


Joseph R. Polenzani

**Mobile Homes**  
Small House - Big Challenge



Joseph R. Polenzani  
Battalion Chief  
Franklin (TN) Fire Department

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**Why Mobile Homes?**



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**Mobile Homes**

- Term used for manufactured homes produced prior to June 15, 1976
- 16% in 2005



Source: Manufactured Housing Institute

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**“Manufactured” Home?**

- Federal Manufactured Home Construction and Safety Standards
  - “HUD Code”
  - June 15, 1976.
  - Only federally-regulated national building code.
- Built entirely in the factory and transported to site

Source: Manufactured Housing Institute

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**Other Factory-Built Housing**

- Modular Homes
- Panelized Homes
  - Whole walls (includes windows, doors, wiring, and outside siding)
- Pre-Cut Homes
  - Includes kit, log, and dome homes
- All must meet state, local, or regional codes where they are sited

Source: Manufactured Housing Institute

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**What’s This?**



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**What’s This?**



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**What’s This?**



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**Manufactured Home Myths**

**Myth**  
Only found in rural areas

**Fact**  
24% of manufactured homes are in population markets of over 2,000,000 people.

Source: 2005 Foremost Insurance Group Study

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**Manufactured Home Myths**

**Myth**  
A mobile home fire is always a defensive operation.

**Fact**  
With proper notification and response, offensive operations are possible.

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**Manufactured Home Myths**

**Myth**  
Manufactured homes are "built to burn".

**Fact**  
Federal standards regulate manufactured housing design and construction, including fire resistance. The HUD Code also sets performance standards for the heating and electrical systems.

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**Owner Modifications**

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**Sizing Up the Structure**

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**Owner Modifications**

Fire/Rescue  RIT

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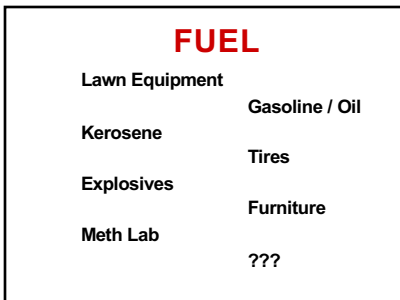
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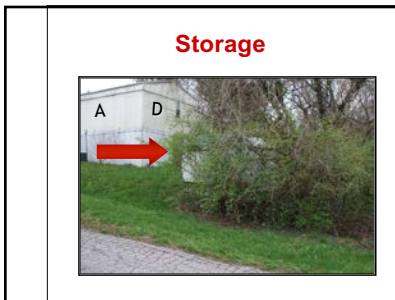
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Fire/Rescue  RIT

**Tactics for Success**

Fire/Rescue

- 360° Size-Up
- TIC (6-point Scan)
- Open/Force Storage Area Doors
- Ventilate (PPV)
- Aggressive Overhaul
- Reinforce Floor

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**Tactics for Success**

RIT

- 360° Size-Up
- Remove Skirting
- Use Exterior Visual Cues
- Open Exits
- Stage Appropriate Tools

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**The Front Door...**

 A photograph of the exterior of a mobile home, showing the front porch and steps.

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**The Back Door**

 A photograph of the exterior of a mobile home, showing the back entrance and a green utility vehicle parked nearby.

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**The Back Door**

 A photograph of the exterior of a mobile home, showing the back entrance and surrounding vegetation.

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Fire/Rescue  RIT

**The Back Door**

 A photograph of the exterior of a mobile home, showing the back entrance and a grassy area.

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Fire/Rescue  RIT

**The Back Door**

 A photograph of the exterior of a mobile home, showing the back entrance and a grassy area.

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Fire/Rescue  RIT

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**The Back Door**



Fire/Rescue  RIT

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**The Back Door**




Fire/Rescue  RIT

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**Tactics for Success**

Fire/Rescue

- 360° Size-Up
- Communicate the Hazard
- Can You Force the Door?
- May Be Needed for:
  - Ventilation
  - Fire Attack
  - Rescue



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**Tactics for Success**

RIT

- 360° Size-Up
- Check w/Command and/or Safety
- Proactive Ladders
- Open/Control All Doors
- Clear Area Below Door



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**Elevation and Terrain**



Fire/Rescue  RIT

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**Elevation and Terrain**



Fire/Rescue  RIT

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**Elevation and Terrain**



Fire/Rescue  RIT

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**Elevation and Terrain**



Fire/Rescue  RIT

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**Elevation and Terrain**



Fire/Rescue  RIT

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**Tactics for Success**

Fire/Rescue

- 360° Size-Up
- Check Floor Integrity
- Essentially a 2<sup>nd</sup> Floor Fire
- Command: What's Division 1?
- Plan Ahead: 2nd Entry/Exit Point
- "One Length for the Fire Floor"

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**Tactics for Success**

RIT

- 360° Size-Up
- Access Area Below House Early
- Check/Monitor Structural Stability
- Proactive Ladders (Call for Help!)

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**Risk vs. Benefit**  
January 11, 2001

50

**Lt. Andrew J. White**  
Rocky Grove (PA) Fire Department

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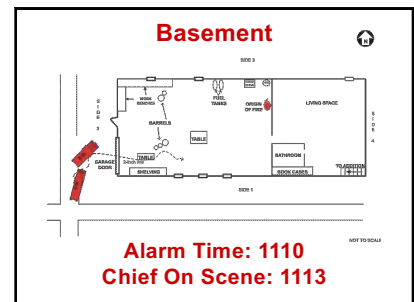
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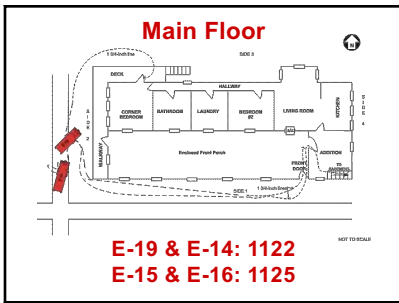


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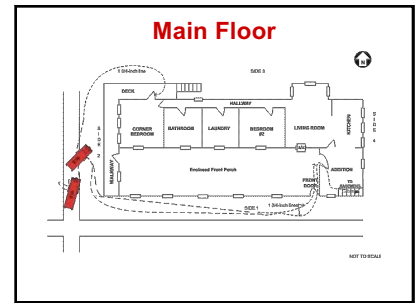
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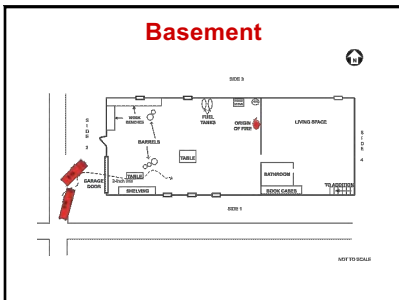
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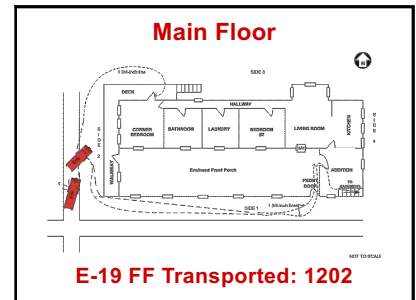
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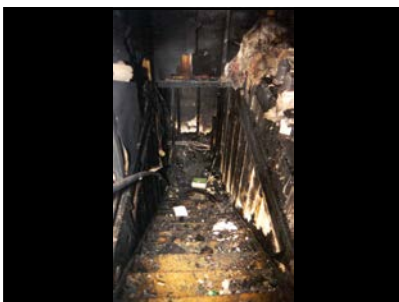
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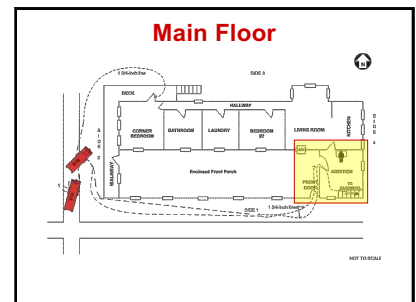
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**Risk vs. Benefit**  
January 11, 2001

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**Other Hazards**

- Design Limitations
- Fuel Storage
- Propane Appliances
- Heat Tape

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**Design Limitations**

Fire/Rescue  RIT

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**Design Limitations**

Fire/Rescue  RIT

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**Fire Behavior**  
February 19, 2009

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**Lt. Johnnie Hammons**  
**FF Timothy Nicholas**

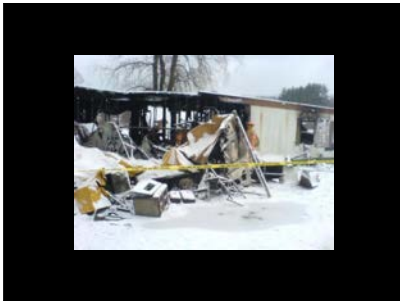
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Dispatch: 2157  
Chief & E-30: 2200  
T-31: 2201  
E-32: 2203

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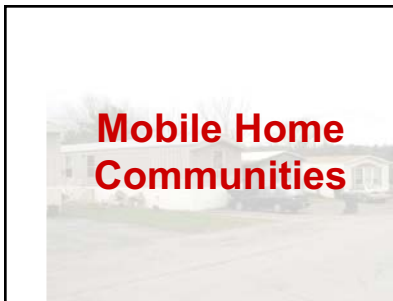
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**Hazards: Heat Tape**

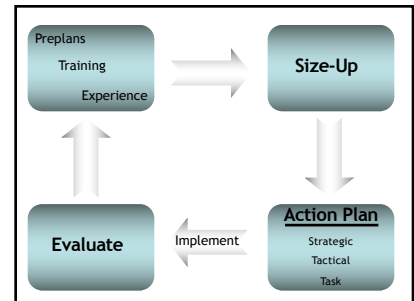


3-5 Year Life Span  
Owner-Installed

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When Does Size-Up Start?



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What Does It Include?

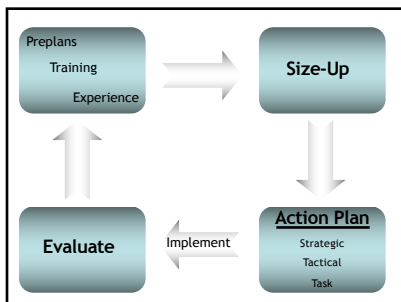


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When Does Size-Up Stop?



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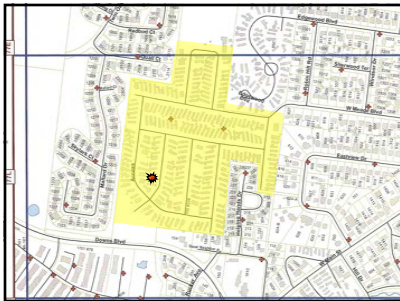
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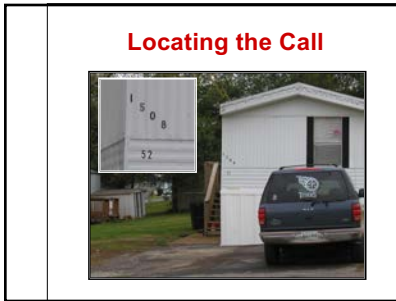
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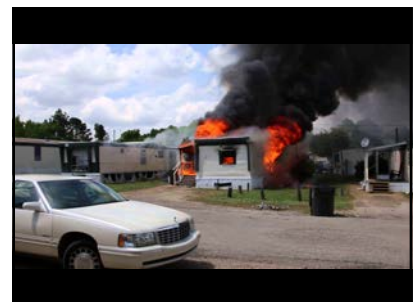
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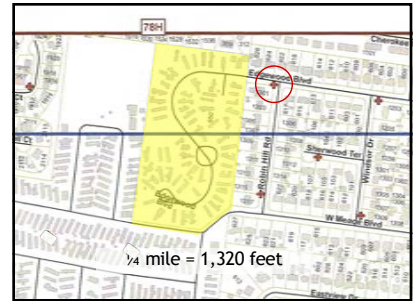
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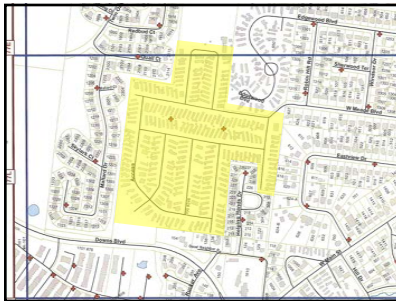
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**Florida**

September 27, 2007

**Family loses dog, home in fire**  
 Homeowner Jacqueline Fountain, left, stands with her friend Ashley Williams, who holds Man-Man, the one dog that escaped the mobile home on Friday afternoon. (AP Photo/Tony Stone Worldwide)

A mobile home fire killed a family pet and destroyed a residence in Land O'Lakes. Firefighters got the call at about noon, and said the structure off Lake Palmetto Road was burned almost to the ground by the time they arrived.

Jackie Fountain and her boyfriend James Hancock had lived in the trailer for seven years with their 4-year-old daughter, Cheyenne. But for the past three months, the couple has been without running water. Five of the eight other people living in the trailer court said they also had been without water. The landlord could not immediately be reached for comment.

Firefighters still don't know what started the fire. Fountain and Hancock were next door, helping a relative move to a home with running water.

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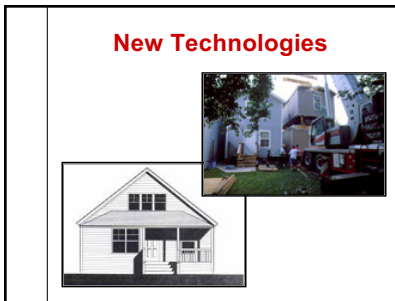


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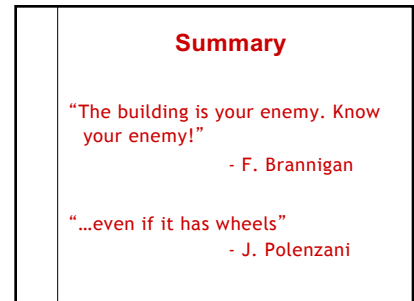
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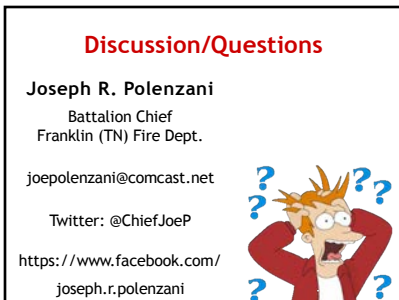
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## **Volunteer Lieutenant and a Fire Fighter Die While Combating a Mobile Home Fire - West Virginia**



*Incident Scene  
(Photo courtesy of fire marshal)*

### **SUMMARY**

On February 19, 2009, a 49-year-old male volunteer lieutenant (Victim #1) and a 26-year-old male fire fighter (Victim #2) were fatally injured while combating a mobile home fire. They arrived on scene to find a camper fully involved with fire and flames impinging on an adjacent mobile home.

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In fiscal year 1998, the Congress appropriated funds to NIOSH to conduct a fire fighter initiative. NIOSH initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. For further information, visit the program Web site at <http://www.cdc.gov/niosh/fire> or call toll free at 1-800-CDC-INFO (1-800-232-4643).



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***Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia***

The occupants of the camper and mobile home escaped without injury, prior to the fire department's arrival. The victims entered the mobile home through the front door with a charged 1½-in hoseline. Within 5 to 10 minutes of them entering, the pump operator sounded the evacuation alarm when he noticed his tank water was low. The victims did not evacuate from the structure. Fire fighters on scene attempted to contact the victims via radio and by yelling into the mobile home. The fire chief and a fire fighter tugged on the 1½-in hoseline several times with no response. They then pulled on the hoseline and it came freely from the mobile home. Fire conditions were primarily contained to the one side of the structure while several attempts were made to locate the victims by fire fighters entering through the front door and noninvolved side of the mobile home. The victims were eventually discovered in the front room of the mobile home—several feet from the front door they had entered through. Their facepieces were not on when they were found. The victims were pronounced dead on scene. Key contributing factors identified in this investigation include lack of department administrative controls in regards to donning respiratory protection and SCBA maintenance, SCBAs were not equipped with an integrated or stand-alone PASS device, incident commander (IC) involvement in fireground activities, and wind conditions pushing smoke through the mobile home.

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

- *ensure that fire fighters use their self-contained breathing apparatus (SCBA) during all stages of a fire due to the potential exposure and health affects of fire-produced toxins*
- *ensure that all SCBAs are equipped with an integrated personal alert safety system (PASS) device*
- *ensure that all fire fighters are equipped with a means to communicate with fireground personnel before entering a structure fire*
- *ensure that the incident commander (IC) does not become involved with fire fighting activities*
- *ensure that the incident commander (IC) maintains close accountability for all personnel operating on the fireground and that procedures and training for the use of a personnel accountability report (PAR) are in place*
- *ensure that a properly trained incident safety officer (ISO) is appointed at all structure fires*
- *ensure that a rapid intervention team (RIT) is established and available to immediately respond to emergency rescue incidents*



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*Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia*

- *ensure that hoseline operations are properly coordinated so as not to impede search-and-rescue operations*
- *develop, implement, and enforce written standard operating procedures (SOPs) for fireground operations*
- *ensure that all fire fighters properly wear their department-issued turnout gear and personal protective equipment (PPE) during fire suppression activities*
- *develop and maintain a comprehensive respiratory protection program*
- *ensure that fire fighters are aware of the dangers involved in fighting mobile home fires*
- *ensure that policies and procedures for proper inspection, use, and maintenance of self-contained breathing apparatus (SCBA) are implemented to ensure they function properly when needed*

## **INTRODUCTION**

On February 19, 2009, a 49-year-old male volunteer lieutenant (Victim #1) and a 26-year-old male fire fighter (Victim #2) were fatally injured while combating a mobile home fire. On February 21, 2009, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On February 25, 2009, a safety and occupational health specialist and a safety engineer from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated this incident. The NIOSH investigators interviewed the fire chief from the victims' department and the fire marshals investigating the incident and visited the incident site. The NIOSH investigators returned March 2-March 4, 2009 with a second safety and occupational health specialist and conducted interviews with fire fighters and officers from the victims' department and the mutual aid department that provided support in this incident. The investigators met with the state fire marshal and the state's investigative team, reviewed their investigative photographs, spoke with the medical examiner, and photographed the victims' gear and SCBAs. The investigators also met with the local 911 dispatch center.

NIOSH investigators also reviewed photographs of the fireground and training records of the victims and incident commander and toured the fire station. Although the performances of the victims' SCBAs were not considered a factor in this incident, these SCBAs were examined by NIOSH's National Personal Protective Technology Laboratory to determine conformity to the NIOSH-approved configuration (see Appendix for a summary of this examination).

The investigators spoke with the West Virginia Fire Extension Service regarding volunteer fire fighter requirements. The West Virginia Fire Extension Service also provided facilities and resources





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***Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia***

for NIOSH investigators to test the function of the nozzle that was on the hoseline when pulled into the mobile home by the victims. It had been secured by the state fire marshals at the incident scene immediately after the fatalities occurred. NIOSH investigators took the nozzle to the state fire service extension training center on April 3, 2009. The nozzle was connected to three 50 ft sections of 1 3/4-in preconnected hoseline on a 2001 model pumper. A qualitative test was conducted by NIOSH investigators in which water was flowed through the nozzle at varying stream patterns using pump pressures ranging from 80 to 150 psi. The nozzle was rated by the manufacturer to 70 to 200 gallons per minute at 100 psi. The actual flow was not measured. The nozzle appeared to function properly. NIOSH investigators recommend that the nozzle also be evaluated by the manufacturer or a certified test facility before it is placed back into service.

## **FIRE DEPARTMENT**

*Station 3—Victims' Department.* The victims' volunteer department is comprised of 30 fire fighters. The department has one station and serves a rural population in a geographical area of 75 square miles. The fire department had established standard operating guidelines (SOGs) several years ago, but they were mostly administrative in nature and out-dated. The department is currently revising them.

*Station 2—Mutual Aid Department.* The mutual aid volunteer department is comprised of 34 fire fighters. The department has one station and serves a rural population in a geographical area of 170 square miles.

## **TRAINING and EXPERIENCE**

Victim #1 had been with this department for more than 11 years. He had completed certification courses in Fire Fighter I, Fire Officer I, Hazardous Materials Operations, Basic First Aid and Cardiopulmonary Resuscitation (CPR). The victim had also completed various online training courses on the incident command system (ICS).

Victim #2 had been with this department for more than seven months and was recently released from probationary status. *Note: The fire department's policy is to place all new members on probation until they complete the state requirements to be a volunteer fire fighter, which include Fire Fighter I, Hazardous Materials Awareness, Basic First Aid and CPR.* Prior to joining this department he had been a volunteer fire fighter for approximately five years while stationed with the military in North Carolina and three years in another volunteer fire department in West Virginia. He had completed certification courses in Fire Fighter I, Hazardous Materials Operations, Basic First Aid, and CPR.

At the time of the incident, the IC served as the chief of the department. He had been a volunteer fire fighter with this department for more than 22 years and had been a command officer for



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***Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia***

approximately 15 years. He was certified to the levels of Fire Fighter II (NFPA 1001), Fire Instructor II, Hazardous Materials Technician, and Fire Officer II. He had also completed Leadership I – III, Incident Safety Officer, Managing Company Tactical Operations (Tactics, Decision Making, and Preparation), and several online and instructor-led courses in incident command systems.

This department periodically provided training to their members on topics such as use of personal protective equipment, SCBA, search and rescue, and water supply.

**EQUIPMENT and PERSONNEL**

- **Station 3—Victims’ Department**

- Engine 30 (E30) with five fire fighters (Victim #1, Victim #2, an officer, FF1, pump operator)
- Tanker 31 (T31) with three fire fighters
- Engine 32 (E32) with five fire fighters
- Special operations vehicle (SOV) with four fire fighters (FF2, FF3)
- Privately owned vehicles (POVs) with fire chief (IC) and one fire fighter

- **Station 2—Mutual Aid Department**

- Utility 226 (U226) with three fire fighters (FF4)
- Engine 224 (E224) with three fire fighters (FF5, FF6)
- Privately owned vehicles (POVs) response by four fire fighters

- **Water Supply on Scene**

- E30 750 gallons
- T31 1,500 gallons (not connected when evacuation alarm was sounded from E30)
- E32 1,200 feet of 6-in supply hose laid from hydrant on main road to scene

**TIMELINE**

The timeline for this incident includes the initial call to the 911 dispatch center at 2156 hours. Only the units directly involved in the operations preceding the incident are discussed in this report. Once Station 3 arrived on scene all radio traffic went to their private repeater channel and was not heard or recorded by the county dispatch center. The response, listed in order of arrival and key events, includes:

- **2156 Hours**

- 911 dispatch center receives a call from a civilian stating his “trailer” was on fire
- Power company notified



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*Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia*

- **2157 Hours**  
Station 3 dispatched for mobile home fire
- **2159 Hours**  
Fire chief en route  
E30 en route  
T31 en route
- **2200 Hours**  
Fire chief on scene; requests law enforcement for traffic control  
E30 on scene per fire chief
- **2201 Hours**  
T31 on scene  
E32 en route
- **2203 Hours**  
E32 on scene; lays 6-in supply line to the scene
- **2210 Hours**  
Law enforcement on scene; assists fire fighters in protecting the supply line on the main road
- **2220 Hours**  
Station 2 dispatched to assist with manpower at mobile home fire
- **2226 Hours**  
E224 en route  
U226 en route
- **2236 Hours**  
Fire chief requests manpower assistance because two of his men are missing  
U226 on scene
- **2239 Hours**  
E224 on scene

**PERSONAL PROTECTIVE EQUIPMENT**

It was reported to NIOSH investigators that Victim #1 and Victim #2 were seen wearing a full array of personal protective clothing and equipment, consisting of turnout gear (coat and pants), helmet, Nomex® hood, gloves, boots, and a self-contained breathing apparatus (SCBA). It could not be



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***Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia***

determined whether the victims were on air when they entered the mobile home. Victim #1's Nomex® hood met the 1997 edition of NFPA 1971 and Victim #2's Nomex® hood met the 1991 edition of NFPA 1971; the victims' structural fire fighting rubber boots and turnout gear (manufactured in March of 2002) met the 2000 edition of NFPA 1971. The turnout gears' heat-resistant outer shells, moisture barriers, and insulating thermal linings were all present during the incident and documented during the investigation.

The victims were found equipped with a flashlight and various fire fighter hand tools in their pockets. Victim #1 was found without his helmet on and Victim #2 still had his on. The victims were also found with their Nomex® hoods rolled down on their necks, without their facepieces on, and without a stand-alone or integrated PASS device.

The department used SCBAs from two different manufacturers.<sup>a</sup> Some SCBAs in the department used low pressure tanks and others used high pressure tanks, and many first-out and spare air bottles had not been hydrostatically tested. *Note: A hydrostatic test is a testing method that uses water under pressure to check the integrity of pressure vessels. Air cylinders must be stamped or labeled with the manufactured date and the date of the last hydrostatic test. According to the U.S. Department of Transportation, steel and aluminum cylinders must be tested every five years; composite cylinders every three years.*<sup>1</sup> Some SCBAs had integrated PASS devices and some had only stand-alone PASS devices attached to the harness. The SCBAs that the victims used did not have an integrated PASS device and were recently placed on the fire apparatus for use without a stand-alone PASS placed on them. Stand-alone PASS devices were shared among department SCBAs that did not have an integrated PASS.

The victims' face-mounted regulators were connected securely to the SCBAs' assigned facepieces and were hanging at waist level. Soot was found on the outside and inside of both facepieces when photographed by the fire marshal. Victim #2's facepiece was missing the lower left fastener that anchors the harness to the facepiece (see Photo 1). Both face-mounted regulators were last flow-tested in March of 2002. *Note: The members were not issued their own facepieces, but rather shared a universal facepiece assigned to each SCBA. During the investigation, many members, including incident photos viewed of Victim #1, were observed with excessive facial hair or beards. Also, both remote pressure gauges were found to be in the "empty" position. Note: Records were not provided to NIOSH investigators to determine the initial air cylinder readings. The air cylinder gauges were damaged and unreadable.*

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<sup>a</sup>The SCBAs that were primarily used by this department were the subject of a recent NIOSH user notice that can be found at [http://www.cdc.gov/niosh/npptl/usernotices/pdfs/GSSP11\\_11202008.pdf](http://www.cdc.gov/niosh/npptl/usernotices/pdfs/GSSP11_11202008.pdf). However, this model of SCBA was not used by the victims on the night of the incident.



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**Photo 1. Facepiece missing a harness fastener.**  
*(NIOSH photo)*

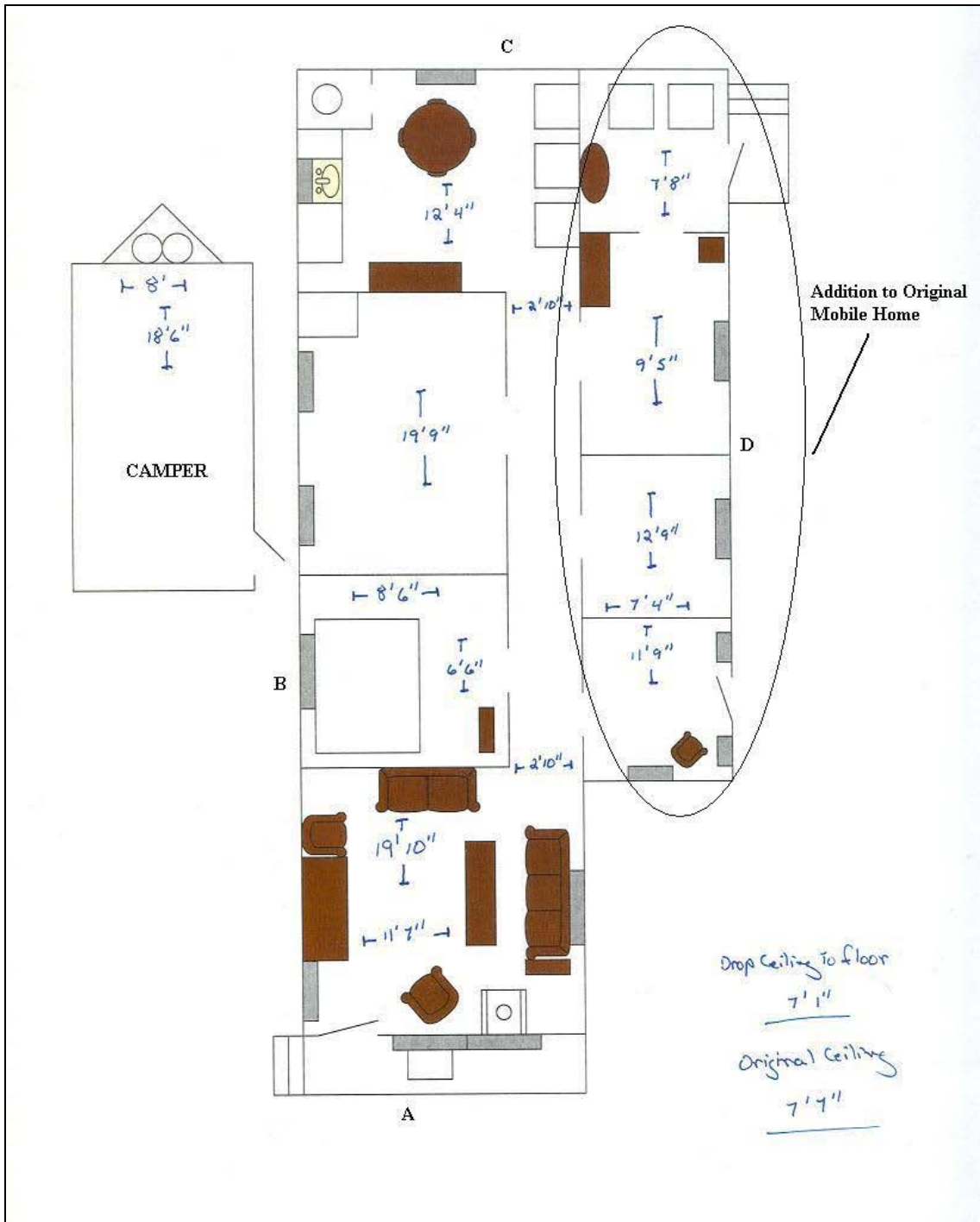
## **STRUCTURE**

The incident structure was a single-story, single-wide mobile home built between 1970 and 1980. The mobile home had approximately 980 ft<sup>2</sup> of furnished living space (65 x 12 ft mobile home and a 41 ft 6 in x 7 ft 4 in addition, D-side) (see Diagram #1). The mobile home was of wood-frame construction with aluminum siding, flat metal roof, and linoleum floors throughout the home. The walls were fiberglass-insulated under particle board and covered with sheets of finished wood paneling. The home had drop-ceiling panels rested in a suspended grid system that measured 7 ft 1 in to the floor. Fiberglass insulation was placed in the 6-in void space between the drop ceiling and original ceiling. The home had a wood-burning stove at the A-D corner.

The fire originated from an occupied camper that was parked near the B-side of the mobile home, approximately four feet away (see Photos 2 and 3). The camper measured 18 ft 6 in x 8 ft and was completely destroyed during the fire. It is believed the camper fire directly impinged on the B-side of the structure causing a window to fail, allowing the fire to ignite the B-side wall and bedroom materials inside the mobile home.



*Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia*



**Diagram 1. Approximate dimensions of mobile home.**  
*(Diagram courtesy of fire marshal; with added labels)*



*Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia*



**Photos 2 and 3. Camper located on the B-side of the structure.  
Photos taken after snow had melted.  
(Photos courtesy of fire marshal)**

## **WEATHER**

The weather at the time of the incident was cloudy with snow and a temperature of 21°F, a wind of 13 mph and gusts upwards of 24 mph blowing west-northwest.

## **INVESTIGATION**

On February 19, 2009, at 2156 hours, the 911 dispatch center received a 911 call from a civilian stating his “trailer” was on fire. The initial dispatch included Station 3 at 2157 hours. The initial on-scene conditions were not reported by arriving personnel, but during interviews fire fighters stated the camper was fully involved with fire and flames impinging on the mobile home. The occupants of the camper and mobile home were able to evacuate without injury prior to the fire department’s arrival.

### **Activities of the Incident Commander**

The fire chief arrived on scene at 2200 hours. The fire chief blocked traffic with his POV allowing E30 and T31 to position into the incident scene. Because he was the highest ranking officer on scene, the fire chief assumed the role of IC, following the department’s SOPs. The IC did not provide to dispatch an incident size-up nor did he state that he was in command upon his arrival. *Note: The fire chief and initial apparatus responded together from the fire station. Fire fighters interviewed stated they were aware that the fire chief was the IC because he was the highest ranking officer on scene.* After T31 passed his position, the IC followed T31 into the scene and saw a hoseline stretched in the mobile home through the A-side door. The IC never saw Victim #1 or Victim #2 enter the mobile home. He also saw two fire fighters spraying water on a fully involved camper that was sitting next



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to the mobile home. He stated that he did not see the mobile home on fire, but the fire from the camper was hitting the B-side of the mobile home.

The porch light was still on and the IC thought he could see the interior lights on as well. He immediately exited his vehicle and walked around the mobile home performing his size-up and trying to locate the electric meter. He noticed that the meter was positioned across the residential street from the mobile home. He asked a fire fighter, who responded in a POV, to stand on the A-side porch of the mobile home and let him know when the power went out. *Note: This fire fighter stated that the smoke was heavy and gray, hanging in the mobile home, but he could see 10 ft inside the mobile home from the doorway.* The IC pulled the electric meter and then heard the evacuation alarm sound from E30. *Note: The IC could still see the incident scene from where the meter was pulled.*

The IC walked over to E30 and asked the pump operator why the alarm was sounding. He then realized the initial attack crew had not come out. The IC and the fire fighter assigned to the front porch tugged several times on the 1½-in hoseline running through the A-side door and eventually pulled it out with no response from the victims. The IC stated it was a normal practice for him to pull on the hoseline to get his fire fighters to respond if they didn't respond initially to the evacuation alarm. He asked the pump operator for a head count. The pump operator advised the IC his head count was five, but he did not know who went in from E30. The IC called a member back at the fire station to confirm who responded on E30. The IC then walked around the mobile home to see if Victim #1 and Victim #2 exited through a different door. He tried to contact the victims by radio while other fire fighters on scene yelled through the front and rear doors. *Note: It was later determined that both victims had left their assigned radios at the station.* He noticed two fire fighters were flowing water with a 2½-in hoseline at the C-D corner of the mobile home trying to extinguish the fire and locate the victims. The IC instructed two fire fighters, FF2 and FF3 (arrived by SOV) from Station 3, to "pack-up" and enter through the A-side door to search for the victims. He stated that heavy gray smoke was coming from this door, but no fire was present. He then assisted the pump operator of E32 in placing that apparatus into pump service so that they could supply E30. The IC then contacted the state fire marshal's office to report the missing fire fighters and to request additional manpower assistance as well.

The IC was notified of failed attempts to locate the victims in the A-side front room. *Note: FF2 and FF3 entered to find conditions to be very hot, with black smoke and fire rolling across the ceiling. They exited after running out of air, and then one fire fighter from Station 2 (FF4) and FF2 reentered to find the same conditions.* The IC then noticed the officer of E30 coming around the A-D corner with the 2½-in hoseline that was being used at the C-D corner. The IC took the hoseline, set the nozzle to fog, and sprayed it through the A-side door which improved visibility.

### **Activities of E30**

E30 arrived on scene at 2200 hours. The crew from E30 reported the camper, located on the B-side of the mobile home, being fully involved upon their arrival and flames impinging on the mobile home. Light gray smoke was also visible around the mobile home. E30 was positioned at the A-B corner with T31 pulling in behind E30. Victim #1 and Victim #2 pulled a 150-ft preconnected 1½-in





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hoseline off the officer side of the engine and positioned it at the front door (A-B corner) of the mobile home. The E30 officer and Fire Fighter #1 (FF1) pulled a second 150-ft preconnected 1½-in hoseline off the officer side of the engine and positioned it at the camper (B-side of mobile home). Victim #1 then walked over to the E30 officer and pointed at the mobile home, indicating he was going inside. That was the last time the E30 officer saw Victim #1. The E30 officer could not recall whether the victims were wearing their facepieces when they entered the mobile home.

The E30 officer flowed water from the A-B corner of the mobile home diagonally across the camper trying to keep the fire off the mobile home. He then went to the opposite side of the camper and flowed water onto it. The camper walls were coming down and he believed that the hose stream may have pushed into the mobile home's B-side. He then heard the evacuation alarm sound from E30 (see Diagram 2).

The pump operator sounded the evacuation alarm after he noticed that the panel light indicating a half-tank capacity was no longer illuminated. *Note: Fire marshals estimated the evacuation alarm was sounded within 10-15 minutes of E30's arrival.* He stated that the panel light indicating a quarter-tank capacity was not working. He sounded the evacuation alarm at this time because he wanted to make sure that the fire fighters inside the mobile home had enough water to get out in case the fire was not extinguished. He sounded the alarm three times with no response from the interior crew.

The E30 officer left the hoseline with FF1 positioned at the camper and went back to E30 to see what was happening. He was told by the E30 operator that the victims had not exited the mobile home, so he took a 2½-in hoseline from E30 around to the D-side of the mobile home. With assistance from two Station 2 members (FF5 and FF6), the officer flowed water on the mobile home's addition and through the rear door located at the C-D corner. FF5 and FF6 entered through the D-side door and fought fire until they ran out of air. The officer then went back to the A-side of the structure with the 2½-in hoseline; the IC took the 2½-in hoseline from the officer and sprayed a fog pattern through the front door. The fog pattern pushed the smoke back, allowing the officer and a Station 3 fire fighter (FF2) to enter the mobile home where they discovered Victim #1 on the floor approximately 10 feet from the front door and Victim #2 approximately sixteen feet from the door.

### **Activities of T31**

T31 arrived on scene at 2201 hours and positioned behind E30. T31 connected a section of 2½-in supply line to E30 to provide them with their tank water. As T31 was connecting to E30 the evacuation alarm was sounded. The pump operator immediately looked at the mobile home and saw smoke around the front door, but no fire. He then quickly filled E30's tank. The pump operator then assisted E32 in supplying E30. *Note: T31 was initially used for its tank water and did not supply E30, after E32 laid a supply line into the scene.* The pump operator remembers the IC, the fire chief, briefly assisting the crew of E32 when they could not get E32 to pump.



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**Activities of E32**

E32 arrived on scene at 2203 hours and connected to the hydrant located on the main road. They laid 1,200 ft of 6-in supply line to the incident scene. They were short; therefore 100 ft of 2½-in supply line was laid from E32 to E30 to supply them with water. Initially, E32 would not pump due to being in the wrong gear. The IC was able to fix the problem and a viable water supply was established to E30.

**Activities of Station 2**

Station 2 was dispatched to assist with manpower with U226 arriving at 2236 hours and E224 arriving at 2239 hours. All apparatus from Station 2 were staged on the main road. The IC tasked two fire fighters in full turnout gear and SCBA (FF5 and FF6) to go to the C-D corner to assist E30's officer, FF4 was tasked to the A-side to assist with search and rescue, and one fire fighter to assist with extinguishing the camper fire.

FF5 and FF6 took a 2½-in hoseline in through the D-side door; no smoke was coming out of this door. They entered into what was later determined to be the kitchen area. They went in standing up and were met with gray to black smoke. They turned left from the kitchen and noticed fire coming from a bedroom on the B-side. They started flowing water on the flames with a straight stream when, while advancing down the hall, FF5 fell through the floor. FF5 stated he held onto the nozzle while flowing water down the hallway. FF6 immediately assisted FF5 up, and they went to their knees to fight the fire. FF5 changed the straight stream pattern to a fog pattern and placed the nozzle through the bedroom wall that had been breached by fire. They sprayed water for 10-15 minutes before their low-air alarms sounded.

FF2 (from Station 3) and FF 4 entered through the A-side front door. FF4 recalls seeing no fire conditions in the front room and the gray/black smoke was being blown around them. He was able to walk around the front room and remembers walking on a lot of debris. The suspended ceiling had fallen allowing the fiberglass insulation to fall, covering the living room floor and the victims (see Photos 4 and 5).



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**Photos 4 and 5. Front room of mobile home before and after debris and victims were removed.**  
*(Photos courtesy of fire marshal)*

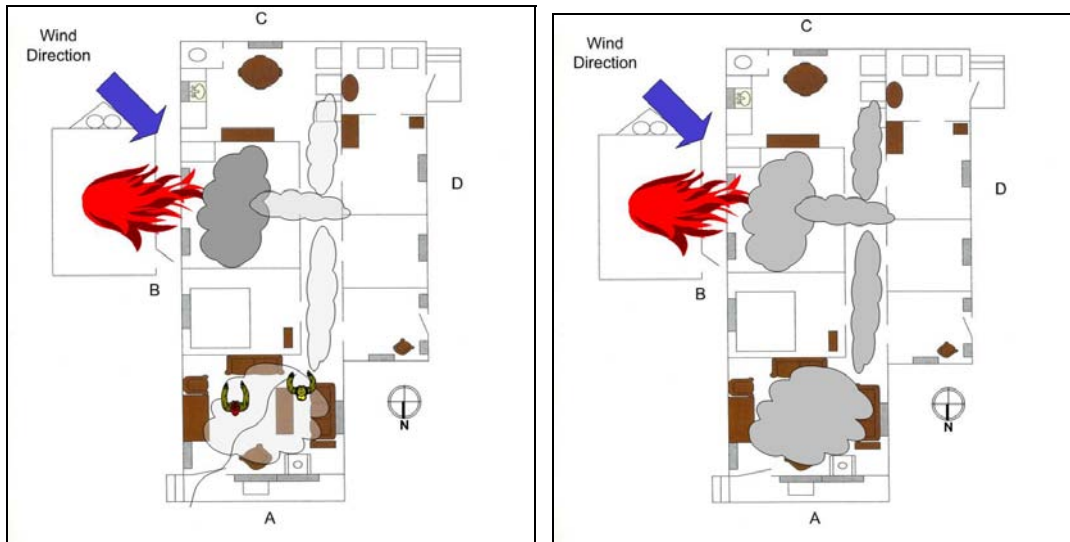
**Discovery of Victims**

Victim #1 was found 9 ft 10 in and Victim #2 was found 15 ft 11 in from the A-side door they entered through. *Note: These measurements were taken from the doorway to the victims' closest extremities.* Victim #1 was face down with his arms by his side and legs straight. His regulator was connected to his facepiece and was discovered under him at waist level. His body was positioned toward the C-side of the mobile home. His helmet was found sitting upright on a couch several feet away from him as if he had taken it off and laid it on the couch. Victim #2 was found 1 ft 10 in ahead of Victim #1, also face down. His left leg was bent under his right leg, right arm under his body, and left arm facing up. His regulator and facepiece were also connected and discovered under his body at waist level. His body was also pointing toward the C-side of the mobile home. Both victims had their Nomex® hoods rolled down on their necks. Also, both victims were found without an integrated or stand-alone PASS device.

State fire marshal and NIOSH investigators have not been able to determine what happened in the mobile home causing the deaths of the two fire fighters. According to the medical examiner, both victims had lethal doses of carbon monoxide and cyanide in their systems, thermal burns to their tracheas, and soot in their lungs. NIOSH investigators believe that the victims may have entered the structure without being on air because there was no evidence of fire within the mobile home, only light smoke. *Note: Fire fighters interviewed stated if no fire was present and smoke conditions were light, then the department fire fighters may not have initially been on air.* It is believed that while advancing the hoseline into the front room, the camper fire continued to directly impinge on the mobile home, causing materials to heat up and off-gas until they reached their ignition temperature; fire from the camper also breached into the interior of the mobile home through a B-side window. The windy conditions and the mobile home acting as a horizontal chimney may have contributed to the movement of products of combustion, smoke toxins, and hot fire gases through the mobile home, which could have quickly overcome the victims (see Diagrams 3 and 4).



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**Diagrams 3 and 4. Diagram on left depicts smoke and visibility conditions when fire fighters entered into the mobile home, with the gray cloud indicating heavy smoke and products of combustion and the transparent clouds indicating lighter smoke conditions and good visibility. NIOSH investigators believe that smoke and visibility conditions quickly changed engulfing the fire fighters in an oxygen-deficient atmosphere and exposing them to fire-produced toxins, with the gray clouds indicating increased smoke conditions and products of combustion (Diagram on right).**

### **CONTRIBUTING FACTORS**

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. NIOSH investigators identified the following items as key contributing factors in this incident that may have led to the fatalities:

- Lack of department administrative controls in regards to donning respiratory protection and SCBA maintenance.
- SCBAs were not equipped with an integrated or stand-alone PASS device.
- Incident commander involvement in fireground activities.
- Wind conditions pushing smoke through the mobile home.



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**CAUSE OF DEATH**

According to the county medical examiner's office, the victims died from smoke inhalation and thermal inhalation burns. The carboxyhemoglobin (COHb) levels were 63% for Victim #1 and 64% for Victim #2. The toxicology reports for both victims showed lethal doses of cyanide in their systems.

**RECOMMENDATIONS**

***Recommendation #1: Fire departments should ensure that fire fighters use their self-contained breathing apparatus (SCBA) during all stages of a fire due to the potential exposure and health affects of fire-produced toxins.***

Discussion: An SCBA is a device that allows fire fighters to operate safely within an environment with inhalation hazards such as toxic smoke and oxygen deficiency,<sup>2</sup> defined by OSHA as immediately dangerous to life and health (IDLH). OSHA 29 CFR 1910.134 (g) (4) (iii) states, "all employees engaged in interior structural firefighting use SCBAs."<sup>3</sup> During this incident, it is believed that the victims entered the mobile home without being on air and were overcome by toxins in the smoke and hot fire gases. Fire fighters on scene reported light smoke conditions within the mobile home when the victims entered. The B-side of the mobile home received direct flame impingement from the camper fire, causing materials to off gas until they reached their ignition temperature. A sustained wind of 13 mph with gusts of 24 mph blowing toward the A-D corner of the mobile home may have contributed to conditions that overcame the victims.

The medical examiner stated both victims received thermal burns to their tracheas and soot was discovered in their lungs, which were indications that they had taken several breaths of superheated gases and smoke. They sustained very minor thermal burns to exposed skin areas. The medical examiner also indicated that the victims' COHbs levels (a measure of carbon monoxide in the bloodstream) were over 60% and both contained lethal doses of cyanide. In the absence of carbon monoxide, the victims' cyanide levels alone were enough to be fatal. Studies conducted in 1991<sup>4</sup> and 1988<sup>5</sup> showed that cyanide and carbon monoxide may potentiate the toxic effects of one another.<sup>6</sup> The medical examiner advised NIOSH investigators that both victims' skin color was cherry red which is an indication of exposure to carbon monoxide and cyanide.

It is important for fire fighters to understand that as temperatures increase in the initial stages of a fire, plastics begin to give off large quantities of various gases. This is called quantitative decomposition, and it happens long before materials reach their ignition temperatures.<sup>7</sup> Hydrogen cyanide is a colorless, odorless gas that is released from plastics, natural and synthetic building components, and household items like carpet fibers and polyurethane foam cushions, all of which were present in the structure. Symptoms of exposure include confusion, involuntary muscle movement, vertigo, shortness of breath, or coma.<sup>6</sup> Carbon monoxide is a by-product of incomplete



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combustion which can be present before fire fighters visualize fire, and its exposure will present in the same manner as hydrogen cyanide.

Even if nothing but carbon dioxide, water vapor, and nitrogen were present in the fire products, and these were to mix with the air being breathed by a fire fighter, then the oxygen percentage would be reduced below the normal 21%. At 15% oxygen, fire fighters can experience lethargy, poor coordination, and confused thinking. The two principal toxins in smoke—carbon monoxide and hydrogen cyanide—act to deprive the brain of oxygen, and their effects would be enhanced due to the lower levels of oxygen in the air.<sup>8</sup> Exposures to these types of respiratory hazards can be reduced or eliminated by the mandatory use of SCBA during all fire suppression and overhaul operations.

***Recommendation #2: Fire departments should ensure that all SCBAs are equipped with an integrated personal alert safety system (PASS) device.***

Discussion: NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* states, “each member shall be provided with, use, and activate his or her PASS devices in all emergency situations that could jeopardize that person's safety due to atmospheres that could be IDLH, in incidents that could result in entrapment, in structural collapse of any type, or as directed by the incident commander or incident safety officer.”<sup>9</sup> The intent of the PASS device is to emit an audible warning signal that other fire fighters can hear in the event a fire fighter becomes incapacitated or requires help. The PASS device operates in either manual or automatic mode. Fire fighters can manually operate their device when they find themselves in trouble; the automatic mode will operate when the fire fighter is not moving for a period of time, approximately 30 seconds. During the fire marshal’s investigation it was discovered that the victims were using SCBAs that did not have an integrated or stand-alone PASS device.

***Recommendation #3: Fire departments should ensure that all fire fighters are equipped with a means to communicate with fireground personnel before entering a structure fire.***

Discussion: NFPA 1561 *Standard on Emergency Services Incident Management System* states, “to enable responders to be notified of an emergency condition or situation when they are assigned to an area designated as immediately dangerous to life or health (IDLH), at least one responder on each crew or company shall be equipped with a portable radio and each responder on the crew or company shall be equipped with either a portable radio or another means of electronic communication.”<sup>10</sup> Radio communications on the fireground is imperative for the IC to command and control the incident and for fire fighters working within a structure fire. Fire fighters within a structure are unable to see all areas affected by fire and whether the structure is maintaining its stability. Having radio communications can enhance fire fighter safety and health by providing them a means to communicate with other crew members or with the IC when they find themselves in need of assistance.



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This fire department recently issued portable radios to all active members. On the night of the incident, the victims were discovered within the mobile home without their department-issued radios. Their radios were later found at the fire station.

***Recommendation #4: Fire departments should ensure that the incident commander (IC) does not become involved with fire fighting activities.***

Discussion: NFPA 1561 *Standard on Emergency Services Incident Management System* states, “the Incident Commander shall be responsible for the overall coordination and direction of all activities at an incident.” In addition to conducting an initial size-up, the IC should maintain a command post outside the structure to assign companies and delegate functions and continually evaluate the risk versus gain of continued fire fighting efforts.<sup>9</sup> According to the International Fire Service Training Association (IFSTA) publication, *Fire Department Company Officer*, there are three modes of operation for the first-arriving officer assuming IC: nothing showing, fast attack, and command.<sup>11</sup>

During this incident, the conditions at this incident suggested the need to implement the command mode of operation. The first arriving officer should assume command by naming the incident and designating the command post, giving an initial report on conditions, and requesting additional resources as needed. In this incident, the IC became involved with fireground activities including traffic control, pulling the electrical meter, and helping with pump operations. These tasks took the IC’s attention away from initial fire fighting activities of the victims and search and rescue activities of other fire fighters. Being able to command and control the incident scene requires the IC to be cognizant of all directed tasks and evolving conditions.

***Recommendation #5: Fire departments should ensure that the incident commander (IC) maintains close accountability for all personnel operating on the fireground and that procedures and training for the use of a personnel accountability report (PAR) are in place.***

Discussion: An important aspect of an accountability system is the personnel accountability report (PAR). A PAR is an organized on-scene roll call in which each supervisor reports the status of his crew when requested by the IC or emergency dispatcher.<sup>1</sup> The use of an accountability system is recommended by NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program*<sup>9</sup> and NFPA 1561 *Standard on Emergency Services Incident Management System*.<sup>10</sup> A functional personnel accountability system requires the following:

- development of a departmental SOP
- training all personnel
- strict enforcement during emergency incidents

In this department each apparatus operator was responsible for the names and head count of personnel riding on that apparatus. During this incident, the IC requested a head count when the operator of E30 sounded the evacuation alarm. Although the number of members who arrived on the



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engine was known, the identities of arriving members were not known and a call back to the station was needed. After determining who was missing, the IC then went looking for the victims on the fireground. A properly initiated and enforced accountability system that is consistently integrated into fireground command and control enhances fire fighter safety and survival by helping to ensure a more timely and successful identification and rescue of a disoriented or downed fire fighter.

***Recommendation #6: Fire departments should ensure that a properly trained incident safety officer (ISO) is appointed at all structure fires.***

Discussion: NFPA 1521 *Standard for Fire Department Safety Officer* defines the role of the ISO at an incident scene and identifies duties such as reporting pertinent fireground information to the IC; ensuring the department's accountability system is in place and operational; monitoring radio transmissions and identifying barriers to effective communications; and ensuring that established safety zones, collapse zones and other designated hazard areas are communicated to all members on scene.<sup>12</sup> The presence of a safety officer does not diminish levels of personal responsibility that each fire fighter and fire officer must assume for their own safety and the safety of others. Instead, the ISO adds a higher level of attention and expertise to help individuals on the fireground monitor their own safety and the IC to manage the scene. The ISO must have particular expertise in analyzing safety hazards and must know the particular uses and limitations of protective equipment.<sup>10</sup> During this incident no incident safety officer was established to assist the IC in accountability, fire fighter safety, or ensuring the donning of personal protective equipment.

***Recommendation #7: Fire departments should ensure that a rapid intervention team (RIT) is established and available to immediately respond to emergency rescue incidents.***

Discussion: A RIT should be designated and available to respond before interior attack operations begin. The team should report to the IC and be available within the incident's staging area. The RIT should have all tools necessary to complete the job, e.g., search and rescue ropes, Halligan bar and flat-head axe combo, first-aid kit, and resuscitation equipment.<sup>1</sup> These teams can intervene quickly to rescue a fire fighter who is running out of breathing air, disoriented, lost in smoke-filled environments, trapped by fire, or involved in structural collapse.<sup>9</sup>

During this incident the department members who were properly trained as a RIT member were not present and a RIT team was not established. The IC chose who would perform search and rescue operations from the available personnel on scene due to their experience.

***Recommendation #8: Fire departments should ensure that hoseline operations are properly coordinated so as not to impede search-and-rescue operations.***

Discussion: When a hose nozzle is opened it forces a certain amount of air ahead of the pattern, and replacement air is drawn in behind the nozzle.<sup>13</sup> Hydraulic ventilation is the use of a fog pattern





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through a window or door opening that draws large quantities of heat and smoke in the direction in which the stream is pointed.

During this incident, fire fighters entered the mobile home through the D-side door with a 2½-in hoseline. They began flowing water on a straight stream setting as they entered the kitchen area spraying hot spots as they progressed to the hallway. Once in the hallway, the nozzle was switched to a fog pattern and directed down the hallway toward the A-side for a period of time. Search and rescue crews were operating in the front room on the A-side and complained of heat and smoke whirling around. The narrowness of the hallway acted as a tunnel forcing heat and smoke toward the crews and hampering their efforts to find the victims quickly.

The hose crew backed out of the mobile home, after running out of air, taking the hoseline around to the A-side. The IC took the hoseline from the crew, set the nozzle to fog and sprayed it into the A-side door. Smoke and heat immediately dissipated in the front room allowing the search crews to immediately find the victims.

***Recommendation #9: Fire departments should develop, implement, and enforce written standard operating procedures (SOPs) for fireground operations.***

Discussion: Written SOPs 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 SOPs. The NIOSH Alert, *Preventing Injuries and Deaths of Fire Fighters* identifies the need to establish and follow fire fighting policies and procedures.<sup>14</sup> To be effective, guidelines and procedures should be developed, fully implemented, and enforced. The following NFPA standards also identify the need for written documentation to guide fire fighting operations:

NFPA 1500 *Fire Department Occupational Safety and Health Program* states that “fire departments shall prepare and maintain written policies and standard operating procedures that document the organizational structure, membership, roles and responsibilities, expected functions, and training requirements, including the following: The procedures that will be employed to initiate and manage operations at the scene of an emergency incident.”<sup>9</sup>

NFPA 1561 *Standard on Emergency Services Incident Management System* states that standard operating procedures (SOPs) shall include the requirements for implementation of the incident management system and shall describe the options that are available for application according to the needs of each particular situation.<sup>10</sup>

NFPA 1720 *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments* states that the authority having jurisdiction shall promulgate the fire department’s



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organizational, operational, and deployment procedures by issuing written administrative regulations, standard operating procedures, and departmental orders.<sup>15</sup>

NIOSH investigators received a copy of the fire department's standard operating guidelines (SOGs). The fire chief explained that the SOGs were outdated and in the process of being revised. These SOGs contained mostly administrative guidelines and did not contain detailed fireground operation procedures that would enhance fire fighter safety and health and overall incident stabilization.

It is important to understand the difference between a policy and a procedure, also known as a guideline. A department policy is a guide to decision making that originates with or is approved by top management in a fire department. Policies define the boundaries within which the administration expects department personnel to act in specified situations. A procedure is a written communication closely related to a policy. A procedure describes in writing the steps to be followed in carrying out organizational policies. SOPs are standard methods or rules in which an organization or a fire department operates to carry out a routine function. Usually these procedures are written in a policies and procedures handbook and all fire fighters should be well versed as to their content.<sup>1</sup> Operational procedures that are standardized, clearly written, and mandated to each department member establish accountability and increase command and control effectiveness.<sup>1</sup> The benefits of having clear, concise, and practiced SOPs are numerous. For example, SOPs can become an outline for training curriculum and a tool to guide fire department members. Above all, successfully integrated SOPs improve departmental safety.<sup>16</sup>

***Recommendation #10: Fire departments should ensure that all fire fighters properly wear their department-issued turnout gear and personal protective equipment (PPE) during fire suppression activities.***

Discussion: NFPA 1500 *Standard on Fire Department Occupational and Health Program* states, "the fire department shall provide each member with protective clothing and protective equipment that is designed to provide protection from the hazards to which the member is likely to be exposed and is suitable for the tasks that the member is expected to perform...protective clothing and protective equipment shall be used whenever a member is exposed or potentially exposed to the hazards for which the protective clothing (and equipment) is provided."<sup>9</sup>

Both victims were discovered with their Nomex® hoods rolled down on their necks. Victim #1's helmet was found melted on a couch next to Victim #2 as if it had been taken off and laid there. Both victims' facepieces were found hanging at waist level with their regulators attached, possibly indicating that they were stored in this manner. NFPA 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* has established minimum requirements for structural fire fighting protective ensembles and ensemble elements designed to provide fire fighting personnel limited protection from thermal, physical, environmental, and bloodborne pathogen hazards encountered during structural fire fighting operations.<sup>17</sup> These requirements will assist in protecting firefighters, but only if they wear the PPE as recommended by the manufacturer.



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***Recommendation #11: Fire departments should develop and maintain a comprehensive respiratory protection program.***

Discussion: Fire fighting is a physically and psychologically demanding occupation that requires strength, physical agility, and endurance as well as the ability to operate effectively with the limitations created by a SCBA and other personal protective equipment. A fire fighter may have the physical ability to perform functions, such as hose advancement or rescuing victims, but should be trained in performing those functions while vision is obscured and movement is restricted (e.g., while using required personal protective equipment such as SCBA). Fire departments should recognize and implement SCBA best practices such as described by the minimum requirements outlined in NFPA 1404 *Standard for Fire Service Respiratory Protection Training*.<sup>18</sup>

The fire department had not instituted a respiratory or health and wellness program within its department. Members were provided basic training on the use of a SCBA but no respiratory fit testing was provided. The members had not been issued their own facepieces, but rather shared a universal facepiece assigned to each SCBA. Policies for facial grooming were not instituted by the department that could potentially affect the seal required for the facepiece to keep hazardous gases out. The development of a respiratory protection program is an integral part of an overall fire department's safety and health program.

***Recommendation #12: Fire departments should ensure that fire fighters are aware of the dangers involved in fighting mobile homes fires.***

Discussion: Mobile homes present challenges to successful fireground operations because of the close proximity of external structures, small interior spaces, and lack of permanent water supplies inside mobile home parks.<sup>19</sup> The materials used to finish the interior of a mobile home can include wood paneling, vinyl and other plastic floor coverings, carpeting, and low-density fiberboard ceilings, which are all highly combustible, and give off toxic gases and compounds such as formaldehyde, hydrogen cyanide, carbon monoxide, carbon dioxide, ammonia, and benzene. These combustible materials coupled with limited ventilation, small interior spaces (see Diagram 1), conduction of heat from the home's metal frame and exterior siding, and central hallway acting like a horizontal chimney can increase fire progression and make conditions prime for a potential flashover.<sup>b</sup> Other concerns while fighting a mobile home fire may include deteriorating floor members, noncode-compliant additions, pitched or aesthetic roofs built over the existing flat metal roof, and cylinders of liquefied petroleum gas (LPG).

Fire departments should consider preplanning firefighting operations at mobile home parks in their response areas and provide this information to mutual aid departments. They should plan for sources of water, overhead electrical hazards, storage of LPG cylinders, accessibility, lot numbers, and

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<sup>b</sup>The vinyl and resin particle board construction found in mobile homes increases the production of volatile vapors which can accelerate the production of an explosive fuel-to-air ratio much faster than in larger homes with different construction, thus bringing a room to flashover more quickly.<sup>20</sup>



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additions to mobile homes. Fire departments should also develop SOPs on size-up, search and rescue, and fire attack for mobile homes due to potential hazards to fire fighters. And finally, fire departments should train fire fighters on the hazards involved in mobile home fires.

***Recommendation #13: Fire departments should ensure that policies and procedures for proper inspection, use, and maintenance of self-contained breathing apparatus (SCBA) are implemented to ensure they function properly when needed.***

Discussion: NFPA 1981 *Standard on Open-Circuit Self-Contained Breathing Apparatus for Emergency Services* and NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus* speak directly to the maintenance and use of self-contained breathing apparatus.<sup>21.22</sup> The fire department had not established a preventative maintenance program for their SCBAs. Annual maintenance, testing, and repairs require an individual to receive specialized training from factory-certified technicians and to perform required tasks as outlined by the manufacturer. This requires special tools, equipment, and knowledge to take apart the components of a SCBA, which are normally not available to a fire department. Daily, weekly, and or monthly inspections of a SCBA needs to be documented to include items like air cylinder and remote pressure gauge readings, general state of SCBA components and face piece, PASS device actuation, and regulator flow test and hydrostatic tests. A documented inspection can catch minor issues before they result in a SCBA malfunction or failure.

The victims' facepieces had not been flow tested since 2002, and the SCBAs did not meet the current edition of NFPA 1981. The face piece used by victim #2 was missing a harness anchor screw which could affect the seal of the mask. Also, the victims' air packs did not contain an integrated or stand-alone PASS device. Fire fighters need to know and officers need to reinforce that a SCBA is an integral part of fire fighters' protective clothing, and without it they cannot safely enter hazardous environments requiring respiratory protection. Preventative maintenance programs are designed to extend the life of a product and catch potentially life-threatening problems.

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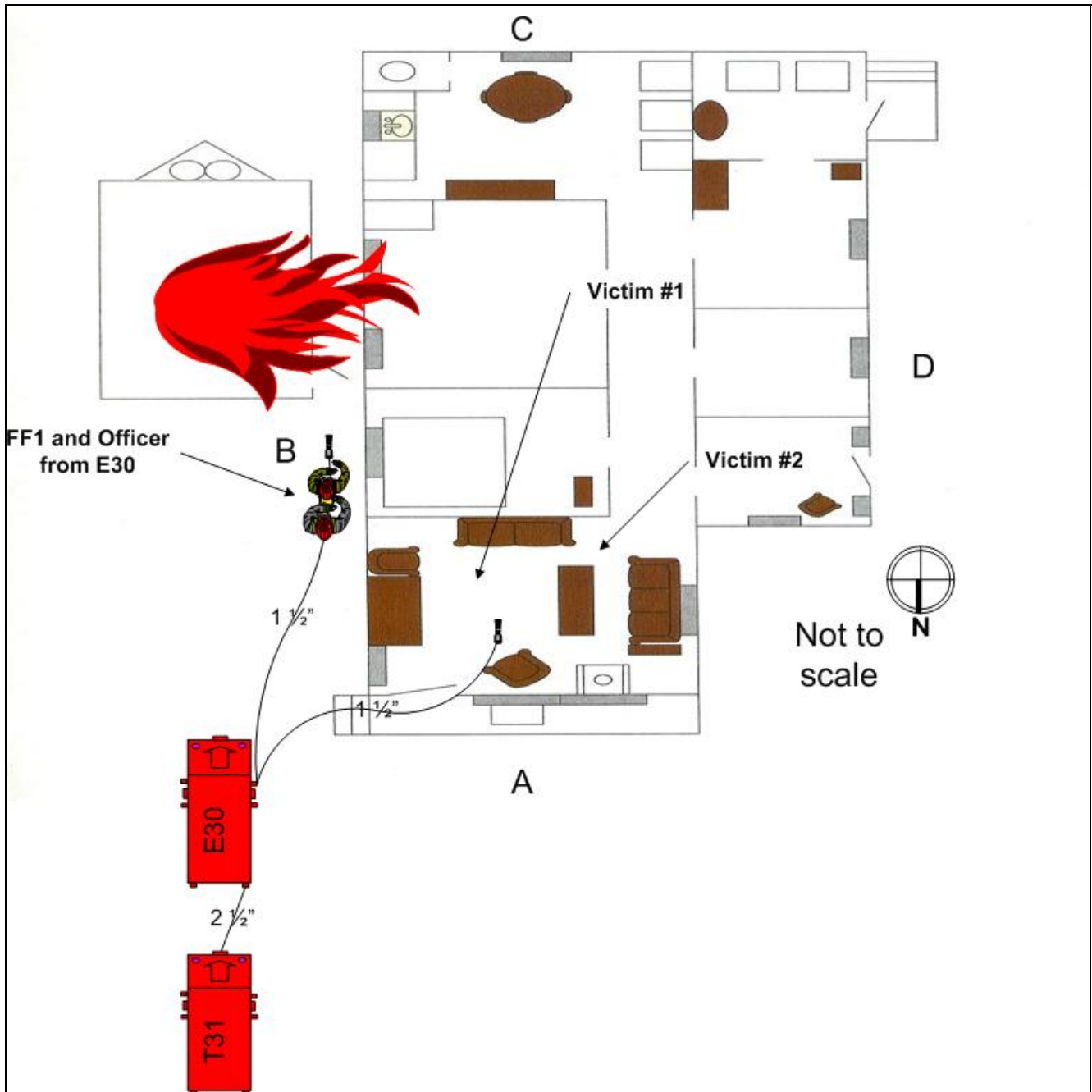
## **INVESTIGATOR INFORMATION**

This investigation was conducted by Stacy C. Wertman and Jay Tarley, Safety and Occupational Health Specialists, and Tim Merinar, Safety Engineer with the Fire Fighter Fatality Investigation and Prevention Program, Fatality Investigations Team, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. This report was authored by Stacy C. Wertman. A technical review was provided by Division Chief W. Edward Buchanan. Vance Kochenderfer, NIOSH Quality Assurance Specialist, National Personal Protective Technology Laboratory, conducted an evaluation of the victims' self-contained breathing apparatus.

Special thanks to the staff of the West Virginia Fire Commission, Office of the State Fire Marshal and the West Virginia University Fire Service Extension for their assistance during this investigation.



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**Diagram 2. Incident scene when evacuation alarm sounded and location of victims when found.**



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*Volunteer Lieutenant and a Fire Fighter Die While Battling a Mobile Home Fire- West Virginia*

## APPENDIX

### Status Investigation Summary of Two Self-Contained Breathing Apparatus NIOSH Task Number 16263

#### Background

As part of the *National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program*, the Technology Evaluation Branch agreed to examine and evaluate two Scott Air-Pak Fifty 4.5, 4500 psi, 30-minute, self-contained breathing apparatus (SCBA).

This SCBA status investigation was assigned NIOSH Task Number 16263. The West Virginia Fire Commission was advised that NIOSH would provide a written report of the inspections and any applicable test results.

The SCBA, contained within a corrugated cardboard box, were delivered to the NIOSH facility in Bruceton, Pennsylvania on March 25, 2009. After its arrival, the package was taken to building 108 and stored under lock until the time of the evaluation.

#### SCBA Inspection

The package was opened in the Firefighter SCBA Evaluation Lab (building 02) and a complete visual inspection conducted on May 26, 2009 by Eric Welsh, Engineering Technician, NPPTL.

The first SCBA inspected was designated as Unit #1. The second, designated Unit #2, was opened and inspected that same day. The SCBA were examined, component by component, in the condition as received to determine their conformance to the NIOSH-approved configuration. The visual inspection process was video recorded. The SCBA were identified as the Scott Air-Pak Fifty 4.5 models.

Both units have suffered heat damage. This is prevalent on the rearward-facing portions of the SCBA such as the cylinder and waist belt fabric. In contrast, forward-facing components such as the facepiece and shoulder straps generally do not show signs of excessive heat exposure. Labels on the regulators of both units seem to indicate they were last flow-tested in 2002. The nose cup in the Unit #1 facepiece is missing an inhalation valve and is not secured to one of the speech diaphragm tubes. While this would not compromise the respiratory protection provided, it could contribute to fogging of the lens or carbon dioxide buildup in the facepiece. The heat damage to this unit, particularly the high-pressure hose, prevented it from being tested. One of the head harness attachment point studs of Unit #2 is missing. It is impossible to tell from this examination when this occurred, although it does not appear to have been the result of excessive pull force on the head harness strap as the attachment hole in the fabric is not distorted.





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The Beacon Alarm remaining service life indicator appears to be damaged and did not function at all during the evaluation. It was judged that this unit could be safely pressurized and tested using a substitute facepiece and cylinder.

**SCBA Testing**

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

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

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

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

7. Air Flow Performance Test [Chapter 5, 5-1.1]

Unit #2 was tested on July 2, 2009 using a substitute facepiece and cylinder. All testing was video recorded with the exception of the Exhalation Resistance Test and Static Pressure Test. The SCBA failed to meet the requirements of the NFPA Air Flow Performance Test. This was a result of the Beacon Alarm failing to activate during testing, which may have been caused by damage or depletion of the batteries. Had the Beacon Alarm operated properly, the unit would have met the requirements of all tests.

**Summary and Conclusions**

Two SCBA were submitted to NIOSH by the West Virginia Fire Commission for evaluation. The SCBA were delivered to NIOSH on March 25, 2009 and inspected on May 26, 2009. The units were identified as Scott Air-Pak Fifty 4.5, 4500 psi, 30-minute, SCBA (NIOSH approval number TC-13F-76). Both units have suffered heat exposure, with Unit #1 exhibiting somewhat greater damage. The Beacon Alarm on Unit #2 did not function. One head harness attachment stud on the Unit #2 facepiece was missing. Only Unit #2 was judged to be in a condition safe for testing, with the use of a substitute cylinder and facepiece. Testing was conducted on July 2, 2009. As a result of the SCBA's



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Beacon Alarm not operating, it failed to meet the requirements of the NFPA Air Flow Performance Test. Unit #2 passed all other testing. No maintenance or repair work was performed on the units at any time. In light of the information obtained during this investigation, NIOSH has proposed no further action on its part at this time. Following inspection and testing, the SCBA were returned to storage pending return to the West Virginia Fire Commission. If the units are to be placed back in service, they must be repaired, tested, and inspected by a qualified service technician. The cylinders of both units are damaged beyond repair and should be condemned and disposed of. Labels on both units seem to indicate they were last flow-tested in 2002; the fire department must conduct such testing and other maintenance activities following the schedule prescribed by the SCBA manufacturer. Typically a flow test is required on at least an annual basis.



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### SUMMARY

On January 11, 2001, a 27-year-old male volunteer fire fighter (the victim) died after becoming separated, disoriented, and lost as he and another fire fighter were trying to escape from the interior of a fully involved mobile home fire. Fire apparatus were dispatched to the site at 1110 hours, and at 1113 hours, the Chief arrived on scene in his privately owned vehicle (POV) and assumed incident command (IC). At 1122 hours, the first apparatus arrived: Engine 19 with the First Assistant Chief, a driver/operator, and two fire fighters (including the injured fire fighter). The Chief told them to set up in the driveway of the mobile home (Side 2), and pull two attack lines. At 1123 hours the next apparatus arrived: Engine 14 (mutual aid) with a driver/operator. Engine 14 set up his apparatus behind Engine 19, and prepared to supply water. At 1125 the final two apparatus arrived: Engine 15 (Captain and two fire fighters) and Engine 16 (Captain, Lieutenant [the victim], driver/operator, and one fire fighter. Both engines set up their apparatus and awaited instructions.



*Mobile Home Involved in Fire*

The IC sent two crews to attack the fire—one crew entered the basement (Side 2), and the second entered the main floor from the porch (Side 1). The victim and the fire fighter from Engine 15 were in the first crew; they moved their attack from the basement to the porch, and then moved into the structure. A fire fighter from Engine 19, who was originally in the basement, joined them, and the three fire fighters moved down the hallway toward a back bedroom. The low-air alarm went off on the fire fighter from Engine 15, and he exited the mobile home to change his air bottle. The victim and remaining fire fighter hit the fire in the back bedroom until conditions deteriorated, and intense heat and smoke forced them to quit the interior attack and try to leave the structure. The deteriorating conditions also forced the second crew to quit the interior attack, and they were able to exit the home.

As the victim and fire fighter from the first crew were trying to exit, thick smoke banked down to the floor and the heat intensified further, forcing them to follow the handline on their hands and knees. However, the line had looped over itself

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](http://www.cdc.gov/niosh/firehome.html)  
or call toll free 1-800-35-NIOSH



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several times, and the two fire fighters became disoriented, got off the line, and crawled into an addition (12 ft x 12 ft) to the mobile home. The fire fighter from Engine 19 found a window, broke through it, and fell outside the mobile home. Other fire fighters assisted him, and he was transported to the local hospital, at 1202 hours.

Between 30 and 40 minutes elapsed before it was determined that the victim was missing. At this time, several fire fighters began searching the grounds and the interior, and even called the local hospital to see if the victim had been transported there with the injured fire fighter. The victim was eventually located by a chief from one of the mutual aid departments, who crawled into the addition and saw the victim's boot. His body was removed to the outside and he was pronounced dead at the scene by the local coroner. NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should

- ***ensure that the Incident Command conducts a complete size-up of the incident before initiating fire fighting efforts, and continually evaluates the risk versus gain during operations at an incident***
- ***ensure that fire command always maintains close accountability for all personnel at the fire scene***
- ***ensure consistent use of personal alert safety system (PASS) devices at all incidents and consider providing fire fighters with a PASS integrated into their self-contained breathing apparatus***
- ***ensure that a rapid intervention team is established and in position immediately upon arrival***

- ***ensure that a separate incident safety officer, independent from the incident commander, is appointed***
- ***ensure fire fighting tactics and operations do not increase hazards on the interior—e.g., opposing hose streams***
- ***ensure that any hoseline taken into the structure remains inside until all crews have exited***
- ***use evacuation signals when command personnel decide that all fire fighters should be pulled from a burning building or other hazardous area***
- ***ensure that personnel equipped with a radio, position the radio to receive and respond to radio transmissions***
- ***ensure that team continuity is maintained***
- ***ensure that ventilation is closely coordinated with the fire attack.***

## **INTRODUCTION**

On January 11, 2001, a volunteer fire fighter (the victim) died and one fire fighter was injured at an incident involving a mobile home fire. The victim became disoriented and lost as he and the injured fire fighter were trying to escape from the interior of a fully involved mobile home fire.

The National Institute for Occupational Safety and Health (NIOSH) was notified of this incident by the U.S. Fire Administration (USFA) on January 12, 2001. On January 24-25, 2001, the team leader and a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated this incident. Meetings and



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interviews were conducted with the Chief, First Assistant Chief, and the fire fighters from the first response companies. Also, the incident was discussed with two chiefs from the mutual aid fire departments, additional fire fighters from mutual aid departments, the local Police Chief, Coroner, State Police Arson Investigator, and the person who reported the fire. NIOSH investigators reviewed copies of photographs and a videotape of the incident scene, dispatch records, the police report, and the department's standard operating guidelines. The victim's SCBA was sent to the NIOSH Respirator Branch in Morgantown, West Virginia, for testing (see attachment). A site visit was conducted and the incident site photographed. The site was a single-family residence (1977 mobile home [trailer]). The home was typical in construction (e.g., wood frame with aluminum siding, flat roof with metal roofing, and was fully carpeted). It was 12 feet wide and 65 feet long with a 12-foot by 12-foot addition constructed on Side 1 (see Figure 1). Access into the basement from the first floor was provided by a stairway from the addition down into additional living quarters. The home had been placed on a 24-foot-wide by 65-foot-long concrete-block foundation which was 7 feet in height (basement). The basement was equally partitioned off and consisted of finished living quarters on the east side, and a workshop area which contained a garage on the west side (see Figures 1 and 2). Access into the garage area was through a garage door located on the west side (Side 2) and a doorway adjacent to the garage door. Additionally, an enclosed porch 12 feet wide by 43 feet long had been attached to the home (Side 1).

The fire department involved in this incident consists of two fire stations with a total of 39 uniformed fire fighters. The department serves a population of approximately 4500 in a geographic

area of 44 square miles. The following training is available at the State fire training center on an as-needed basis: personal safety, forcible entry, ventilation, fire apparatus, ladders, self-contained breathing apparatus, hose loads, streams, hazardous materials, structure fire, pumps, rappelling, search and rescue, terrorism, vehicle extraction, cardiopulmonary resuscitation, first aid, aerial operations, and electrical emergencies. The victim had received training in the following areas: Emergency medical technician, basic wildland fire suppression, arson detection and first responder, fire police, emergency vehicle driver training, fundamentals of fire fighting, bus vehicle fires and rescue emergencies, and hazardous materials for first responders. The victim had 14 years of fire fighting experience, 4 years through the junior fire fighter program. The origin of the fire, which was determined by the State Police Arson Investigator, was in the top of a closet in the workshop side of the basement. The cause was determined to be electrical in nature.

Although eight volunteer fire departments were involved in this incident, only those directly involved up to the time of the fatal incident are mentioned in this report.

### **INVESTIGATION**

On January 11, 2001, a female at a mobile home noticed smoke and heat coming from the corner bedroom of her parents' residence at about 1110 hours, and immediately called 911 to report a fire. At 1113 hours, the Chief of the local volunteer fire department, who lived near the mobile home, arrived on scene in his POV, reported "smoke showing" and assumed Incident Command (IC). The IC conducted a size-up of Side 1 (see Figures 1 and 2), and was told by the female who reported the fire that everyone was out of the house and that she thought there was a problem with the wood burner in the basement. At 1122 hours,



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Engine 19 arrived on scene with the First Assistant Chief, a driver/operator and two other fire fighters (including the injured). They were instructed to enter the driveway of the mobile home (Side 2), set up, and pull two attack lines. Engine 14 (mutual aid) arrived next with a driver/operator and set up his apparatus behind Engine 19 to supply water. Engine 15 (Captain, two fire fighters) and Engine 16 (Captain, Lieutenant [the victim], driver/operator, and fire fighter) both arrived on scene at 1125 hours, set up their apparatus and awaited instructions.

In the interim, the First Assistant Chief and a fire fighter from Engine 19 pulled a 1 ¾-inch line to the front door (first floor, Side 1) entrance of the mobile home and entered (see Figure 1 and Photo 1). After entering, they moved left along a wall and discovered they were in an enclosed porch on the outside of the mobile home (see Photo 2), but could see fire through the windows in the interior of the home. The First Assistant Chief gave the nozzle to the fire fighter and an unidentified fire fighter, and he began breaking windows along the outside wall of the mobile home. The two fire fighters hit the fire through the windows, but had little effect on the fire. The two fire fighters then proceeded through another door off the porch area into the interior (addition) of the mobile home to attack the fire (see Photo 3). At that time, the First Assistant Chief's low-air alarm sounded on his self-contained breathing apparatus (SCBA), and he turned over interior command to the 2<sup>nd</sup> Assistant Chief, who had arrived earlier in his POV. The First Assistant Chief changed his air bottle, then pulled a 1 ¾-inch line off the front of Engine 19 to Side 3 and began hitting the fire through the doorway (Side 3, first floor) into the corner bedroom (see Photo 4).

Meanwhile, another 1 ¾-inch line had been pulled off Engine 19 to the garage door (basement level,

Side 2) by a fire fighter from Engine 19 and a fire fighter from Engine 15 (see Figure 2 and Photo 5). They entered the garage area and started hitting the fire in the basement area. A Lieutenant (the victim) from Engine 15 approached the two fire fighters in the basement and asked if they needed anything. A fire fighter replied that they needed a large hand light. The victim acknowledged the request, left the area, and returned a minute later with a hand light. Shortly thereafter, the SCBA low-air alarm for the fire fighter from Engine 19 sounded, and he left the basement area to change his air bottle. The remaining crew in the basement (fire fighter from Engine 15 and the victim) proceeded to the front door (first floor, Side 1) with their line and entered the porch area. After trying to knock down the fire through the windows on the outside wall of the mobile home, they moved inside the mobile home with their line. Shortly thereafter the fire fighter from Engine 19 who changed his air bottle followed one of the lines into the interior of the mobile home. Because of limited (zero) visibility, the fire fighter crawled on his hands and knees in order to follow the line. He followed the line until he met up with two other fire fighters, but never made identification of either fire fighter. About that time, the low-air alarm on the fire fighter from Engine 15 who was on the interior line began to sound, and he left the line and found his way out of the house. The remaining two fire fighters moved back through the hallway hitting fires in various rooms off to their left (see Photo 6). They reached a point in the hallway where they were hitting the fire in the corner bedroom and conditions worsened. The crew began backing out as the heat and smoke became more intense. The second hose crew, which was hitting the fire in another part of the house, backed out and exited as the heat and smoke intensified. As the crew that was in the hallway backed out



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(the victim and injured fire fighter), their line had looped over itself several times which slowed their retreat. Thick dark gray smoke had banked down to the floor and the heat was intensifying as the crew was trying to make their way out of the mobile home. They became disoriented because of the interior conditions, got off the line and started crawling around inside the 12-foot by 12-foot addition looking for a door or window to escape through. They apparently became separated as they continued to look for a way out. *Note: Although the victim had become lost and disoriented, no distress or mayday call was ever heard over the radios.* The injured fire fighter from Engine 19, after crawling around the inside of the addition for several minutes, found the doorway leading into the enclosed porch area. Once inside the porch area, the fire fighter saw light coming from a window on the outside wall of the porch, and ran toward the light. The fire fighter broke through the window and fell to the ground. He was assisted by two fire fighters on the exterior of the mobile home and was then transported by ambulance to the local hospital at 1202 hours.

At that time, a fire fighter from Engine 15 was ordered to take a 2-inch line to the basement. He arrived at the basement with the 2-inch line and from the doorway began spraying water into the interior until another fire fighter from Engine 19 joined him, and the two took the line into the basement and fought the fire until their low-air alarms sounded. During this time a fire fighter from a mutual aid department found a helmet in the mobile home addition and gave it to the First Assistant Chief, who initiated a search, and started calling the local hospitals trying to locate the victim. *Note: According to witness interviews and the ambulance run sheet, between 30 and 40 minutes had elapsed before the victim was discovered missing.*

The two fire fighters in the basement backed out and went to change their air bottles when they heard that the victim was missing. The two fire fighters were ordered by the First Assistant Chief to search for the victim. *Note: At this time, several other fire fighters were searching the grounds, the interior, and calling the local hospital to try and locate the victim.* The two fire fighters encircled the mobile home on the exterior, but did not locate him. Next, they began a search on the interior, but were hampered by zero visibility and soft floors. *Note: At one point during the search, a captain and two fire fighters from a mutual aid department, along with four other fire fighters, entered and searched the addition without finding the victim.* Finally, the basement area was searched and a red 1 ¾-inch line was found lying on the stairway that connected the basement to the addition (see Photo 7). The line was followed up the stairs into the addition and out the exterior door onto the enclosed porch. The fire fighters moved to the front yard to rest, and at that time heard someone yell that the victim had been found. The victim had been located by a chief from one of the mutual aid departments. The chief had crawled into the addition with a 1 ¾-inch line that he found on the enclosed porch. He opened the line with a fog spray and directed it at the open window which started clearing the room of smoke. He then saw a boot of the victim who was bent over backwards on a desk in the addition. The chief, along with several other fire fighters, dragged the victim out onto the lawn where he was subsequently pronounced dead by the local Coroner. The victim's facepiece was intact and still donned, but the air bottle was empty. He was wearing full turnouts and boots, but his helmet had been found earlier, and his structural fire fighting gloves were later found at the top of the stairway leading into the basement. His



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PASS device was attached to a strap for his SCBA, but had not been turned on, and his radio was found in his turnout pants pocket.

**CAUSE OF DEATH**

The cause of death as released by the Coroner's Office was asphyxiation.

**RECOMMENDATIONS/DISCUSSION**

***Recommendation #1: Fire departments should ensure that Incident Command conducts a complete size-up of the incident before initiating fire fighting efforts, and continually evaluates the risk versus gain during operations at an incident.<sup>1,2</sup>***

The initial size-up conducted by the first-arriving officer allows the officer to make an assessment of the conditions, allowing his decisions to be proactive as opposed to reactive. The following general factors are important considerations: (1) occupancy type involved, (2) smoke conditions, (3) type of construction, (4) age of structure, (5) exposures, and (6) time considerations, such as time of incident, time fire was burning before arrival, time fire was burning after arrival, and type of attack. The IC's initial size-up involved all available information received from the home owner and what he saw upon his arrival on the scene (Side 1 of the mobile home). A view of all four sides may have revealed fire extension from the basement area up into the corner bedroom located above the workshop area of the basement. The additional information may have helped in the decision-making process and in the development of an effective attack plan, which may have included an exterior fire attack.

***Recommendation #2: Fire departments should ensure that fire command always maintains close accountability for all personnel at the fire scene.<sup>1-3</sup>***

Accountability on the fire ground 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 incident command. Accountability on the fire ground can be maintained by several methods: by a system using individual tags for every fire fighter and officer responding to an incident, or by a company officer's riding list stating the names, assigned tools, and duties of each member responding with every fire company. One copy of the list should be posted in the fire apparatus and one copy carried by the company officer. The list posted in the apparatus is used if the company officer or the entire company is reported missing. Additionally, fire fighters should not work beyond the sight or sound of the supervising officer unless equipped with a portable radio. This member should communicate with the supervising officer by portable radio to ensure accountability and indicate completion of assigned duties. Standard operating procedures (SOPs) should address accountability, including the location and the duties of the responding fire companies. Just as company officers should know the location of all fire fighters assigned to the company, the chief officer in command should know the operating locations of officers and companies assigned on the first-alarm assignment. One of the most important aides for accountability at a fire scene is an incident management system. It should be established by the officer in command of the incident.

***Recommendation #3: Fire departments should ensure consistent use of personal alert safety system (PASS) devices at all incidents and consider providing fire fighters with a PASS integrated into their self-contained breathing apparatus.***





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PASS devices, which are electronic devices worn by the fire fighter, emit a loud and distinctive alarm if the fire fighter becomes motionless for more than 30 seconds. Fire fighters entering hazardous areas should be equipped with a PASS device. There are several types of PASS devices available. One device that could be used is a PASS that is integrated into the SCBA. PASS devices integrated into the SCBA will be activated when the SCBA air cylinder is turned on. Manual PASS devices are also used throughout the fire service. These devices require the fire fighter to manually turn on the device each time they use it.

***Recommendation #4: Fire departments should ensure that a rapid intervention team is established and in position immediately upon arrival.***<sup>4</sup>

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—including tools for 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 an 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. In this incident, a RIT had not been established.

***Recommendation #5: Fire departments should ensure that a separate incident safety officer, independent from the incident commander, is appointed.***<sup>2-4</sup>

According to NFPA 1561, paragraph 4-1.1, “The Incident Commander shall be responsible for the overall coordination and direction of all activities at an incident. This shall include overall responsibility for the safety and health of all personnel and for other persons operating within the incident management system. While the Incident Commander (IC) is in overall command at the scene, certain functions must be delegated to ensure adequate scene management is accomplished. According to NFPA 1500, paragraph 6-1.3, “As incidents escalate in size and complexity, the incident commander shall divide the incident into tactical-level management units and assign an incident safety officer to assess the incident scene for hazards or potential hazards.” The incident safety officer (ISO), by definition is “An individual appointed to respond to or assigned at an incident scene by the incident commander to perform the duties and responsibilities specified in this standard. This individual can be the health and safety officer or it can be a separate function.” According to NFPA 1521, paragraph 2-1.4.1, “An incident safety officer shall be appointed when activities, size, or need occurs.” Each of these guidelines complements each other and indicates that the incident commander is in overall command at the scene, but oversight of all operations is



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difficult. On-scene fire fighter health and safety is best preserved by delegating the function of safety and health oversight to the ISO.

***Recommendation #6: Fire departments should ensure fire fighting tactics and operations do not increase hazards on the interior—e.g., opposing hose streams.***<sup>5</sup>

Several times during the fire, the crews were attacking the fire from different perspectives simultaneously. Active fire fighting was taking place in the interior of the mobile home, while fire fighting activities were also being conducted in the basement and through a basement window from the exterior. Also, an attack line was directed through the doorway of the back bedroom from the exterior. Interior fire attack should be a coordinated event. Opposing hose streams may inadvertently push the fire in the direction of other hose crews.

***Recommendation #7: Fire departments should ensure that any hoseline taken into the structure remains inside until all crews have exited.***<sup>5</sup>

Fire fighters who enter smoke-filled enclosures for the purpose of fire attack, should be equipped with a safety line or hoseline in the event that a fire fighter becomes disoriented or trapped. Many fire fighters who die from smoke inhalation, a flashover, or are caught or trapped by fire, actually become disoriented first. They are lost in smoke, their SCBA runs out of air, or they cannot find their way to exit through the smoke. Although fire or smoke kills them, the primary contributing factor is disorientation. By using a hoseline, the fire fighter is able to determine the direction of exit by the couplings that connect two hose lines together. The male coupling signifies the exit direction. The line should remain inside as a guide for fire fighters to follow.

***Recommendation #8: Fire departments should use evacuation signals when command personnel decide that all fire fighters should be pulled from a burning building or other hazardous area.***<sup>5</sup>

Evacuation signals are used when command personnel decide that all fire fighters should be pulled from a burning building or other hazardous area because conditions have deteriorated beyond the point of reasonable safety. All fire fighters should be familiar with their department's method of sounding an evacuation signal. There are several ways this communication can be done. The two most common methods are to (1) broadcast a radio message ordering all fire fighters to evacuate, and (2) to sound an audible warning device on the apparatus at the fire scene for an extended period of time. The message should be broadcast several times to make sure everyone hears it.

***Recommendation #9: Fire departments should ensure that personnel equipped with a radio, position the radio to receive and respond to radio transmissions.***<sup>6</sup>

The fireground communications process combines electronic communication equipment, a set of standard operating procedures, and the fire personnel who will use the equipment. To be effective, the communications network must integrate the equipment and procedures with the dynamic situation at the incident site, especially in terms of the human factors affecting its use. The ease of use and operation may well determine how consistently fire fighters monitor and report over the radio while fighting fires. Fire departments should review both operating procedures and human factors issues to determine the ease of use of radio equipment on the fireground to ensure that fire fighters consistently monitor radio transmissions from the IC and



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respond to radio calls. In this incident, a portable radio was found on the victim in the off position and located in the pants pocket of his turnouts.

***Recommendation #10: Fire departments should ensure that team continuity is maintained.***<sup>5,7</sup>

Each fire fighter should be assigned to a team of two or more and given specific assignments to help reduce the chance of injuries. Team continuity relies on knowing who is on your team, knowing the team leader, staying within visual contact at all times (if visibility is obscured then teams should remain within touch or voice distance of each other), communicating your needs and observations to the team leader, rotation to rehabilitation and staging as a team, and watching your team members (practice a strong “buddy-care” approach). These key factors help to reduce the risks involved in fire fighting operations by providing personnel with the added safety net of fellow team members.

***Recommendation #11: Fire departments should ensure that ventilation is closely coordinated with the fire attack.***<sup>5,8</sup>

Chapter 10 of the *Essentials of Fire Fighting, 4<sup>th</sup> edition*, states that, “ventilation must be closely coordinated with fire attack. When a ventilation opening is made in the upper portion of a building, a chimney effect (drawing air currents from throughout the building in the direction of the opening) occurs.” Ventilation is necessary to improve a fire environment so that fire fighters can approach a fire with a hoseline for extinguishment. However, window and door ventilation should be coordinated with fire extinguishment. Only after a charged hoseline is in place and ready for extinguishment is ventilation of windows and doors most effective. Command should determine if ventilation is needed and where

ventilation is needed. The type of ventilation should be determined, based on evaluation of the structure and conditions on arrival.

**REFERENCES**

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8. Dunn, V [1988]. *Collapse of Burning Buildings*, Saddle Brook, NJ: Publisher Penn Well.

**INVESTIGATOR INFORMATION**

This investigation was conducted by Richard W. Braddee, Team Leader/Project Officer, and Nancy T. Romano, Safety and Occupational Health Specialist, NIOSH, Division of Safety Research, Surveillance and Field Investigations Branch.

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***Volunteer Fire Fighter (Lieutenant) Killed and One Fire Fighter Injured During Mobile Home Fire—Pennsylvania***



*Photo 1. Front Door Entrance to Mobile Home (Side 1)*



*Photo 2. Enclosed Porch Attached to Mobile Home*

*Volunteer Fire Fighter (Lieutenant) Killed and One Fire Fighter Injured During Mobile Home Fire—Pennsylvania*



*Photo 3. Addition to Mobile Home (12 ft x 12 ft)*



*Photo 4. Doorway Into Corner Bedroom (Side 3)*



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*Volunteer Fire Fighter (Lieutenant) Killed and One Fire Fighter Injured During Mobile Home Fire—Pennsylvania*



*Photo 5. Entrance to Garage and Basement Area (Side 2)*



*Photo 6. Hallway to Corner Bedroom*

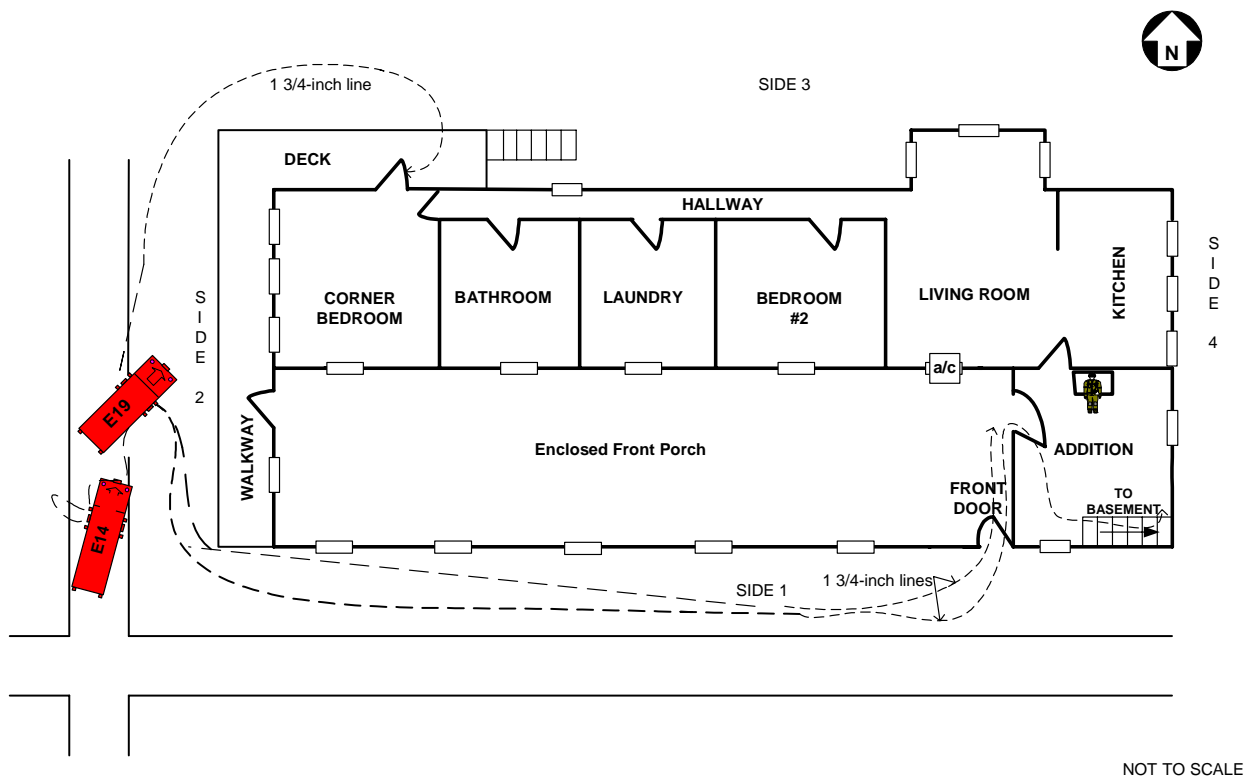
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*Volunteer Fire Fighter (Lieutenant) Killed and One Fire Fighter Injured During Mobile  
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*Photo 7. Stairway Connecting Addition to Basement*

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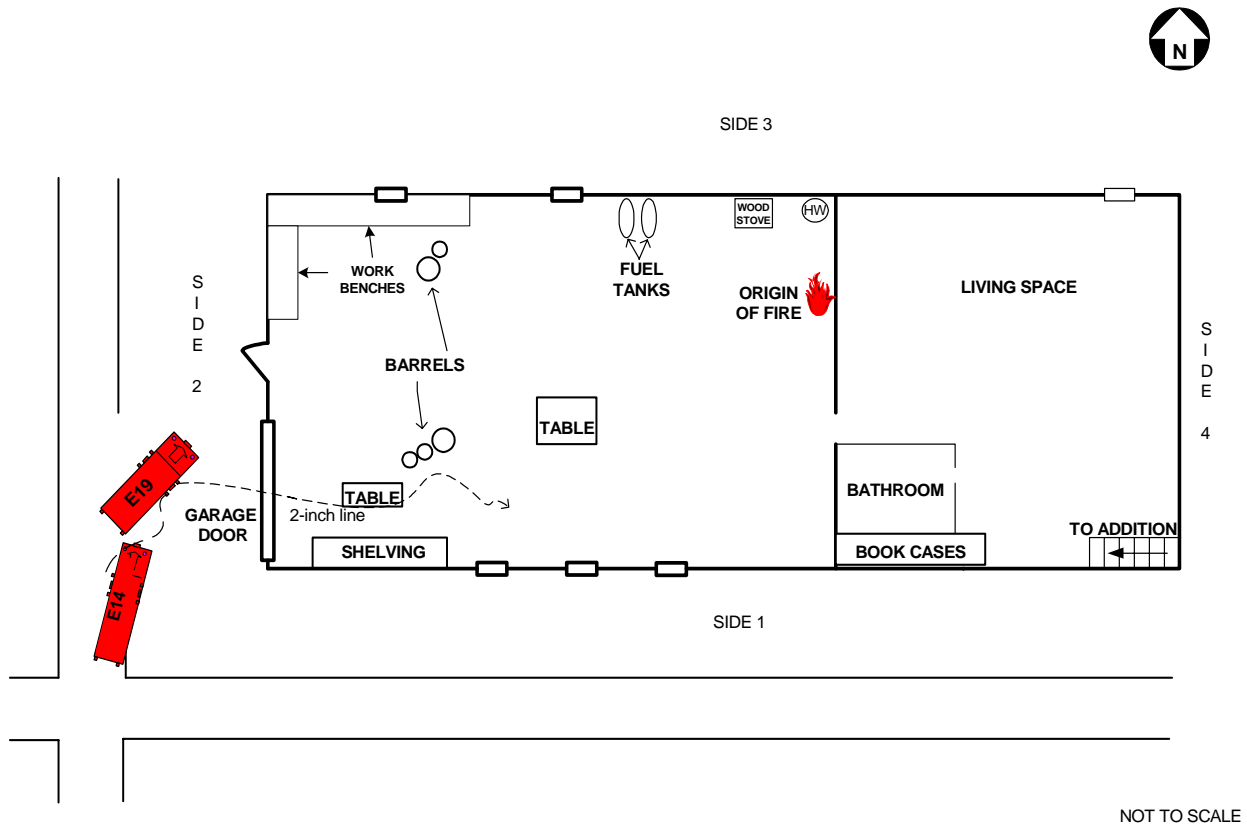


*Figure 1. Mobile Home, First Floor Layout*





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*Figure 2. Mobile Home, Basement Floor Layout*



Fatality Assessment and Control Evaluation  
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**ATTACHMENT**

The following is a summary of NIOSH Task No. TN-11837. For a full report, including photos, tables, and diagrams, contact NIOSH, Division of Respiratory Disease Studies, Respirator Branch at (304) 285-5907.

	<b>DEPARTMENT OF HEALTH &amp; HUMAN SERVICES</b>	Public Health Service
	NIOSH Reference: TN-11837	<b>Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health - ALOSH 1095 Willowdale Road Morgantown, WV 26505-2888 Phone: (304) 285-5907 Fax: (304) 285-6030 May 7, 2001</b>
<p>Dear Investigator Whitman:</p> <p>The National Institute for Occupational Safety and Health (NIOSH or the Institute) has concluded its investigation conducted under NIOSH Task Number TN-11837. This investigation consisted of the inspection and evaluation of one self-contained breathing apparatus (SCBA) received by NIOSH from your office on January 25, 2001. The primary purpose of this investigation was to determine the SCBA's conformance to the NIOSH certification requirements of <b>Title 42, Code of Federal Regulations, Part 84 (42 CFR 84)</b>. Our detailed Status Investigation Report is enclosed.</p> <p>The box that was shipped to NIOSH by your office contained one complete Mine Safety Appliances (MSA) Model 401, 30-minute, 2216 psi, SCBA (NIOSH approval number TC-13F-30). The SCBA has the appearance of having seen considerable use as well as exposure to high heat and flames. Several components and sub-assemblies are severely damaged. The SCBA was examined component by component in the condition as received to determine its conformance to the NIOSH-approved configuration. The entire inspection process was videotaped. The SCBA inspection is summarized in Attachment Two of the enclosed report. The condition of each major component was also photographed with a digital camera. Images of the unit are contained in Attachment Three of the enclosed report.</p> <p>Inspection of the SCBA revealed many severely damaged components:</p> <ul style="list-style-type: none"><li>• The exhalation valve diaphragm was melted to its seat.</li><li>• The high-pressure hose had a significant bulge near the Audi-Larm assembly.</li><li>• The belt-mounted regulator was found to contain debris and a substantial amount of liquid.</li><li>• The compressed air cylinder displayed signs of exposure to heat well beyond the manufacturer's recommendations.</li></ul>		



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**ATTACHMENT (continued)**

In order to safely test this SCBA, these deficiencies would have to be rectified through part replacement and/or overhaul. Replacing or servicing these key components would render any performance test results as meaningless. Therefore, no performance testing was conducted on the SCBA.

No further action will be taken by NIOSH and the investigation of Task Number TN-11837 will be considered closed. The SCBA will be stored under lock in room 1520 of the NIOSH Appalachian Laboratory for Occupational Safety and Health (ALOSH) pending written instructions from your office.

I trust this information is satisfactory to meet your needs. If you require further assistance, please contact me at (304) 285-6337.

Sincerely yours,

Thomas W. McDowell,  
General Engineer  
Respirator Branch  
National Personal Protective Technology Laboratory