



Fire Ground Survival

Chapter 1: Preventing the Mayday



Objectives

Students will be able to explain how each of these methods helps prevent a Mayday:

- Pre-planning.
- Size up.
- Reading smoke.
- Interior layout size up.
- Room orientation.
- Crew continuity.
- Air management.
- Deciding to go defensive.



Introduction

Preventing a Mayday:

- Begins well before the call is received from dispatch.
- Begins during training of fire fighters as new hires.
- Continues every shift a fire fighter arrives at the station.
- Must consciously occupy a fire fighter's thoughts.



Mayday Prevention

Examples of critical conditions or causes that may lead to fatalities or near misses:

- They are operating off the hose line and lose their “lifeline” to the exterior.
- They fail to monitor their SCBA air consumption and run out of air.
- They get separated from their partner or are operating alone.
- They tunnel vision on the task at hand and fail to maintain an awareness of the larger fire event and how it might affect them.



Pre-Planning

Pre-fire planning can increase survivability by allowing companies to:

- Analyze construction elements in their districts.
- Anticipate building compromise.
- Discuss strategies.
- Recognize potential response problems.

Most importantly, the pre-plan can provide clues to where and when a building may fail.



Comprehensive Pre-plan

- Construction Type.
- Fuel Loads (Heat Release of Fuels).
- Overhead Weight (HVAC, Tanks, Billboards, etc.).
- Building History.
- Derelict Buildings.



Comprehensive Pre-plan

Construction Type

One of the most critical findings during a pre-plan is that of building construction.



Outline

Structural Stability of Engineered Lumber in Fire

Active Partners

In the Line of Duty

Course Navigation

▶ Module 1: Background

▶ Module 2: Modern Fire Challenges

▶ Module 3: Fire Tests

▶ Module 4: Fire Service Learnings

▶ Module 5: Building Codes

▶ Additional Resources

Structural Stability of Engineered Lumber in Fire Conditions

Department of Homeland Security Grant 2006

<http://content.learnshare.com/courses/73/187716/player.html>



SLIDE 1 OF 67

PAUSED

00:04 / 00:05





Light-weight Truss Systems

What do you know about light-weight truss construction?

- 25 LODDs
- Collapse in 6 to 8 minutes.
- Collapse can occur at time of arrival.





Light-weight Truss Systems



- Fire in concealed spaces leads to truss collapse.
- TIC (Thermal Imaging Camera) reliability reading heat in concealed spaces.



Light-weight Truss Systems

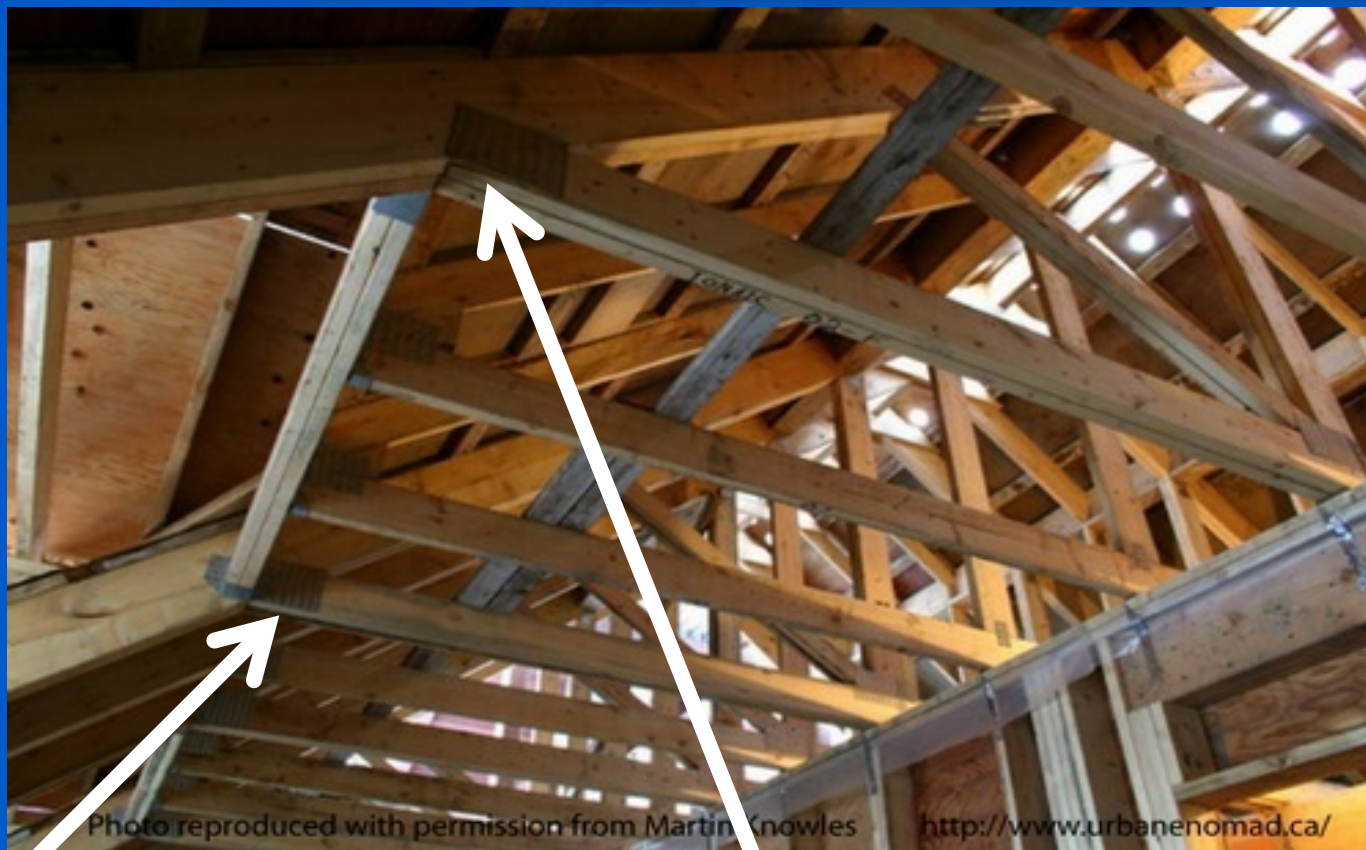


Photo reproduced with permission from Martin Knowles

<http://www.urbanenomad.ca/>

- Trusses fail at the connection points.
- More connection points = more failure points.



Light-weight Truss Systems



More connection points = less time to fight the fire before failure and collapse.



Light-weight Truss Systems

No ridge board = light weight truss



Companies must visit construction sites during all phases of construction.



Light-weight Truss Systems



- Small/Localized truss failure is just as dangerous as Large/System truss failure.
- Research the location of the contents.



Light-weight Truss Systems

Open DVD Video File: "Roof Collapse"





Comprehensive Pre-plan

Fuel Loads

All of the contents in a building add fuel to the fire and can influence the rate and spread of the fire.



DO NOT ENTER buildings where fire fighters can be trapped by a rapidly advancing fire.



Comprehensive Pre-plan

Overhead Weight

A pre-plan must identify the amount of weight carried on a roof and to what extent the roof construction will support that weight.





Comprehensive Pre-plan

Overhead weight increases the potential for roof collapse



DO NOT ENTER light-weight truss structures supporting overhead weight if the building is on fire.



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

February 7, 2001

Restaurant Fire Claims the Life of Two Career Fire Fighters - Texas

SUMMARY

On February 14, 2000, a 44-year-old male and a 30-year-old female, both career fire fighters, died in a restaurant fire. At 0430 hours, Central Dispatch received a call from a civilian who reported that fire was emitting through the roof of the restaurant. Medic 73 was first to arrive

met up with his crew, and then exited the structure to assist with the advancement of their hoseline. Engine 73 (Captain, FAO, and two fire fighters) arrived on the scene and one fire fighter entered the structure with a 1¼-inch hoseline. He stretched the hoseline past the

<http://www.cdc.gov/niosh/fire/reports/face200013.html>

companies that there was visible fire emitting through the roof. The Captain on Engine 76 radioed dispatch reporting that he and his crew were going to complete a "fast attack" (enter the structure with a 1¼-inch hoseline and knock down the fire with the water from their engine). Approximately 2 minutes later, Ladder 76 (Captain, FAO, and one fire fighter) arrived on the scene and the Captain assumed Incident Command (IC). After making forcible entry, the victims entered with a 1¼-inch hoseline as their Captain finished donning his gear. Shortly after, the Captain entered the structure,



Photograph by R. Harris.

Restaurant Fire in This Incident

on. After meeting up with a fire fighter on the end of the line, the Captain exited and reentered the structure a second time. As he followed the line, debris began to fall and there was visible fire throughout the middle section of the kitchen (see Diagram 1). Soon after, District 10 (District Chief) arrived, completed a size-up, and assumed command. Due to the heavy fire he observed, he requested all companies convert to a defensive attack and evacuate the structure. At this point the middle roof section (over the kitchen) of the building had collapsed. An interior evacuation took place, and neither of the victims exited. The IC sent several fire fighters inside to search for

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. 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:

<http://www.cdc.gov/niosh/firehome.html>

or call toll free 1-800-35-NIOSH



Overhead Weight



**Fire + light-weight truss + overhead weight =
EARLY COLLAPSE**



Comprehensive Pre-plan

Building History

A pre-plan must identify renovations and previous fires that buildings have undergone.





Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation November 30, 1998

Sudden Floor Collapse Claims the Lives of Two Fire Fighters and Four Are Hospitalized with Serious Burns in a Five-Alarm Fire—New York

SUMMARY

On June 5, 1998, a call came into fire dispatch reporting a fire in the boiler room at residential commercial complex. Several units were dispatched, and upon arrival, Engine 332 reported smoke emitting from the building. The building involved in the fire was one of five three-story wood frame dwellings (see Figure 1). The fire building (building #1) and the collapse building (building #2) were both owned by the City, with some of the units occupied and some vacant. The building, which had undergone renovations over the past several years, was built around the turn of the century. The fire department initiated fire fighting operations, and several fire fighters were conducting an interior attack on the first floor of one of the dwellings, when it was reported that a civilian was trapped on the second floor. The Captain (Victim #1) and a fire fighter on Ladder 176, the Lieutenant (Victim #2) and two fire fighters on Engine 332, and the Lieutenant on Ladder 103 went to the second floor to search for the trapped civilian. Without warning, approximately 10 minutes after the arrival of

the first unit, the rear of the second floor of building #2 collapsed, trapping five fire fighters in a burning inferno on the first floor. NIOSH investigators conclude that, to minimize the chances of similar occurrences, fire departments should:

- ensure that Incident Command conducts a thorough initial size up of the incident before initiating fire fighting efforts, and continually evaluates the risk versus gain during operations at an incident
- ensure that Incident Command always maintains close accountability for all personnel at the fire scene
- ensure that some type of tone or alert that is recognized by all fire fighters be transmitted immediately when conditions become unsafe for fire fighters

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Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation November 6, 2007

Revised March 14, 2008

Floor Collapse at Commercial Structure Fire Claims the Lives of One Career Lieutenant and One Career Fire Fighter - New York

SUMMARY

On August 27, 2006, a 43-year-old male career Lieutenant (victim #1) and a 25-year-old male fire fighter (victim #2) died after the floor they were operating on collapsed at a commercial structure fire. At approximately 1230 hours, crews were dispatched to a fire. The victims' engine was dispatched at 1236 hours as an additional unit alarm and arrived on the scene at approximately 1240 hours. At approximately 1251 hours, victim #1, victim #2 and fire fighter #1 advanced a 2 1/2-inch hand line through the front of the structure and down an aisle toward the rear of the store. The fire was located in the rear interior of the structure (discount store) that sold a variety of numerous small household commodity items. Approximately three minutes later, the structural members supporting the floor directly below the victims failed. The V-shaped collapse of the floor caused victim #1 and victim #2 to fall into the basement and shoving stocked with merchandise to fall in on top of them. Multiple MAYDAYs were transmitted and the fire fighter assist and search team (FAST) was deployed to the front of the structure where they assisted in the rescue of numerous members who had been operating in the interior of the structure at the time of the collapse. Battalion Chief #1, Lieutenant #1 and fire fighter #1 were freed from the debris. At approximately 1415 hours, victim #1 was removed from the debris in the basement and transported to the hospital. He died the next day as a result of his injuries. At approximately 1435 hours, victim #2 was removed from the basement and transported to the hospital where he was pronounced deceased as a result of his injuries.

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

- consider the possibility of a substandard structure when building information is not available from pre-incident plans
- consider the live load of water on the structure and go defensive when water load potentially compromises the structural integrity

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Injury in the line of duty...

A summary of a NIOSH fire fighter fatality investigation October 30, 2001

Roof Collapse Injures Four Career Fire Fighters at a Church Fire—Arkansas

SUMMARY

On December 28, 2000, at 0724 hours, fire fighters from a career fire department responded to a structural fire at a local church. A 49-year-old captain (Injured Fire Fighter #1), a 28-year-old fire fighter/engine operator (Injured Fire Fighter #2) assigned to drive an air service truck (Air Service 1), and two 27-year-old fire fighters (Injured Fire Fighters #3 and #4) were injured while performing interior suppression activities when a section of the roof collapsed, trapping them inside the structure. At 0728 hours, the Chief arrived on the scene, assumed incident command (IC), and reported that he had a fire in a large church, which was not heavily involved. The IC radioed a hydrant position and asked central dispatch to tone out a second alarm. At 0730 hours, Fire Fighter #1 pulled a 1 1/2-inch preconnect off Engine 4 and advanced the double doors, where he met up with his crew. The IC ordered this crew (the Captain from Engine 4 and Fire Fighters #1 and #2) to enter the structure for an aggressive fire attack; however, the IC instructed them not to enter the structure very far. At 0732 hours, Air Service 1 (a

captain and Injured Fire Fighter #2) arrived on the scene and pulled a second 1 1/2-inch preconnect off Engine 4 and advanced it to the front doors of the structure. At 0734 hours, Engine 5 arrived on the scene with Injured Fire Fighters #1 and #4 and an engine operator. Upon arrival, the IC ordered them to pull a third 1 1/2-inch preconnect from Engine 4 and advance into the structure. At approximately 0737 hours, the crew from Engine 5 (Injured Fire Fighters #1, #3, and #4) and the crew from Air Service 1 (Captain and Injured Fire Fighter #2) met up in a classroom. They noticed intense fire in the ceiling/truss void area where a small piece of ceiling in the northeast corner of the classroom had fallen. At approximately 0740 hours, as the crew from Truck 1 made their way to the front of the structure, the roof collapsed in the classroom area, trapping and injuring Fire Fighters #1, #2, #3, and #4. They began frantically searching for an exit. Injured Fire Fighter #4 located a section of the wall that felt different from the other walls in the room. He began to bang his helmet, still on his head, against this section of the wall. After approximately six blows, he heard glass break and realized that he had located a window. The Captain from Air Service 1 helped



Photo courtesy of the Fire Department
Structure Involved in this Incident

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Comprehensive Pre-plan

Derelict Buildings

Knowing that a building is abandoned and in disrepair can assist with determining fire ground tactics.



DO NOT ENTER derelict and abandoned buildings.



Derelict Buildings

LODDs

Missouri – May 3, 2002

Houston – Feb. 19, 2005

<http://www.cdc.gov/niosh/fire/reports/face200220.html>

<http://www.cdc.gov/niosh/fire/reports/face200509.html>



Defensive exterior fire attack is the correct tactic for derelict and abandoned buildings.



Size Up

Size up is an assessment of the situation that must occur on all incidents.

Four Components of Size up:

1. Construction
2. Location and Extent of the fire
3. Occupancy
4. Life Hazard



360° view – self or assign to someone else



Reading Smoke

Helps the fire fighter make the decision to enter or exit a structure



Reading Smoke

1. Volume
2. Velocity
3. Density
4. Color



Reading Smoke

- Would you enter a building full of smoke?
- Would you enter a building full of propane?



Reading Smoke

Propane

Smoke/CO

Flammable Range

2.1% - 9.6%

12.5% - 74%

Ignition Temperature

920° F - 1120° F

1128° F

Ignition Source

???

Yes

A building filled with smoke is just as dangerous as a building filled with propane.



Reading Smoke - VOLUME

Open Video File: "Reading Smoke – Volume"



- Amount of smoke showing
- Relative to the size of the structure (box)
- Indicates how much fuel has off gassed
- Volume or heat pushed?



Reading Smoke - VELOCITY

Open Video File: "Reading Smoke – Velocity"



- The speed of the smoke
- Is based on comparing the smoke venting from like size openings
- Can help identify where the fire is located now and where it's going next



Reading Smoke - DENSITY

Open Video File: "Reading Smoke – Density"



- **MOST IMPORTANT ATTRIBUTE!**
- Tells you how much "Fuel" is present
- The thicker the smoke the more likely a hostile fire event will occur and the more dangerous and explosive that event will be
- Continuity of fuel increases this risk. A flashover in one room can ignite all the smoke in the building!



Reading Smoke - COLOR

Open Video File: "Reading Smoke – Color"



- Stage of heating / Filtration of smoke
- Fire location - Rarely indicates material burning
- Amount of flaming
- Helps tie together and confirm information previously obtained



Reading Smoke - COLOR

White Smoke



- First determine the Volume & Velocity – Compare information with the size of the structure and the vent openings
- Slow venting smoke can indicate initial stage heating
- Fast moving smoke indicates heat, but the smoke has traveled a distance



Reading Smoke - COLOR

Brown Smoke



- Brown smoke occurs during mid to late stage heating of Unfinished wood
- Observing brown smoke venting from void spaces in the floors, walls, ceilings or roof is an indicator that structural components are being heated and compromised— **Be on guard for collapse!**



Reading Smoke - COLOR

Black Smoke



- Seeing black thin fast moving smoke venting from a specific location indicates clean burning and that the fire is nearby



Reading Smoke - INTERIOR

Open Video File: "Reading Smoke – Interior"





Interior Size Up

En Route



Think

- Prior knowledge
- Information from Dispatch
- Mental images

On Scene



Look

- Windows
- Layout of the room

Inside



Feel

- Floor plan
- Doorways
- Furniture



Interior Size Up

Inside

Fire fighters must orient themselves to the interior of the building:

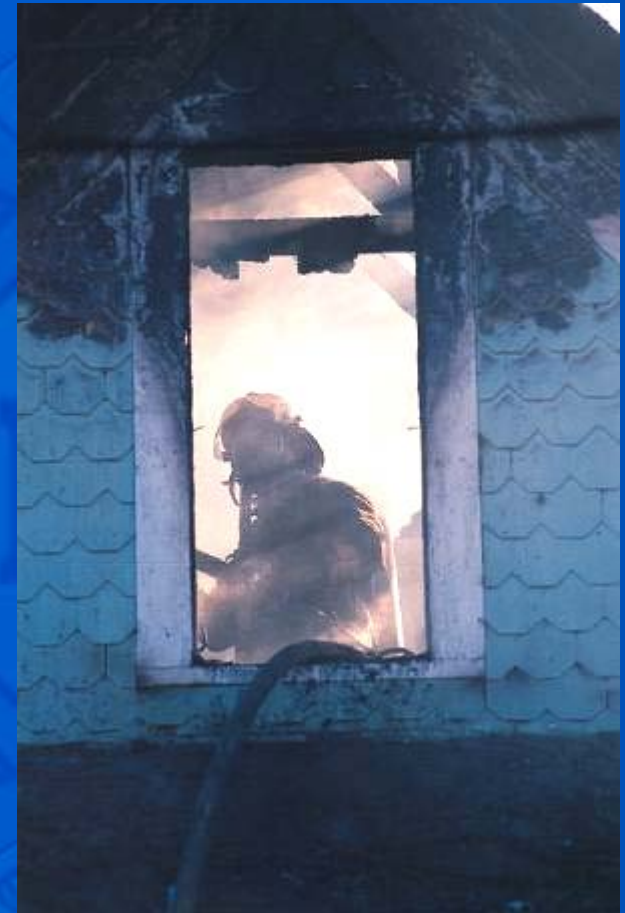
- Map the location of each room.
- Identify furniture pieces and their location.
- Remember types, locations and sizes of doorways.



Room Orientation

Stay oriented at all times so you can get out of the building if conditions deteriorate:

- Know where you are.
- Know how you got there.
- Know how to get out.





Room Orientation

- Fire fighters work in pairs.
- Fire fighters exit in pairs.
- Company officer is able to see, touch or hear all members of the crew.





Air Management

Fire departments should have a written Air Management Policy that, at a minimum:

- Requires individual fire fighters to monitor and report their air supply to their officers at specific intervals.
- Identifies an acceptable air supply that should be remaining when a fire fighter exits a building.
- Meets or exceeds the SCBA manufacturer's recommended usage guidelines.



NFPA 1404 – Standard for Fire Service Respiratory Protection Training

- Underwent a revision in 2006. It now mandates that fire fighter's be out of the IDLH area before the low air alarm activates.



Air Management – Fit to Survive

How do fire fighters perform more work with a limited air supply?

Fitness and Training

Increased cardiovascular fitness, muscular strength and endurance allows fire fighters to perform arduous tasks while consuming less air.





Consider Defensive Operations If:

- Pressurized smoke exiting the structure.
- Smoke coming from the walls of the structure.
- Truss roof assemblies exposed to fire upon arrival.
- Fire self-venting from the roof of the structure.
- Two or more floors involved with fire.
- Any factor likely to destabilize the structure.



Emergency Evacuation

On emergency evacuations, Brannigan states:

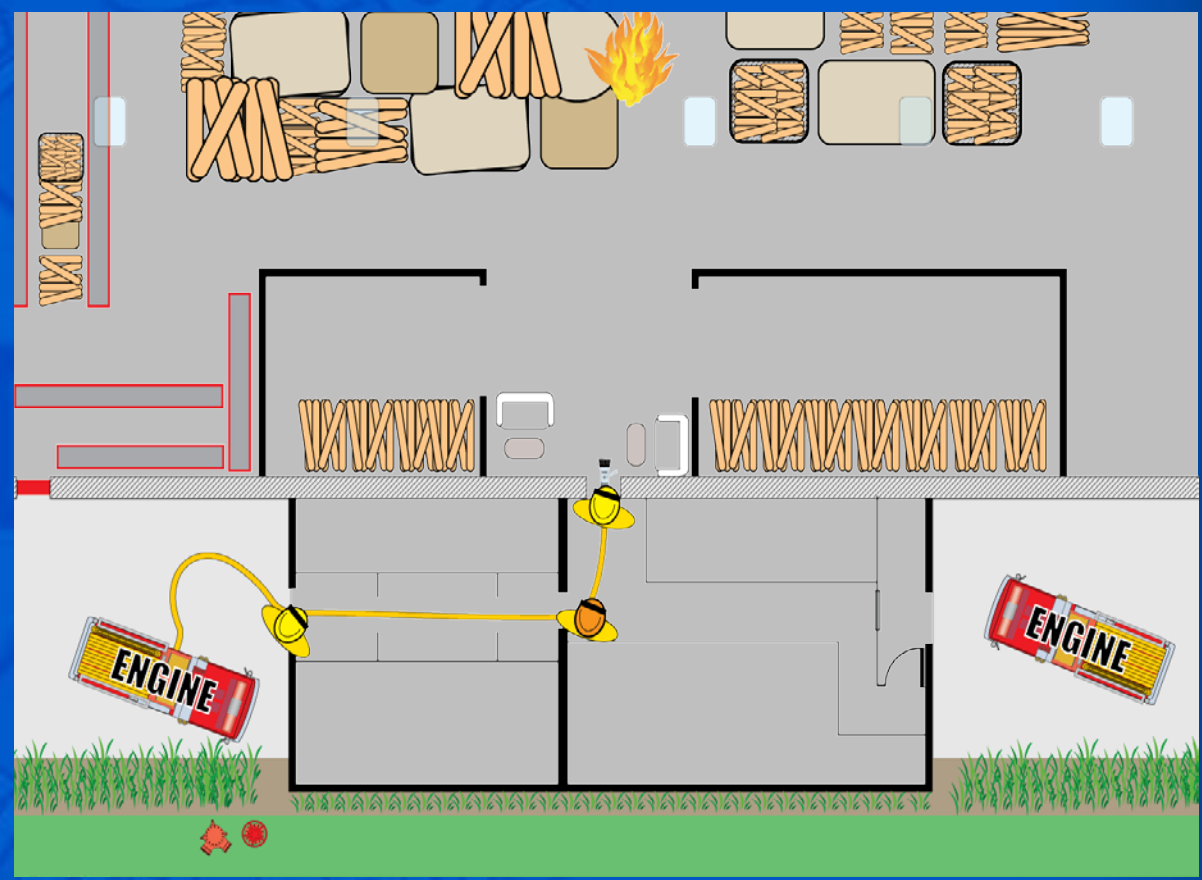
By nature and training, fire fighters are aggressive and often resist orders to back out. The overall gravity of the situation may not be apparent to those fighting the fire. “We’ve got a good shot at the fire” is often an excuse for delay. The authors know of no fire department that drills on immediate evacuation. This is a critical oversight.

Companies Must Practice Backing Out



Positioning on the Hose Line

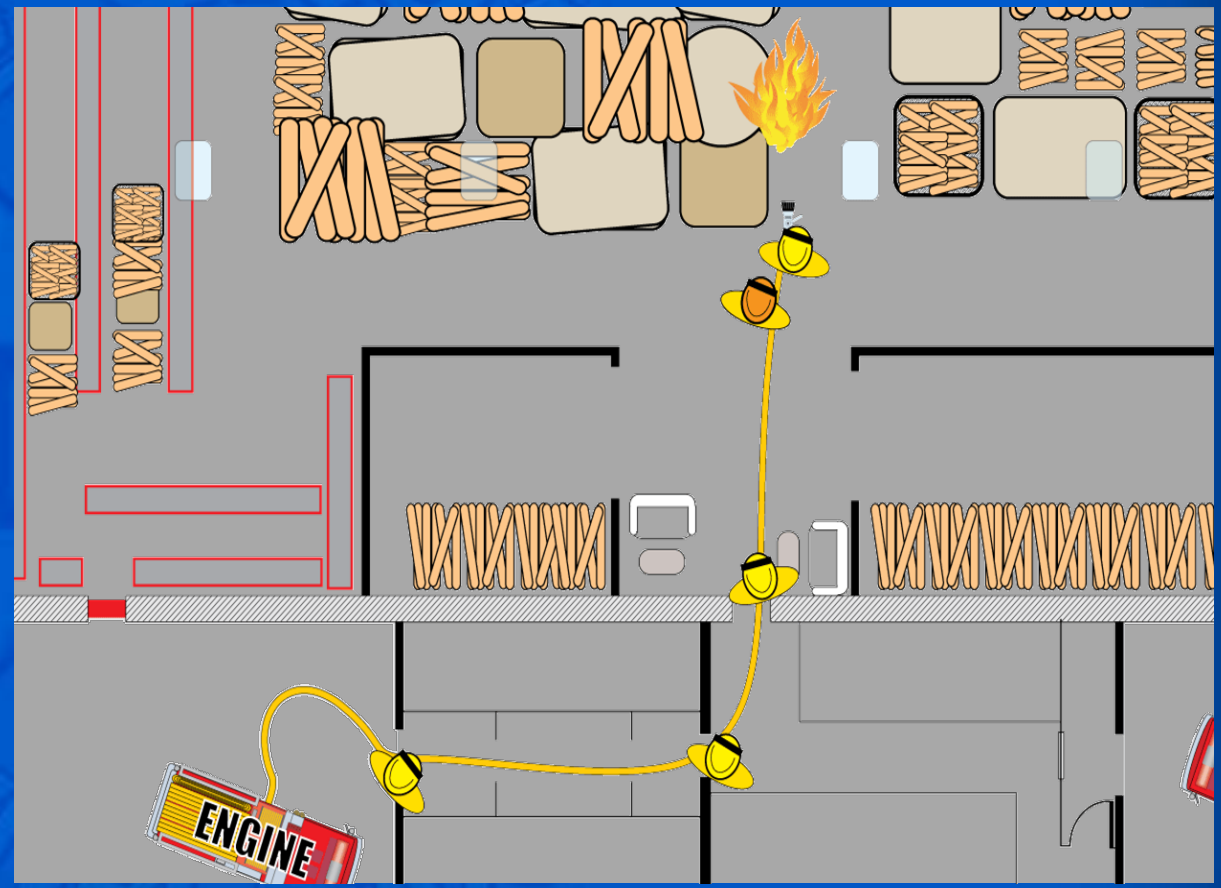
Four personnel with one apparatus operator at panel, two fire fighter's on hose line with officer or most experienced fire fighter just behind the fire fighter at the tip.



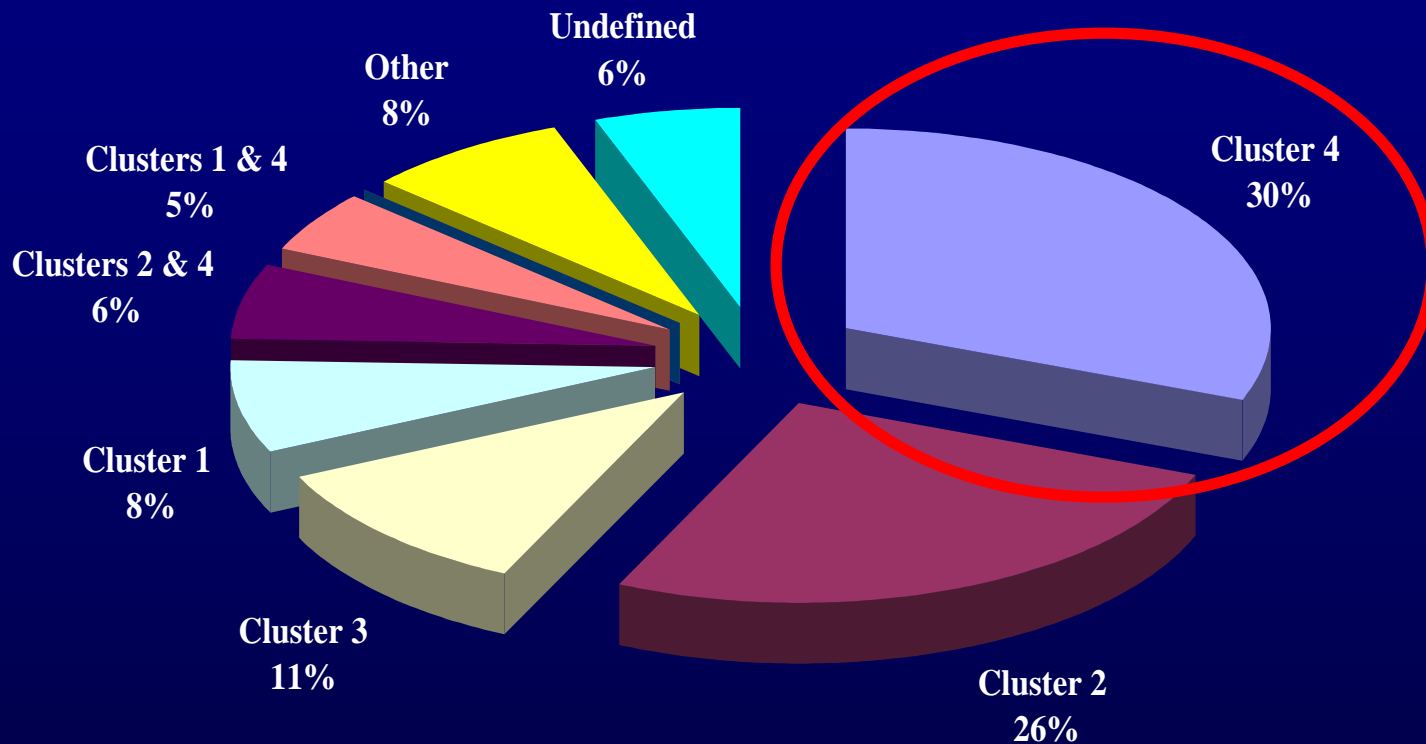


Positioning on the Hose Line

As hose line is extended further, more fire fighter's are added ensuring each egress is protected.



Contributing Factors to Fire Fighter LOD Injuries All Categories



Cluster 4: Decision Making, Lack of Communication, Standard Operating Guidelines / Procedure Breach, Protocol Breach, Human Error, Lack of Situational Awareness



Individual Fire Fighter Awareness

- Preventing a Mayday requires all personnel to communicate what they see and identify conditions that indicate immediate disengagement.





Rapid Heat and Smoke Release

Hose lines must be in place attacking the fire before the search of the floor above the fire can be conducted safely.



240 Seconds (4 min.)



NIST Study 1999 Iowa Duplex Fire

NIST Study, December 22, 1999 Iowa Duplex Fire:

- Three fire fighters lost their lives.
- Two story unit with smoke and fire.
- Children trapped.
- Fire conditions changed from tenable to lethal in approximately 60 seconds.



NIST Study 1999 Iowa Duplex Fire

A-Side/Front

Resident w/ child





NIST Study 1999 Iowa Duplex Fire



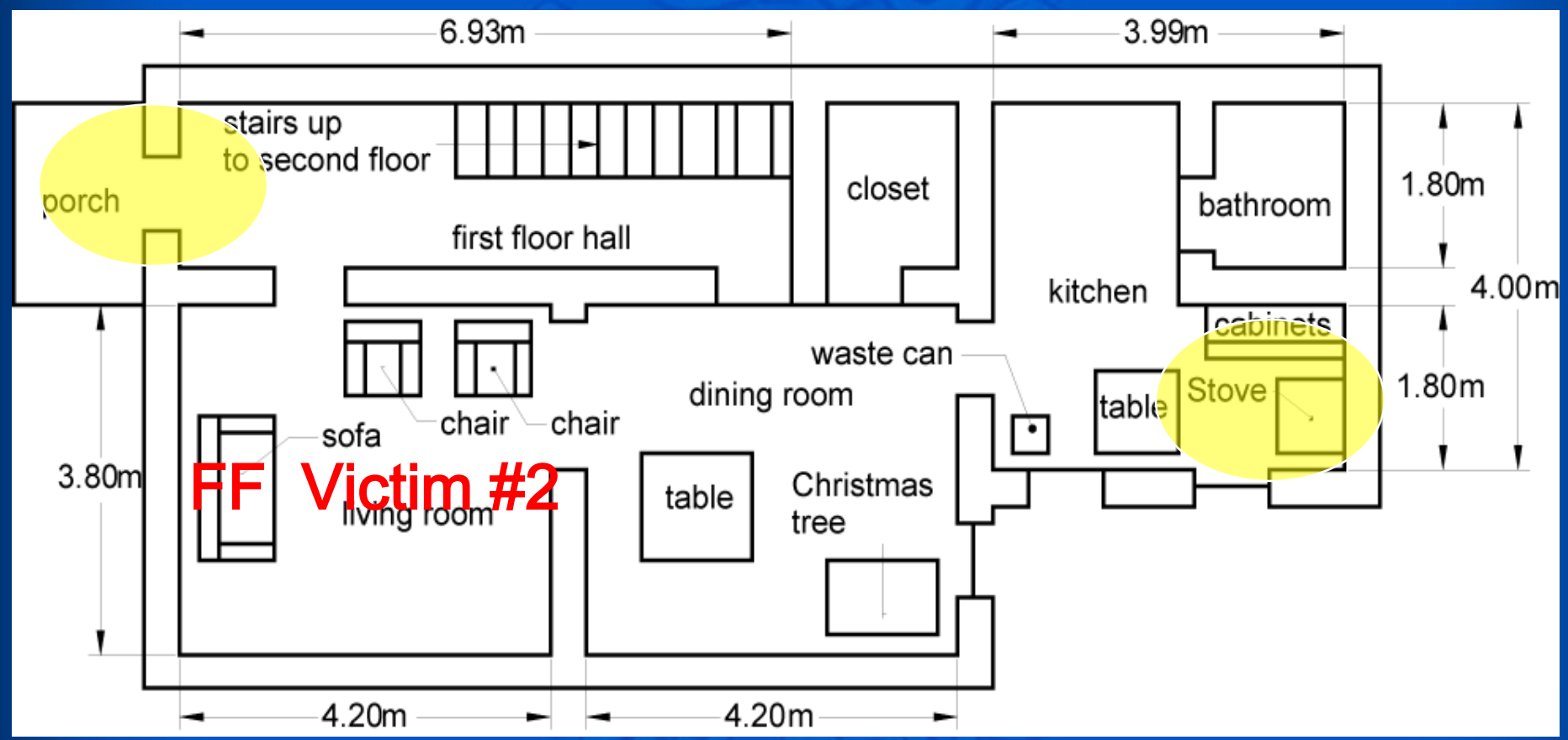
← Origin: Kitchen

C-Side/Rear



NIST Study 1999 Iowa Duplex Fire

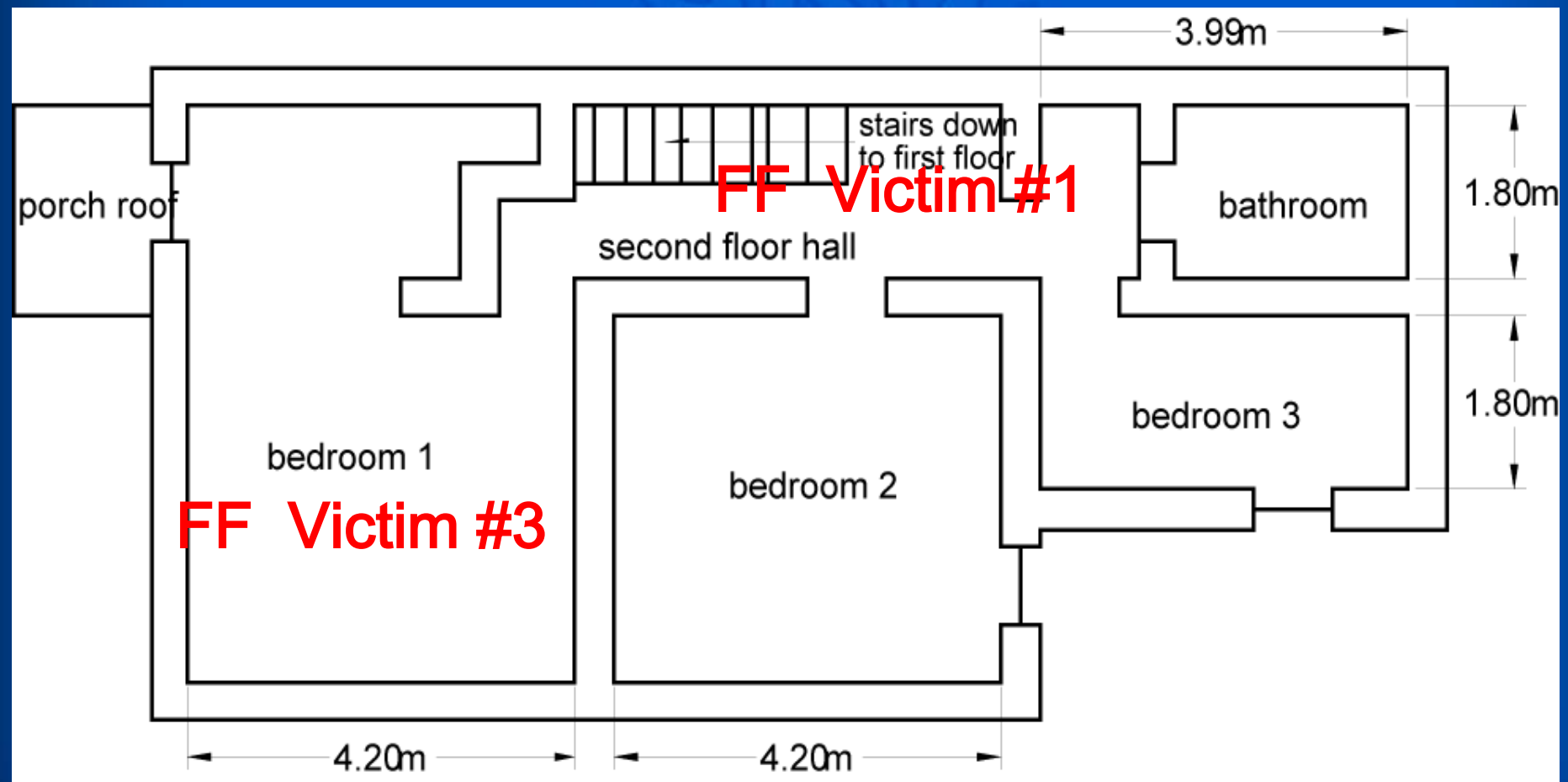
First Floor





NIST Study 1999 Iowa Duplex Fire

Second Floor





NIST Study 1999 Iowa Duplex Fire



Kitchen



NIST Study 1999 Iowa Duplex Fire



FF Victim #1

Stairwell

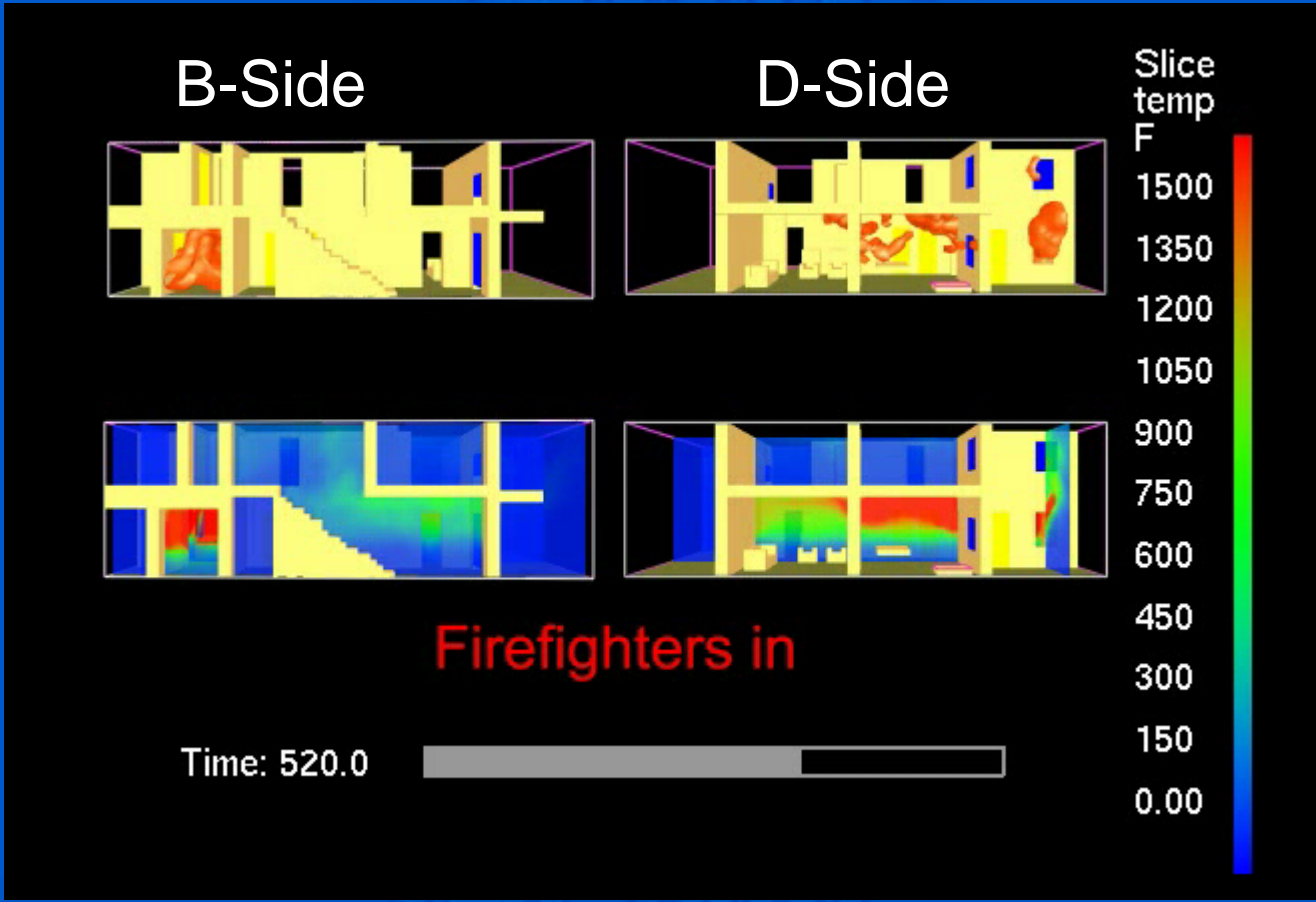


NIST Study 1999 Iowa Duplex Fire

Open Video File: "NIST Iowa Fire"

FLAME

HEAT





NIST Study 1999 Iowa Duplex Fire

NIOSH Recommendations:

- Hose lines in place while search is conducted.
- Interior conditions communicated to IC.
- IC to remain in command.

<http://www.cdc.gov/niosh/fire/reports/face200004.html>