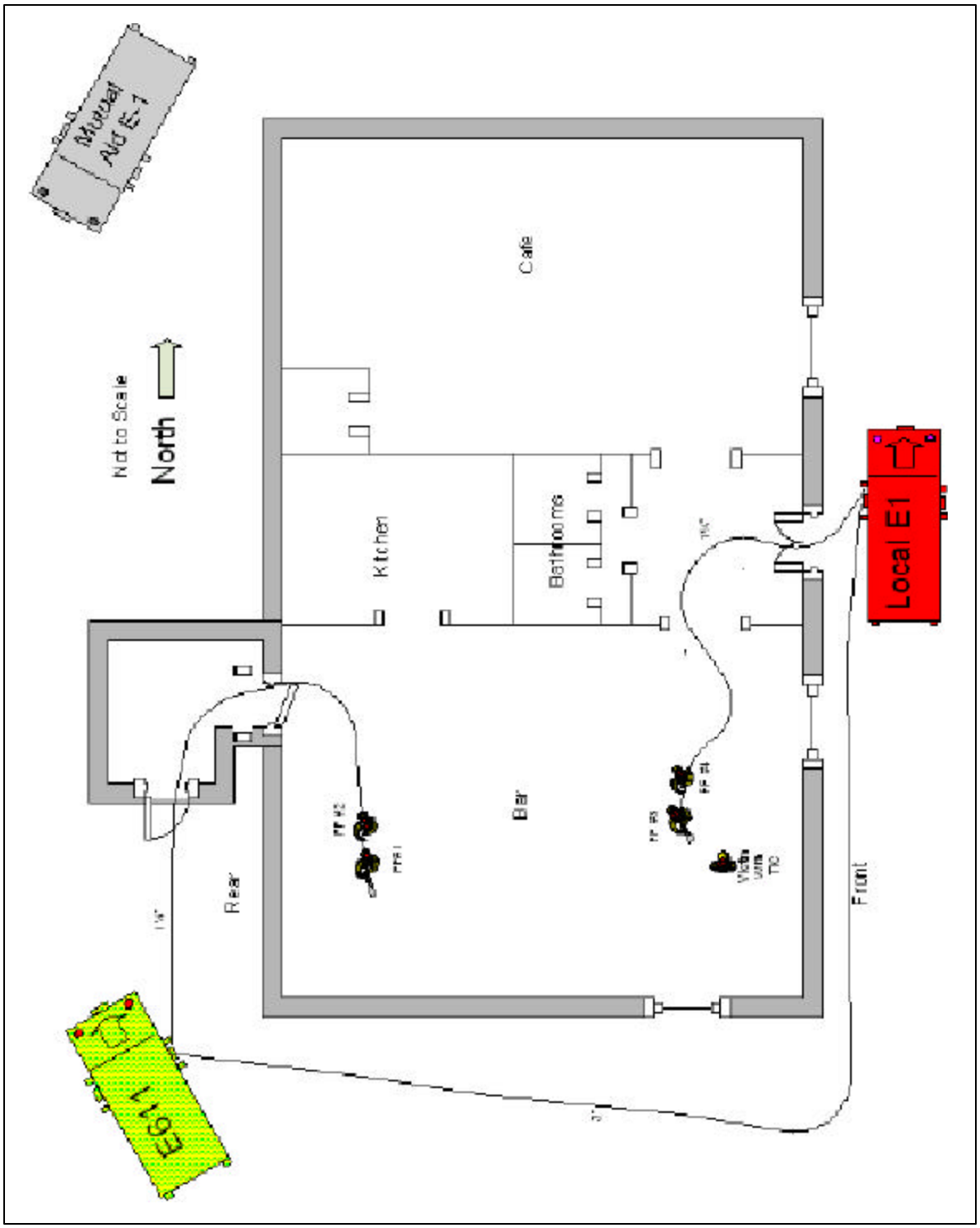

Diagram. Aerial view of incident scene

U. S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway, MS C-13
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