

## ***Flashover Simulator Safety Guidelines***

The following guidelines have been assembled for your safety while participating in the flashover simulator. Strict adherence to these guidelines is not only necessary for your safety and well being, but for the safety and well-being of the other participants as well as the instructors involved in this program. Please read these guidelines carefully and completely.

1. You should be in very good physical condition. Any cardio-vascular or respiratory problems should prohibit you from participating in this program. The extreme heat and use of turnout gear could result in cardiac problems or even failure.
2. Proper hydration is extremely important since you will be experiencing body fluid loss while training. Drink plenty of fluids starting the day before, if possible, and continue to replace your fluids throughout the day. Water is preferred and nothing caffeinated should be taken in.
3. Good hydration and good health need to be stressed. You should not enter the simulator if you have a cold or the flu. Minor discomforts such as these can be very dangerous when you subject your body to additional heat stress. It has been shown that a respiratory infection can lead to heart damage or worse if ignored.
4. Since communication is difficult at best while in SCBA, talking should be kept to a minimum so that everyone will be able to hear the instructors. If it becomes necessary for anyone to leave, it is imperative that the instructor be notified. Again, if necessary to leave, participants must under no conditions stand erect. Maintain a crawling position and head for the doors at the rear of the simulator. Discipline is a must and is absolutely essential for the safety of everyone involved.
5. Remember that this not a lesson in stamina and the ability to outlast your peers. If you feel that it is necessary to leave do the following: Notify an instructor, crawl to the rear, head for one of the doors and above all else, STAY LOW.
6. SCBA must be worn at all times during a burn session. The safety instructor will also be in his/her SCBA since a rapid entry may become necessary and for respiratory protection since quite a lot of smoke is generated during a burn session.

7. All protective gear should be in good condition. Members of the staff will check your PPE prior to entry. Take the following suggestions into consideration:
  - A. Protective clothing should not be too tight fitting to allow for additional layers underneath your normal gear such as a long sleeved sweatshirt and a pair of sweat pants for leg protection.
  - B. Wear an extra pair of socks for protection to your feet, if possible.
  - C. Nomex hoods are MANDATORY. No bare skin should be exposed before entry.
  - D. MFA helmets with faceshields removed and MFA SCBA are to be worn inside the simulator.
8. Consider loosening the shoulder straps of your SCBA slightly so that air will have an opportunity to circulate under your turnout coat. Never grab anyone by the arm, shoulder or back since compression of the fabric might cause heat burns. If necessary to get someone's attention, tap them on the helmet or on the SCBA bottle.
9. Once inside, the nozzle and hose should be kept clear. Make sure that no one is standing on or blocking movement of the hose or nozzle. All lines must be charged and purged of air prior to entry. Two lines are to be used. The first is the attack line and the other is a safety or backup line. Both of these lines should have separate water sources.
10. Thorough washing is necessary after completion of the training exercise before eating. This is necessary to prevent ingestion by contamination.
11. It is advised to thoroughly wash all undergarments after your exposure in the simulator. This keeps skin exposure to contaminants to a minimum. It is also suggested that turnout gear be properly laundered as well. Extra heavy buildup of grime and contaminants should be pre-treated with a product such as Simple Green, 409, or equivalent cleaner.

*We wish you the best of luck in your training and are thoroughly convinced that the experiences learned today will remain in your mind throughout your career.*

# FLASHOVER RECOGNITION

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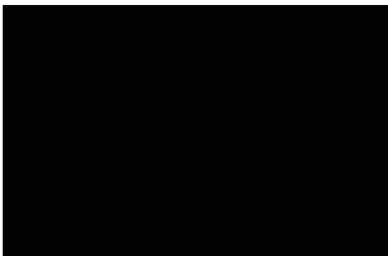
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## Goals

- To provide the fire service with a safe and secure system of flashover recognition training.
- To teach firefighters to recognize the signs of flashover.
- To provide firefighters with techniques to possibly give them time to escape an impending flashover.
- To save firefighters from injury and death from flashover.

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## Dangers

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## Dangers of Flashover

- Catches firefighters off guard.
- Develops rapidly with little warning.
- Increases firefighting problems.
- Occupants CANNOT survive.

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### Dangers of Flashover

- From Aug.1985 to Mar.2010, 113 firefighters were killed in structure fires in the United States.
- 16 of these firefighters died as a result of rapid fire development or ***“FLASHOVER”***

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### Dangers of Flashover

- An additional 7 firefighters were killed by FLASHOVERS during training evolutions.
- Many of the firefighters that died were trained and experienced !

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### Dangers of Flashover

- Flashover catches firefighters off guard if untrained to recognize the warning signs before full flashover occurs.
- Firefighters have been in flashover situations and escaped with only injuries.

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### Dangers of Flashover

- FLASHOVER can develop rapidly and with little warning.
- With the threat of flashover present, firefighting problems increase.
- Firefighting becomes more dangerous and the fire is very difficult to extinguish.

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### Dangers of Flashover

*No one can accurately  
predict when a flashover  
will occur !!*

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### Dangers of Flashover

Firefighter exposure to flashover potential has increased over the last several years due to:

- ◆ Better personal protective clothing.
  - ◆ Faster notification of fires.
- ◆ Better insulation in buildings.
- ◆ Class A fires vs. Class B fires.
- ◆ Polyurethane-12,000 Btu/Lb.
- ◆ Polystyrene-18,000 Btu/Lb.

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## What is Flashover ?

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## What is Flashover?

–*National Fire Academy:*

“The ignition of combustibles in an area heated by convection or radiation, or a combination of the two.

The combustible substances in a room are heated to their ignition point and almost simultaneous combustion of the material occurs.”

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## What is Flashover?

–*IFSTA:*

“The stage of a fire at which all surfaces and objects within a space have been heated to their ignition temperature, and flame breaks out almost at once over the surface of all the objects within the space”.

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## What is Flashover?

– *Deputy Chief Vincent Dunn, FDNY (ret.):*

“The sudden full room involvement in flame. Flashover is caused by thermal radiation feedback. During a fire in a room, the heat is absorbed into the ceiling and walls and re-radiated downward, gradually heating the combustible gases and contents to their ignition temperatures and the room and its contents simultaneously ignite.”

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## Flashover Development

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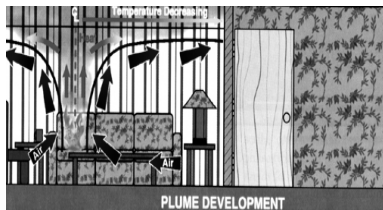
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## Plume Development



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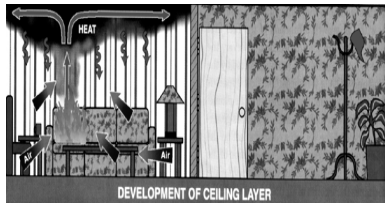
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## Ceiling Layer Development



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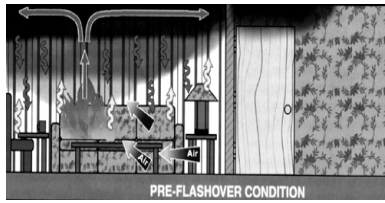
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## Pre-Flashover Condition



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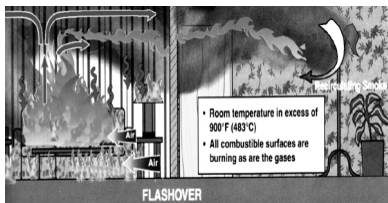
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## Flashover



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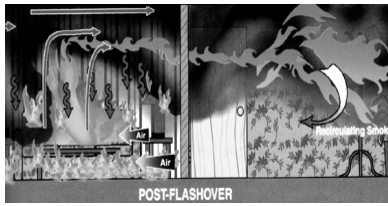
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## Post-Flashover



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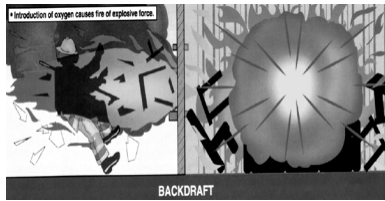
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## Backdraft vs. Flashover



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## Flashover Compared to Backdraft

### –Definition of Backdraft:

“The explosion or rapid burning of heated gases that occurs when oxygen is introduced into an oxygen deficient atmosphere.”

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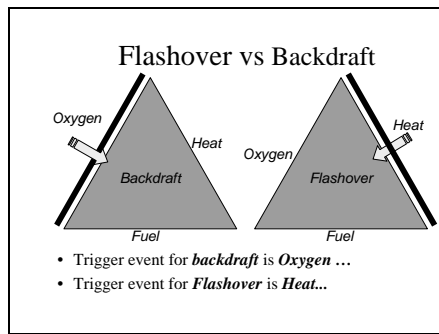
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## Fire Science & Flashover

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### Fire Science and Flashover

- Combustion only occurs within the flammable range of a vapor (gas).
- Flammable Range is the % of vapor in air necessary for combustion to occur.

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## Fire Science and Flashover

- Lower Explosive Limit (LEL) - the minimum % of vapor in air that will burn (lean end).
- Upper Explosive Limit(UEL) - the maximum % of vapor in air that will burn (rich end).

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## Fire Science and Flashover

- Gasoline – 1.4%-7.6%
- Acetylene – 2.5%-100%
- CO – 12.5%-74%

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## Fire Science and Flashover Fire Gas Formation

- The formation and emission of fire gases from walls and ceilings begins as the temperature in the room rises.
- The higher the temperature the more fire gases are produced.

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## Fire Science and Flashover Fire Gas Formation

- Flames climb upward until they ignite the “fire gas pillow” that has formed.
- When flames die down, the temperature falls but is still great enough to continue the production of the gases.

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## Fire Science and Flashover Fire Gas Formation

- **Ignition Temperature:** the minimum temperature to which a material must be heated to cause the production of gases that will ignite.
  - CO ignites at 1128 deg. F.
- Rapid oxidation (fire) occurs if oxygen or an oxidizer are present.

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## Fire Science and Flashover Water as an Extinguishing Agent

- Extinguishing ability is optimum when water droplets are 1/10th of an inch in diameter.
- Small droplets allow more surface area to absorb more heat.

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## Fire Science and Flashover Water as an extinguishing agent

- During firefighting, in order to provide the most efficient extinguishing effect from water, the nozzle should be moved in a circular motion vs. keeping nozzle in a stationary position.
- This insures that more surface area of the water is exposed to the heated atmosphere.

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## Fire Behavior in Structures

- The distribution and amount of fuel in a room affects the behavior of fire.

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## Warning Signs

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## Warning Signs of Flashover

- HEAT BUILD UP
- THICK DARK SMOKE
  - ROLLOVER
- FREE BURNING FIRE

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## Warning Signs of Flashover

### HEAT BUILD UP

- Hot smoke / gases that force firefighters to crouch down when entering a building.
- The lower you are forced to crouch, the greater the chance of flashover.

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## Warning Signs of Flashover

### THICK, DARK SMOKE

- Caused by large amounts of fire gases being produced and heated by thermal radiation feedback.

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### Warning Signs of Flashover

- Heavy, rolling clouds violently twisting skyward indicate extremely hot smoke from an intense fire deep in the building.
- This is frequently followed by fire igniting through openings the smoke is pouring through.
- Firefighters should use extreme caution when entering, to prevent being caught in a flashover.

(John Norman, FDNY)

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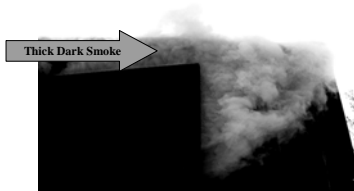
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### Warning Signs of Flashover



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### Warning Signs of Flashover

#### ROLLOVER

- Sporadic small flashes of flames ("snakes and jellyfish") mixed with smoke seen just prior to flashover occurring.
- Before entering a room, FFs should check the smoke exiting for signs of rollover.

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## “Snakes & Jellyfish”

- “Snakes & Jellyfish” are generic terms to describe rollover formations.



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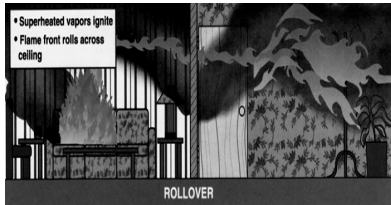
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## Rollover



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## Warning Signs of Flashover

### FREE-BURNING FIRE

- Flame production which heats materials and contents and allows the production of fire gases.

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# Variables of Flashover

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## Variables of Flashover

- Room size
- Room openings
- The rate and the amount of heat released
- The insulating qualities of the structure
- Ceiling height

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## Variables of Flashover

### ROOM SIZE

- A small room flashes more quickly than a larger room.

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## Variables of Flashover

### ROOM OPENINGS

- Number and type of room openings such as doors and windows.

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## Variables of Flashover

### RATE and AMOUNT OF HEAT RELEASED

- Affected by the type and quantity of contents of a room.

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## Variables of Flashover

### INSULATING QUALITIES OF THE STRUCTURE

- Thermopane windows
- Metal clad doors
- Weather stripping

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## Variables of Flashover

### CEILING HEIGHT

- Ceilings of 15 to 20 feet in height can result in dangerously misleading flashover size up information.

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## Ventilation

- Venting a fire can delay a flashover or cause it to occur, depending upon what stage the fire is in.

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## Preparation

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## Be Prepared

- Recognize the warning signs.
  - Heat and rollover.
- Avoid disorientation.
  - Follow a system.
  - Work in teams of at least 2 firefighters.
  - Take a rope or hoseline to follow out.
  - Have a tool and flashlight with you.

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## Be Prepared

- Note secondary means of egress before entering building.
- Enter and exit through same door if possible.
- Remain calm if disorientated.
- Control breathing.
- Do not remove your SCBA face piece.
- Wear full protective clothing.

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## Point of No Return

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### “The Point of No Return”

- KNOW the “*Point of No Return*” !
- A firefighter in full PPE can travel an average of 2.5 ft. per second when crawling.
- A firefighter has approximately 2 seconds to exit when flashover occurs.
- There is a possibility of escape if a firefighter is 5 ft. from the exit.

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### “The Point of No Return”

REMEMBER:

THE POINT OF NO RETURN IS 5 feet  
FROM THE EXIT

Even within 5 ft. from door you may  
make it out, but probably not without  
getting burned !

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## Nozzle Technique

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### Nozzle Technique to Detect Rollover

- To aid in recognizing rollover:
  - Test the atmosphere with nozzle on full fog.
  - Hold nozzle straight above your head.
  - Use a short, quick burst of water.
  - If water droplets fall on you the atmosphere above you is less than 212° F.

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### Nozzle Technique to Detect Rollover

- If no water falls back down, the water has been converted to steam and is hotter than 212°F.

The possibility of flashover exists!

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### Nozzle Techniques that may Delay Flashover

“AGGRESSIVE COOLING”:

- Several short bursts of water using 60° fog pattern into upper atmosphere.
- DO NOT upset the thermal balance or steam burns may result.
- Move nozzle in a circular pattern for maximum cooling.

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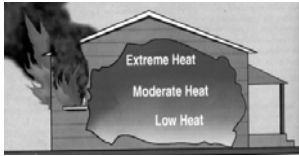
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## Nozzle Techniques that May Delay Flashover

- The Thermal Layer.



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## Nozzle Techniques that may Delay Flashover

### “PENCILING”

- Set nozzle to straight stream.
- Several short, rapid bursts to walls and ceiling - to slow re-radiation of heat.
- Move nozzle to cool different areas.

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## Nozzle Techniques that may Delay Flashover

- These 2 techniques, Aggressive Cooling and Penciling, when used in conjunction with each other, may possibly delay a flashover long enough to allow for firefighters to immediately exit the area.
- This is a *1 TIME ONLY* Survival Technique - to buy a few extra seconds.

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# Evacuate

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## If Flashover Occurs

- Get as close to the floor as possible.
- GET OUT!! EVACUATE the area as quickly as possible!!!
- Remember... If within 5 feet of the door you may probably escape with little harm.

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## If Beyond the Point of No Return

- Stay as low as possible.
- Operate nozzle over your head to possibly provide some cooling.
- GET OUT!! Evacuate the area immediately !!

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# The Flashover Recognition Simulator

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## Flashover Recognition Simulator

- The container and training program were developed by Swedish National Rescue Services Board in 1986.
- Training is designed to meet standards NFPA 1500 and NFPA 1403.

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## Flashover Recognition Simulator

- Two Sea cargo containers bolted together
  - Upper* = Burn Room
  - Section* Crib barrel
  - Masonite racks
  - Lower* = Observation Room
  - Section* Vent control

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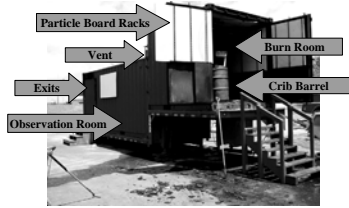
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## Flashover Recognition Simulator



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## Flashover Recognition Simulator

The purpose of the container :

- To demonstrate various stages of fire in confined areas.
- To provide students with an opportunity to become familiar with various firefighting nozzle techniques that may possibly delay a flashover.

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## Flashover Recognition Simulator

REMEMBER:

- It is ONLY a *Training Aid* used to help recognize fire conditions that can lead to flashover.

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## Flashover Recognition Simulator

- The purpose is to provide firefighters an opportunity to experience :
  - Personal response to heat and stress.
  - Limitations of protective clothing.

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## PPE

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## Proper Personal Protective Equipment

- 100% NFPA Compliant Gear.
- Use MFA Helmets with protective covering.
- Safety Officer will check ALL participants BEFORE they enter the container !!!

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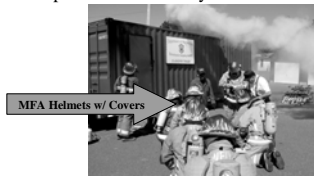
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## Inspection & Entry

- All students must be inspected and pass inspection before entry.



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## Operations

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## What to Expect



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### What to Expect



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### What to Expect



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### What to Expect



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Inside the Flashover Recognition Simulator



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Inside the Flashover Recognition Simulator



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Inside the Flashover Recognition Simulator



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## Preparing Yourself

- Limit drinks containing caffeine.
- Drink plenty of water ahead of time.
- Studies have shown that power drinks will settle and not be absorbed into your system unless properly diluted with water at a ratio of 50/50.



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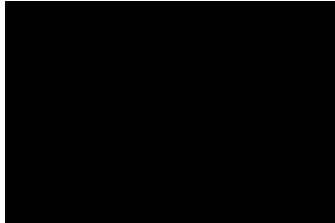
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## THERMAL LAYERING



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Career Officer Injured During a Live Fire  
Evolution at a Training Academy Dies  
Two Days Later - Pennsylvania

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On October 23, 2005, a 47 year old male career firefighter (the victim) was severely burned during a training evolution in the burn building at the State Fire Academy.....

The victim died from his injuries on October 25, 2005

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The NIOSH investigators concluded, fire departments and training academies should:

- ensure two training officers present with charged hose lines during ignition or refueling of a training fire in accordance to NFPA 1403.
- use the minimum fuel load to conduct live fire training

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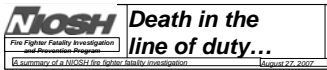
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- determine minimum amount of flame, heat and/or smoke required during live fire evolutions to perform the training while ensuring firefighter safety.
- have a written respiratory protection program and ensure SCBA facepieces are properly inspected, used, and maintained.
- have burn rooms with two exits

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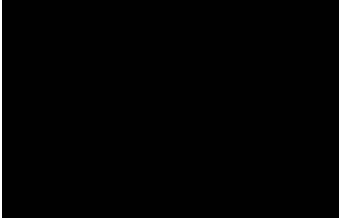
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## SCBA FACEPIECE



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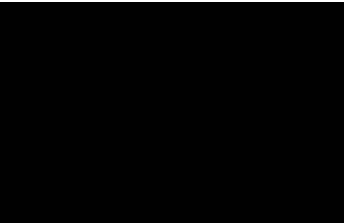
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## SCBA FACEPIECE



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## DURING OPERATIONS

After evolution is terminated:

- Keep SCBA ON and OPERATING !
- Stay LOW and exit the container.
- Report to REHAB area and re-hydrate.

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## DURING OPERATIONS

- Crib Fire started.
- Instructor cools ceiling as fire develops.
- Notice the high-pressure zone and smoke pillow develop.
- Perform temperature check.
- Watch for snakes, "black fire", rollover.
- Instructor cools area with fog and penciling.

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## DURING OPERATIONS

- Pay attention to the atmosphere !
- Follow instructions!

*DO NOT STAND UP !*

*DO NOT TOUCH OTHER FFs !*

- If problem occurs, tell the Instructor, crawl to exit in rear, report to Safety Officer.

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## Summary

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## SUMMARY

- There are NO ROUTINE STRUCTURE FIRES !
- Be aware of your surroundings and the environment at ALL TIMES !!
- React accordingly and BE SAFE !!

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## SUMMARY

- Container is only a Training Aid !
- The techniques demonstrated are to provide time to escape in emergency situations
- Remember!!
- fog --> pencil --> get out!
- MAY buy a few seconds

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## SUMMARY

**Remember:** In actual fires the firefighters are on the *same level* as the fire and not 3 feet below the fire floor as in the simulator

Be observant of conditions upon arrival in order to avoid becoming part of the fuel load !

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