



## **A Volunteer Fire Fighter and Volunteer Assistant Lieutenant Die After a Smoke Explosion at a Town House Complex - Wyoming**

### **SUMMARY**

On April 18, 2005, a 23-year-old male volunteer fire fighter (Victim #1) and a 39-year-old male volunteer Assistant Lieutenant (Victim #2) died after a smoke explosion at a town house complex. Both victims were in the first apparatus to arrive on the scene and were advised that there were children inside on the second floor of the fire unit. The victims made entry into the structure and proceeded to the second floor with a charged hoseline. Within minutes, Victim #2 returned to the front door to request a thermal imaging camera and returned to the second floor just as another crew prepared to provide back-up. As the back-up crew entered the front door an explosion occurred forcing them back down the porch stairs and entrapping the victims in the bedroom on the second floor. The fire, which intensified after the explosion, had to be knocked down before the victims could be recovered. NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- *develop and enforce standard operating procedures (SOPs) for structural fire fighting that include, but are not limited to, the incident command system, accountability, ventilation, and emergency evacuation*
- *ensure that the Incident Commander completes a size-up of the incident and continuously evaluates the risk versus benefit during the entire operation*
- *ensure that adequate numbers of staff are available to immediately respond to emergency incidents*
- *ensure that the Incident Commander maintains the role of director of fireground operations and does not become directly involved in firefighting operations*
- *ensure that the Incident Commander is clearly identified as the only individual with overall authority for management of all activities at an incident*



*Front of town house complex*

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/fire/](http://www.cdc.gov/niosh/fire/)  
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- *ensure that fire fighters are trained to identify truss roof systems and their potential hazards*

## **INTRODUCTION**

On April 18, 2005, a 23-year-old male volunteer fire fighter (Victim #1) and a 39-year-old male volunteer Assistant Lieutenant (Victim #2) died after a smoke explosion at a town house complex. On April 19, 2005, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of the fatalities. On May 22 through May 26, 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 lead Alcohol, Tobacco and Firearms (ATF) investigator and officers of the fire department. Interviews were conducted with a representative from the State Fire Marshal's Office and officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the ATF's report, the State Fire Marshal's report, the department's standard operating procedures (SOPs), the fire department's incident report, the victims' training records, photographs and drawings of the site. The incident site was visited and photographed.

### **Department**

The combination department involved in this incident is comprised of 4 career and 55 volunteer fire fighters who operate out of four stations. The department serves a population of approximately 15,000 residents in a geographic area of about 2,200 square miles.

### **Training**

The State of Wyoming does not require any specialized training for its fire fighters. The

department requires that all fire fighters receive their certification for Fire Fighter I and Fire Fighter II through the protocol and testing provided by the State. Victim #1 was National Fire Protection Association (NFPA) Level I- and Level II-certified, and had also received training for Hazardous Materials (HazMat). He had more than 2 years of fire-fighting experience. Victim #2 was NFPA Level I- and Level II-certified, and he had also received other training including HazMat, Wildland Fire Fighting, Emergency Medical Technician, Fire Instructor I, and Flashover. He had more than 11 years of fire-fighting experience.

### **Units for Initial Alarm**

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

Engine 1 (Captain/driver, Victim #1, Victim #2)  
Engine 2 (Driver/operator, 3 fire fighters)  
Ladder 1 (Lieutenant/driver, 2 fire fighters)  
Privately Owned Vehicle (POV) [Lieutenant/  
Incident Commander (IC)]  
POV [Lieutenant (Lt. #1)]  
POV [Lieutenant (Lt. #2)]

### **Weather**

The conditions were clear with strong winds gusting to over 30 mph and temperatures averaging 42-degrees Fahrenheit. The average humidity was 61 percent.

### **Structure**

The structure was a tri-level town house with two levels above ground and a daylight basement which extended above-ground in the rear of the structure. It was located on the northern end of a five unit town house complex. The residence



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was of ordinary construction which encompassed approximately 1,600 square feet that was built in the 1980s. The residence had smoke detectors that were working at the time of the fire.

The area of fire origin was in a storage area behind a knee wall in the bedroom on the upper floor. The bedroom was the only major room on the second floor and was framed by room-in-attic trusses. This construction allowed the storage areas behind the knee walls to connect to the attic space above. The void space provided by the room-in-attic trusses allowed the bedroom to be surrounded by the fire and hot gases.

### **INVESTIGATION**

At approximately 1510 hours Central Dispatch received a call of a structure fire and paged out the local fire department. A Lieutenant who arrived in his personally owned vehicle (POV) at the rear of the structure assumed Incident Command (IC) at 1514 hours just as Engine 1 (E1) arrived on the scene. E1 was the first apparatus to arrive on the scene and was advised by a neighbor that there were children inside on the second floor of the fire unit. Engine 1 was positioned in front of the unit, which was on the east side of the complex, and reported to Central Dispatch that smoke was showing. The Captain and both victims from E1 prepared to make entry to search for the trapped children. The Captain, who did not have his bunker gear, pulled the 200-foot 1-¾-inch pre-connect from E1 as Victim #1 and Victim #2 donned their self contained breathing apparatuses (SCBA) and prepared to make entry. The Captain noticed small flames coming from the roof peak near the front side of the chimney chase on the D-side of the structure. He also noted light colored smoke seeping from the roof shingles of the fire unit and smoke from the attic area of the adjacent unit.

The IC was staged at the rear of the structure and assisted setting up Ladder 1 (L1) when they arrived on the scene at 1516 hours. He noticed smoke coming from the two end units and a small amount of flames were coming from the roof of the fire unit where the two units met (Photo #1).

The Captain returned to E1 and charged the line. The victims made entry into the structure and proceeded to the second floor with a charged hoseline. The Captain then requested another Lieutenant (Lt. #1), who arrived in his POV as the Safety Officer, to operate the pump. He also requested another fire fighter to get the positive pressure ventilation (PPV) fan off of E1 and set it up at the front door of the unit. The Captain took a 24-foot extension ladder from E1 to the D-side of the complex to find a second-floor window to assist ventilation as his crew made entry through the front door. The Captain did not find a window on the second floor on the D-side, but there was a skylight in the roof of the C-side or rear of the unit (Diagram #1 and Photo #2). He returned to the front of the structure and saw that Victim #2 was at the front door requesting the thermal imaging camera (TIC). The Captain retrieved the TIC from E1 and gave it to Victim #2.

Just after Engine 2 (E2) arrived at 1518 hours, another Lieutenant (Lt. #2) who responded in his POV joined a fire fighter from E2 to provide back-up at the front of the structure with an 1-¾-inch pre-connect the fire fighter pulled off of E1. Heavy brown smoke was filtering down the stairs and out the front door at this time. *Note: At approximately 1520 hours the IC at the rear of the structure received information and reports from bystanders that the kids were out of the fire unit. This transmission was never acknowledged by any of the crews at the front of*



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*the structure conducting interior operations. At this time command was transferred to another officer arriving on the scene; however, the new IC did not have direct involvement in the incident preceeding the fatal event.*

The back-up crew made their way up the porch stairs to the stair landing just inside the structure and radioed for the line to be charged at approximately 1521 hours. The Captain was walking around to the back and had just passed the first floor window on the D-side of the fire unit when the explosion blew out the window directly behind him at 1522 hours (Diagram #2 and Photo #3). The Captain immediately attempted to contact the entry team by radio and did not get a response.

The Captain returned to the front of the structure where the explosion had blown the back-up crew out of the front door and down the porch stairs. Thick black smoke and heavy fire was coming out of the front door. The back-up crew re-entered the structure and made it up three steps and attempted to follow the victims' handline to the second floor. The heat and flame conditions on the stairway were so intense that the back-up crew was forced to exit. Lieutenant #2 ordered fire fighters to flow water through the D-side window on the first floor, which was fully involved, and then he proceeded to the rear of the structure.

Lieutenant #2 met the Captain and another fire fighter at the rear entrance. The Captain informed them that they had two members down and possible occupants. Lieutenant #2 and the fire fighter advanced a 1-3/4-inch handline from L1 in through the rear entrance (Diagram #2). The crew proceeded through the kitchen and living room knocking down fire as they made their way to the stairs. The crew was able to fight back the flames as they followed the victims' handline

up the stairs to a landing just outside the second floor bedroom (Diagram #1). The bedroom was completely involved with heavy fire in the rafters above them. As they knelt at the landing fighting fire, Lt. #2 could hear a low air alarm sounding. They were able to knock down the fire in the rafters and restore some visibility. They immediately spotted Victim #1's boots just inside and to the left of the bedroom door. Victim #1 was in the prone position with his feet towards the bedroom door, with his gloves removed, and the TIC beside him to the right (Diagram #1). *Note: It is believed that the victims were searching for the trapped children and opened the door in the window dormer leading to the storage area behind the wall. The seat of the fire was in the storage area just behind the door on the west side of the bedroom. It is believed that the fire was throughout the entire storage area. The attic area and the storage areas on both sides of the room were connected by a void space through the design of the room-in-attic truss (Diagram #3). The bedroom was charged with smoke and the wind was blowing from west to east in excess of 30 mph. According to the ATF and State Fire Marshal, when the door was opened, the fire blew into the room and instantaneously ignited the smoke, causing an explosion.*

Approximately 15 minutes after the explosion, additional fire fighters assisted the rescue crew to remove Victim #1 and place him in an ambulance. Crew members re-entered and found Victim #2 in the northeast corner of the bedroom. They removed Victim #2 and placed him in an ambulance. Both victims were transported to a local hospital and pronounced dead.

**CAUSE OF DEATH**

The medical examiner lists the cause of death for both victims as smoke inhalation and thermal burns to over 50% of their bodies.



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**RECOMMENDATIONS/DISCUSSIONS**

***Recommendation #1: Fire departments should develop and enforce standard operating procedures (SOPs) for structural fire fighting that include, but are not limited to, the incident command system, accountability, ventilation, and emergency evacuation.***

Discussion: SOPs are organizational directives or plans that establish how the organization will react in various situations to increase the effectiveness and ensure the safety of the fire fighting team. Standard fireground procedures include but are not limited to basic command functions; delegation of command responsibility; communications and dispatching; fire ground safety; tactics; initial resource deployment; and designation of roles and responsibilities of companies and units.<sup>1</sup> SOPs should be comprehensive and encompass training, fire protection agreement plans, and procedures for those incidents involving mutual and automatic aid. SOPs should be written, periodically reviewed, and enforced.

Incident Command System: NFPA 1720 § 4.5.1.2 states that “the Incident Commander shall be responsible for the overall coordination and direction of all activities for the duration of the incident.”<sup>2</sup> It is important that specific tasks and responsibilities are addressed in SOPs so that responding crew members know what their tasks are upon arrival and that the IC or company officer will be prepared to assign responsibilities as needed on the scene. The recommended span of control (the number of personnel one can effectively supervise) is 4-7. Thus, as the number of personnel increases, the IC must delegate supervision of specific duties and tasks such as ventilation, search & rescue, and fire attack or sectors. In this incident, functions were not formally assigned.

Accountability: According to NFPA 1720 § 4.2.1.3 “the incident commander shall ensure that a personnel accountability system is immediately utilized to rapidly account for all personnel at the incident scene.”<sup>2</sup> SOPs should require a company officer to record every responding fire fighter, including him or herself at the start of operations. If an incident occurs on the fire ground, each officer will be asked to conduct a roll call and verify the whereabouts of their personnel. In this incident, members were arriving without reporting to the IC for accountability. Accountability was not set up until after the explosion.

Ventilation: Ventilation decisions should be a part of the initial size-up and are necessary to improve the fire environment in order for fire fighters to approach a fire with a hoseline for extinguishment or to allow a quick search for any victims. Smoke, heat, and gases should be vented above the fire to eliminate conditions for a flashover, or in this incident, an explosion.<sup>3,4,5</sup>

Emergency Evacuation: Evacuation signals are used when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area because conditions have deteriorated beyond the point of reasonable safety. There are several ways this communication can be done. The two most common methods are (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.<sup>3</sup> SOPs should identify the types of emergency evacuation signals that will be used by the fire department.

***Recommendation #2: Fire departments should ensure that the Incident Commander completes a size-up of the incident and continuously***

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***evaluates the risk versus benefit during the entire operation.***

Discussion: The information obtained from a complete size-up 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, the type of structure and its construction, occupants, time of day, contents of the structure, and potential hazards.<sup>6</sup>

In this incident, a 360° walk-around of the structure was never conducted by the first arriving officer who was acting as the IC. The first arriving apparatus, Engine 1, was positioned in the front of the structure, and had received information from a neighbor that children were trapped on the second floor of the fire unit. The officer from E1 took control of the operations in front of the structure and immediately deployed his crew in attempt to locate and rescue the children. While the IC was pulling a supply hose for aerial water tower operations, he received confirmation that the children were out of the fire unit. The IC was unaware of any interior operations occurring in the front of the structure; therefore, he didn't make any tactical changes in the operation. He radioed that the children were out of the structure at 1520 hours, but did not receive confirmation of his transmission. The officer from E1 was charging the pump, retrieving gear for the victims, and attempting to ventilate the structure. He did not receive the transmission.

***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.”<sup>7</sup>

In this incident, there were 11 fire fighters and the Incident Commander on the scene. The Captain was responding on his day off and did not have any gear on the engine to effectively assist with fireground operations. The ladder truck responded with only the driver/operator and two fire fighters, which forced the IC to assist with setting up their truck for aerial operations. Fire apparatus that are staffed below minimum requirements can result in less effective and ultimately unsafe fire fighting conditions.

***Recommendation #4: Fire departments should ensure that the Incident Commander maintains the role of director of fireground operations and does not become directly involved in fire-fighting operations.***

Discussion: According to NFPA 1720, “The responsibility for assigning fire companies at an emergency belongs to the incident commander, who establishes priorities and assigns units based on identified objectives.”<sup>22</sup> In addition to conducting an initial size-up, the IC must maintain an awareness of the location and function of all companies or units at the incident, initiate and maintain accountability, and control communications for the tactical, command, and emergency traffic channels for the incident. To effectively coordinate and direct fire-fighting operations on the scene, it is essential that adequate staff are available for immediate



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response to ensure that the IC is not required to become involved in fire-fighting efforts. In this incident the IC was involved in non-command functions such as pulling a supply hose and helping to set up the aerial truck.

***Recommendation #5: Fire departments should ensure that the Incident Commander is clearly identified as the only individual with overall authority for management of all activities at an incident.***

Discussion: NFPA 1561 states, “There should be one, clearly identifiable incident commander for the duration of the incident, from the arrival of the first emergency services organization unit until the incident is terminated.”<sup>8</sup> The IC should make assignments based on the availability, qualifications, and expertise of individuals. It is imperative that the IC clearly be in charge of all operations on the fireground to ensure the successful completion of an operation.

This incident had an identified IC, but command was never established, nor was a plan ever developed. Independent and uncoordinated operations were taking place at the front and rear of the structure. An effective fireground operation revolves around one IC who develops and coordinates tactical decisions with all personnel on the fireground. Companies responding as assigned must ensure that they report to the IC to establish a unified command system. If there is no command, or if there are multiple commands, fireground operations can quickly break down.

***Recommendation #6: Fire departments should ensure that fire fighters are trained to identify truss roof systems and their potential hazards.***

Discussion: Trusses come in many sizes, shapes, and design. It is important that fire fighters are

able to identify them and the dangers they may pose. Trusses generally consist of wood but may also be constructed with various types of metals. Truss systems that have the bottom cords covered with a ceiling create a void space between the ceiling and roof. During a fire, this void space could conceal smoke and fire, accumulate hot gases, and allow rapid fire spread. Once burning of a truss has been confirmed, defensive fire fighting tactics should be used.<sup>9</sup>

Typical residential construction using roof trusses create a void space between the roof and the ceiling. The roof of the structure involved in this incident was built with a room-in-attic truss. A room-in-attic truss system has a room framed into the void space typically created between the roof and ceiling, placing the void space around the entire room. In this incident, the attic fire was not only overhead, but it surrounded the victims as they conducted a search in the upstairs bedroom (Diagram #3). Fire fighters should be provided with training to identify the different types of truss systems and their potential hazards in a fire. Training to identify trussed buildings should be a part of the fire department’s pre-fire planning or inspections.<sup>9</sup>

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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.



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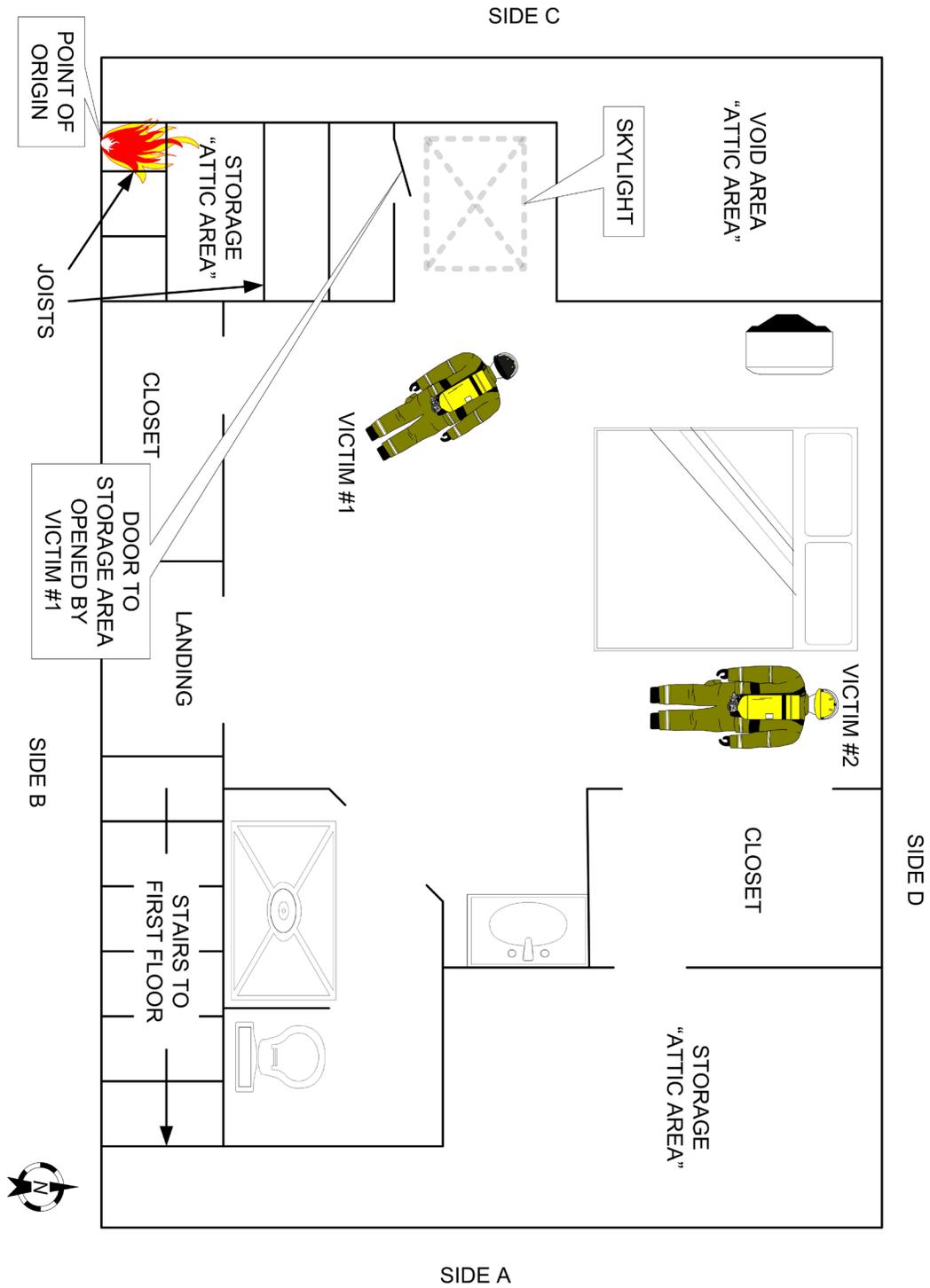


Diagram 1. Second floor bedroom



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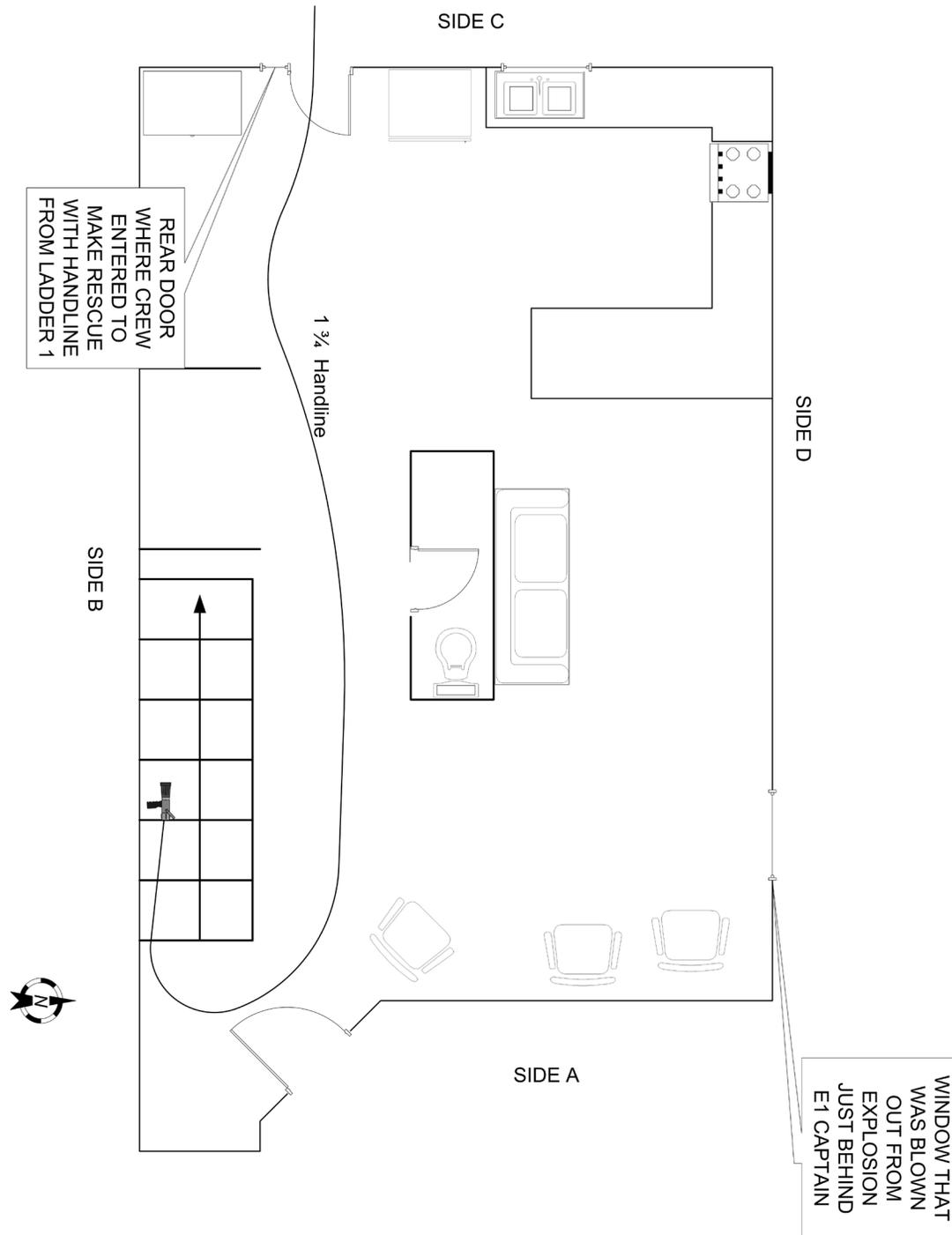
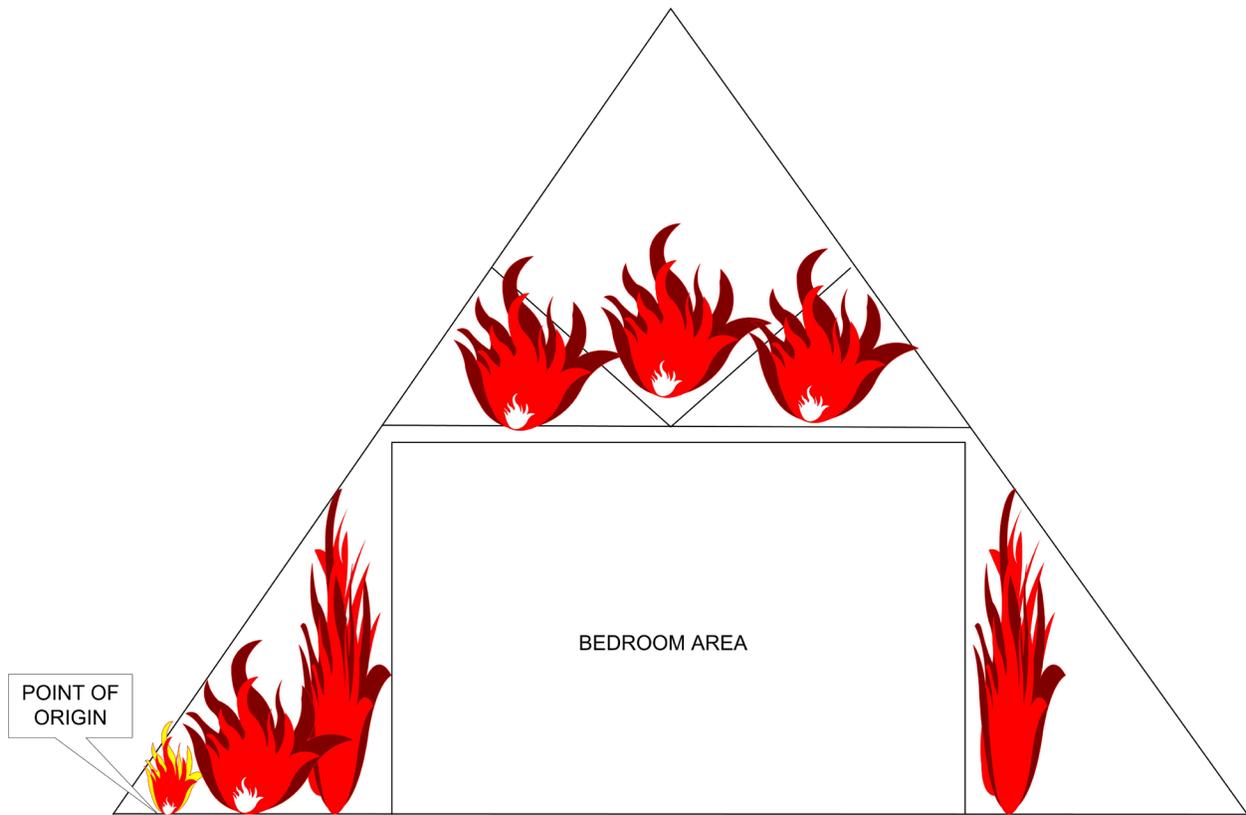


Diagram 2. First floor layout; Aerial view



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*Diagram 3. Room-In-Attic Truss; Side view. See link below for additional information.*

<http://www.firefighterclosecalls.com/drills/FCC%20Vol%208-95%20Void%20Spaces%20&%20Hidden%20Fire.pdf>



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*Photo 1. Rear-view of structure*



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*Photo 2. Location of skylight at rear of structure*



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*Photo 3. Window that was blown out by explosion*



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