
ENGELSKA PRESENTATIONER

Cornwall County

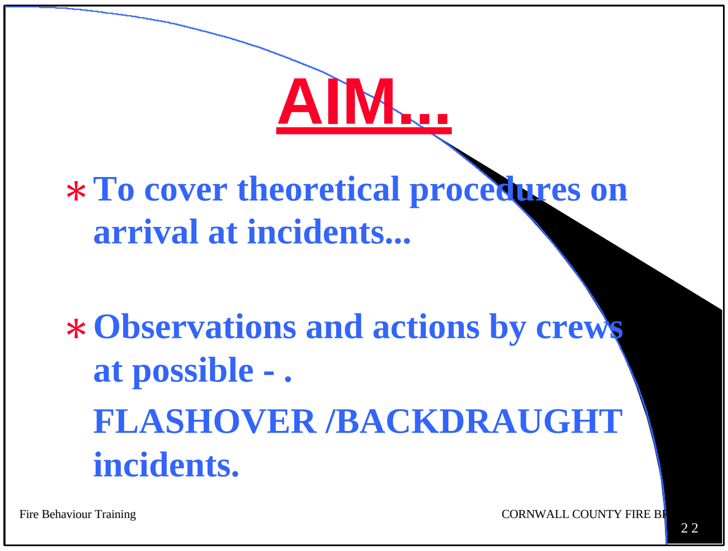
Fire Brigade

45 minutes

INTRODUCTION

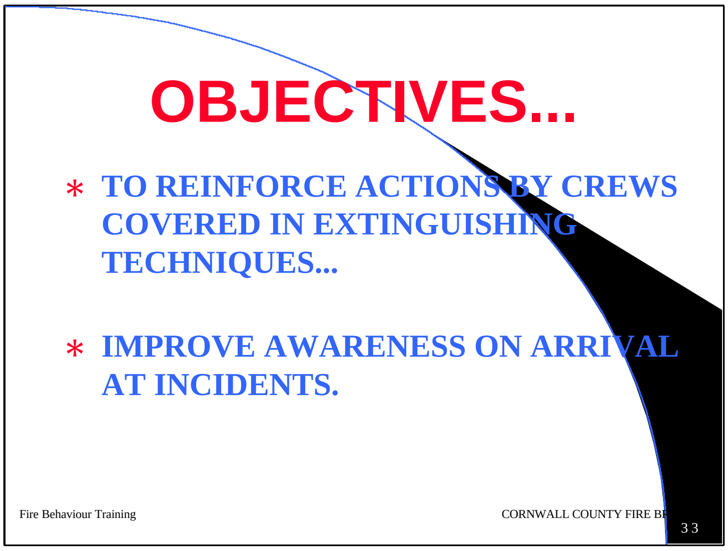
- Using what we learned yesterday and applying it to procedures at incidents...

Next Slide - Aims



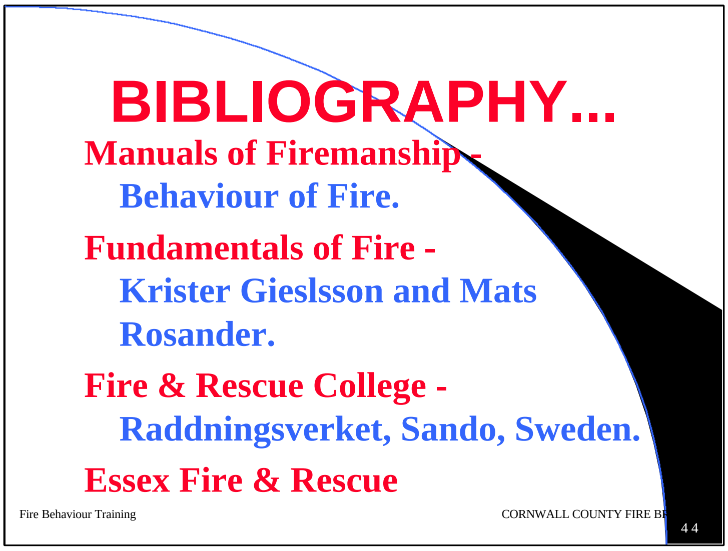
Self Explanatory

Next Slide - Objectives

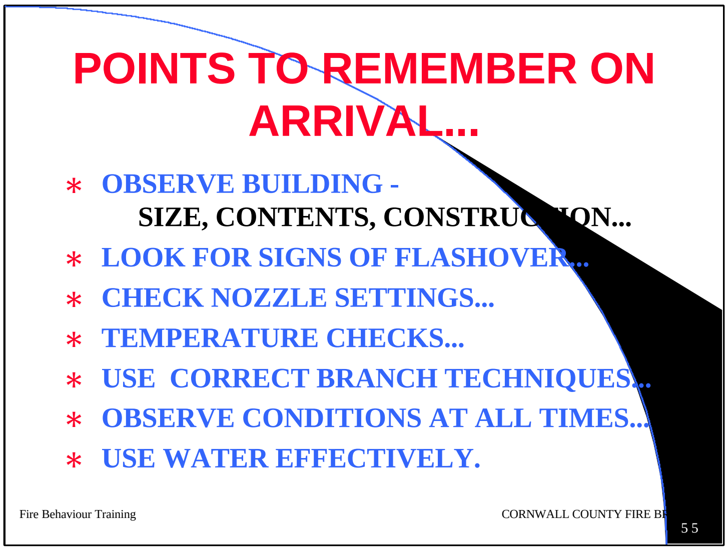


By remembering actions and improving awareness, the safety of crews will be improved.

Next Slide - Bibliography



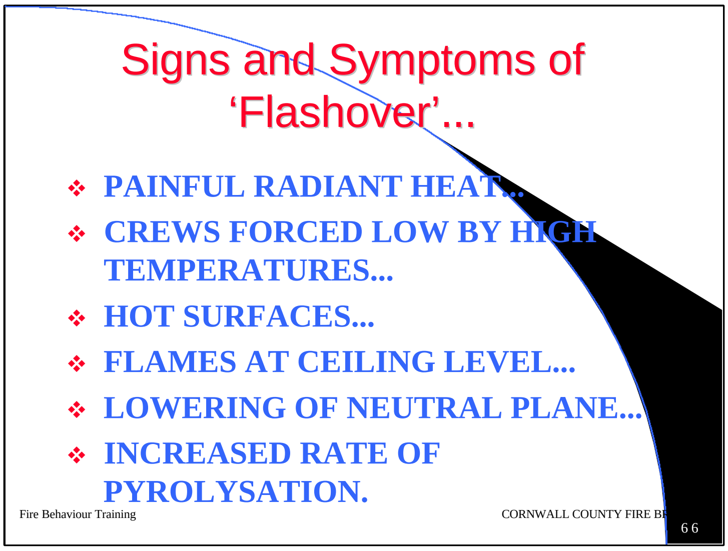
Next Slide - Points to remember on arrival



What is in the building an it's construction will affect firefighting.

Re-emphasise all points already covered in the practical sessions.

Next Slide - Signs



The temperature will be so great that even a short duration exposure will feel painful.

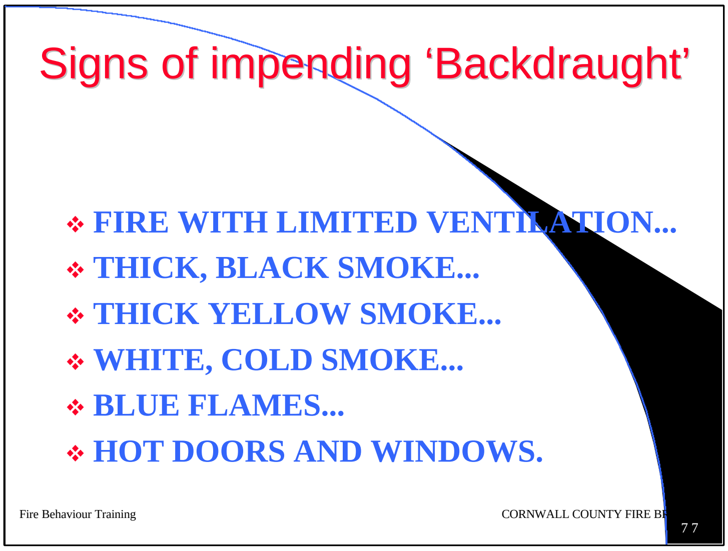
All surfaces in the compartment will be very hot, and at about 320 ^{o}c any surface will be painful to touch.

Flames will be visible within the neutral plane.

The level of the neutral plane will lower.

All fixtures and fittings will start to pyrolysis at a greater rate rapidly filling the compartment with combustible gas.

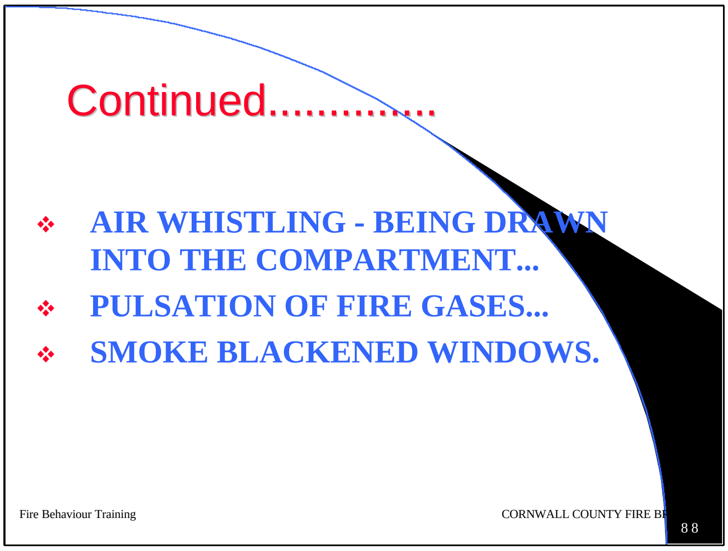
These are the signs of an impending flashover which you could experience in a compartment fire, but not necessarily at the same time.



These are the signs of an impending backdraught which can be observed from either inside or outside the compartment. The colour and temperature of the smoke depends on what is in the compartment on fire.

Thick smoke indicates that it is very rich with fuel and compressed.

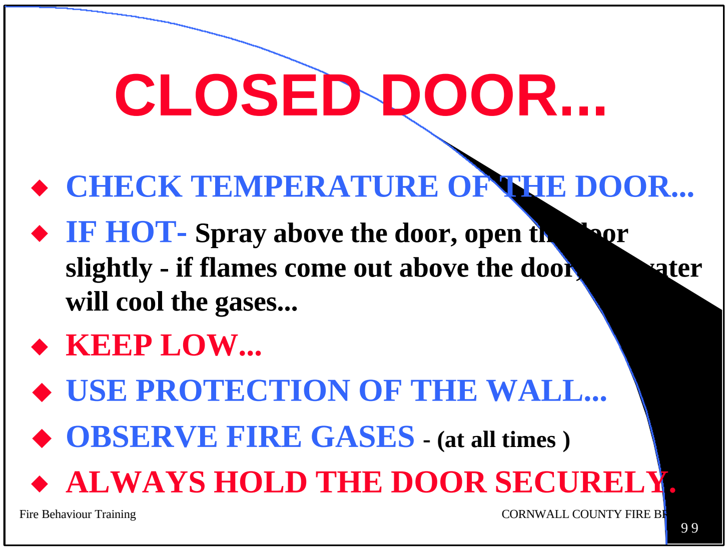
Blue flames may be visible if CO (carbon monoxide) is burning.



Air whistles as it is drawn in to compartment as the fire dies down and the pressure drops.

Fire gases can be seen to pulsate through gaps or openings. This is due to small amounts of combustion taking place as air leaks in and the pressure increases. When the compartment cools the pressure decreases, air is forced in and combustion takes place again.

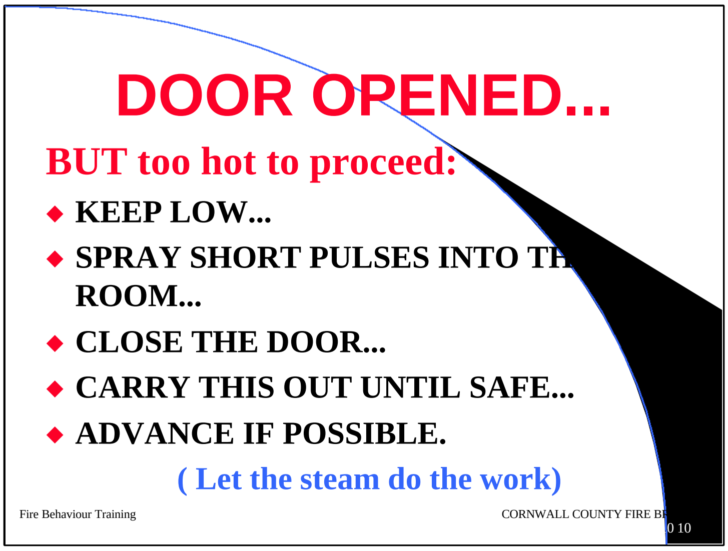
Windows will be smoke blackened due to the thickness of the smoke which may have a high carbon content.



General Rules:

Explain these and refer to the fact that they must be carried out when working in the Attack container later (Defensive Firefighting tactics).

Next Slide - Door opened

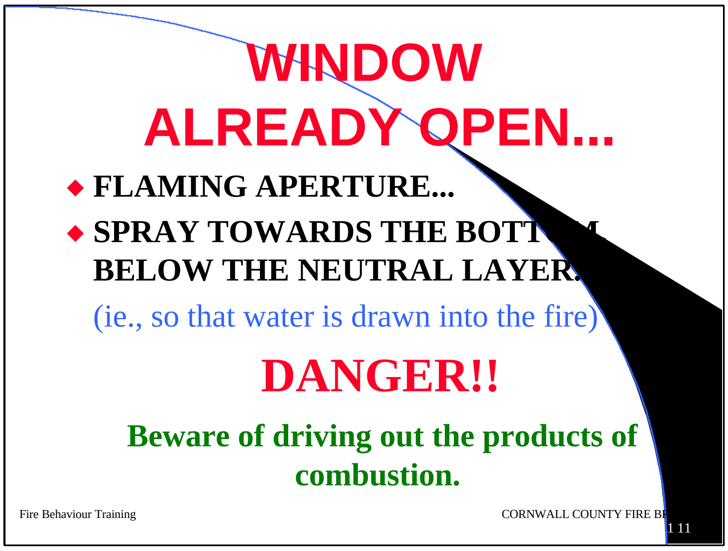


Several ‘short’ pulses high into the room, closing the door immediately to prevent the generated steam leaving.

Repeat as necessary, allowing enough time for the steam to ‘quench’ the fire gases and reduce the temperature.

Advance only when safe.

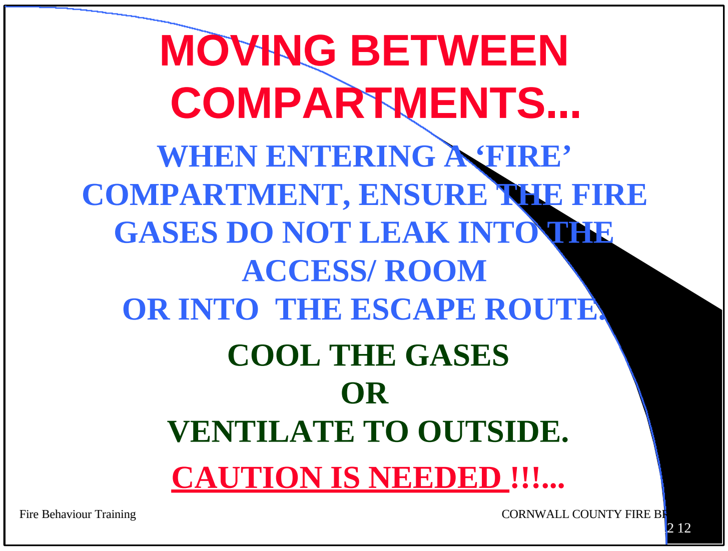
Next Slide - Door/window already open.



Use outside because driving steam into a room creates an over-pressure driving out the products of combustion (indirect attack).

Use covering sprays.

Next Slide - Moving between compartments



Creating a possible flashover by

- Having an ignition source.
- Providing air for gases above their auto ignition temperature
- Secure your position in the room you are in

DANGER:

Always protect your escape route.

Emphasise - closing doors on fires.

Next Slide - .... and ...

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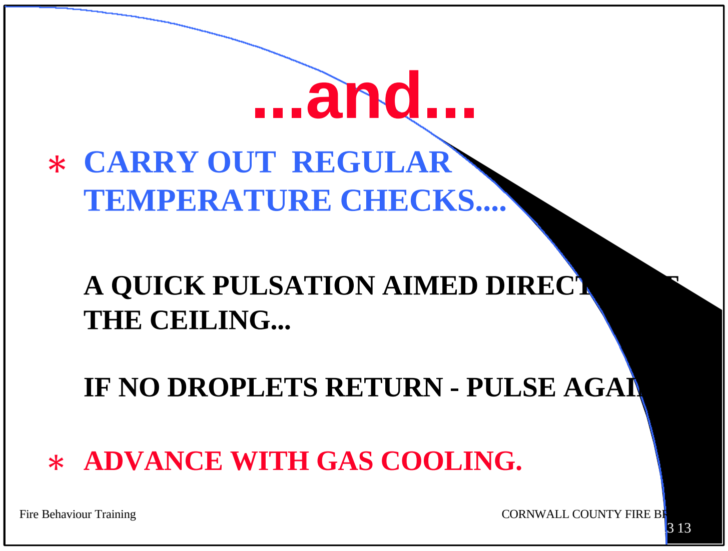
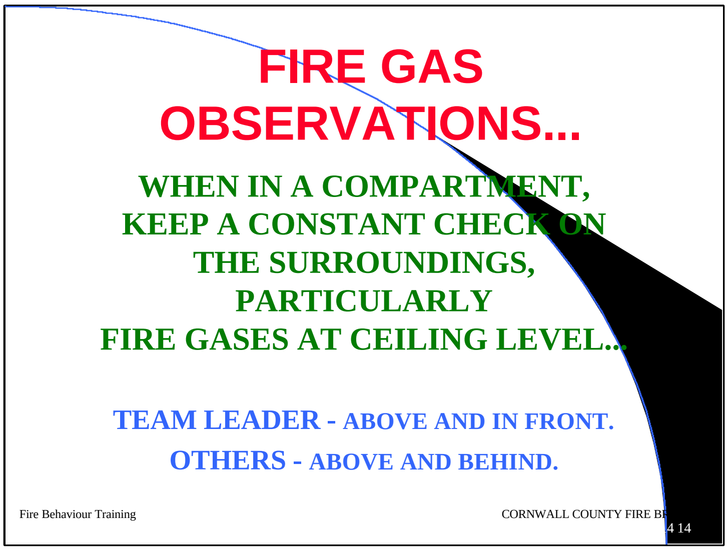


Cooling

Takes fire gases out of their flammable range.

Discuss the crews advancing as they gas cool (offensive).

Next Slide - Fire Gas Observations

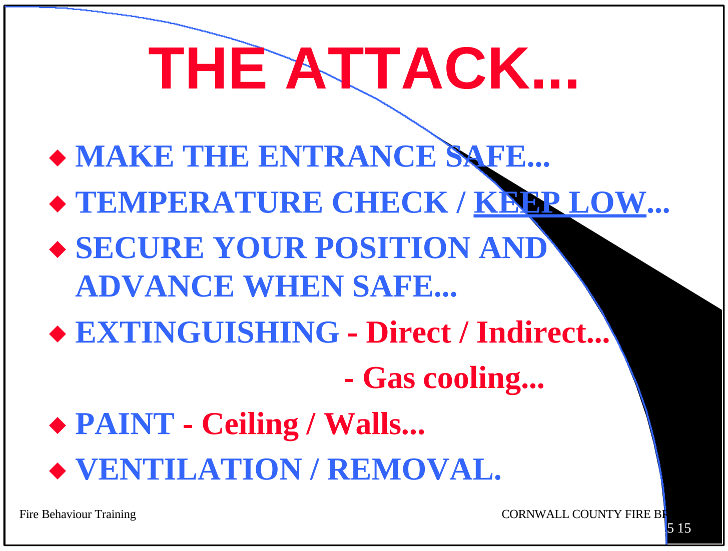


Take action by:

Gas cooling/advancing/securing/retreating!!

Keep Low!

Next Slide - The Attack

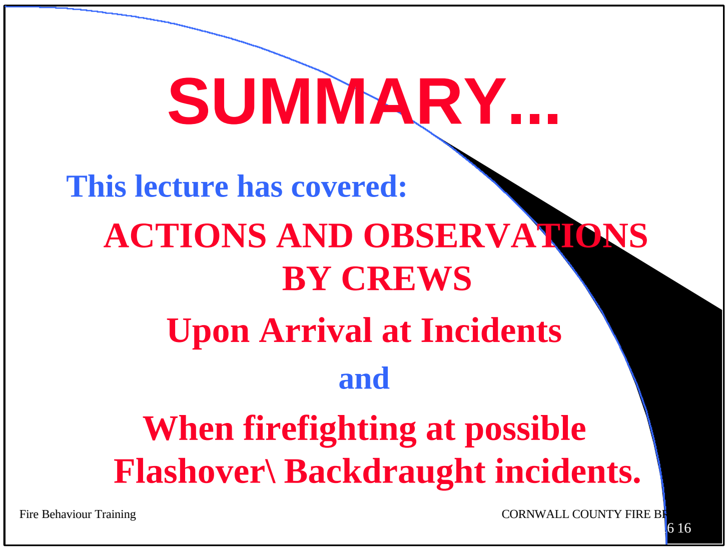


Temperature check up into room so as not to hit room surfaces.

If water returns, it is relatively cool - advance if safe.

Extinguishing techniques as discussed in 'Extinguishing Techniques' lecture.

Next Slide - Summary



We have covered the theory - seen the demo and practiced our nozzle drill.

Next Slide - Remember

- Look after yourself and the crew...
- If uncertain, DO NOT proceed...
- Communicate...

1. Crew inside...
2. Crew outside...

   Outside crew can observe for possible danger signs.

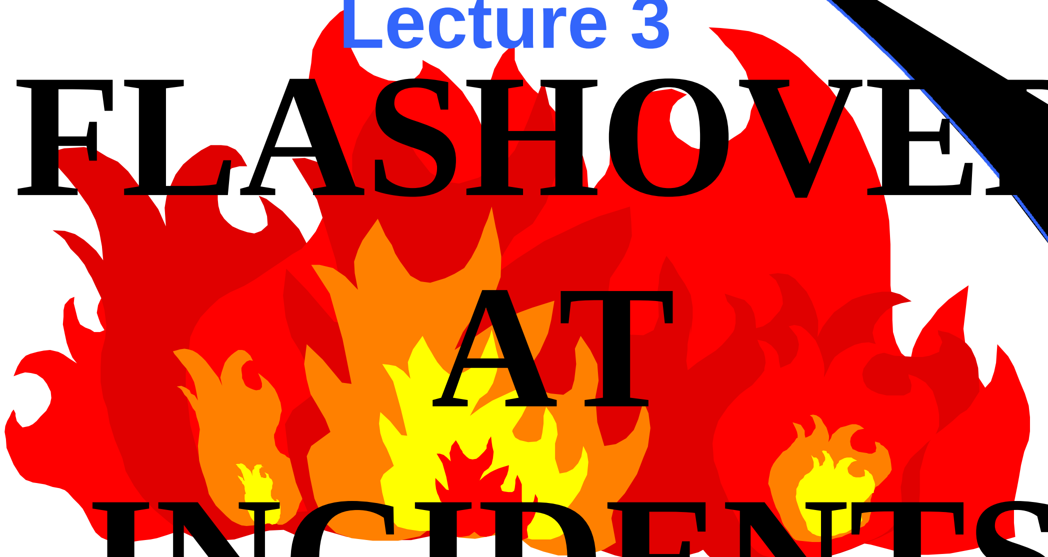
   - Thick, dark smoke.
   - Fire pulsation
   - Uncontrolled ventilation by:
     - the fire
     - collapse
     - or other crews

QUESTIONS?

END........

FIRE BEHAVIOUR TRAINING

Lecture 3



FLASHOVER AT INCIDENTS

A Training Department Presentation

AIM...

* To cover theoretical procedures on arrival at incidents...
* Observations and actions by crews at possible - .

  FLASHOVER /BACKDRAUGHT incidents.

OBJECTIVES...

* TO REINFORCE ACTIONS BY CREWS COVERED IN EXTINGUISHING TECHNIQUES...

* IMPROVE AWARENESS ON ARRIVAL AT INCIDENTS.

BIBLIOGRAPHY...

Manuals of Firemanship -
Behaviour of Fire.

Fundamentals of Fire -
Krister Gieslsson and Mats Rosander.

Fire & Rescue College -
Raddningsverket, Sando, Sweden.

Essex Fire & Rescue

POINTS TO REMEMBER ON ARRIVAL...

* **OBSERVE BUILDING -**
  SIZE, CONTENTS, CONSTRUCTION...
* **LOOK FOR SIGNS OF FLASHOVER...**
* **CHECK NOZZLE SETTINGS...**
* **TEMPERATURE CHECKS...**
* **USE CORRECT BRANCH TECHNIQUES...**
* **OBSERVE CONDITIONS AT ALL TIMES...**
* **USE WATER EFFECTIVELY.**

Signs and Symptoms of 'Flashover'...

- **PAINFUL RADIANT HEAT...**
- **CREWS FORCED LOW BY HIGH TEMPERATURES...**
- **HOT SURFACES...**
- **FLAMES AT CEILING LEVEL...**
- **LOWERING OF NEUTRAL PLANE...**
- **INCREASED RATE OF PYROLYSATION.**

Signs of impending ‘Backdraught’

- **FIRE WITH LIMITED VENTILATION...**
- **THICK, BLACK SMOKE...**
- **THICK YELLOW SMOKE...**
- **WHITE, COLD SMOKE...**
- **BLUE FLAMES...**
- **HOT DOORS AND WINDOWS.**

Continued..............

- AIR WHISTLING - BEING DRAWN INTO THE COMPARTMENT...
- PULSATION OF FIRE GASES...
- SMOKE BLACKENED WINDOWS.

CLOSED DOOR...

- **CHECK TEMPERATURE OF THE DOOR...**
- **IF HOT- Spray above the door, open t[illegible]oor slightly - if flames come out above the door[illegible]ater will cool the gases...**
- **KEEP LOW...**
- **USE PROTECTION OF THE WALL...**
- **OBSERVE FIRE GASES - (at all times)**
- **ALWAYS HOLD THE DOOR SECURELY.**

DOOR OPENED...

BUT too hot to proceed:

- **KEEP LOW...**
- **SPRAY SHORT PULSES INTO TH ROOM...**
- **CLOSE THE DOOR...**
- **CARRY THIS OUT UNTIL SAFE...**
- **ADVANCE IF POSSIBLE.**

(Let the steam do the work)

WINDOW ALREADY OPEN...

- **FLAMING APERTURE...**
- **SPRAY TOWARDS THE BOTT M, BELOW THE NEUTRAL LAYER.**

(ie., so that water is drawn into the fire)

DANGER!!

Beware of driving out the products of combustion.

MOVING BETWEEN COMPARTMENTS...

WHEN ENTERING A 'FIRE' COMPARTMENT, ENSURE THE FIRE GASES DO NOT LEAK INTO THE ACCESS/ ROOM OR INTO THE ESCAPE ROUTE.

COOL THE GASES

OR

VENTILATE TO OUTSIDE.

CAUTION IS NEEDED !!!...

...and...

* **CARRY OUT REGULAR TEMPERATURE CHECKS....**

A QUICK PULSATION AIMED DIRECT
THE CEILING...

IF NO DROPLETS RETURN - PULSE AGAI

* **ADVANCE WITH GAS COOLING.**

FIRE GAS OBSERVATIONS...

WHEN IN A COMPARTMENT,
KEEP A CONSTANT CHECK ON
THE SURROUNDINGS,
PARTICULARLY
FIRE GASES AT CEILING LEVEL...

TEAM LEADER - ABOVE AND IN FRONT.

OTHERS - ABOVE AND BEHIND.

THE ATTACK...

- MAKE THE ENTRANCE SAFE...
- TEMPERATURE CHECK / KEEP LOW...
- SECURE YOUR POSITION AND ADVANCE WHEN SAFE...
- EXTINGUISHING - Direct / Indirect...

  - Gas cooling...
- PAINT - Ceiling / Walls...
- VENTILATION / REMOVAL.

SUMMARY...

This lecture has covered:

ACTIONS AND OBSERVATIONS BY CREWS

Upon Arrival at Incidents

and

When firefighting at possible Flashover\ Backdraught incidents.

REMEMBER...

- SLOW DOWN...
- WATCH..LISTEN.. FEEL..THINK...
- <u>KEEP LOW...</u>
- MOVE...
- COMMUNICATE.

45 minutes

INTRODUCTION

NOTE FOR INSTRUCTOR

BRANCH REQUIRED TO DEMONSTRATE TECHNIQUES..

Next Slide - Aims

Revised 23/5/97 Pages 1,7,8,10,11,12,15,21.

1

AIM...

To cover theory on:

- Practical Extinguishing of Fires...
- Controlling Fires in compartments.

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Self Explanatory

Next Slide - Objectives

OBJECTIVES...

To understand:

- The fire signs.
- Mechanics of extinguishing fires...
- Practical branch techniques...
- How to carry out an attack into a compartment...

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Self Explanatory

Next Slide - Bibliography

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  - Raddningsverket, Sando, Sweden.

Next Slide - Safety

SAFETY...

- THINK / LISTEN / WATCH / FEEL..
- DECISION...
- MOVE...
- KEEP AWAY FROM OPENINGS...
- PASS THROUGH OPENINGS QUICKLY...

READ THE SIGNS!!

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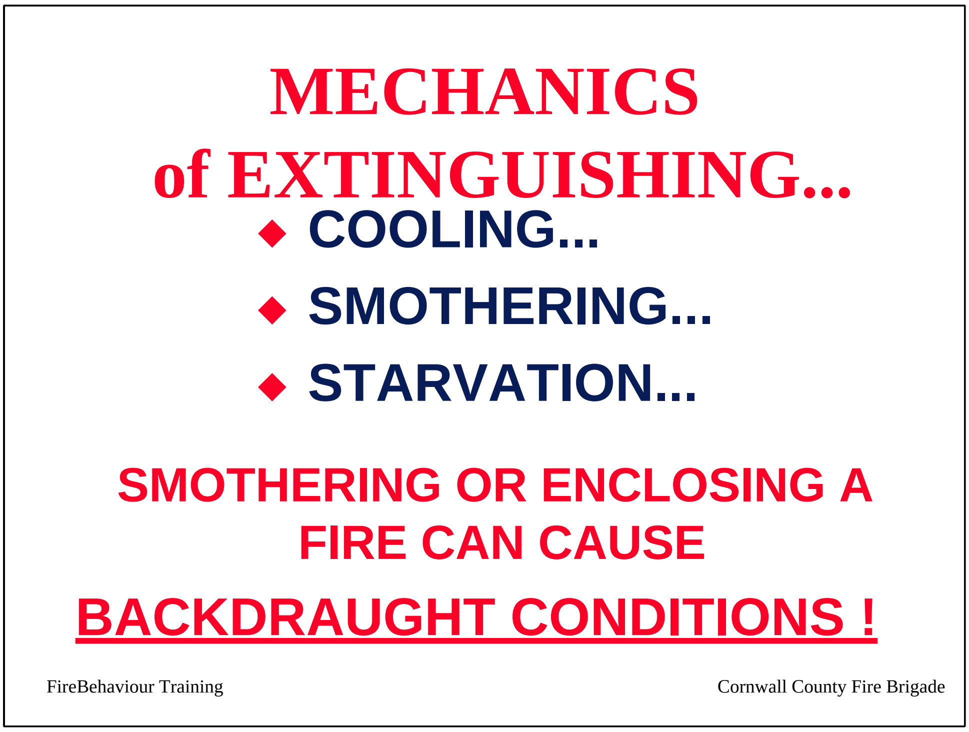
Door openings are very dangerous areas because fire gases mix with air or escape into areas where air is available.

Move through door openings quickly once a decision has been made to enter the compartment.

Communicate and keep other crews away from alternative openings - possibility of being caught by flashover.

Next Slide - Mechanics of Extinguishing.



Explain the three methods

Next Slide - Water as an Extinguishing Medium

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WATER AS AN EXTINGUISHING MEDIUM...

Latent heat of vaporisation -

This is the most effective way of removing heat from a fire. So the more water that can be turned to steam the more effective it will be.

ADVANTAGE

Removes heat energy

DISADVANTAGE

Produces large amounts of steam

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When water turns to steam it absorbs large amount of heat - expansion ratio of 1700:1.

Steam - 1 Litre of water produces:

at 100ºC - 1700 lts

at 450ºC --3500 lts

Latent heat means hidden heat - this is the heat absorbed from the fire to turn water into steam

The energy absorbed in example 3 is far greater so

the more water turned to steam (ie, vapourised) the

more cooling will take place.

Examples

1 . To melt ice req.

0.334 MJ [Mega Joules]

2 . To bring water up to boiling point.

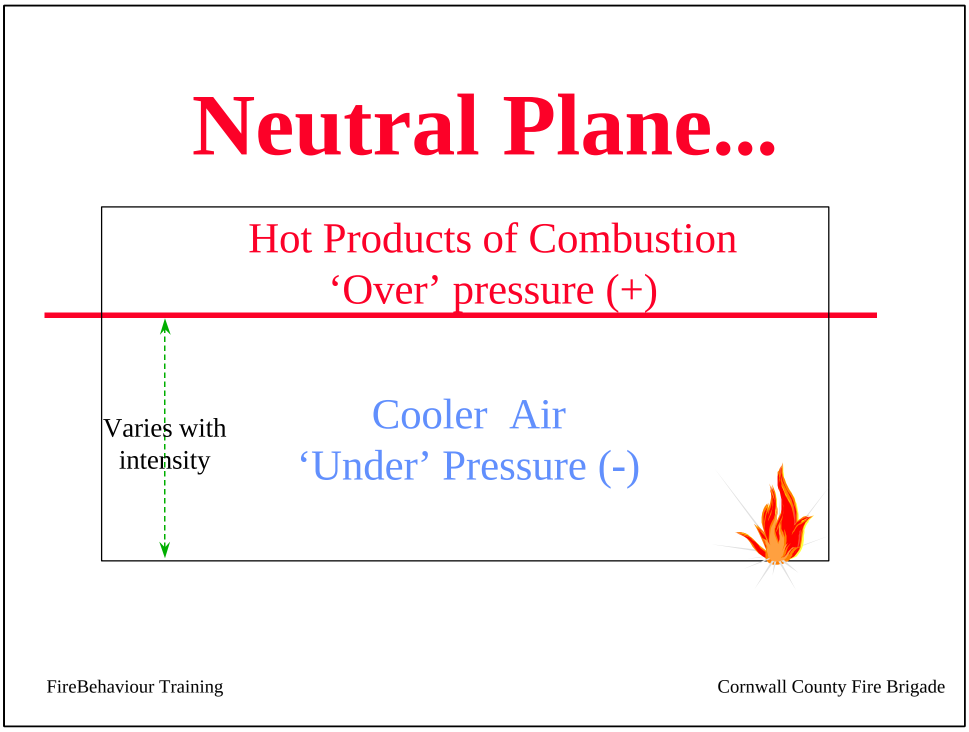
0.419 MJ

3 . To turn the 100ºC water to steam.

2.263 MJ

Next Slide - Neutral Plane

7



Explain what happens to the neutral plane -

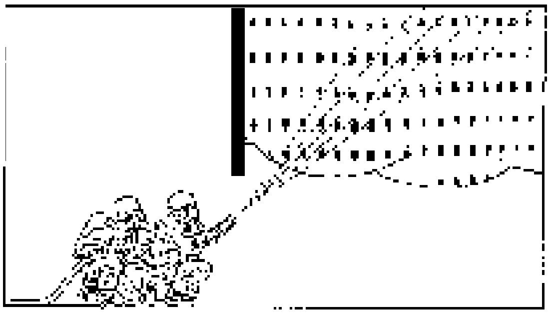
As the fire develops a small over-pressure develops above a distinct line which can be clearly seen in a fire situation

With an increase in development ,the neutral plane is forced down by the increasing amount of fire gases produced.

Next Slide - Tactics - Indirect Technique

INDIRECT TECHNIQUE...

(Defensive)



Large quantities of steam produced.
Creates an over pressure.

Lowers neutral plane.

Direct the pulse spray up into the compartment to produce steam and create an over-pressure which will keep out the air and smother the fire.

This should be an external attack method.

Can be carried out internally but great care must be taken for the following reasons:

a) large quantities of steam produced which could scald BA teams and casualties.

b) Reduced visibility.

c) Worsens conditions.

Next Slide: Direct

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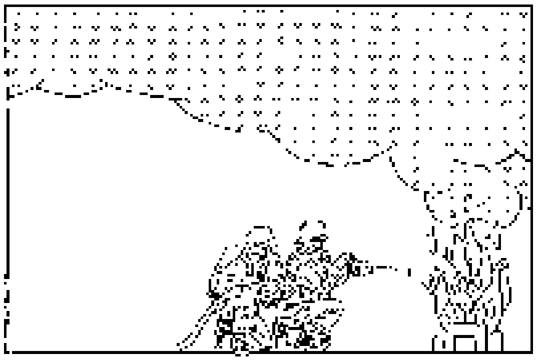
DIRECT TECHNIQUE...



Early attack method to extinguish initial fire.

Danger:-

Beware of combustible gases igniting.

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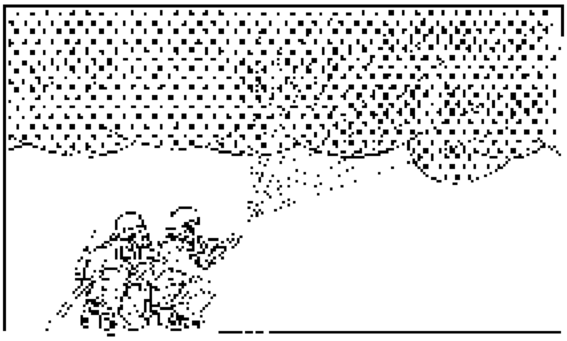
If this method is used in the later stages of the fire, when the compartment may be full of fire gases, there is a danger that your actions may stir up the initial fire and introduce an ignition source to the rich fire gases and trigger a delay gas combustion.

Do not get in to this position until you have carried out the other necessary tactics, i.e.., gas cooling.

Next Slide: Gas Cooling

GAS COOLING TECHNIQUE... (Offensive)



Cools fire gases.
Needs fogfighter branch.

Shrinks fire gases.

Neutral plane may remain constant or rise, improving conditions.

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'Offensive' or 'Protective' method used when gain access to carry out rescues etc. Rapid, short pulsation's.

The Fogfighter branch produces the correct water droplet size (0.3mm) which penetrates the fire gas and converts to steam before reaching the walls and ceiling.

The fire gases contract due to them being rapidly cooled and the neutral plane may rise.

Next Slide: Use of Branch

USE OF A BRANCH...

- SHORT PULSATION'S

  On and off - short distance protection...
- LONG PULSATION'S

  3 - 4 seconds to cover a longer distance...
- SWEEP (Left to right or floor to ceiling)

  Move across large areas.

ALTER THE ANGLE OF THE BRANCH TO REACH FURTHER INTO THE FIRE.

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Firefighters use a combination of all three.

This will- with sweeps and long pulsations be a

combination of gas cooling and indirect techique

Care must be taken as to the amount of indirect used

to avoid worsning condtions.

Emphasise this is primarily for ‘gas cooling’.

This will be demonstrated this afternoon in cold conditions.

Next Slide - Branch Techniques.

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CONSIDER...

- Never turn your back on the fire...
- Produce just enough steam to be effective without altering conditions to your disadvantage...
- Use water effectively...
- THINK!
- Protect EXIT.

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Emphasise about not turning your back on the fire and also about retreating, taking branch for protection.

Next Slide - When the door is closed.

(Amended 12/6/97)

ON ARRIVAL - DOOR CLOSED...

- CHECK TEMPERATURE OF THE DOOR...
- KEEP LOW...
- IF HOT - Pulse spray above the door ,open the door slightly...
  - If flames come out above the door the water will cool the gases.

HOLD THE DOOR SECURELY!

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KEEP LOW!!!!!

DO **NOT** OPEN DOOR WITH CREW ON HINGE SIDE OF THE DOOR.

DOOR MAY BE BLOWN OPEN BY THE FORCE OF COMBUSTION.

Next Slide - When door is opened

DOOR OPENED...

If it is too hot to proceed:

- Spray pulses into the room...
- Close the door...
- Repeat if necessary - let the steam do the work...
- **ADVANCE IF POSSIBLE.**

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IF TOO HOT TO PROCEED - DON'T !!

Next Slide - If door or window is open on arrival.

ON ARRIVAL - WINDOW ALREADY OPEN...

- **FLAMING APERTURE...**
- **SPRAY INTO THE BOTTOM, BELOW THE NEUTRAL PLANE...**

  - So that water is drawn into the fire.

DANGER!!

Beware of driving out the products of combustion.

Use from outside because driving steam into a room creates an over-pressure driving out the products of combustion

Covering sprays - support.

Next Slide - The Attack

THE ATTACK...

- Make the entrance safe...
- Temperature check / Communicate...
- Secure your position and advance when safe...
- EXTINGUISHING - Direct / Indirect...
  - Gas cooling...
- PAINT - Ceiling / Walls...
- VENTILATION / REMOVAL.

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Temperature check up into room - if water returns it is relatively cool.

Advance if safe - gas cooling when advancing.

Next Slide - Moving between compartments

MOVING BETWEEN COMPARTMENTS...

When firefighters enter a compartment they must ensure that the fire gases do not leak into the room they are in or their escape route.

- **COOL THE GASES...**
- **VENTILATION TO OUTSIDE...**

CAUTION NEEDED !!!

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Creating a possible flashover by:

1. Having an ignition source

2. Providing air for gases above their auto ignition temperature.

Secure your position in the room you are in.

Next Slide - Signs

Signs and Symptoms of 'Flashover'...

- PAINFUL RADIANT HEAT...
- CREWS FORCED LOW BY HIGH TEMPERATURES...
- HOT SURFACES...
- FLAMES AT CEILING LEVEL...
- LOWERING OF NEUTRAL PLANE...
- INCREASED RATE OF PYROLYSATION.

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All surfaces in the compartment will be very hot, and at about 320 ^{o}c any surface will be painful to touch.

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These are the signs of an impending flashover which you could experience in a compartment fire, but not necessarily at the same time.

Signs of impending ‘Backdraught’

- ❖FIRE WITH LIMITED VENTILATION...
- ❖THICK, BLACK SMOKE...
- ❖THICK YELLOW SMOKE...
- ❖WHITE, COLD SMOKE...
- ❖BLUE FLAMES...
- ❖HOT DOORS AND WINDOWS.

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Continued.............

- AIR WHISTLING - BEING DRAWN INTO THE COMPARTMENT...
- PULSATION OF FIRE GASES...
- SMOKE BLACKENED WINDOWS.

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Air whistles as it is drawn in to compartment as the fire dies down and the pressure drops.

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Windows will be smoke blackened due to the thickness of the smoke which may have a high carbon content.

21

SAFETY...

- THINK / LISTEN / WATCH / FEEL..
- DECISION...
- MOVE...
- KEEP AWAY FROM OPENINGS...
- PASS THROUGH OPENINGS QUICKLY...

READ THE SIGNS!!

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Door openings are very dangerous areas because fire gases mix with air or escape into areas where air is available.

Next Slide - Summary

SUMMARY...

- Water as an extinguishing media...
- Neutral plane
- Branch techniques...
- Attack theory...
- Signs of impending 'Flashover' or 'Backdraught'.

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Next Slide - Remember

23

REMEMBER...

- **THINK...**
- **Use the right branch techniques for the circumstances...**
- **Move when safe...**
- **Maintain conditions to your advantage.**
- **Teamwork**

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In the lecture tomorrow we will cover:

Flashover at incidents which reinforces what we have learned today.

Any Questions?

Finish

24

FIRE BEHAVIOUR TRAINING

Lecture 2

EXTINGUISHING TACTICS

A Training Department Presentation

AIM...

To cover theory on:

- Practical Extinguishing of Fires...
- Controlling Fires in compartments.

OBJECTIVES...

To understand:

- The fire signs.
- Mechanics of extinguishing fires...
- Practical branch techniques...
- How to carry out an attack into a compartment...

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SAFETY...

- THINK / LISTEN / WATCH / FEEL..
- DECISION...
- MOVE...
- KEEP AWAY FROM OPENINGS...
- PASS THROUGH OPENINGS QUICKLY...

READ THE SIGNS!!

MECHANICS of EXTINGUISHING...

- COOLING...
- SMOTHERING...
- STARVATION...

SMOTHERING OR ENCLOSING A FIRE CAN CAUSE

<u>BACKDRAUGHT CONDITIONS !</u>

WATER AS AN EXTINGUISHING MEDIUM...

Latent heat of vaporisation -

This is the most effective way of removing heat from a fire. So the more water that can be turned to steam the more effective it will be.

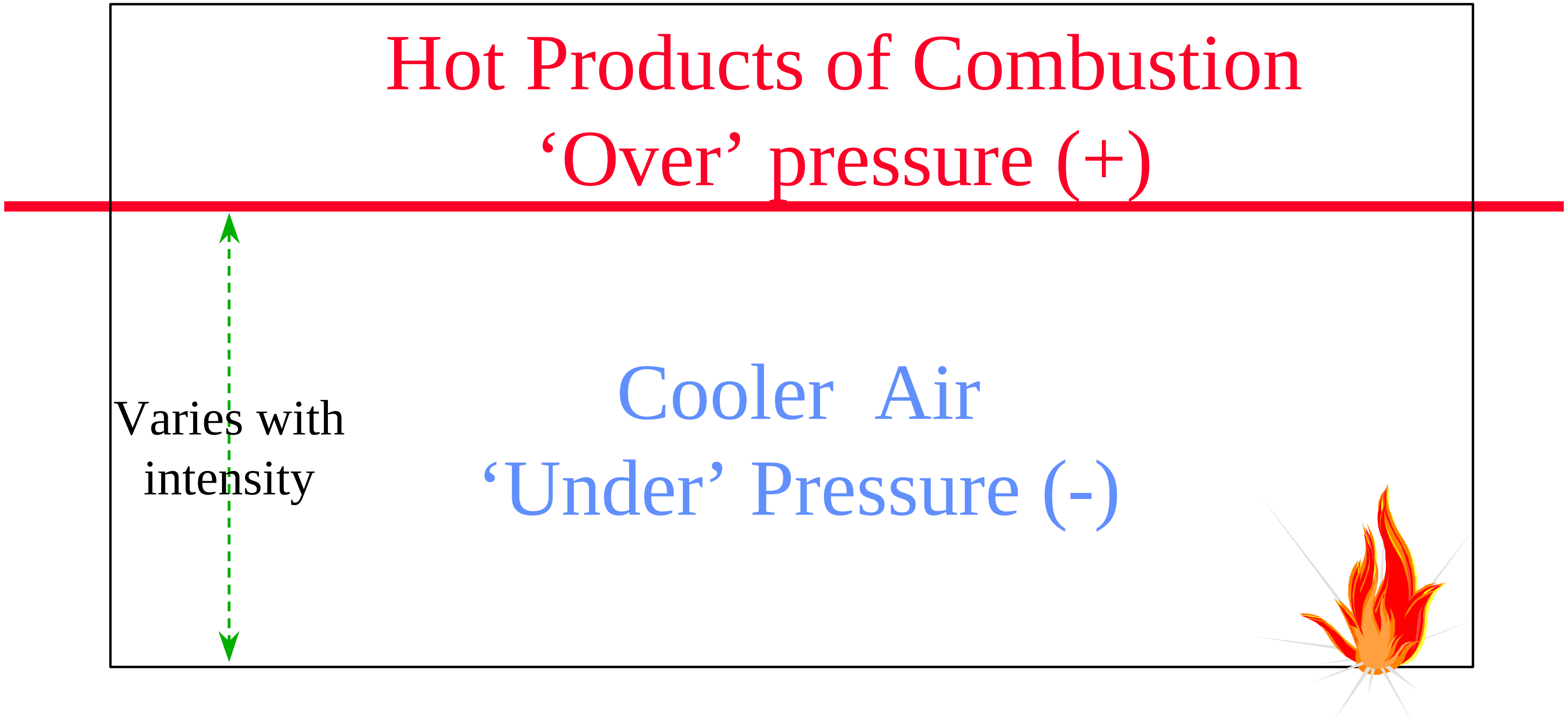
ADVANTAGE

Removes heat energy

DISADVANTAGE

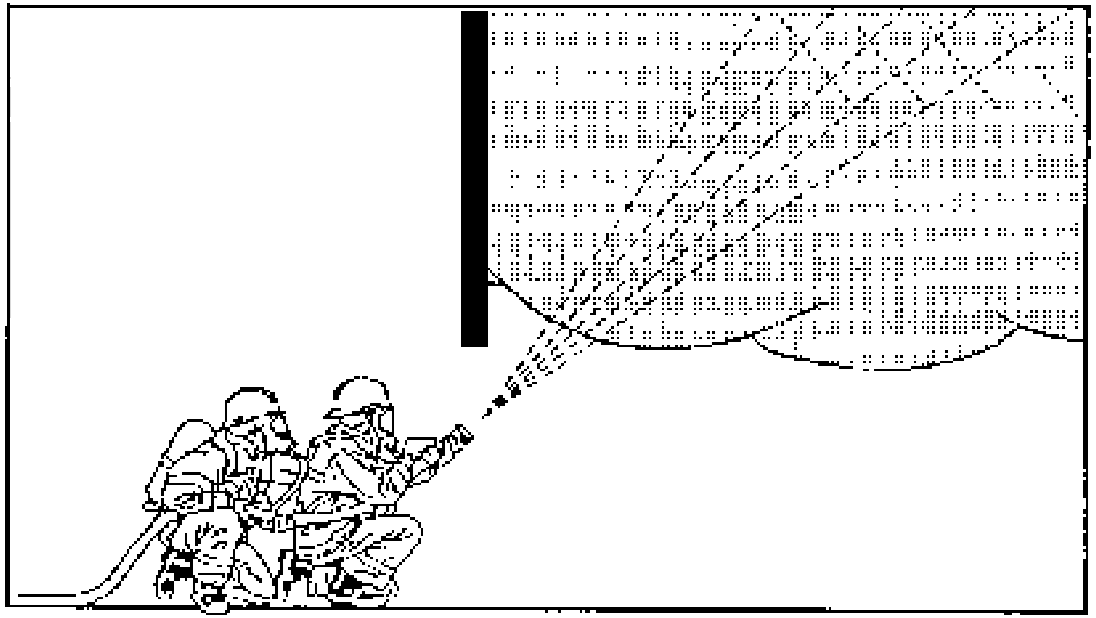
Produces large amounts of steam

Neutral Plane...



INDIRECT TECHNIQUE...

(Defensive)

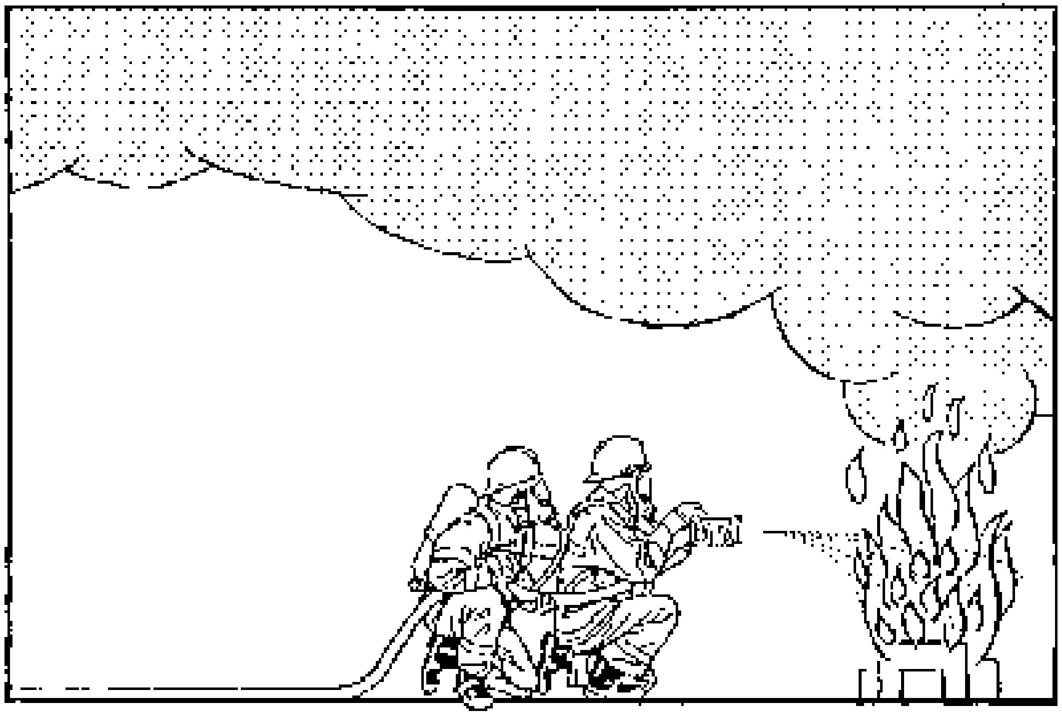


Large quantities of steam produced.

Creates an over pressure.

Lowers neutral plane.

DIRECT TECHNIQUE...

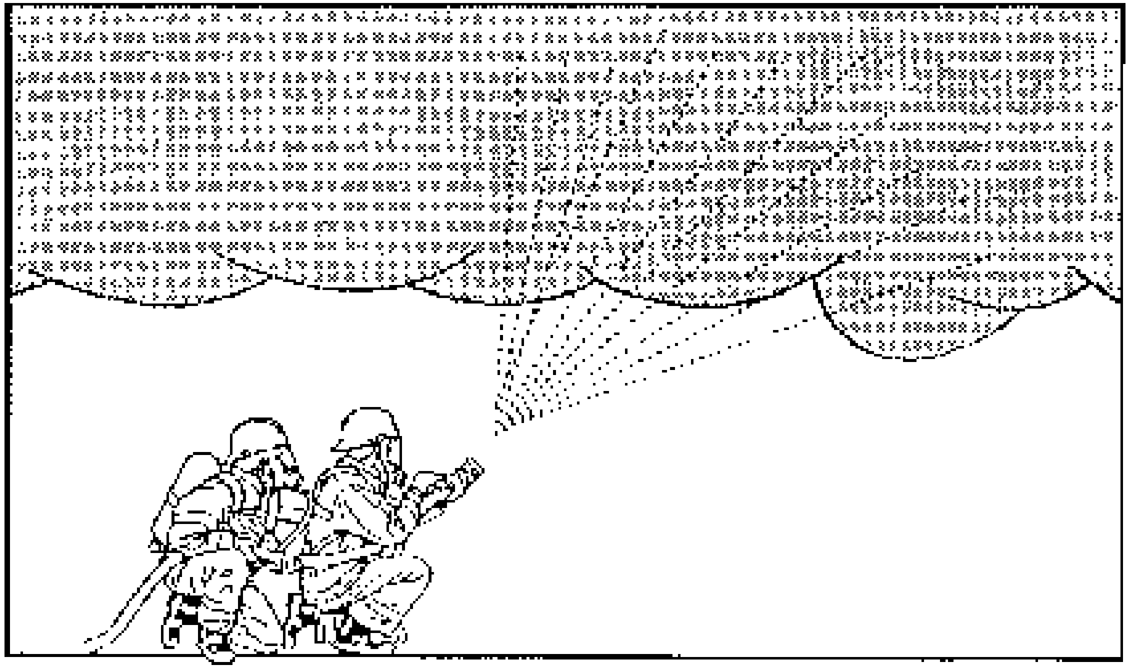


Early attack method to extinguish initial fire.

Danger:-

Beware of combustible gases igniting.

GAS COOLING TECHNIQUE... (Offensive)



Cools fire gases.
Needs fogfighter branch.

Shrinks fire gases.

Neutral plane may remain constant or rise, improving conditions.

USE OF A BRANCH...

- **SHORT PULSATION'S**

  On and off - short distance protection...

- **LONG PULSATION'S**

  3 - 4 seconds to cover a longer distance...

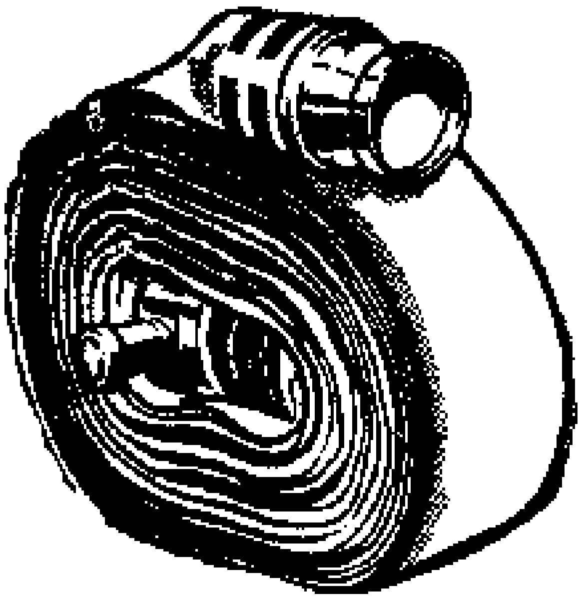
- **SWEEP (Left to right <u>or</u> floor to ceiling)**

  Move across large areas.

ALTER THE ANGLE OF THE BRANCH TO REACH FURTHER INTO THE FIRE.

CONSIDER...

- Never turn your back on the fire...
- Produce just enough steam to be effective without altering conditions to your disadvantage...
- Use water effectively...
- THINK!
- Protect EXIT.



ON ARRIVAL - DOOR CLOSED...

- CHECK TEMPERATURE OF THE DOOR...
- KEEP LOW...
- IF HOT - Pulse spray above the door ,open the door slightly...

  - If flames come out above the door the water will cool the gases.

HOLD THE DOOR SECURELY!

DOOR OPENED...

If it is too hot to proceed:

- Spray pulses into the room...
- Close the door...
- Repeat if necessary - let the steam do the work...
- **ADVANCE IF POSSIBLE.**

ON ARRIVAL - WINDOW ALREADY OPEN...

- **FLAMING APERTURE...**
- **SPRAY INTO THE BOTTOM, BELOW THE NEUTRAL PLANE...**

  - So that water is drawn into the fire.

DANGER!!

Beware of driving out the products of combustion.

THE ATTACK...

- Make the entrance safe...
- Temperature check / Communicate...
- Secure your position and advance when safe...
- EXTINGUISHING - Direct / Indirect...
  - Gas cooling...
- PAINT - Ceiling / Walls...
- VENTILATION / REMOVAL.

MOVING BETWEEN COMPARTMENTS...

When firefighters enter a compartment they must ensure that the fire gases do not leak into the room they are in or their escape route.

- **COOL THE GASES...**
- **VENTILATION TO OUTSIDE...**

CAUTION NEEDED !!!

Signs and Symptoms of 'Flashover'...

- PAINFUL RADIANT HEAT...
- CREWS FORCED LOW BY HIGH TEMPERATURES...
- HOT SURFACES...
- FLAMES AT CEILING LEVEL...
- LOWERING OF NEUTRAL PLANE...
- INCREASED RATE OF PYROLYSATION.

Signs of impending 'Backdraught'

- FIRE WITH LIMITED VENTILATION...
- THICK, BLACK SMOKE...
- THICK YELLOW SMOKE...
- WHITE, COLD SMOKE...
- BLUE FLAMES...
- HOT DOORS AND WINDOWS.

Continued..............

- AIR WHISTLING - BEING DRAWN INTO THE COMPARTMENT...
- PULSATION OF FIRE GASES...
- SMOKE BLACKENED WINDOWS.

SAFETY...

- THINK / LISTEN / WATCH / FEEL..
- DECISION...
- MOVE...
- KEEP AWAY FROM OPENINGS...
- PASS THROUGH OPENINGS QUICKLY...

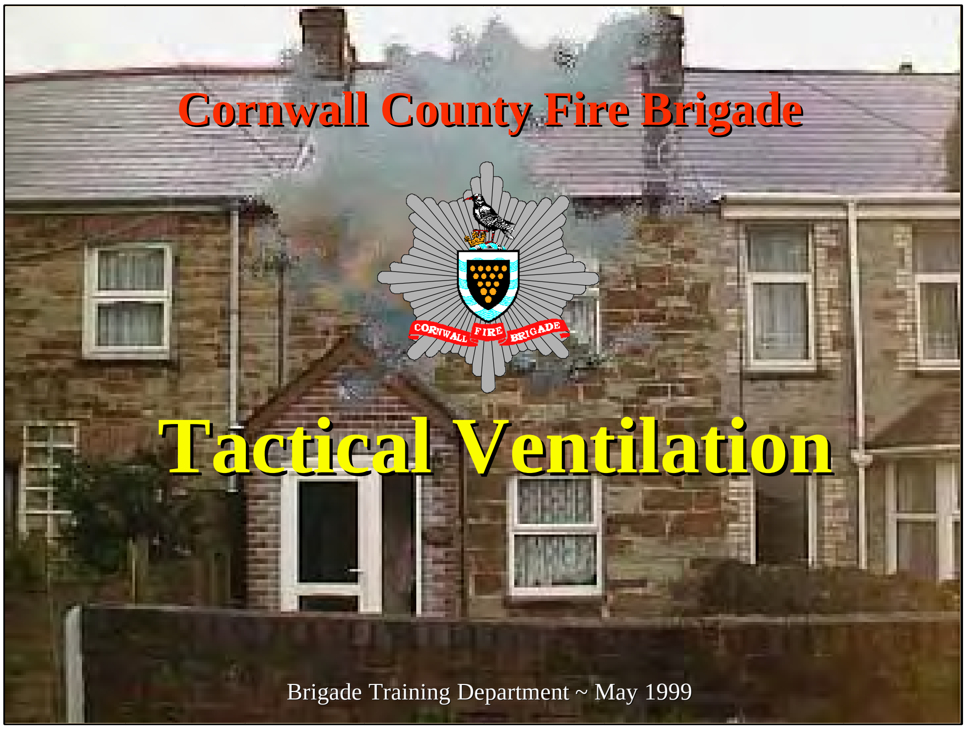
READ THE SIGNS!!

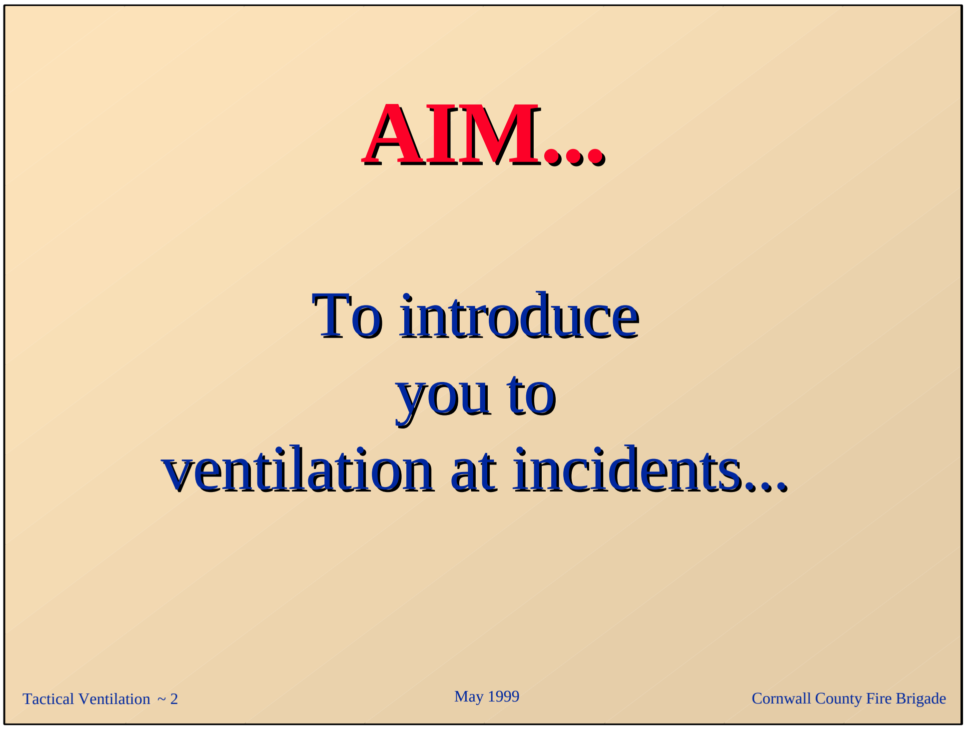
SUMMARY...

- Water as an extinguishing media...
- Neutral plane
- Branch techniques...
- Attack theory...
- Signs of impending ‘Flashover’ or ‘Backdraught’.

REMEMBER...

- THINK...
- Use the right branch techniques for the circumstances...
- Move when safe...
- Maintain conditions to your advantage.
- Teamwork


Cornwall County Fire Brigade
CORNWALL FIRE BRIGADE
Tactical Ventilation
Brigade Training Department ~ May 1999



Next Slide: Objective

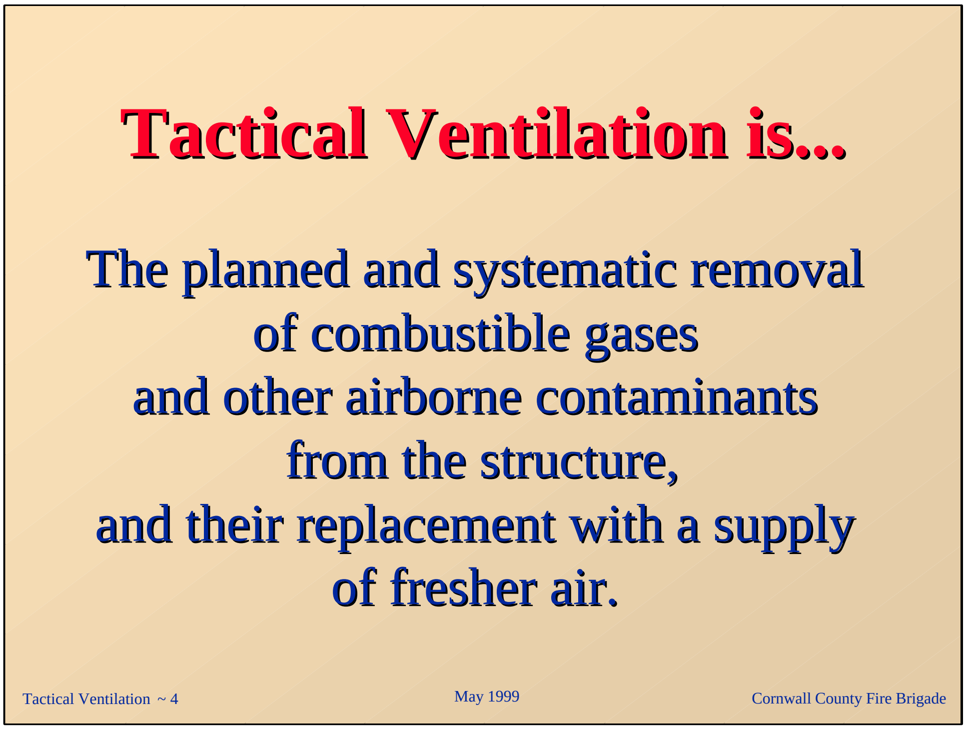
OBJECTIVES...

During this lecture we will cover:~

- Command and Safety!
- Types of Ventilation...
- Smoke Travel...
- When to use Ventilation...
- Methods of Achieving Ventilation...

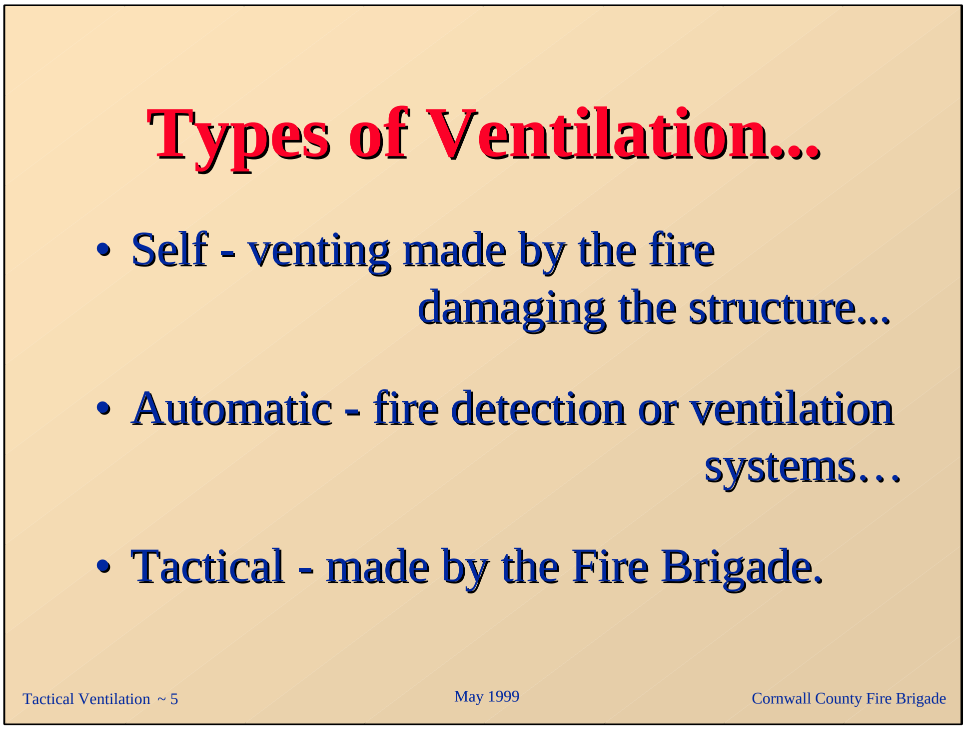
Tactical Ventilation ~ 3 May 1999 Cornwall County Fire Brigade

Next Slide:Tactical Ventilation



Tactical ventilation should form part of the Incident Commander’s dynamic risk assessment and if used skilfully and correctly, give significant benefits.

Next Slide - Types of Ventilation



OPTIONS

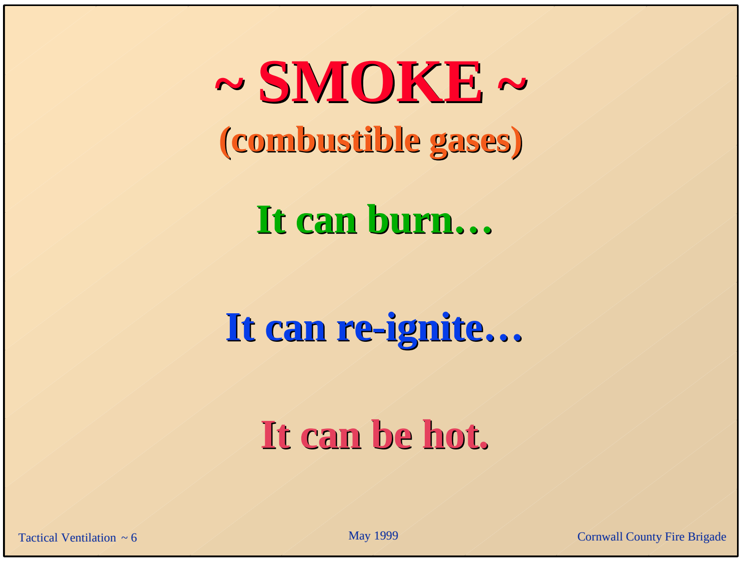
•Before control is achieved.

•After control but before the fire is out.

•After the fire is out.

Self venting by the fire after arrival of the Fire Brigade has to be closely monitored if BA Teams are commmitted.

Next Slide: Smoke



1. Products of combustion may not be fully burnt because of a shortage of air.

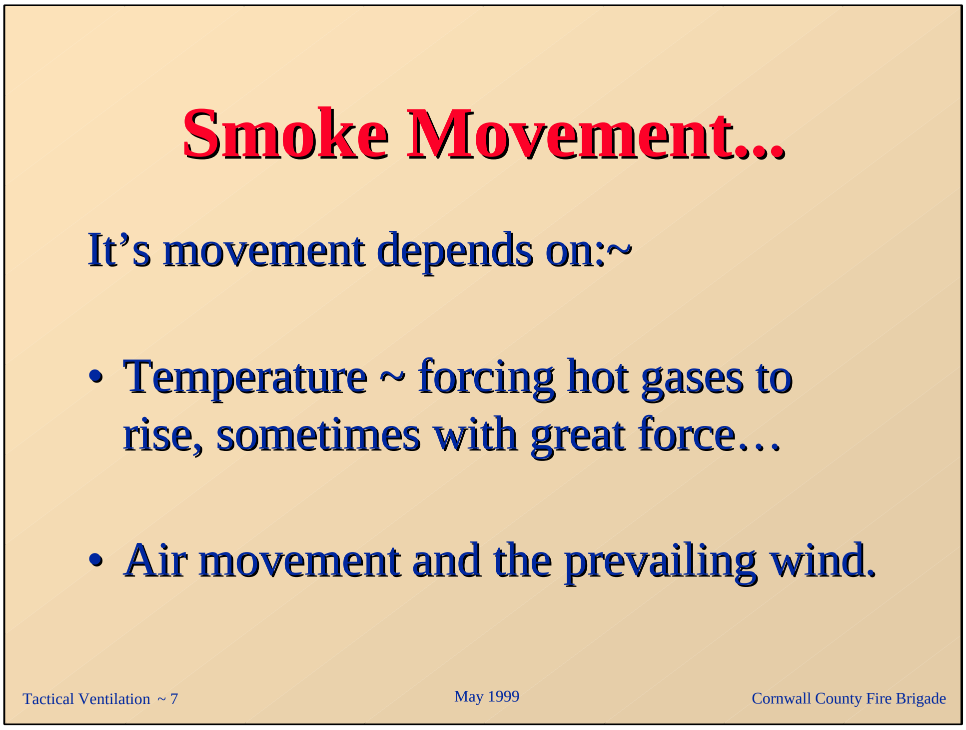
2. Given a source of ignition and an air supply - it can re-ignite.

3. If it is hot enough it may ignite without a source of ignition and also can ignite materials it comes into contact with by travelling through the building.

The dangers of smoke ignition forms the 2 phenomena known as backdraught and flashover.

It has to be carefully considered by the Incident Commander when ventilating compartment fires as the possibility of triggering a backdraught or flashover by poor ventilation techniques.

Next Slide: Smoke movement

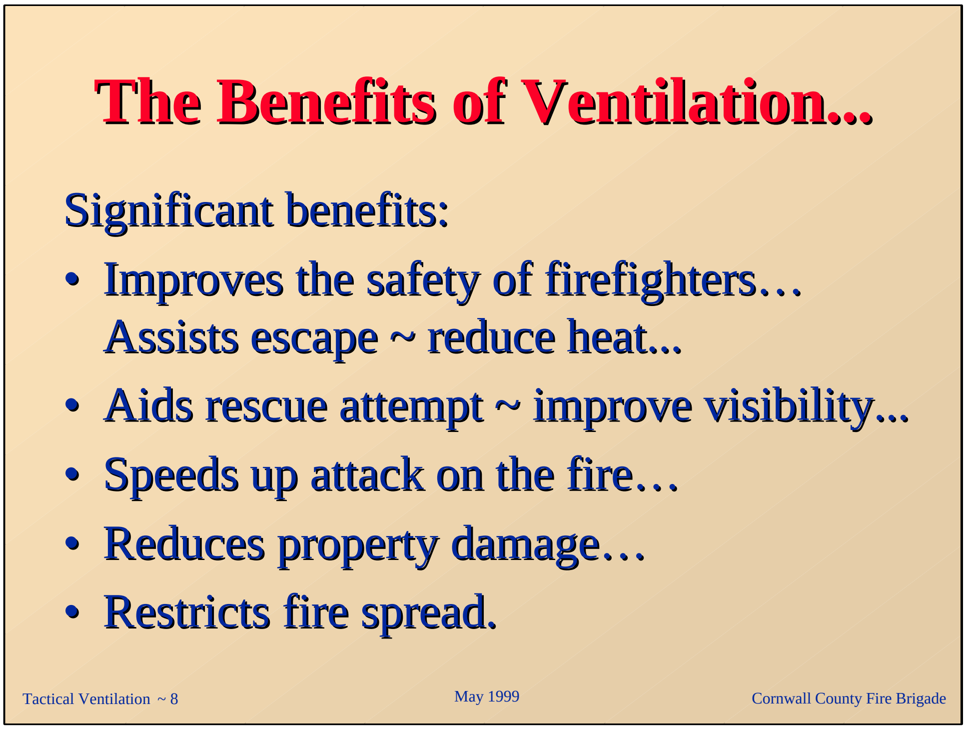


The amount of smoke depends on the size of the fire and what is burning.

By making openings and causing turbulence in the building and using the prevailing wind will cause air movement in the building.

These two natural air movements have to be used to assist ventilation.

Next Slide: The value of ventilation



Like any tactical option, ventilation can make things worse if applied incorrectly.

Assist escape by stopping the spead of smoke.

It can reduce the effect of backdraught or flashover making it safer for firefighters.

Next Slide: When to Ventilate

Before Ventilation.

Try to determine the fires location and consider the likely effects of:~

- Air being drawn into the fire…
- The movement of hot gases inside the building.

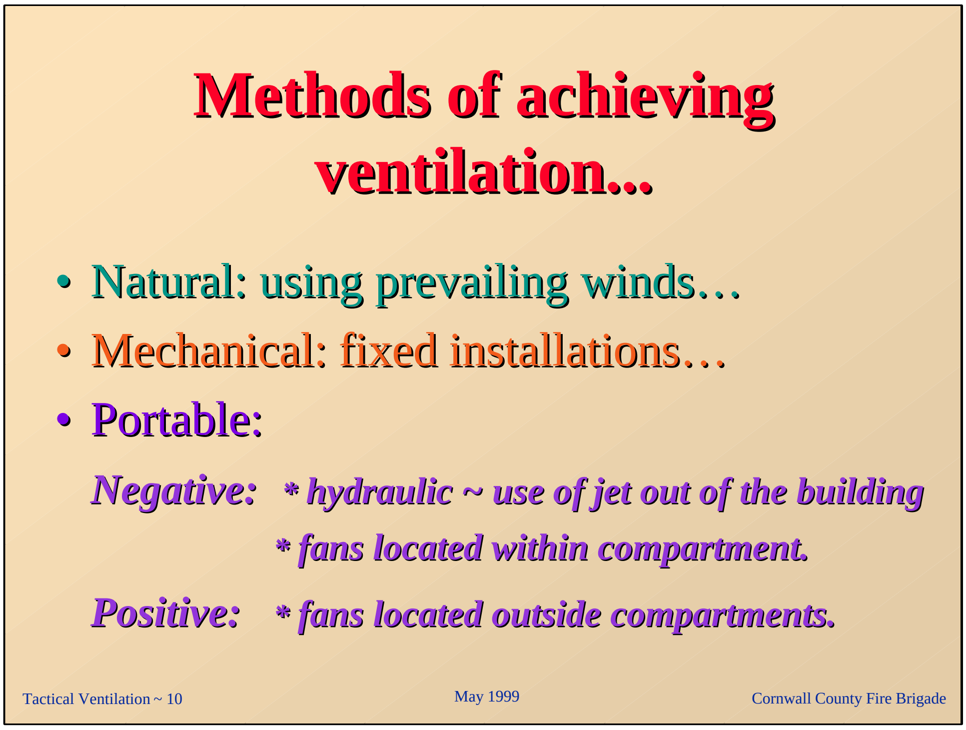
Tactical Ventilation ~ 9 May 1999 Cornwall County Fire Brigade

When assessing how to tackle a fire the use of tactical ventilation and it’s likely effects have to be carefully considered.

The movement of air may trigger a flashover or backdraught.

Hot gases moving in the building can be the main cause of fire spread.

Next Slide: Methods of achieving ventilation

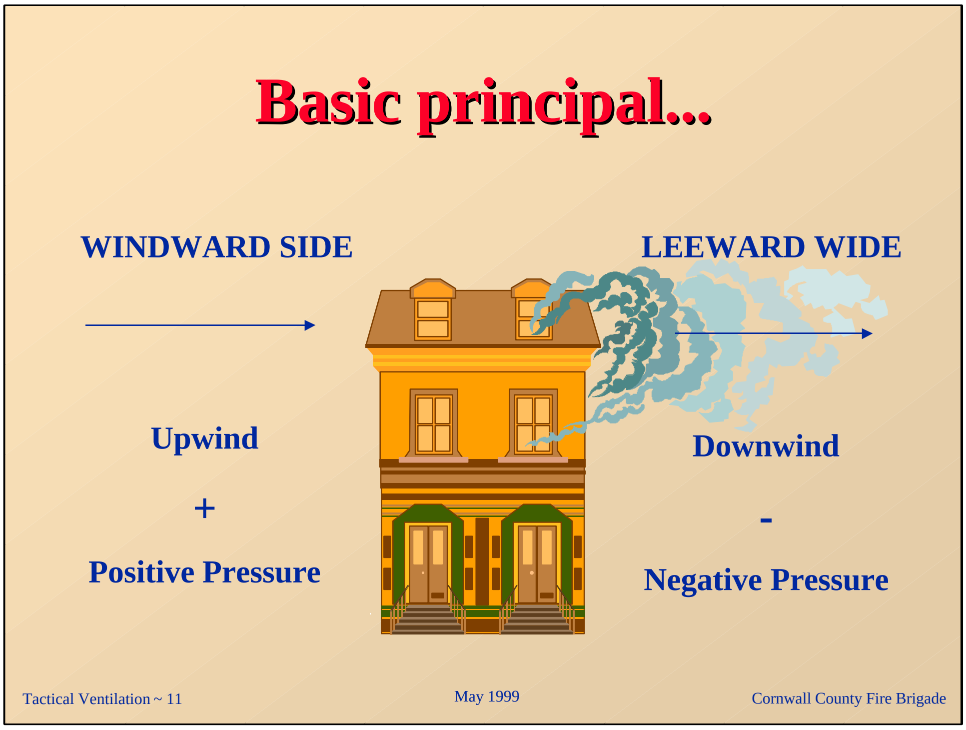


Natural..self explanatory

Mechanical…building systems, i.e., plenum ,balance, exhaust.

Disadvantages are it needs local assistance and knowledge of the systems.

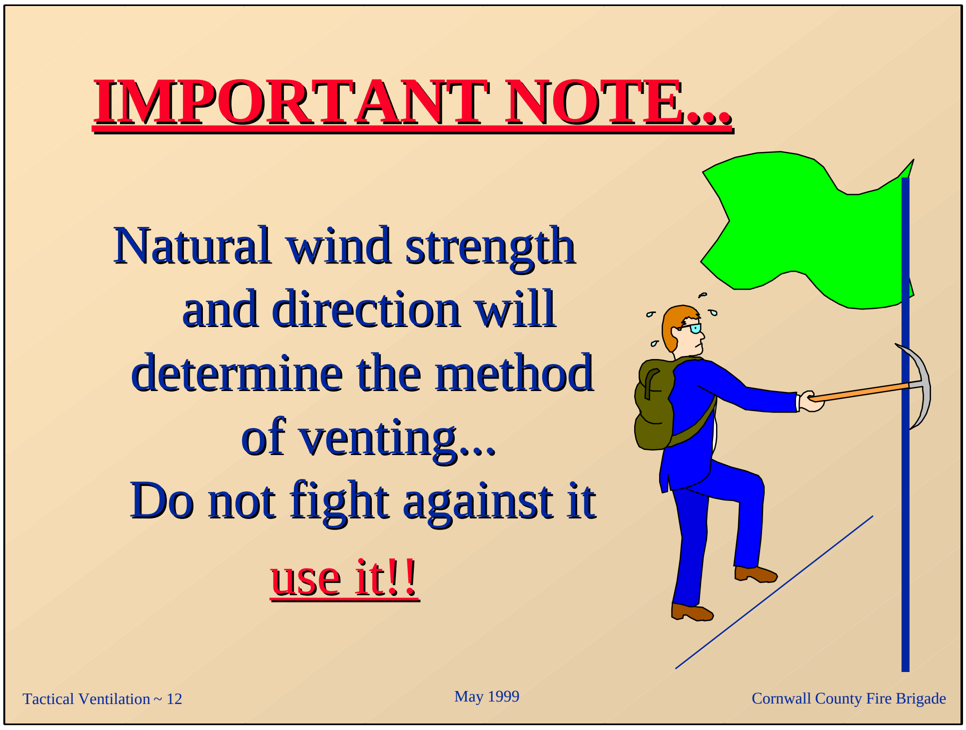
Next slide…Basic Principal



The first priority of the Incident Commander in relation to ventilation is to identify the prevailing wind direction and use the positive pressure created by the wind to force fresh air into the structure.

This must always be controlled and synchronized by the Incident Commander. Communication and timing is vital, if mistimed or uncontrolled the consequences could be hazardous.

Next Slide - Important Note



SELF EXPLANATORY

See next slide

Next slide: Ventilation Techniques

Ventilation Techniques...

There are two basic options:~

Option One:~

Vertical or Top Venting…

Option Two:~

Horizontal or Cross Venting.

Tactical Ventilation ~ 13 May 1999 Cornwall County Fire Brigade

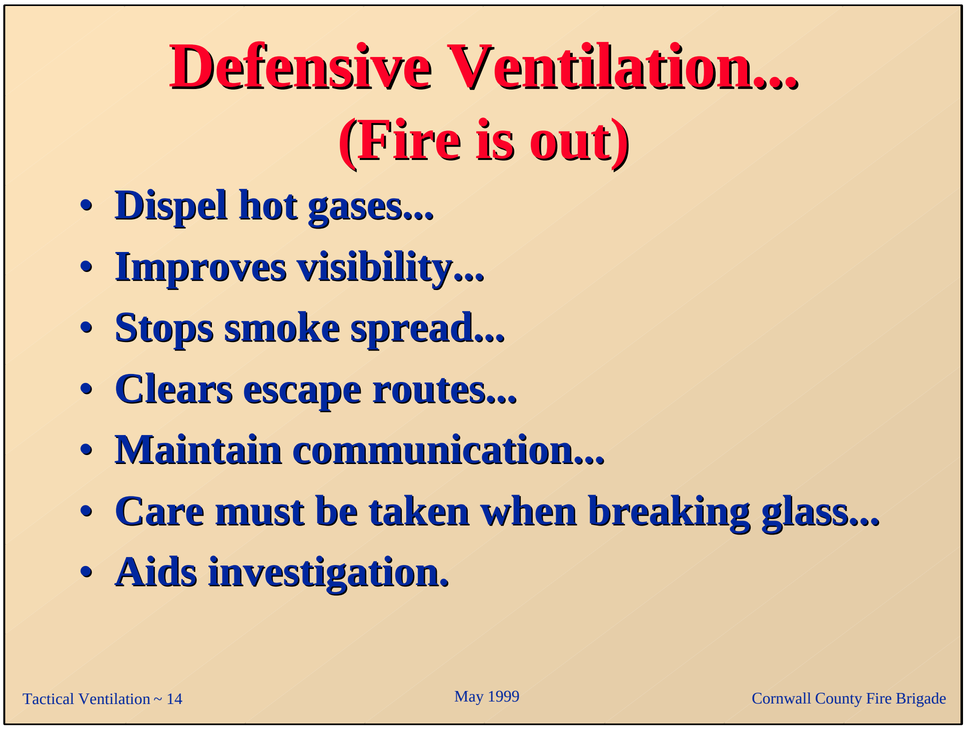
1. Making an opening at high level usually the roof so that the buoyancy of the hot gases enables them to escape.

2. Making an opening, eg., door and windows so that the wind assists the removal of the hot gases.

When using hoizontal venting it is better to have the inlet as low as possible and outlet as high as possible.

In both cases it is possible to accelerate the effects with the use of fans.

Next Slide: Defensive Ventilation (Post/Fire/Overhaul)



Generally, defensive ventilation is utilised when the fire is out to dispel hot fire gases and smoke which have spread from the fire.

If used correctly the benefits are:

a) visibility is improved.

b) making access easier for locating casualties and firefighting.

c) smoke spread restricted to any further compartments.

d) Escape routes cleared and conditions improved for building occupants.

e) Will help with early access for investigation.

Care must be taken when breaking windows and BA should be worn.

Next Slide - Offensive Ventilation

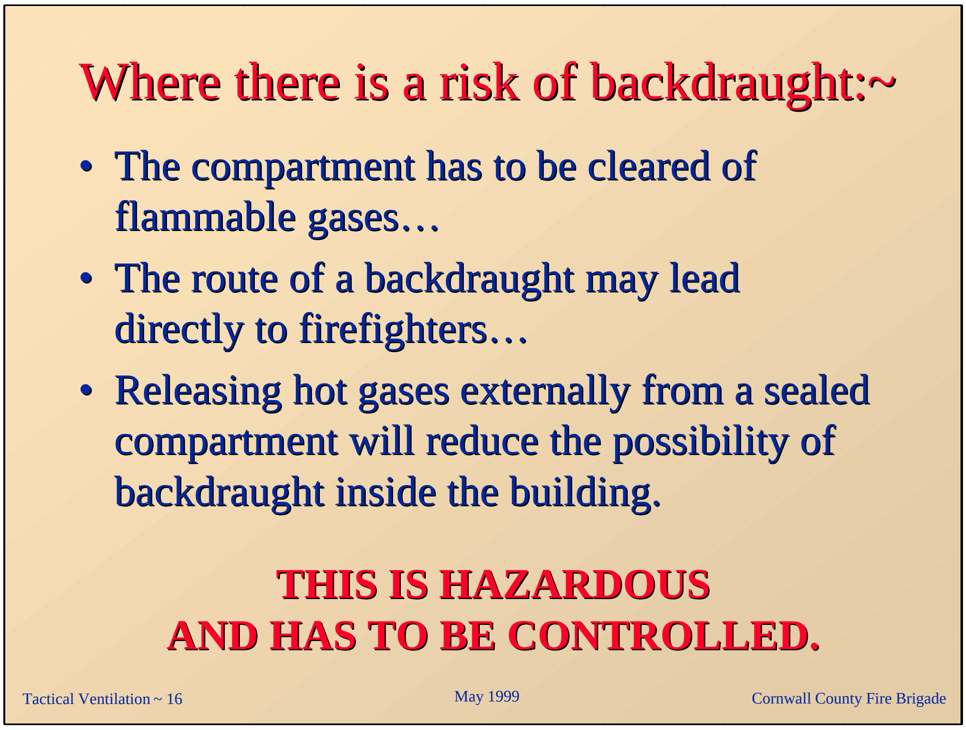
Offensive ventilation is carried out in or near the fire compartment and will have a direct effect on the fire itself.

If performed before the fire is extinguished, firefighters must remember that it could have a dangerous effect on the fire due to the increased oxygen supply.

Offensive ventilation limits fire spread to other parts of the structure and allows products of combustion to escape from the compartment which makes conditions more tenable for firefighters and close quarter firefighting.

Relies on good communication and control.

Next Slide -Benefits of Offensive Ventilation



If there is a lot of hot gases there will be a significant increase in the fire when they are released.

If they have a long way to travel this could spread the fire this may not help casualties or firefighters in the building.

Ventilation should take place as close to the fire as safe to do so.

The pros and cons will have to be decided by the Incident Commander with dynamic risk assessment.

Next Slide: Operational Command

Next Slide: Initiation of Ventilation

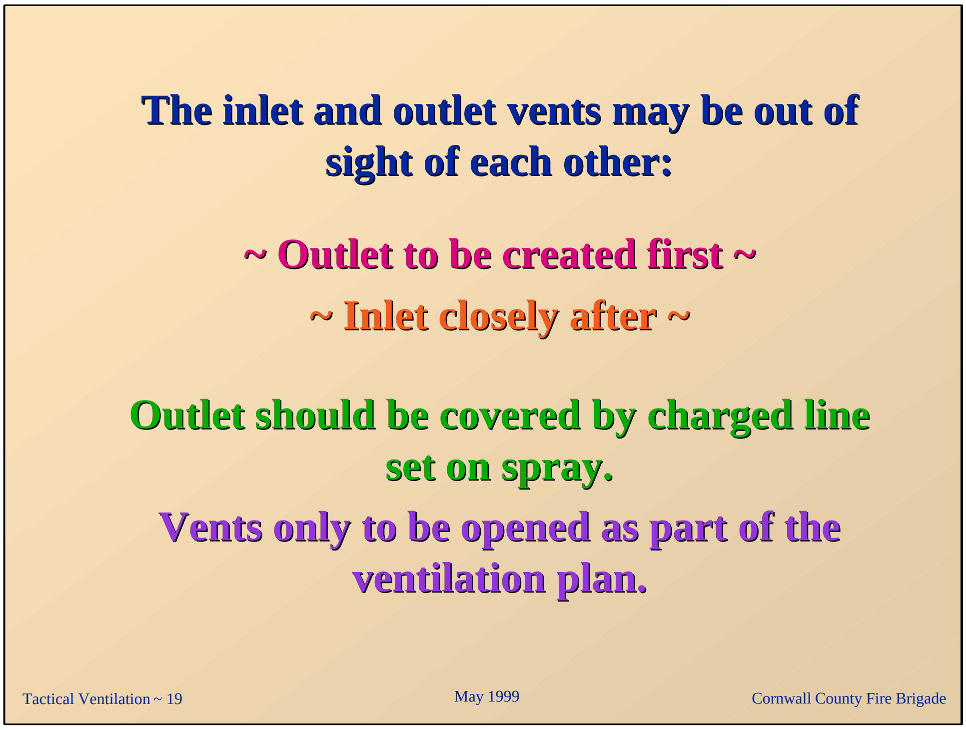
Initiation of Ventilation...

The Incident Commander must consider prior to ventilation:~

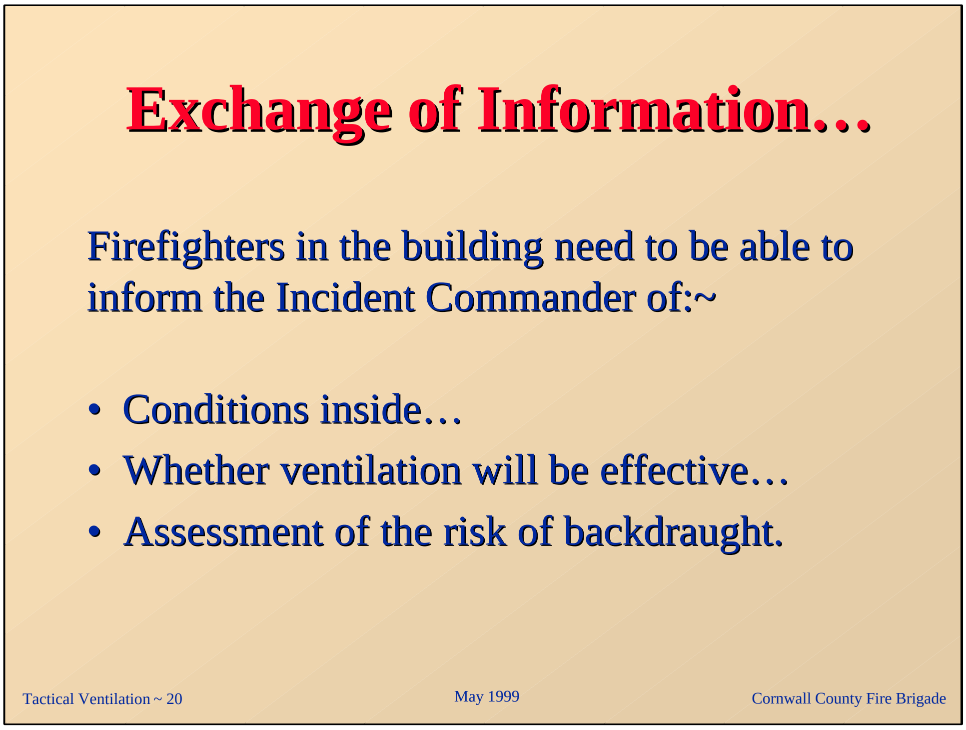
- Evacuation of firefighters until conditions stabilise…
- If staying, firefighters need to protect themselves with hoseline…
- Firefighters outside need to co-ordinate activities ensuring correct sequence is followed.

Tactical Ventilation ~ 18 May 1999 Cornwall County Fire Brigade

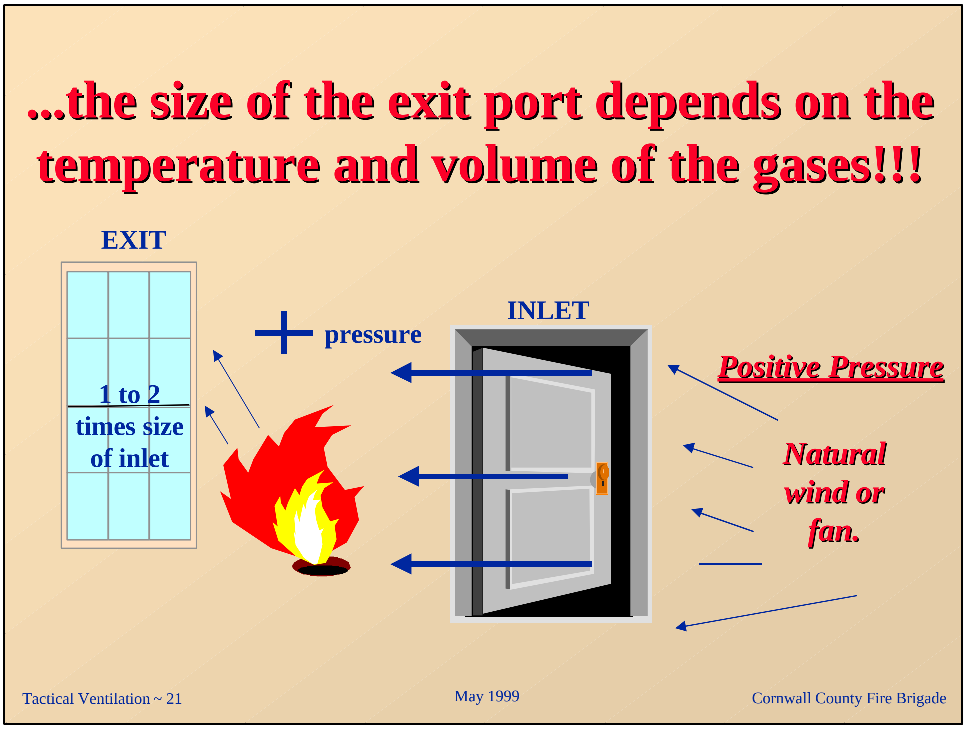
Next Slide: Continuation……...



Next Slide: Information passed to Incident Commander by the BA Teams



Next Slide: Creating an entry and exit port.



If high temperatures are achieved, larger volumes of hot gases may need to be dispelled.

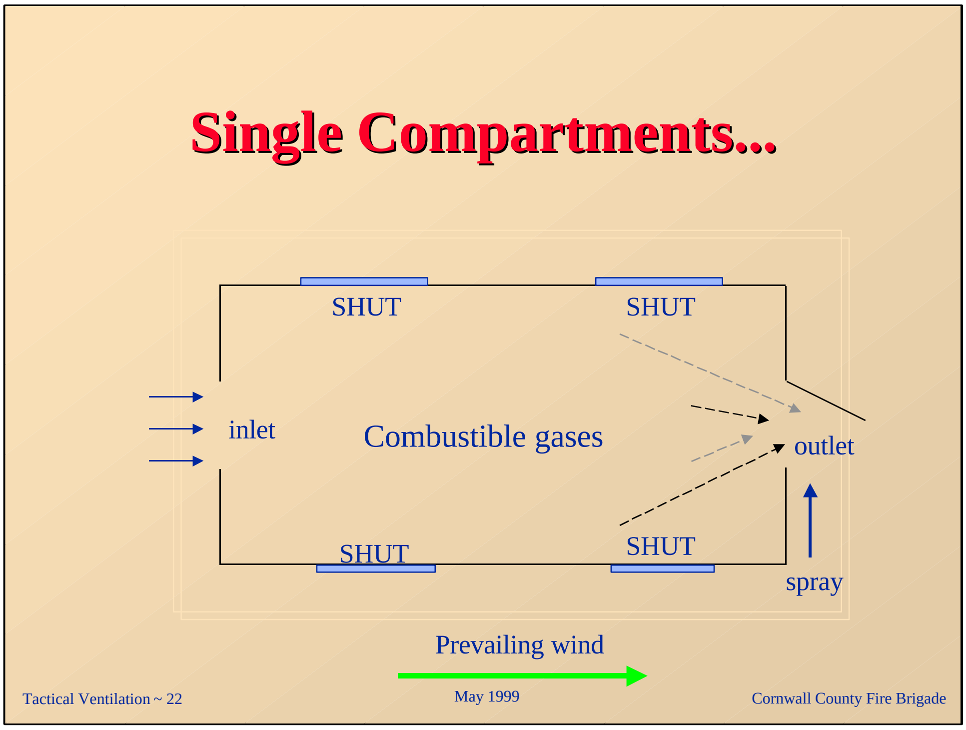
If the outlet/exit is smaller than the inlet, a back pressure may be introduced, therefore worsening the conditions,

The exit port should therefore normally be larger than the inlet port..but must be controlled.

Good communications are of paramount importance.

Do not revert to opening all 'exit ports' at the same time.

Next slide: PPV

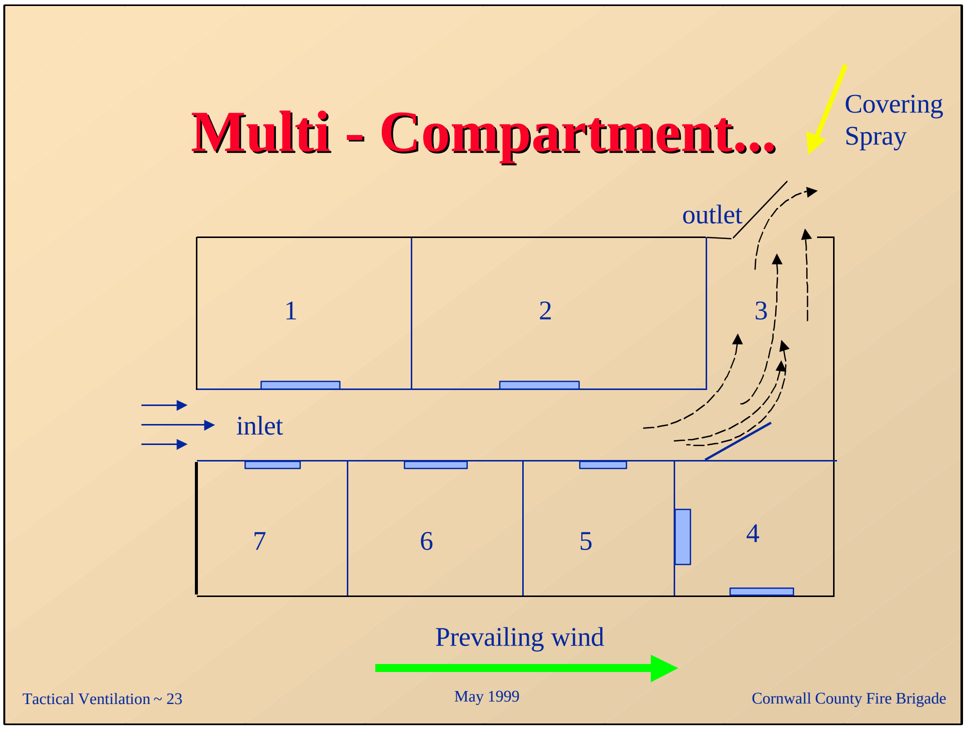


Using the prevailing wind, protect the exit port with a spray, but allow gases to exit - do not direct jets/sprays into exit ports when ventilating. This forces air back in and does not allow gases out.

NOTE

Spray cone can be directed <u>out</u> of compartment, achieving venturi effect to extract gases.

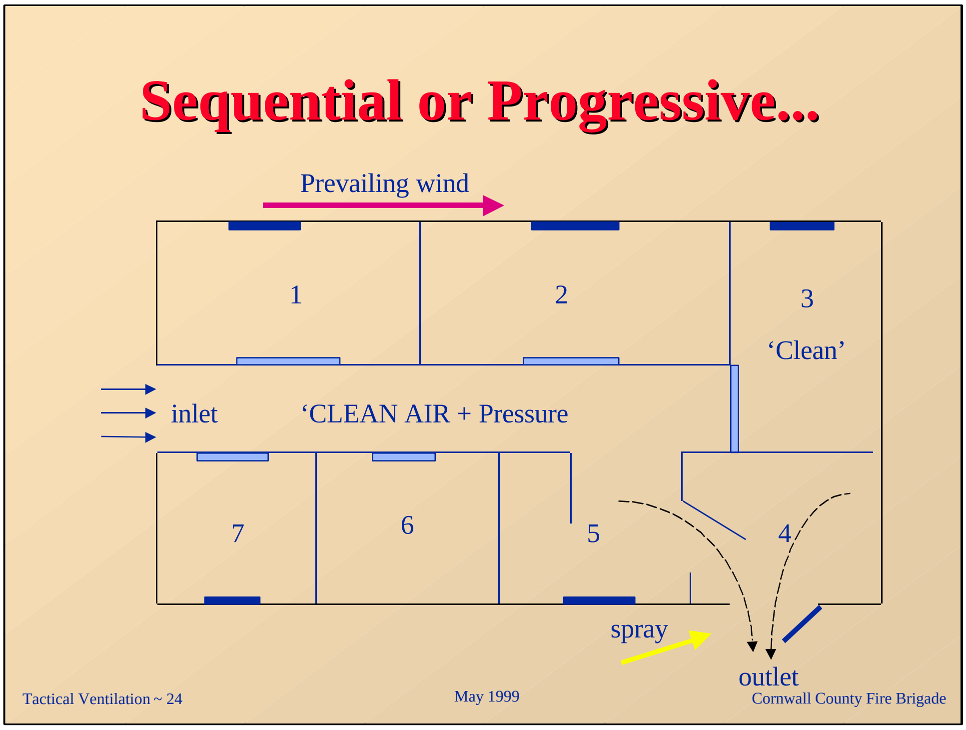
Next Slide: Multi compartment



Using prevailing wind (or with the aid of a fan), clear the access route by shutting all doors and opening an exit port at furthest point.

This then can be extended..

Next Slide: Sequential or Progressive



Once the exit route is clear, then progressively shut rooms and exit ports and move to each room carrying out similar process.

BA must be worn at all times.

Communications should be maintained and firefighting media must be available.

Next Slide: No Exit Port........

Positive Pressure Ventilation
~ PPV ~

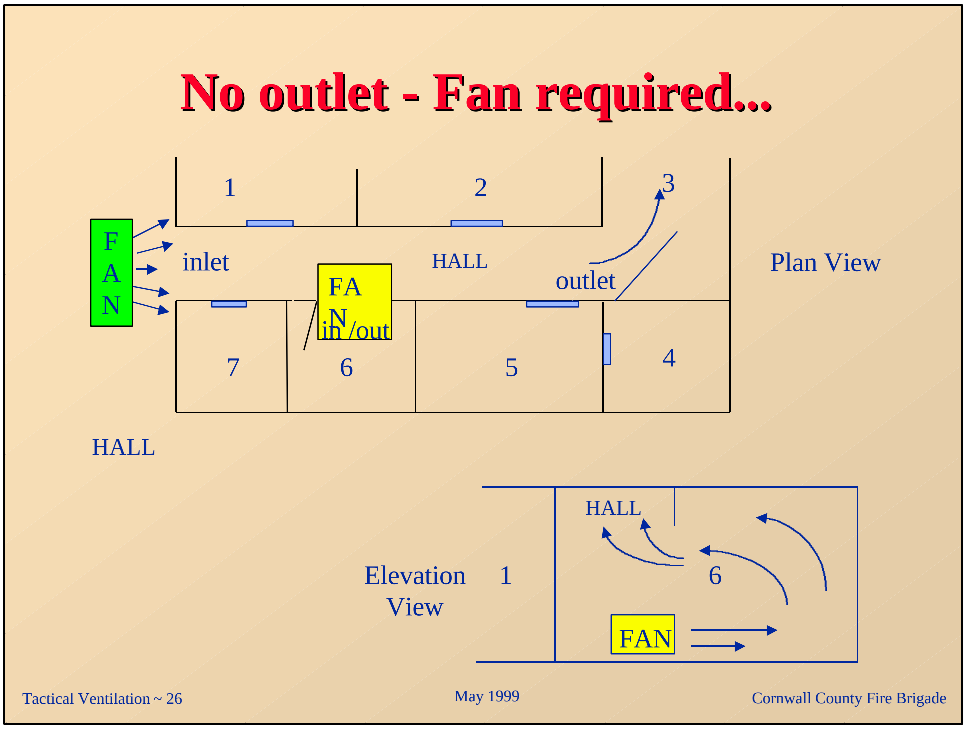
Positive Pressure Ventilation
is the term
used when the pressure
inside a building is
increased by mechanical means.

Tactical Ventilation ~ 25   May 1999   Cornwall County Fire Brigade

Positive pressure ventilation should be used on the .windward side and positioned low on the inlet route.

If the prevailing wind cannot be used, PPV can be of great assistance - but is a subject in it's own right that will be addressed locally..

Next Slide - Single Compartments



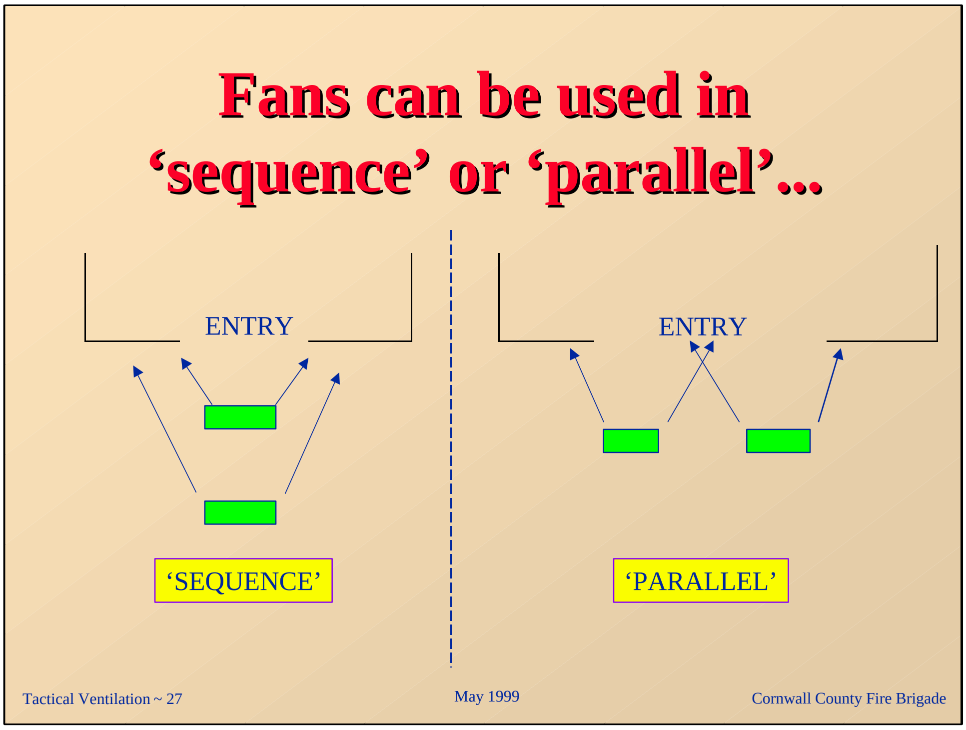
Here a fan would be a distinct advantage - two fans ideal.

First clear all rooms as previously, leaving room closed.

Place fan(s) as shown - start external fan ensuring exit port is open.

Start fan at entrance to Room 6. Products of combustion will then be 'diverted' to exit port.

Next Slide: More Fans!!!

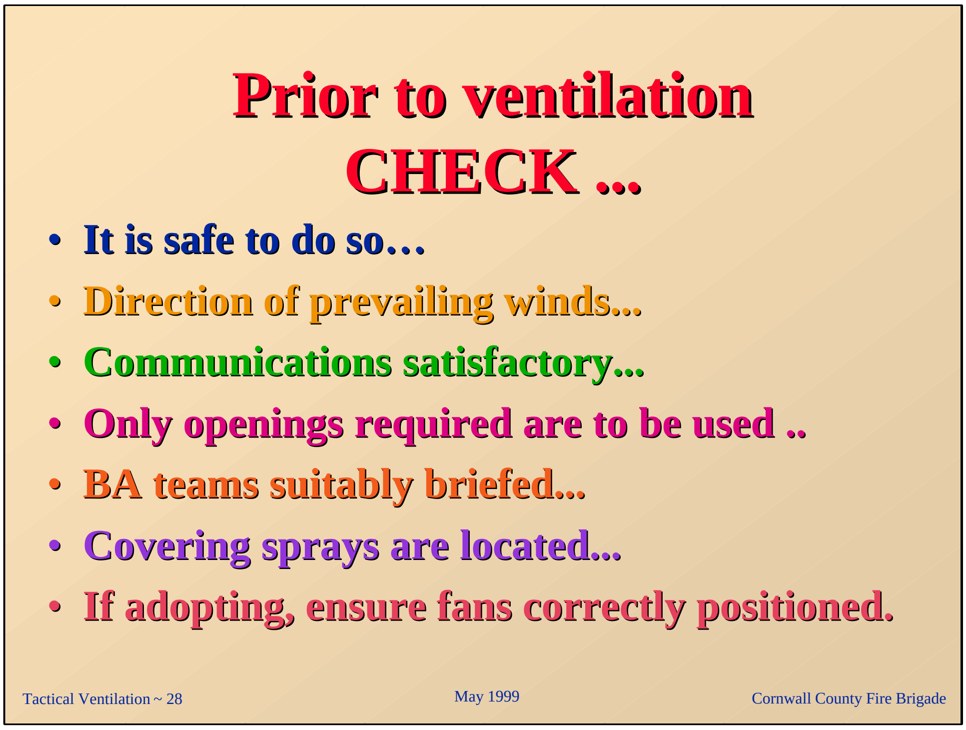


For Large compartments this practice can be adopted.

1. In large compartments, fans can be inaffective.

2. Better to cover the door with the case produces better movement of air in the building.

Next Slide Prior to carrying out ventilation..........



If the risk of increasing fire spread exists - do not vent.

Rest self explanatory.

Next Slide: Summary

Self explanatory

The tactics of dealing with fire previously explained can only work hand in hand with good ventilation controls - communication is essential.

Command and Control is critical.

Next Slide: NOTE

~ SUMMARY of VENTILATION ~

Safety

Types

Smoke and smoke travel

Benefits

Basic principals

Techniques

Defensive and Offensive

Initiation

PPV

Tactical Ventilation ~ 30 | May 1999 | Cornwall County Fire Brigade


Cornwall County Fire Brigade
CORNWALL FIRE BRIGADE
Tactical Ventilation
Brigade Training Department ~ May 1999

AIM...

To introduce
you to
ventilation at incidents...

OBJECTIVES...

During this lecture we will cover:~

- Command and Safety!
- Types of Ventilation...
- Smoke Travel...
- When to use Ventilation...
- Methods of Achieving Ventilation...

Tactical Ventilation is...

The planned and systematic removal
of combustible gases
and other airborne contaminants
from the structure,
and their replacement with a supply
of fresher air.

Types of Ventilation...

- Self - venting made by the fire damaging the structure...
- Automatic - fire detection or ventilation systems…
- Tactical - made by the Fire Brigade.

~ SMOKE ~

(combustible gases)

It can burn…

It can re-ignite…

It can be hot.

Smoke Movement...

It's movement depends on:~

- Temperature ~ forcing hot gases to rise, sometimes with great force…

- Air movement and the prevailing wind.

The Benefits of Ventilation...

Significant benefits:

- Improves the safety of firefighters…
  Assists escape ~ reduce heat...
- Aids rescue attempt ~ improve visibility...
- Speeds up attack on the fire…
- Reduces property damage…
- Restricts fire spread.

Before Ventilation.

Try to determine the fires location and consider the likely effects of:~

- Air being drawn into the fire…
- The movement of hot gases inside the building.

Methods of achieving ventilation...

- Natural: using prevailing winds…
- Mechanical: fixed installations…
- Portable:

Negative: **** hydraulic ~ use of jet out of the building***

**** fans located within compartment.***

Positive: **** fans located outside compartments.***

Basic principal...

WINDWARD SIDE

LEEWARD WIDE

Upwind

+

Positive Pressure

Downwind

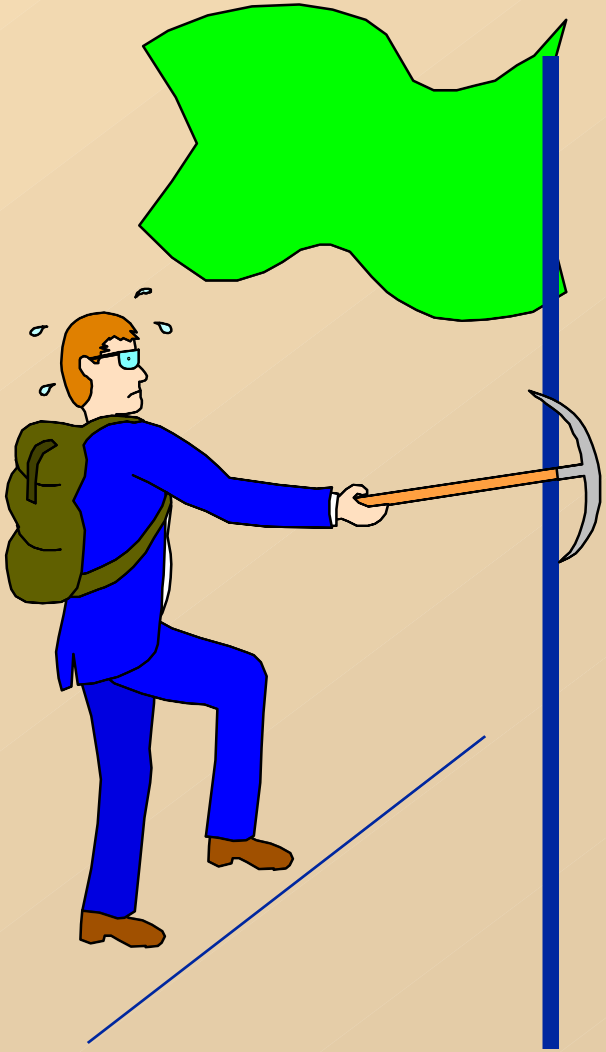
-

Negative Pressure

IMPORTANT NOTE...

Natural wind strength
and direction will
determine the method
of venting...
Do not fight against it

use it!!



Ventilation Techniques...

There are two basic options:~

Option One:~

Vertical or Top Venting…

Option Two:~

Horizontal or Cross Venting.

Defensive Ventilation...
(Fire is out)

- **Dispel hot gases...**
- **Improves visibility...**
- **Stops smoke spread...**
- **Clears escape routes...**
- **Maintain communication...**
- **Care must be taken when breaking glass...**
- **Aids investigation.**

Offensive Ventilation...

- Close to the fire…
- Relies on good communications...
- Will have a direct effect on the fire...
- Limits fire spread...
- Can accelerate fire conditions...
- Makes conditions more tenable.

Where there is a risk of backdraught:~

- The compartment has to be cleared of flammable gases…
- The route of a backdraught may lead directly to firefighters…
- Releasing hot gases externally from a sealed compartment will reduce the possibility of backdraught inside the building.

THIS IS HAZARDOUS
AND HAS TO BE CONTROLLED.

Incident Command...

Sound, tactical decisions
taken by Incident Commanders
managing the incident
and
EFFECTIVE FIREGROUND
COMMUNICATIONS
are essential for the safe use of
ventilation.

Initiation of Ventilation...

The Incident Commander must consider prior to ventilation:~

- Evacuation of firefighters until conditions stabilise…
- If staying, firefighters need to protect themselves with hoseline…
- Firefighters outside need to co-ordinate activities ensuring correct sequence is followed.

The inlet and outlet vents may be out of sight of each other:

~ Outlet to be created first ~

~ Inlet closely after ~

Outlet should be covered by charged line set on spray.

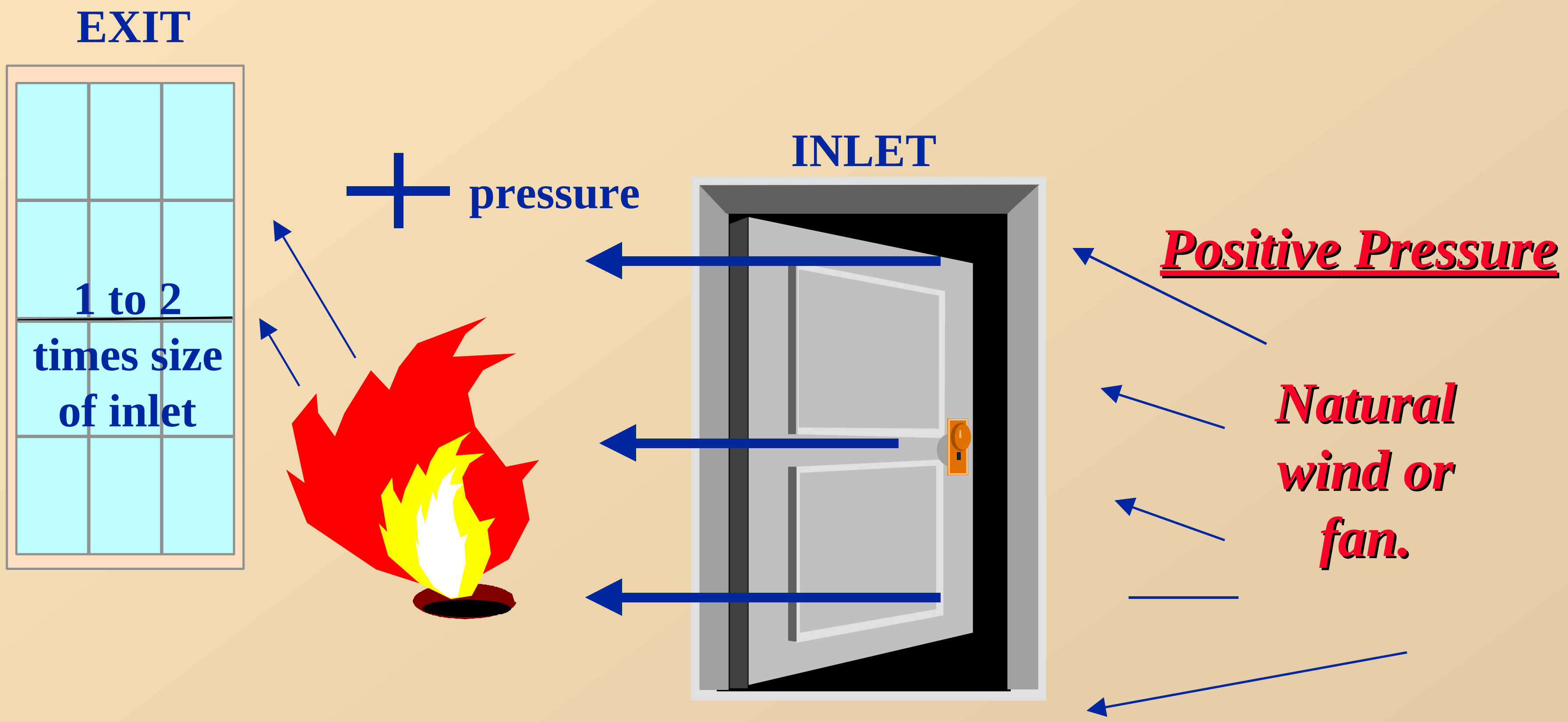
Vents only to be opened as part of the ventilation plan.

Exchange of Information…

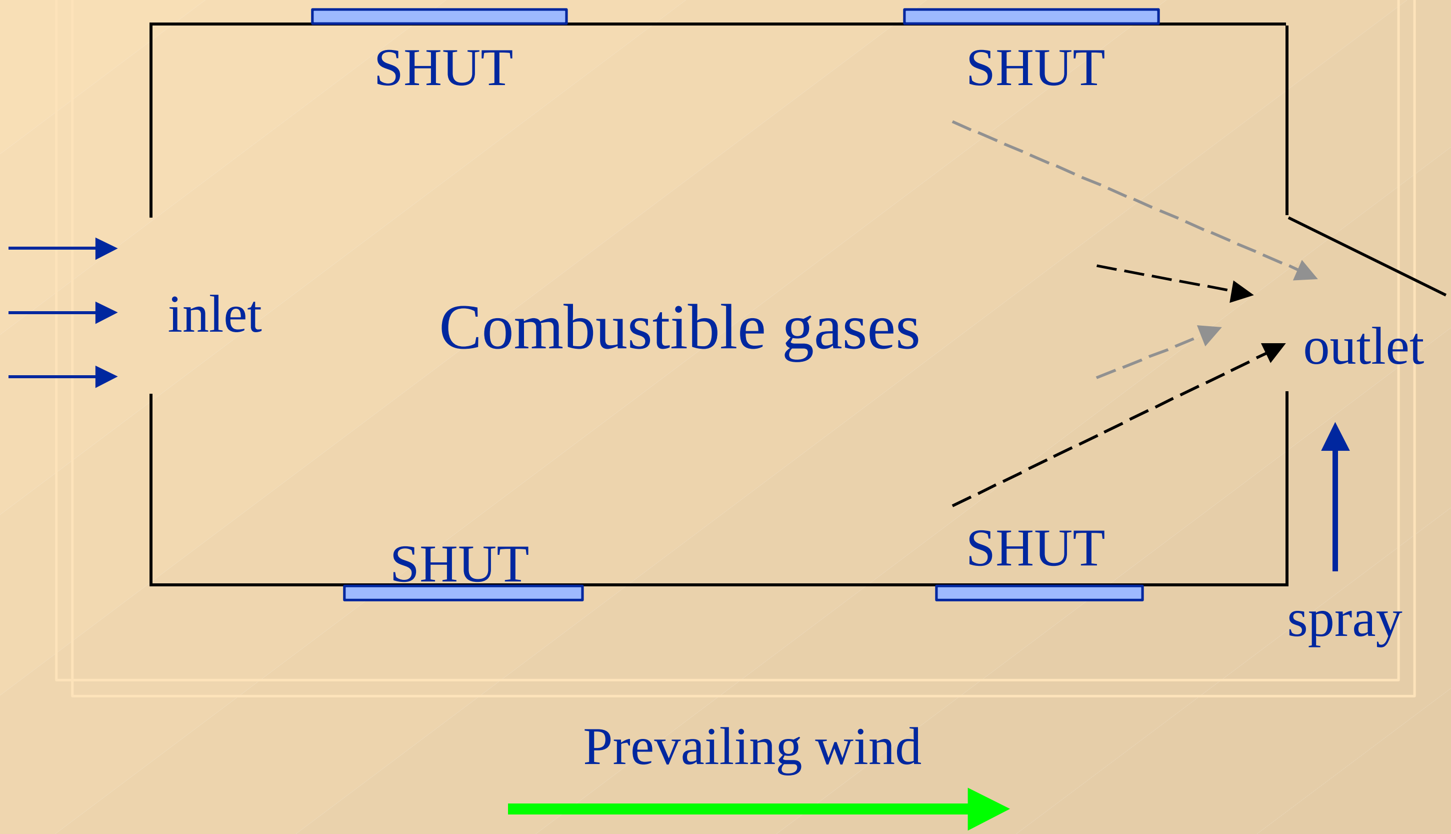
Firefighters in the building need to be able to inform the Incident Commander of:~

- Conditions inside…
- Whether ventilation will be effective…
- Assessment of the risk of backdraught.

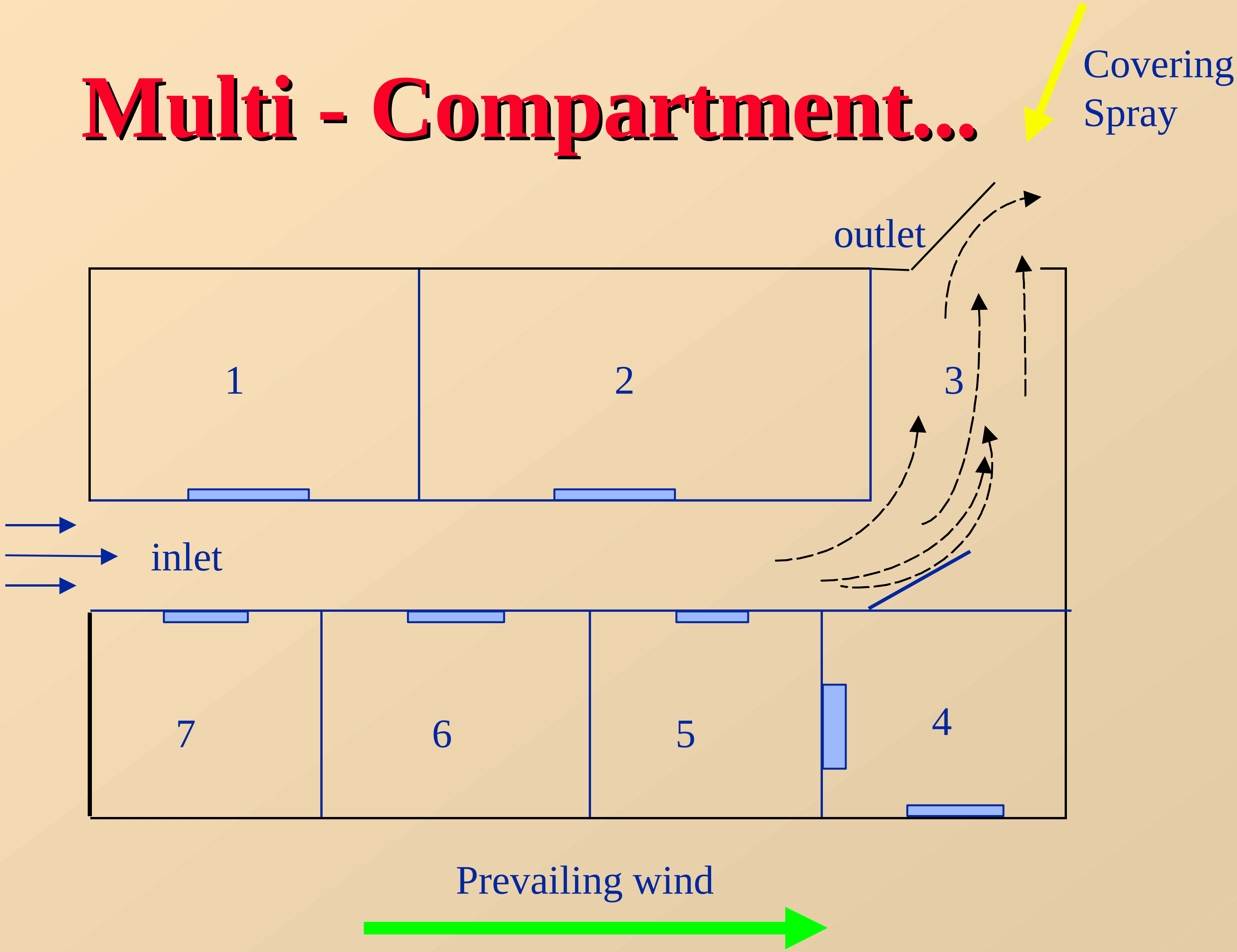
...the size of the exit port depends on the temperature and volume of the gases!!!



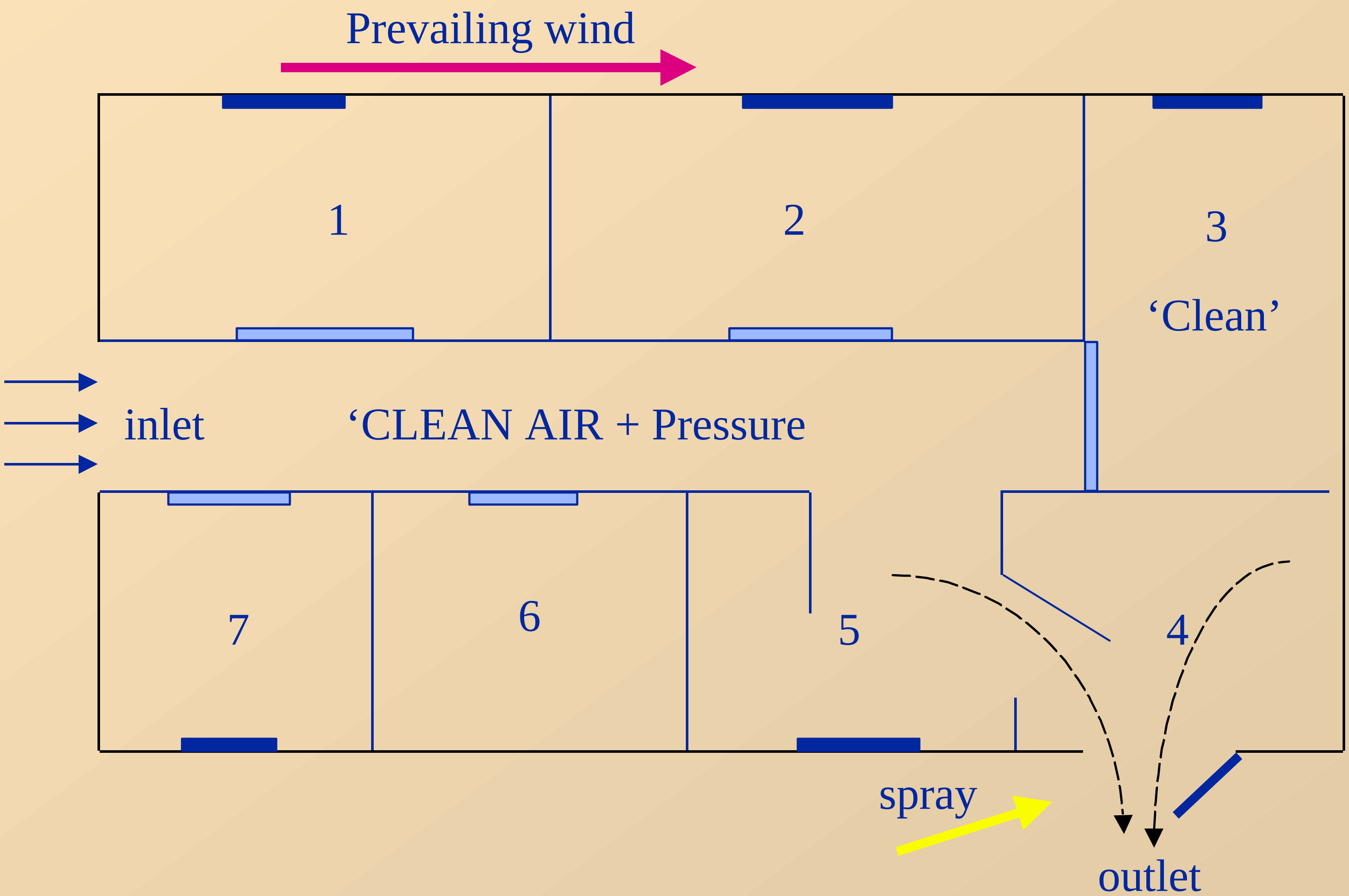
Single Compartments...



Multi - Compartment...



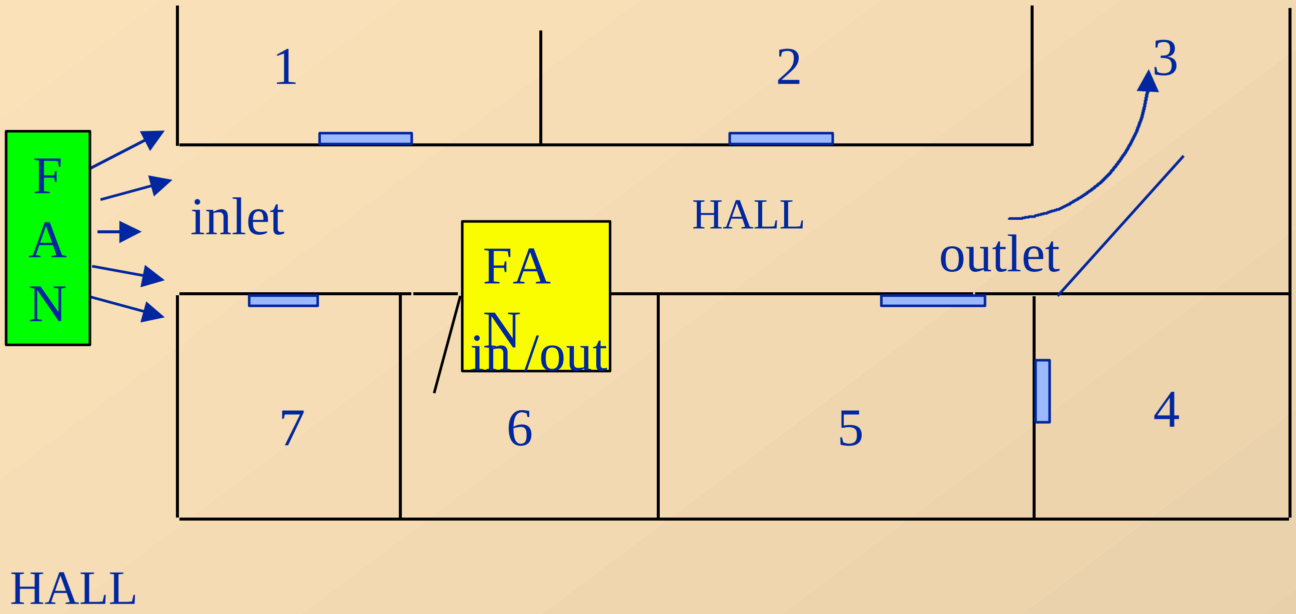
Sequential or Progressive...



Positive Pressure Ventilation
~ PPV ~

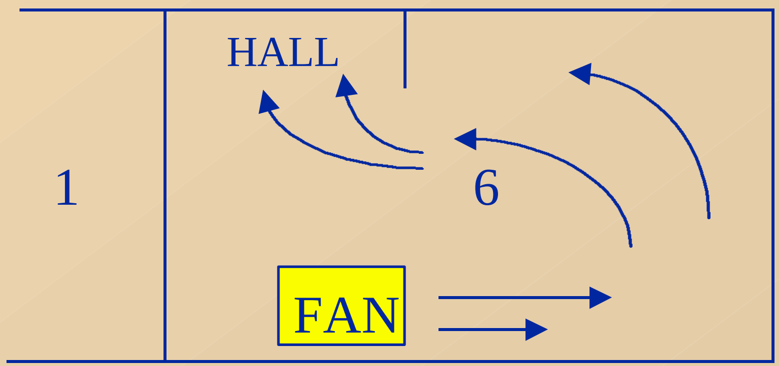
Positive Pressure Ventilation
is the term
used when the pressure
inside a building is
increased by mechanical means.

No outlet - Fan required...

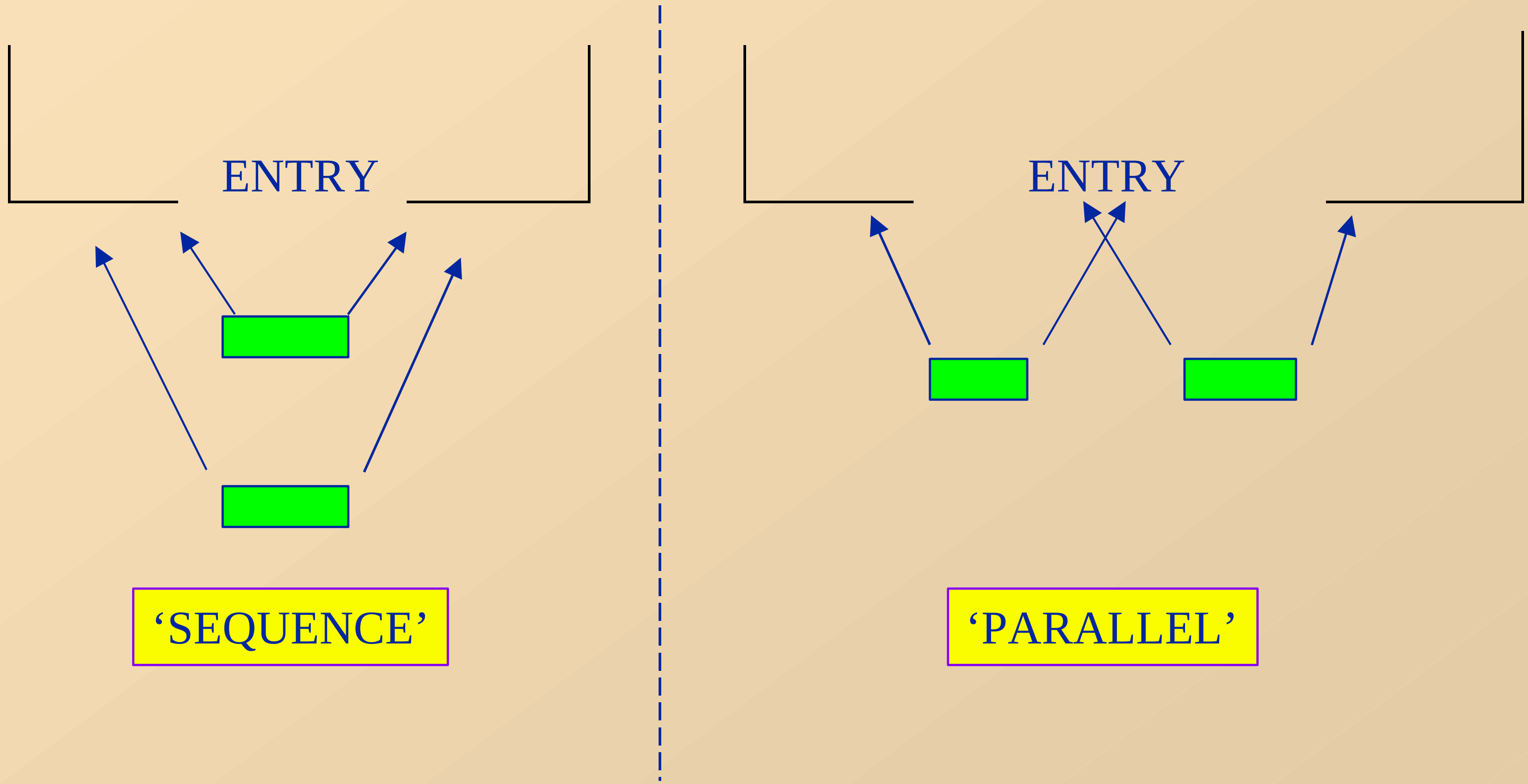


Plan View

Elevation View



Fans can be used in ‘sequence’ or ‘parallel’…



Prior to ventilation CHECK ...

- It is safe to do so…
- Direction of prevailing winds...
- Communications satisfactory...
- Only openings required are to be used ..
- BA teams suitably briefed...
- Covering sprays are located...
- If adopting, ensure fans correctly positioned.

Points to Remember...

* One of many tactics available to the Incident Commander...
* Reduces possibility of backdraught if done correctly...
* Good command, control and communications...
* Entry and exit ports ~ their size and position...
* Covering sprays...
* Minimises smoke damage, aids escape and reduces contaminants...
* Creates a better working environment.

~ SUMMARY of VENTILATION ~

Safety

Types

Smoke and smoke travel

Benefits

Basic principals

Techniques

Defensive and Offensive

Initiation

PPV

CORNWALL COUNTY FIRE BRIGADE

Lecture Pack

FIRE BEHAVIOUR TRAINING

Brigade Training Department

Fire Behaviour Training Cornwalll County Fire Brigade

This presentation will last about 4 hours or 2 Drill nights.

Part 1 - First show compilation video of Flashover and Backdraught followed by first part of lecture on Fire Behaviour training (approximately 2 hours duration).

Part 2 - Ventilation video followed by lecture on Tactical Ventilation.

Part 3 - Practical training of branch techniques, door entry procedures, moving between compartments, etc.

Next Slide - Aims

AIMS…

TO REVISE AND REINFORCE PROCEDURES AND TECHNIQUES TAUGHT ON THE

FIRE BEHAVIOUR TRAINING COURSE'S

HELD AT RAF ST.MAWGAN

Next Slide - Objectives

OBJECTIVES...

- TO REVISE:-
  - i. FIRE BEHAVIOUR IN COMPARTMENT FIRES.
  - ii. EXTINGUISHING TECHNIQUES.
- REINFORCE THE ACTIONS TO BE TAKEN BY CREWS UPON ARRIVAL AT A POTENTIAL ‘BACKDRAUGHT’ OR ‘FLASHOVER’ INCIDENT.

This lecture will be given in the classroom by an officer who has undertaken the Fire Development course at RAF St Mawgan. Shortly following the lecture it is important that extinguishing techniques is practised using the Fogfighter branch.

Next Slide - Bibliography

BIBLIOGRAPHY...

- FIRE SERVICE MANUALS -Operations - Behaviour of Fire...
- FUNDAMENTALS OF FIRE

  Krister Gielsson and Mats Rosander...
- FIRE & RESCUE COLLEGE RADDNINGSVERKET. SANDO SWEDEN.
- FOG ATTACK - Paul Grimwood

Next Slide - Pyrolysis

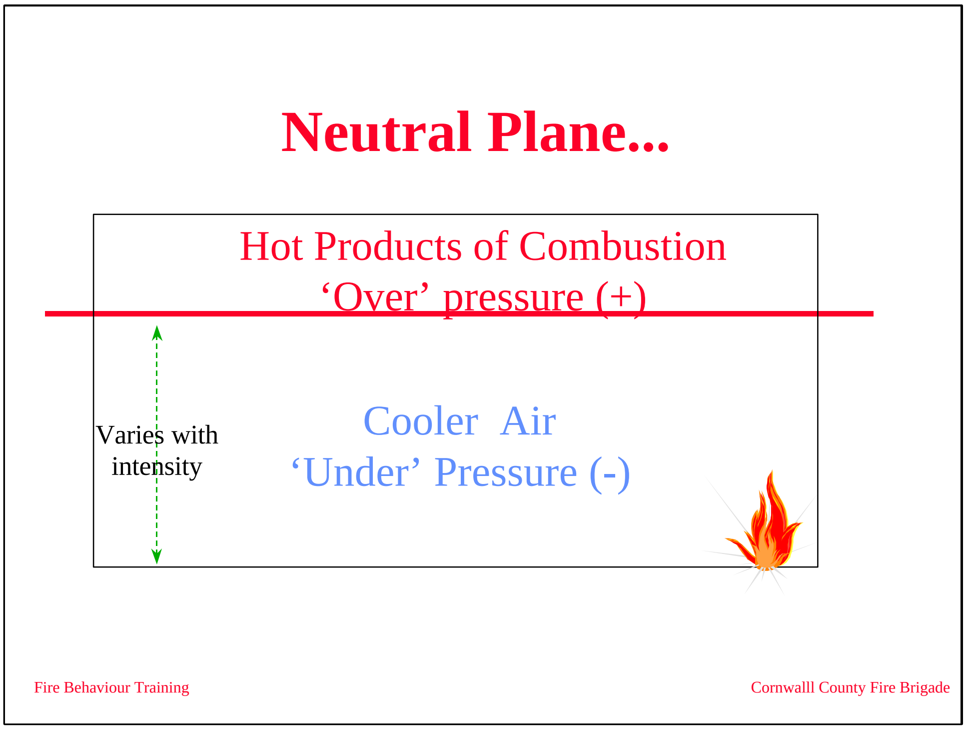
PYROLYSIS...

- PYROLYSIS IS THE PRODUCTION OF COMBUSTIBLE GASES BY HEATING A SUBSTANCE.
- THE AMOUNT OF GASES PRODUCED DEPENDS ON:-
  1. AMOUNT OF HEAT.
  2. SURFACE AREA.
- COMBUSTIBLE GASES WILL BURN WHEN IN THE RIGHT PROPORTIONS.

The greater the heat and the larger the surface area, the greater and faster the rate of pyrolysis.

Refer to the triangle of fire and the fact that the three components (heat, fuel and oxygen) have to be in the correct proportions to achieve combustion.

Next Slide - Neutral Plane



Explain what happens to the neutral plane.

As the fire develops, a small over-pressure develops above a distinct line which can be clearly seen in a fire situation.

This line is constantly moving due to the changing conditions above and below the neutral plane.

With an increase in fire development, the neutral plane is forced down by the increased amount of fire gases produced and the pressure and temperature rises.

Next Slide - Flammability range

FLASHOVER...

In a Compartment fire there can come a stage where the heat from the fire plume, gases and boundaries causes the ignition of all exposed combustible surfaces.

This sudden and sustained transition of a growing fire to a fully developed fire is ‘Flashover’.

Flashover Definition:

A point to remember is that for a flashover to occur there will have to be an abundant supply of oxygen.

Next Slide - Signs of impending Backdraught

Signs and Symptoms of 'Flashover'...

- PAINFUL RADIANT HEAT...
- CREWS FORCED LOW BY HIGH TEMPERATURES...
- HOT SURFACES...
- FLAMES AT CEILING LEVEL...
- LOWERING OF NEUTRAL PLANE...
- INCREASED RATE OF PYROLISATION.

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These are the signs of an impending flashover which you could experience in a compartment fire, but not necessarily at the same time.

The temperature will be so great that even a short duration exposure will feel painful.

All surfaces in the compartment will be very hot, and at about 320 ^{o}c any surface will be painful to touch.

Flames will be visible within the neutral plane.

The level of the neutral plane will lower.

All fixtures and fittings will start to pyrolysis at a greater rate rapidly filling the compartment with combustible gas.

Next Slide - Backdraught - Delayed Gas Combustion

BACKDRAUGHT...

Limited ventilation can lead to a fire in a compartment producing considerable amounts of pyrolised products.

If these accumulate then air is admitted and an ignition source is available, a sudden deflagration can occur.

This deflagration moving through and out of the opening previously provided is ‘Backdraught’.

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Backdraught Definition: Also know as Delayed Gas Combustion.

Point to remember - the fire will have been starved of air for this condition to be possible.

It could be a rapid burning fire or a slowly developing fire, up to when it becomes too rich.

This condition can build up whilst crews are inside a building and become a far greater danger.

Next Slide - Delayed Gas Combustion - continued....

Signs of impending 'Backdraught'

FIRE WITH LIMITED VENTILATION...

- THICK, BLACK SMOKE...
- THICK, YELLOW SMOKE...
- WHITE, COLD SMOKE...
- BLUE FLAMES...
- HOT DOORS AND WINDOWS...

These are the signs of an impending backdraught which can be observed from either inside or outside the compartment. The colour and temperature of the smoke depends on what is in the compartment on fire.

Thick smoke indicates that it is very rich with fuel and compressed.

Blue flames may be visible if CO (carbon monoxide) is burning.

Next Slide - Signs - continued.....

also...

AIR WHISTLING - BEING DRAWN INTO THE COMPARTMENT...

- PULSATION OF FIRE GASES...

- SMOKE BLACKENED WINDOWS.

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Air whistles as it is drawn in to compartment as the fire dies down and the pressure drops.

Fire gases can be seen to pulsate through gaps or openings. This is due to small amounts of combustion taking place as air leaks in and the pressure increases. When the compartment cools the pressure decreases, air is forced in and combustion takes place again.

Windows will be smoke blackened due to the thickness of the smoke which may have a high carbon content.

Next Slide - Tactical Solution

TACTICAL SOLUTION...

- COMMUNICATE !...
- CONTROL AIR !...
- CONTROLLED VENTILATION !...
- COOL THE GASES !...
- ONLY ALTER CONDITIONS TO YOUR ADVANTAGE!!!.

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The tactical solution to deal with any backdraught or flashover situation is:

Communicate - This means every member of the crew. If anyone sees or thinks they notice changing conditions the OiC must be informed immediately.

Control the air - Crew must be aware that allowing air into the compartment may bring the combustible gas into the flammability range.

Discuss uncontrolled ventilation - The importance of only ventilating when BA crews are ready and venting as high as possible.

Cool the gases - Use the indirect method if possible.
- Use gas cooling when entering the compartment..

5 MINUTE BREAK.

WATER AS AN EXTINGUISHING MEDIUM...

ADVANTAGE

Removes heat energy

DISADVANTAGE

Produces large amounts of steam

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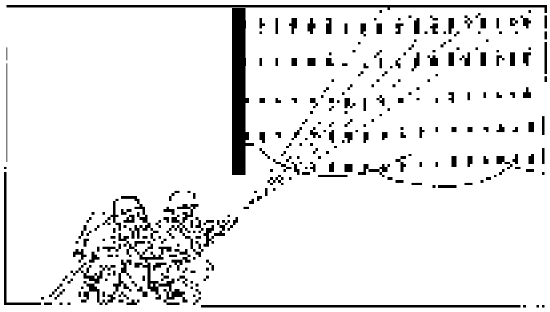
When water turns to steam it absorbs large amounts of heat.

One litre of water at 100^{o}C when converted produces 1700 litres of steam. At 450^{o}C it produces 3500 litres of steam.

Next Slide - Firefighting Techniques

INDIRECT TECHNIQUE...
(Defensive)



Large quantities of steam produced. Creates an over pressure.

Lowers neutral plane.

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Direct the pulse spray up into the compartment to produce steam and create an over-pressure which will keep out the air and smother the fire.

This should be an external attack method, ie., outside the compartment **OR** building. **DO NOT** stand directly in front of openings.

Can be carried out internally but great care must be taken for the following reasons:

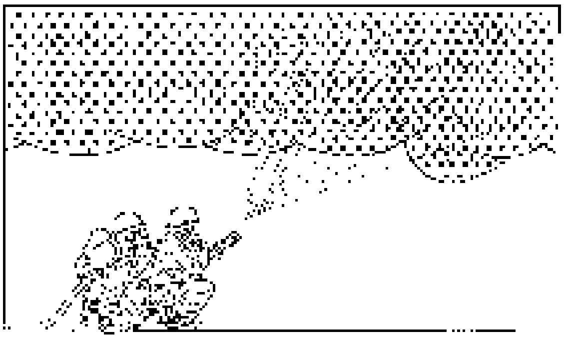
a) large quantities of steam produced which could scald BA teams and casualties.

b) Reduced visibility.

c) Worsens conditions.

Next Slide - Gas Cooling

GAS COOLING TECHNIQUE... (Offensive)



Cools fire gases.
Needs appropriate branch.

Shrinks fire gases.

Neutral plane may remain constant or rise, improving conditions.

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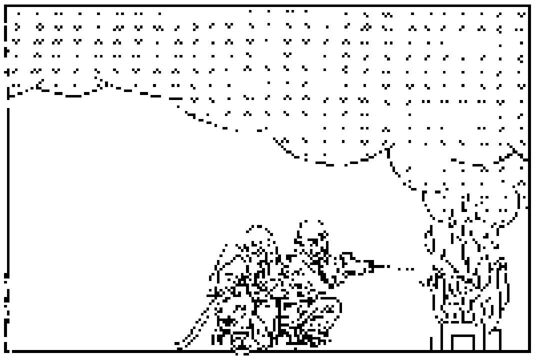
‘Offensive’ or ‘Protective’ method used when gain access to carry out rescues etc. Rapid, short pulsation's.

The Fogfighter branch produces the correct water droplet size (0.3mm) which penetrates the fire gas and converts to steam before reaching the walls and ceiling.

The fire gases contract due to them being rapidly cooled and the neutral plane may rise.

Next Slide - Direct Techniques

DIRECT TECHNIQUE...



Offensive method to extinguish initial fire.

Danger:-

Beware of combustible gases igniting cause by applying too soon.

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If this method is used in the later stages of the fire, when the compartment may be full of fire gases, there is a danger that your actions may stir up the initial fire and introduce an ignition source to the rich fire gases and trigger a delay gas combustion.

Do not get in to this position until you have carried out the other necessary tactics, i.e.., gas cooling.

If indirect and gas cooling have been effective you should only need to use limited water to suppress initial fires.

Next Slide - Use of Branch

USE OF THE *'TA FOGFIGHTER'* BRANCH...

- **SHORT PULSATION'S**

On and off - short distance protection...

- **LONG PULSATION'S**

3 - 4 seconds to cover a longer distance...

- **SWEEP (Left to right or floor to ceiling)**

Move across large areas.

'ALTER THE ANGLE OF THE SPRAY TO REACH FURTHER INTO THE FIRE'

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Care must be taken when using the long pulsation and sweep technique to avoid worsening conditions.

Generally the short pulsation is all that will be required for a domestic property . If this method was not effective then a long pulsation will have to be used to drive the fire back.

If firefighting in a large or commercial premise long pulsation's would have to be used so that the pulsation spray could penetrate far enough , due to high ceilings and larger compartments.

Next Slide -Arriving at an Incident - 'Dynamic Risk Assessment'

POINTS TO REMEMBER ON ARRIVAL
[DYNAMIC RISK ASSESSMENT]...

* OBSERVE BUILDING -
  Size,Contents,Construction, Access, Egress...
* SIGNS OF *FLASHOVER* OR *BACKDRAUGHT*...
* CHECK NOZZLE SETTINGS...
* TEMPERATURE CHECKS...
* CORRECT BRANCH TECHNIQUES...
* OBSERVE CONDITIONS AT ALL TIMES...
* USE WATER EFFECTIVELY.

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What is in a building and it’s construction will affect firefighting, i.e.., foam filled furniture, double glazing, ceiling voids, etc.

Everyone on the crew has to be aware of changing conditions.

Temperature check doors and compartments using pulsation spray.

Do not remove gloves.

Adopt correct technique for conditions presented at time - indirect if an entry is not critical.

Constantly observe the conditions and change techniques to suit changing conditions. Communicate.

Over use of water could worsen conditions,

Making an entry - DOOR CLOSED...

- CHECK TEMPERATURE OF THE DOOR using short spray and / or gloved hand...
- IF HOT - Spray above the door, open the door slightly - if flames come out above the door, the water will cool the gases...
- KEEP LOW...
- USE PROTECTION OF THE WALL...
- OBSERVE FIRE GASES - (at all times)
- ALWAYS HOLD THE DOOR SECURELY…and...

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Temperature checking a door with water spray has two advantages.

1) Visual indicator of temperature.
2) The water curtain cools escaping fire gases.

If at any time fire gases (smoke) are seen within an access room, then ensure these procedures are carried out before moving into a possibly affected compartment.

Next Slide - Door Opened

If / when, DOOR OPEN, but too hot to proceed...

- KEEP LOW...
- SPRAY SHORT PULSES INTO THE ROOM...
- CLOSE THE DOOR...
- REPEAT UNTIL CONDITIONS ARE TENNABLE...
- ADVANCE IF POSSIBLE.

Let the steam do the work.

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Several 'short' pulse sprays high into the room, close the door immediately to prevent the generated steam escaping.

Repeat as necessary, allowing enough time for the steam to 'quench' the fire gases and reduce the temperature.

ADVANCE ONLY WHEN SAFE

Next Slide - Moving between Compartments

Offensive Mode [‘The Attack’]...

- MAKE THE ENTRANCE SAFE...
- TEMPERATURE CHECK / KEEP LOW...
- SECURE YOUR POSITION AND ADVANCE WHEN SAFE...
- EXTINGUISHING - Direct / Indirect...
  - Gas cooling...
- PAINT - Ceiling / Walls...
- VENTILATION / REMOVAL.

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This basically describes the whole operation from start to finish.

Make entrance safe - have crew outside with a charged jet in case of emergency.

Temperature check - keep low. **COMMUNICATE....**

Advance when safe and adopt appropriate extinguishing technique.

Paint walls and ceilings to stop further pyrolisation and extinguish initial fire.

COMMUNICATE....

Ventilate the compartment. (Next Slide - Remember)

MOVING BETWEEN COMPARTMENTS...

WHEN ENTERING A ‘FIRE’ COMPARTMENT, ENSURE THE FIRE GASES DO NOT LEAK INTO THE ACCESS ROOM OR INTO THE ESCAPE ROUTE.

COOL THE GASES
AND/OR
VENTILATE TO OUTSIDE.

CAUTION IS NEEDED !!!

beware of introducing ‘Backdraught’ conditions.

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Fire gases which leak into an access room or escape route could be within there flammability range and only waiting for an ignition source. Cool these gases and ventilate to protect your escape route.

Successful ventilation means communicating with the OiC.

Next Slide - Fire Gas Observations

FIRE GAS OBSERVATIONS...

WHEN IN A COMPARTMENT,
KEEP A CONSTANT CHECK ON
THE SURROUNDINGS,
PARTICULARLY
FIRE GASES AT CEILING LEVEL...

TEAM LEADER - ABOVE AND IN FRONT.

OTHERS - ABOVE AND BEHIND.

'COMMUNICATE'

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Depending upon the circumstance it may be necessary to gas cool, advance, secure your position or retreat if conditions worsen.

Keep low at all times.

Never turn your back on the fire.

Next Slide - The Attack

REMEMBER...

- SLOW DOWN...
- WATCH... LISTEN... FEEL... THINK...
- KEEP LOW...
- MOVE...
- COMMUNICATE.

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At all times look after yourself and your crew.

If uncertain - DO NOT PROCEED.

Communicate

Crews outside can look for possible danger signs, i.e..,

Thick, compressed smoke.
Fire gas pulsation's.
Uncontrolled ventilation by:

a) Crews, or
b) Collapse.

Next Slide - Summary

SUMMARY...

So far we have covered:

- Fires in compartments...
- Extinguishing techniques...
- Awareness at incidents involving fire in possible flashover or backdraught scenarios.…
- but this must go hand in hand with ventilation.

Next Slide - Tactical Ventilation

Tactical Ventilation

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Tactical Ventilation

is...

The planned and systematic removal of combustible gases and other airborne contaminants from the structure, and their replacement with a supply of fresher air.

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Tactical ventilation should form part of the OiC’s dynamic risk assessment and if used skilfully and correctly, give significant benefits.

Next Slide - Using Prevailing Wind

Methods of achieving ventilation...

- Natural..using prevailing winds…
- Mechanical…fixed installations…
- Portable i.e....

  Negative - fans located within compartment

  Positive - fans located outside compartments

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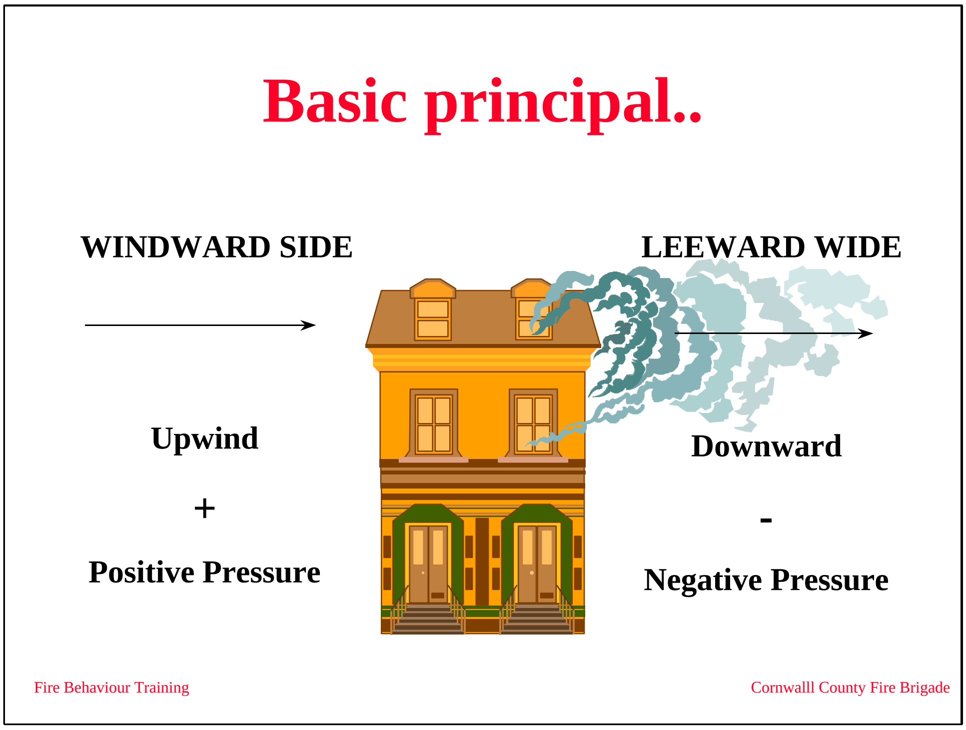
Natural..self explanatory

Mechanical…building systems i.e. plenum.Disadvantages are it needs local assistance and knowledge of the systems.

Portable.negative - locating fans inside damages the equipment and requires more effort from crews and a greater degree of control.

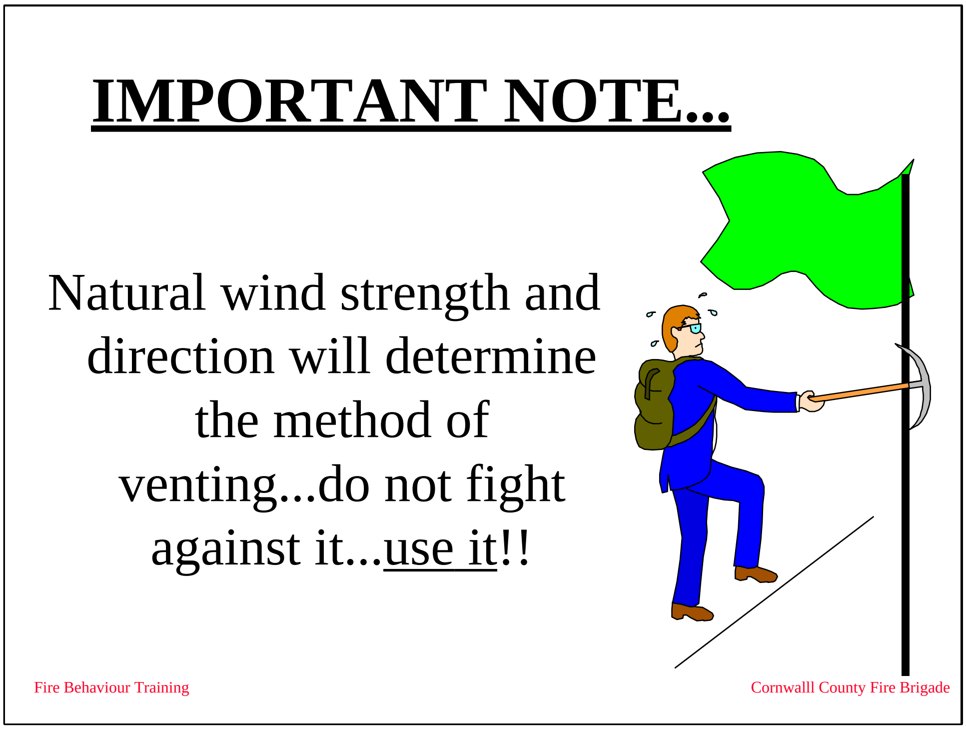
Portable ,positive - set up outside.Supplements ‘natural’ ventilation, no trunking required, requires less maintenance.



The first priority of the OiC in relation to ventilation is to identify the prevailing wind direction and use the positive pressure created by the wind to force fresh air into the structure.

This must always be controlled and synchronized by the OiC. Communication and timing is vital, if mistimed or uncontrolled the consequences could be hazardous.

Next Slide - Important Note



SELF EXPLANATORY

See next slide

Next slide.Defensive or Post Fire (overhaul)

Defensive (Post Fire/Overhaul) Ventilation...

- Fire is out...
- Dispel hot gases...
- Improves visibility...
- Stops smoke spread...
- Clears escape routes...
- Maintain communication...
- Care must be taken when breaking glass...
- Aid investigation.

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Generally, defensive ventilation is utilised when the fire is out to dispel hot fire gases and smoke which have spread from the fire.

If used correctly the benefits are:

a) visibility is improved.

b) making access easier for locating casualties and firefighting.

c) smoke spread restricted to any further compartments.

d) Escape routes cleared and conditions improved for building occupants.

e) Will help with early access for investigation.

Care must be taken when breaking windows and BA should be worn.

Next Slide - Offensive Ventilation

Offensive Ventilation...

- Close to the fire…
- Relies on good communication...
- Will have a direct effect on the fire...
- Limits fire spread...
- Can excelerate fire conditions...
- Makes conditions more tenable.

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Offensive ventilation is carried out in or near the fire compartment and will have a direct effect on the fire itself.

If performed before the fire is extinguished, firefighters must remember that it could have a dangerous effect on the fire due to the increased oxygen supply.

Offensive ventilation limits fire spread to other parts of the structure and allows products of combustion to escape from the compartment which makes conditions more tenable for firefighters and close quarter firefighting.

Relies on good communication and control.

Next Slide - Stages of Ventilation

Positive Pressure Ventilation [PPV]...

Positive pressure ventilation is the term used when the pressure inside a building is increased by mechanical means.

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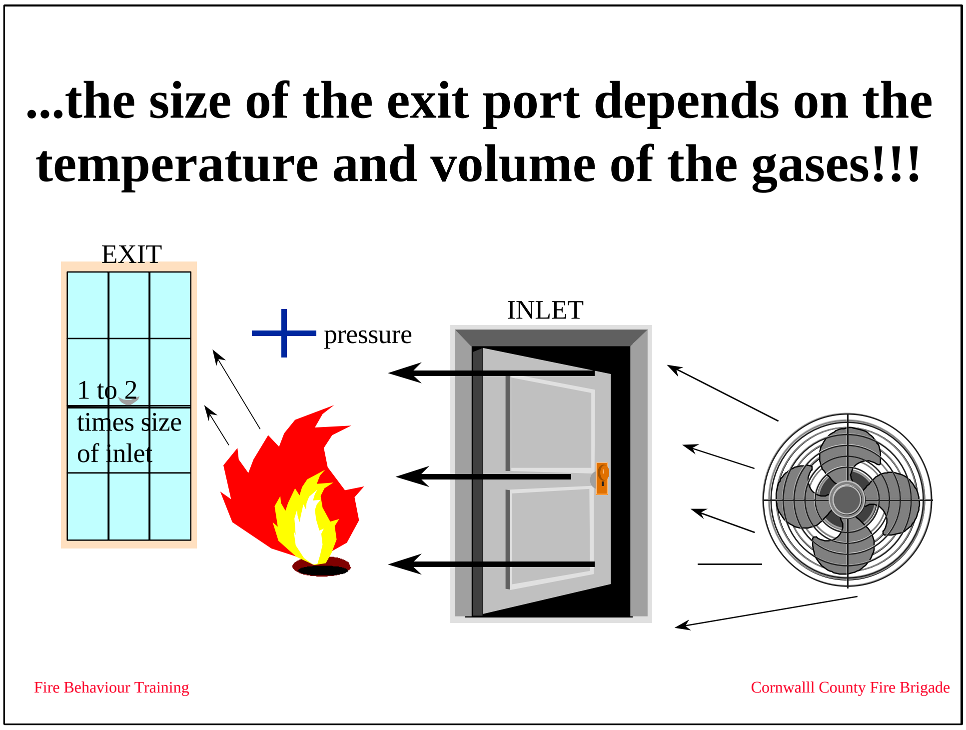
Positive pressure ventilation should be used with the prevailing wind not against it and positioned low on the inlet route.

If the prevailing wind cannot be used, PPV can be of great assistance - but is a subject in it’s own right that will be addressed locally..

Next Slide - Entry/Exit ports



If high temperatures are achieved, larger volumes of hot gases may need to be dispelled.

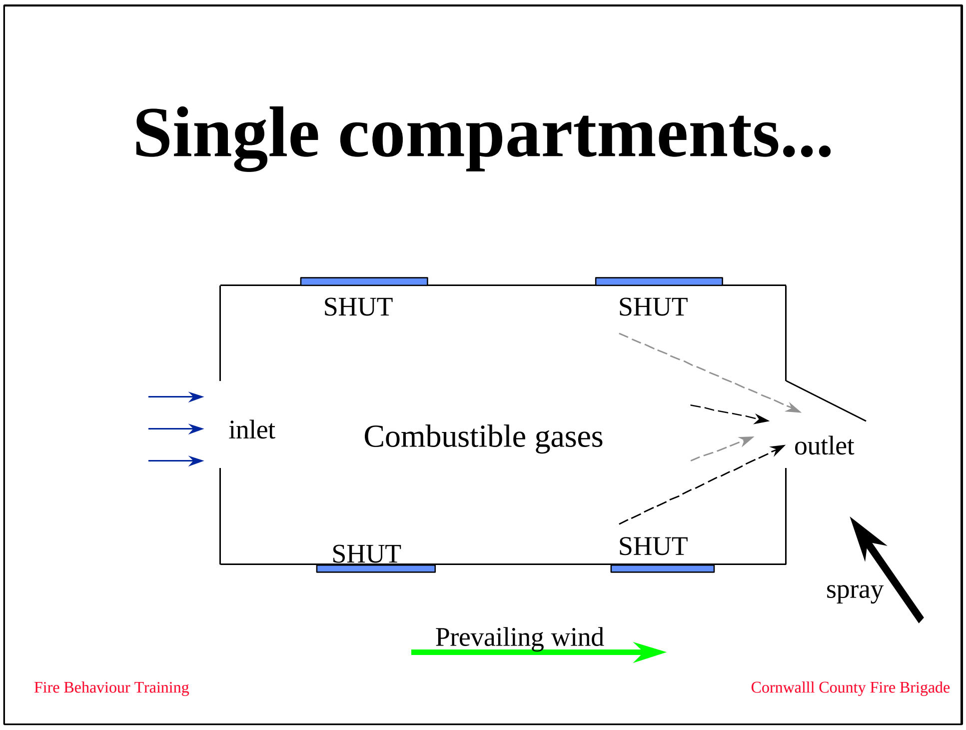
If the outlet/exit is smaller than the inlet, a back pressure may be introduced, therefore worsening the conditions,

The exit port should therefore normally be larger than the inlet port..but must be controlled.

Good communications are of paramount importance.

Do not revert to opening all ‘exit ports’ at the same time.

Next slide…Examples of how to acheive good tactical ventilation.

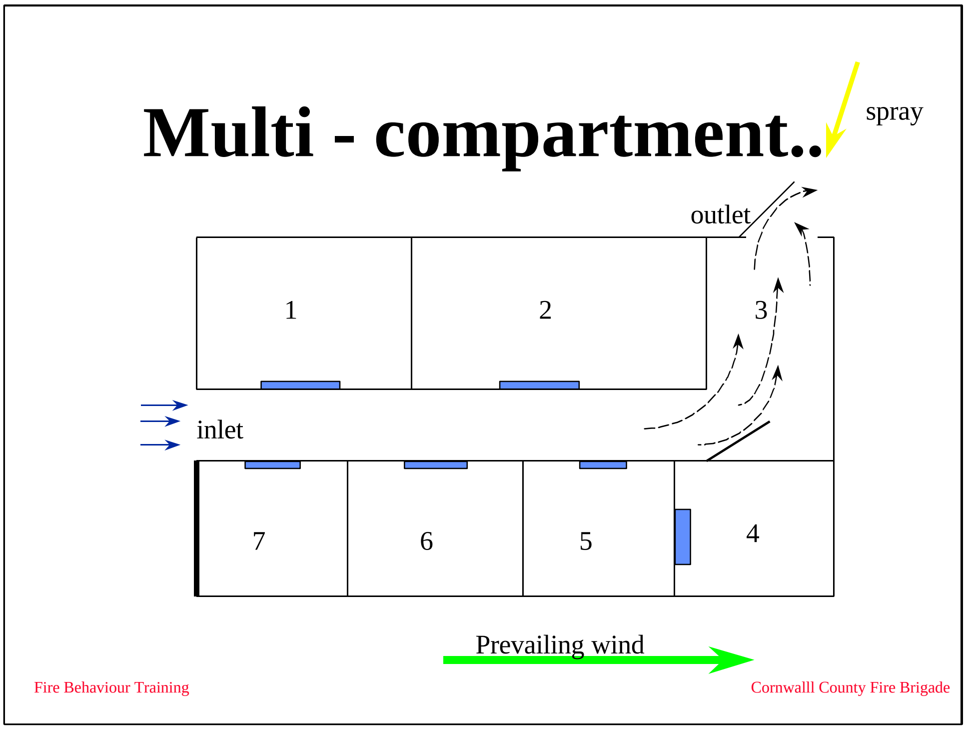


Using the prevailing wind, protect the exit port with a spray, but allow gases to exit - do not direct jets/sprays into exit ports when ventilating. This forces air back in and does not allow gases out.

NOTE

Spray cone can be directed <u>out</u> of compartment, achieving venturi effect to extract gases.

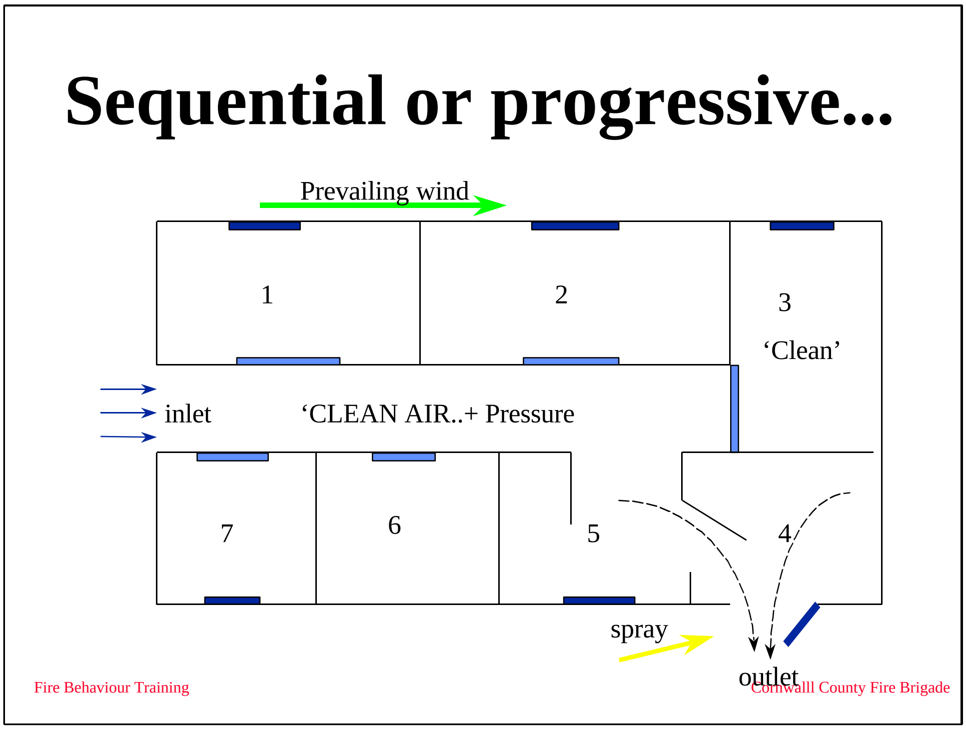
Next Slide: Multi compartment



Using prevailing wind or with the aid of a fan, clear the access route by shutting all doors and opening an exit port at furthest point.

This them can be extended..

Next Slide: Sequential or Progressive

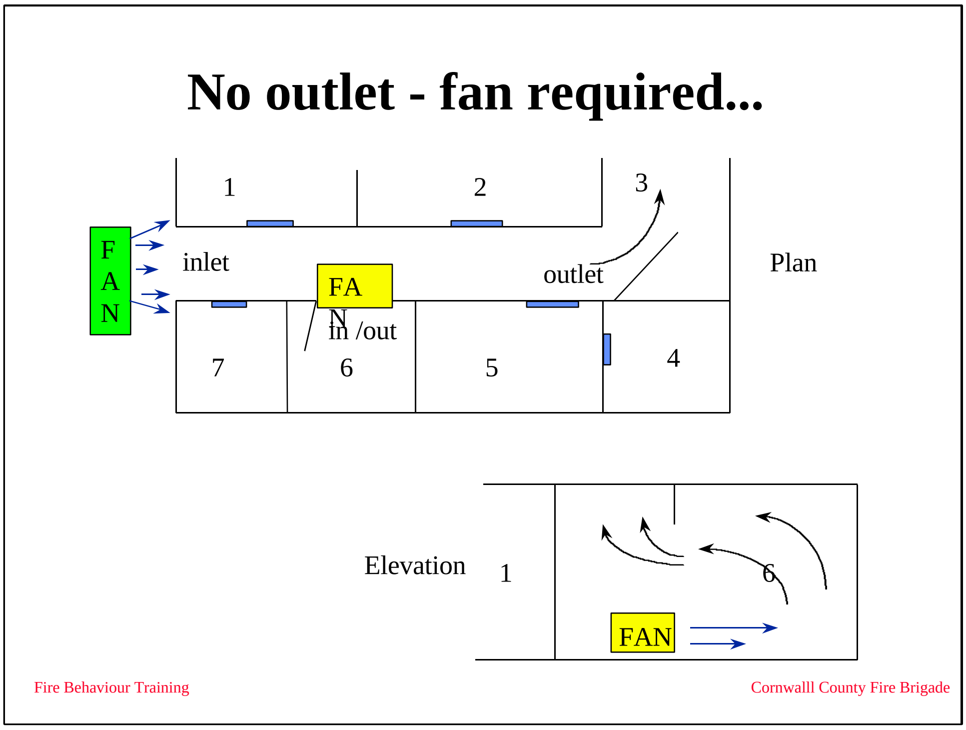


Once the exit route is clear, then progressively shut rooms and exit ports and move to each room carrying out similar process.

BA must be worn at all times.

Communications should be maintained and firefighting media must be available.

Next Slide: No Exit Port........



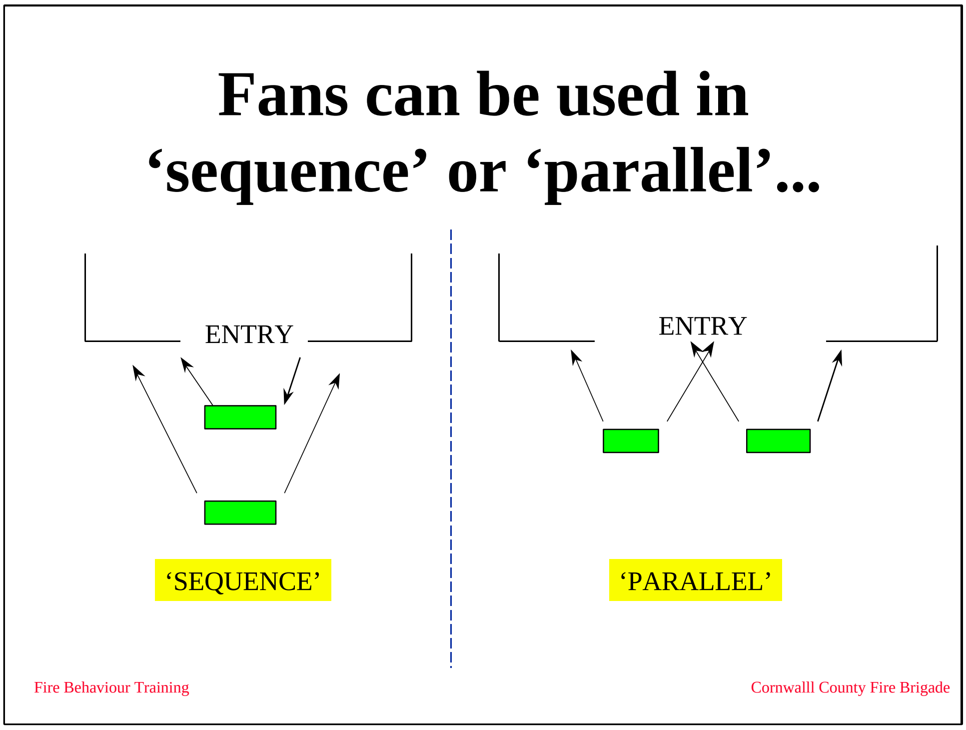
Here a fan would be a distinct advantage - two fans ideal.

First cleal all rooms as previously, leaving room closed.

Place fan(s) as shown - start external fan ensuring exit port is open.

Start fan at entrance to Room 6. Products of combustion will then be ‘diverted’ to exit port.

Next Slide: More Fans!!!



For Large compartments this practice can be adopted.

Next Slide Prior to carrying out ventilation..........

Prior to venting, CHECK...

- It is safe to do so…
- Direction of prevailing winds...
- Communications satisfactory...
- Only required openings are in use...
- BA teams suitably briefed...
- Covering sprays are located...
- If adopting, ensure fans correctly positioned.

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If the risk of increasing spread exists - do not vent.

Rest self explanatory.

Next Slide: Summary

Summary on Ventilation...

- Only one of many tactics available to the O.I.C...
- Minimises smoke damage, aids escape and reduces contaminants...
- Creates a better working environment.
- When to ventilate...
- Using only trained personnel...
- Good command , control and communications...
- Entry and exit ports...
- Covering sprays.

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Self explanatory

The tactics of dealing with fire previously explained can only work hand in hand with good ventilation controls - communication is essential.

Command and Control is critical.

FINISH

Note...

Any reference to PPV applies to the 'Overhaul' mode only, i.e., the fire is out'
The 'Pre attack' [Offensive] use of fans will be identified in a future presentation should this procedure be adopted by the Brigade.

[1st January 1997]

Kent and Medway Towns Fire Authority

KENT FIRE BRIGADE

FIRE BEHAVIOUR TRAINING

STUDENT NOTE

Making Kent Safer

TITLE: FIRE BEHAVIOUR TRAINING NUMBER:

Contents

1. Introduction

The following notes are designed as an aide memoir for students who have undertaken a fire behaviour course and should be considered as a foundation for further learning. As we know the fireground offers a multitude of challenges to a fire fighter, the skills you have been taught should equip you to fight fires more effectively than before. The importance of regular training in the techniques you have been practising cannot be over emphasised.

2. Combustion

Fire is basically a chemical reaction in which a fuel combines with oxygen.

The reaction (combustion) requires energy (heat) to enable it to work and emit heat and light.

The following factors are required for combustion to occur :

HEAT	Energy
FUEL	Initially a flammable gas, in the later stages also solids
OXYGEN	Supports combustion

This process is commonly referred to as the **TRIANGLE OF FIRE**

Providing these three factors are present and in the correct proportions, combustion will occur.

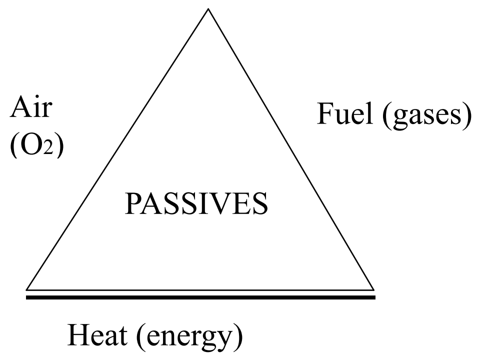
For a candle to burn, an impulse of energy is required to start the process (ie : match). The lighted match melts the wax which is drawn up the wick turning into a flammable vapour (heat from match). The vapour is ignited by the match, forming a flame. The flame now produces heat and light which melts more wax and the cycle continues.

Passive Agents

As mentioned previously, there are three sides to the triangle of fire, which requires that fuel, heat and oxygen must be present for combustion to occur. However, there is a further factor which will affect the triangle. The factor can be termed as “passive agents”.

These passive agents are present in any combustion process and take no part in the chemical reaction of combustion, but the fact that they will absorb heat energy will have an effect on the fires behaviour.

Passive Agents are :
Non-flammable gases (carbon dioxide, water vapour)
Soot - Carbon particles
Nitrogen - a constituent of air that remains inert throughout combustion



3. Pyrolysis

The decomposition of a substance by heat.
If a substance (solid or liquid) is heated, gases will be given off. Once the flammable gases generated are within their flammable range they may ignite. The contents and structure (paint, timber, plastics, textiles, etc) of a compartment will give off gas due to pyrolysis, when it is heated. The amount of pyrolysis taking place will increase as the temperature increases.

4. Types Of Flame

The appearance of the flame produced by a burning substance can give information to a firefighter about the efficiency of the combustion process. The appearance of the flame can be divided into two types - Diffusion & Premixed.

Diffusion Flame

As you are aware the type of flame given off from a bunsen burner when the aperture is closed is a slow, bright, lazy flame. The oxygen vital for combustion is drawn from the area surrounding the flame. We have all seen this type of flame hundreds of times, a candle for example. Now consider the fact that a candle is only 25% efficient. Bearing this in mind, picture an average lounge fire with a settee burning producing diffusion flames, we now know this relatively inefficient combustion is releasing large amounts of unburnt fuel (fire gases) into the room.

Premixed Flame

If we return to the bunsen burner described previously and open the aperture slightly, this allows oxygen and fuel to mix **before** ignition. This greatly improves combustion efficiency, demonstrated by the colour, temperature and speed of the flame. The amount of unburnt fuel (fire gases) is dramatically reduced.

THE MAJORITY OF FIRES THAT YOU WILL BE FIGHTING OPERATIONALLY WILL BE PRODUCING DIFFUSION FLAMES !!!

5. Fire Gases

The products of combustion (smoke) are referred to as **Fire Gases** and consist of :

NON-FLAMMABLE GASES	Mainly carbon dioxide and water vapour
FLAMMABLE	Due to pyrolysis and incomplete combustion, includes carbon monoxide
AIR	Entrained in by rising temperature
SOOT	Carbon Particles

6. Limits of flammability

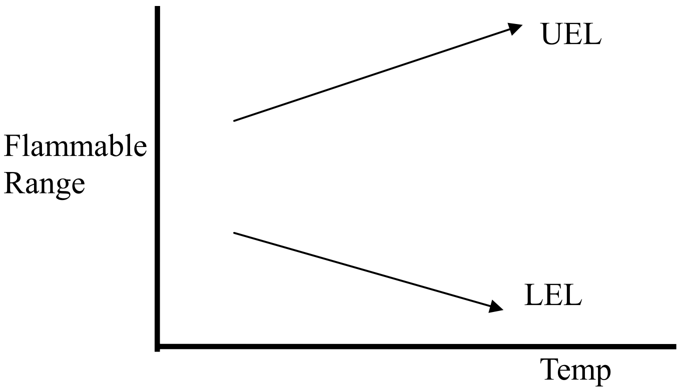
A flammable gas will only burn in air if its composition lies between certain limits. If too little of too much fuel is present burning will not take place; the mixture is either too lean or too rich.
These limits are referred to as the lower explosive limit (LEL) and the upper explosive limit (UEL).
The lower limit is defined as the lowest concentration of fuel that will just support a self-propagating flame.
The upper limit is defined as the highest concentration of fuel that will just support a self-propagating flame.
Between these limits, which are given as percentages, is the flammable range of the gases.
For every flammable gas there is a particular concentration where the amount of gas is exactly right in relation to the amount of oxygen in the air for combustion to occur. This is known as the ideal mixture (IM),

and is found, between the lower and upper limits. Combustion occurs at the ideal mixture with maximum force.
On a scale from 0-100%, the flammable range for any gas can be marked, eg :

PROPANE
Percentage of propane to air

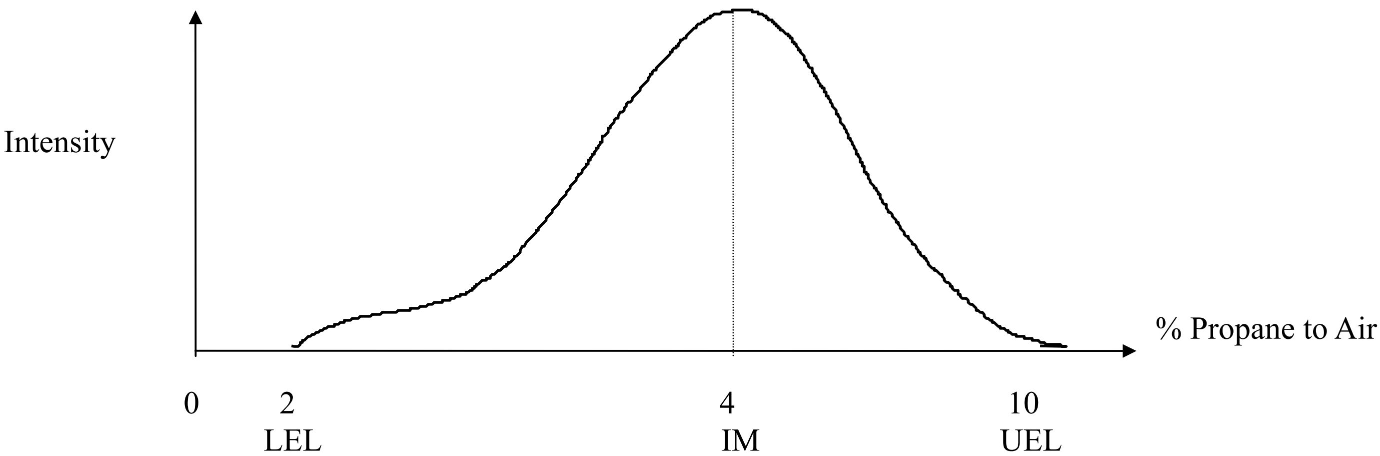
This example shows that the range of flammability for propane is very small and most propane/air mixtures are not flammable.

The flammable range of a gas will widen as the temperature increases.



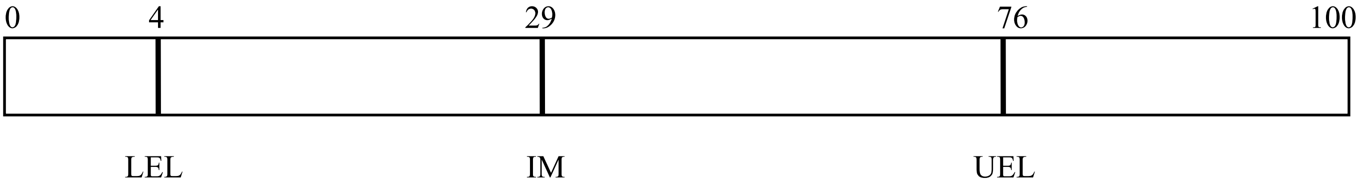
The ideal mixture burns quickly and with the most intensity (energy or force).
However, at the lower and upper limits the gas is only just flammable.

If we add the intensity of the flammable range to the example :

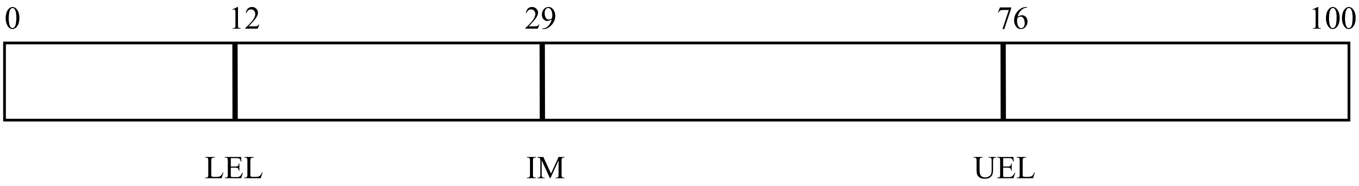


Different flammable gases have different ideal mixtures, different flammable ranges and ignite with different levels of intensity and temperatures, eg :

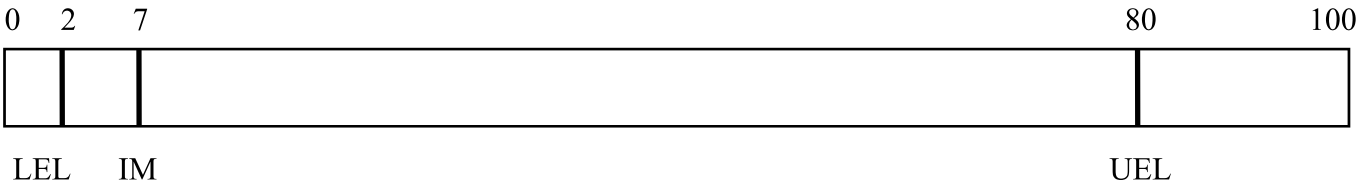
HYDROGEN



CARBON MONOXIDE

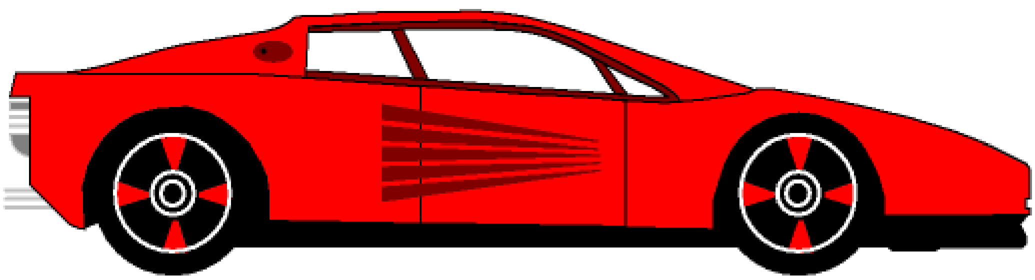


ACETYLENE



7. Summary

If a compartment contains a flammable gas, air plus and ignition source, it will only ignite providing the gas is within its flammable range (ie : between the LEL and the UEL). A simple comparison can be made with a cars engine. Consider if a carburettor is providing insufficient fuel to the engine (mixture of gases too lean). At the opposite end of the scale, too much fuel will cause the engine to flood (mixture of gases too rich). If the carburettor is functioning correctly, an ideal mixture will be achieved and the intensity of the reaction will be at its maximum.

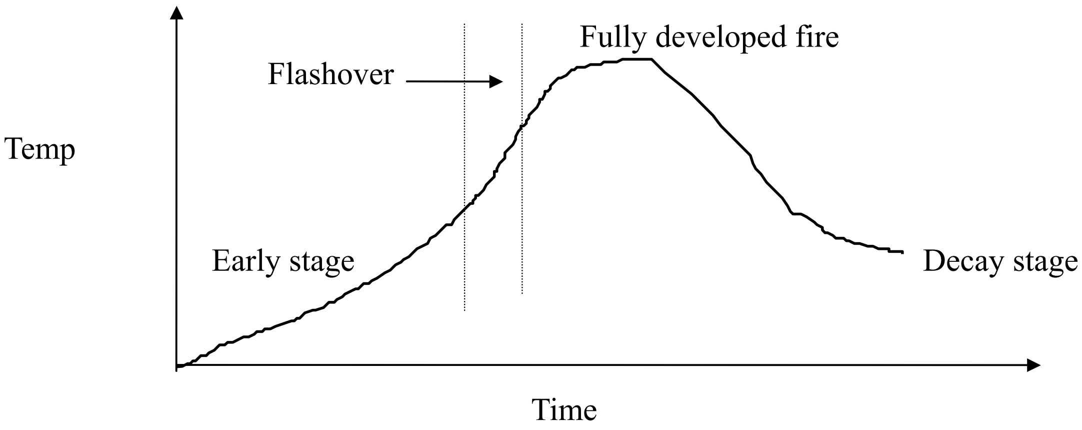


Section II - Flashover Development

8. Flashover

Definition : In a compartment fire there can come a stage where the heat from the fire plume, gases and boundaries, causes the ignition of all exposed combustible surfaces. This sudden and sustained transition to a fully developed fire is “flashover”.
When a fire in a compartment grows, fire gases from the fire collect under the ceiling. The temperature in the compartment will be rising due to heat from the fire and this will increase the production of gases by pyrolysis.

9. Fire Progression



The progression of a fire can be segmented into four distinct phases, using the graph above.
The first phase can be referred to as “early stage”, in which the fire is initially developing at a relatively slow rate, but the rate of development increases with time.
The second phase is the “flashover” stage and this is a transitionary phase which leads to a fully developed fire which can be regarded as the third phase of fire progression.
The fourth phase is the “decay” phase in which the fire gradually dies back as the fuel is consumed.

10. Flashover Development

Insufficient Fuel
If the initial fire has insufficient fuel then it will die out and not reach the next stage.

Airtight Compartment
If the compartment is airtight, the fire will die our when all the oxygen has been used up.

Flashovers at Incidents
Once a flashover has occurred it is controlled by either ventilation (oxygen supply) or the remaining fuel (contents and structure). If either of these is exhausted or not available the fire will die out.
Once there is an opening to the compartment, it develops into a fire controlled by fuel and ventilation. A fire will remain at this stage if the opening is about the size of a doorway. If the opening increased to the size of a complete wall or shop front, then it is possible to move to a fire controlled by fuel only.
The fire gases will be at different mixture levels within a compartment, the mixture being richer nearer the fire and weaker nearer the floor. In a building on fire, because compartments are not airtight, fire gases can leak from one compartment to the next.

In large compartments, the initial fire will not always develop into a flashover. This is due to the fire gases cooling as they rise to the high ceiling and the structure (steel, concrete) cooling them when they reach the ceiling. This cooling will take the fire gases out of their flammable range preventing them from igniting.

11. Fire Gas Explosion

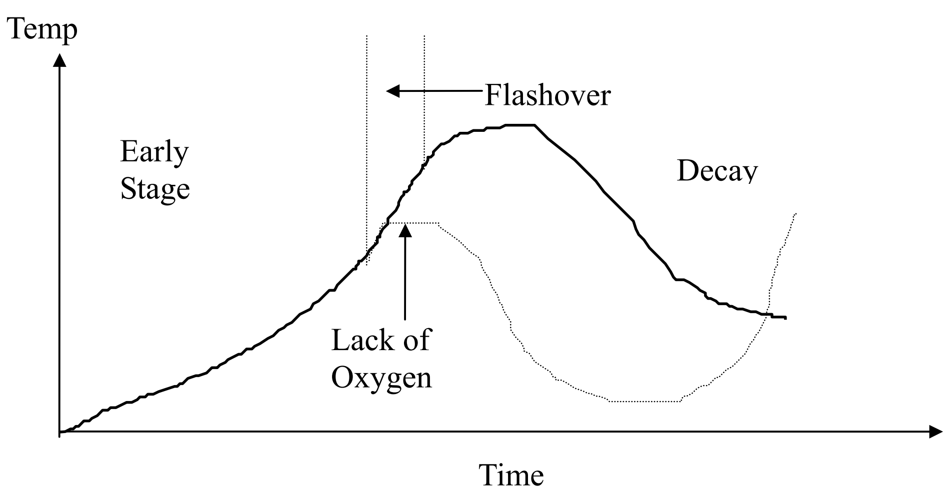
When fire gases are transported into an enclosure adjacent to the fire compartment, these can mix with fresh air. This mixture can, in time, occupy the whole volume and can be close to the stoichometric (IDEAL) mixture concentration. If the mixture is ignited by, for example, a spark from a light bulb, the increase in pressure may be extremely high. This is called a fire gas explosion.

The whole volume of gas ignites instantaneously with massive increases in temperature causing structural damage to the building and loss of life for any persons involved.

It is rare that a fire gas explosion occurs in the fire gas compartment.

12. Backdraught

Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of partial combustion products and unburnt pyrolysis products. If these accumulate, then the admission of air when an opening is made to the compartment can lead to a sudden deflagration. This deflagration moving through the compartment and out of the opening is a backdraught.



Smouldering Fire
If the initial fire is a smouldering fire, it will have insufficient energy to ignite and flashover and will eventually move to a too rich mixture. If the smouldering fire develops or is stirred up by fire-fighters it will then be able to provide an ignition source when the mixture in the compartment is in its flammable range.

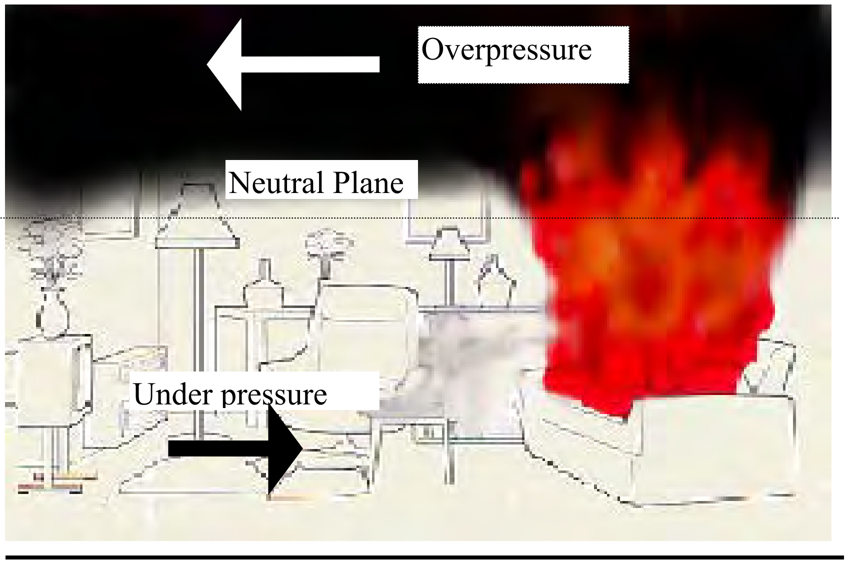
Section III - Fire Extinguishment

When a fire develops inside a compartment two separate layers will appear.

The upper layer will contain the products of the fire (fire gases) and the lower layer will contain the remaining air in the room. Separating these two layers in the neutral plane.

As the fire develops, the pressure in the upper layer will be increasing due to temperature rising and the production of gases from combustion and pyrolysis.

In the lower layer, the pressure will be decreasing as the remaining air in the compartment is being used up and drawn to the fire.



Extinguishing With Water

Water is an ideal extinguishing medium, as it is readily available and when applied to a fire, it attacks all sides of the triangle of fire, ie :

Reduces Fuel The rapid expansion of water to steam dilutes the flammable gases. Reduces further production of flammable gases by Pyrolysis, because of the reduction in heat. The expansion of water to steam drives out some of the existing fire gases.

Reduces Heat Absorbs heat when turning water into steam.

Reduces Oxygen The steam limits the amount of oxygen reaching the fire by smothering.

When water turns to steam it expands in volume by 1:1700. If the temperature is raised to 500C the steam will double in expansion ie : 1:3400.

14.Extinguishing Methods

Extinguishing methods can be grouped under three main headings :
Gas Cooling, Indirect and Direct.

Gas Cooling

The spray is aimed directly into the fire gases. The small droplets passing through the hot gases rapidly cool them, less steam is produced as water does not come into contact with hot surfaces. As the water evaporates into steam the fire gases contract at a greater rate due to them being rapidly cooled, effectively shrinking back the fire gases.

Purpose
Cools and shrinks back fire gases directly in front and above.
Protects firefighters and casualties from hot fire gases.
Does not lower neutral plane so helps maintain visibility.
Branch
Medium/wide spray, using very short pulsation's, aimed directly above and forward.
Effect
Cools fire gases, improving conditions for firefighters.
Neutral plane remains constant due to small quantities of steam produced.
Vision improves.

Indirect

A fire can be extinguished by evaporating water on hot surfaces and producing large amounts of steam.

Purpose

Attack fire gases above the fire.
Cool surrounding area.
Extinguish fire.
Branch
Medium spray aimed above and around the fire.
Branch must be moved around with pulsation's to ensure maximum coverage.
Effect
Cools and extinguishes fire.
Cools structure of compartment.
Large quantities of steam produced has a smothering effect on the fire.
Lowers neutral plane, reducing vision and worsening conditions.

<u>Direct</u>

Purpose
Used directly on the base of the fire.
Branch
Jet/narrow spray aimed directly at the fire.
Effect
Extinguish fire.
Possible water damage.
Entrains air into compartment, intensifying the fire if not correctly used.
Produces large quantities of steam.

15. Effective Use Of Water

To extinguish a fire BA wearers must maintain a fine balance between small quantities of water to keep steam produced to a minimum but sufficient water to extinguish the fire.
Too much water produces large quantities of steam, pushing down the neutral plane and deteriorating the conditions for fire fighters by reduced vision, exposure to steam and arising temperatures.
To cool down the maximum amount of gases with the minimum amount of water, the droplet size from the branch must be kept as small as possible, thereby increasing the amount of surface area of water available

for cooling. These small droplets applied in short pulsation's will provide rapid cooling as they pass through the hot fire gases producing the minimum amount of steam, ensuring conditions inside the compartment are as comfortable as possible.
In addition to the quantity of water used, the place the water is directed is important also. If the water is all over the floor, it is not being effective, therefore the water should be directed into the gas layer where it can be of most benefit.

16. Summary

Although two of the methods for firefighting have been described as indirect and gas cooling, practically, firefighters will use a combination of the two methods. They may decide to use a medium spray with very short pulsation's or a narrower spray with a longer pulsation.

Factors dictating the use of the branch : The size of the compartment.
The contents of the compartment.
The extent of the fire and conditions in the compartment.
Do casualties need rescuing.

Section IV - Flashovers at Incidents

17. Signs of a Flashover

Before entering a compartment, firefighters need to decide if it is safe to enter. The following are signs that a flashover is about to develop :

PAINFUL RADIANT HEAT
CREWS FORCED LOW BY HIGH TEMPERATURES
HOT SURFACES
FLAMES AT CEILING LEVEL
LOWERING OF NEUTRAL PLANE
INCREASED RATE OF PYROLISATION

An increase in the speed and turbulence of the gases indicates that the situation is moving towards flashover (billowing effect).

18. Signs of a Backdraught

FIRE WITH LIMITED VENTILATION
THICK BLACK SMOKE
THICK YELLOW SMOKE
WHITE COLD SMOKE
BLUE FLAMES
HOT DOORS AND WINDOWS
SOOT BLACKENED WINDOWS
LACK OF A VISIBLE FLAME
AIR BEING DRAWN IN (WHISTLING)
SMOKE PULSATING

19. General Principles at an Incident

When firefighters are inside a compartment they should always consider one of the following three options :

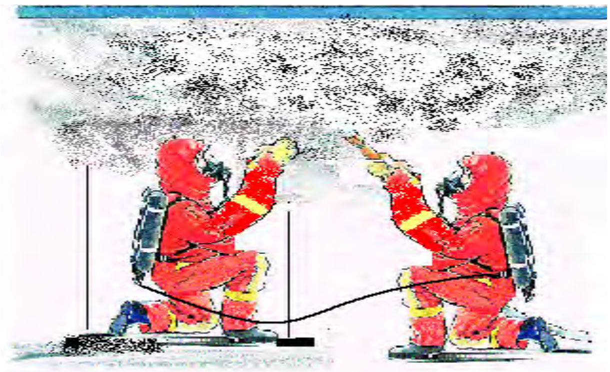
Maintain position	protect their position using gas cooling
Move forward	attack fire gases using gas cooling with short or long pulsation's
Withdraw	if conditions deteriorate withdraw protecting themselves using gas cooling

Firefighters should try to use the minimum amount of water as effectively as possible, ensuring the neutral plane is kept as high as possible, whilst cooling the maximum amount of fire gases.
If the gas cooling and indirect method is applied correctly, then the fire gases will be reduced and cooled sufficiently to take them out of their flammable range.
Painting hot surfaces with a small jet of water will cool surfaces and reduce amount of gases given off by pyrolysis.

20. Fire Gas Observations

When inside a compartment firefighters must keep a constant check on their surroundings, particularly the fire gases at ceiling level :
The team leader will check above and in front
The other team member will check above and behind

21. Door Procedure



Use protection of door and wall, keep low. No. 1 ready to operate the branch, No.2 opening the door. Keep observing the fire gases at all times looking for any signs of flashover.
Remember the wall will be stronger than the door and will give more protection prior to entry, therefore where possible use the wall as protection rather than the door.

22. Temperature Checks

Fire-fighters must carry out temperature checks prior to entering and periodically as they move through a compartment. A quick pulsation is aimed directly into the ceiling. If droplets of water come down then the gases directly above are sufficiently cool to remain in position. If no droplets of water are felt, more pulsation's on the branch are required until droplets appear.

23. Moving Between Compartments

When fire-fighters enter a building, they must ensure the fire in the compartment they are moving into will not ignite fire gases that have leaked into the compartment they are moving from (escape route).

This can be achieved by either :

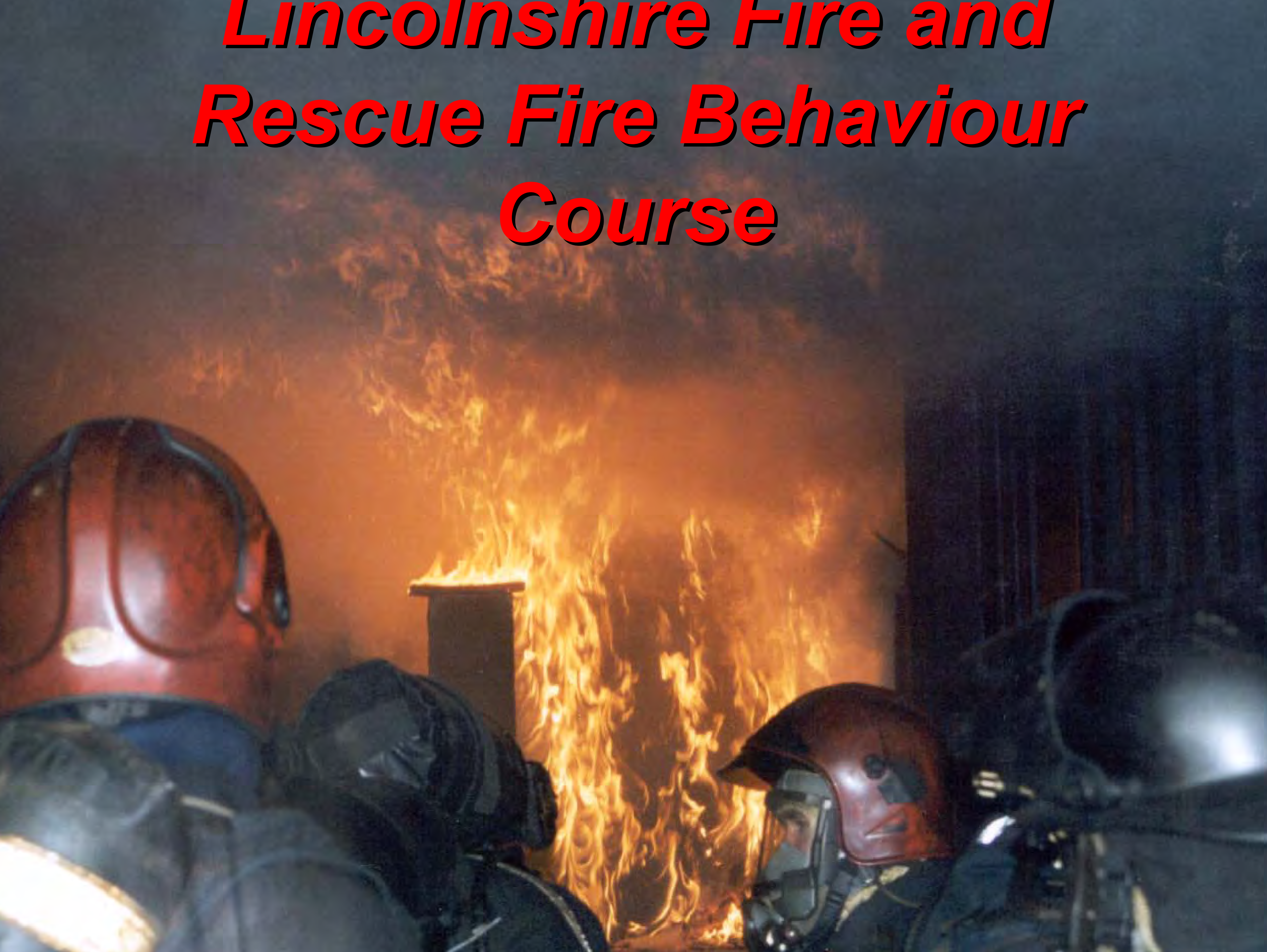
1. Cooling (taking fire gases out of their flammable range).
2. Venting fire gases to outside.

24. Arrival at an Incident

1. Observe building for size, construction, possible contents.
2. Look for signs of a flashover / backdraught.
3. Check branch settings.
4. Open door, using adjacent wall for protection.
5. If unsafe to enter, cool gases and shut door. Keep checking until safe to enter.
6. Temperature check into ceiling.
7. Secure position using gas cooling, advance when safe using appropriate gas cooling techniques.
8. Periodic temperature checks into ceiling.
9. Observe fire gases at ceiling level in front, above and behind at all times.
10. Paint ceiling and walls to prevent re-ignition and secure escape route.
11. Continue advancing through compartment using the principles laid down in points 7, 8, 9 and 10.
12. Paint water onto the base of the fire using the direct method. Cool all surfaces to prevent further gases being given off. If conditions deteriorate then the firefighters should withdraw, observing the fire as they retreat and protecting themselves by gas cooling.

13. When rescuing casualties, the gas cooling method is used to keep the neutral plane as high as possible, thereby increasing their chances of survival from fire, gas and steam burns. This method is purely used to protect firefighters to enable them to advance and locate casualties and withdraw. Firefighters can then re-enter to attack the fire gases and extinguish the fire.
14. When more than one compartment is involved, procedures outlined in the above can be used as firefighters move through each compartment. They must ensure a compartment is safe before entering the next compartment, using the principles laid down in points 2 - 10.

Lincolnshire Fire and Rescue Fire Behaviour Course



Welcome to the Training Department

COURSE DIRECTOR COURSE INSTRUCTORS

FIRE ALARM PROCEDURE

FIRST AID : ACCIDENT BOOK

LUNCH DETAILS (Please use dishwasher)

GENERAL LAYOUT OF THE BUILDING , toilets

TEA BREAK : SMOKING

PLEASE LEAVE MOBILE PHONES SWITCHED OFF

GENERAL HOUSEKEEPING

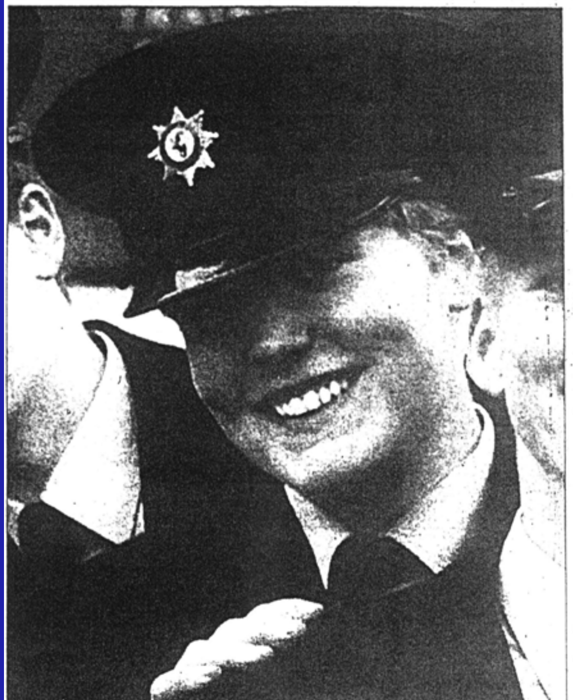
IF IN DOUBT ASK !!!

Why do this training?

- Greater knowledge and understanding
- Changes in building design and materials
- Home Office “Expectations Document”
- HSE improvement notice due to……

BLAINA – GWENT 1996

FLEUR LOMBARD – AVON 1996



Fleur Lombard, 21, excelled as a trainee and was one of a handful of women firefighters

The fire at Leo's supermarket in Bristol in which Miss Lombard was killed

First death of a woman firefighter in store blaze

By Helen Johnstone

A YOUNG woman became the first female firefighter to die on active duty yesterday when the roof of a blazing supermarket collapsed after she went inside to check for trapped people.

Fleur Lombard, 21, was hit by falling debris after entering the building with another officer. He went home after hospital treatment for facial burns, cuts and bruises.

The two were found and pulled clear by six colleagues after becoming trapped minutes after fighting their way into Leo's supermarket in Staple Hill, near Bristol. Paramedics tried to revive Miss Lombard but she died minutes after reaching hospital.

Miss Lombard had been a firefighter for about two years. She was one of the first women to join the 700-strong Avon Fire Brigade full-time, having served in Derby as a part-time retained firefighter. Only a handful of women have taken the opportunity to become firefighters since Britain allowed them to serve on active duty in 1982.

Her father, Roger Lombard, a businessman, of Furness Vale, New Mills, Derbyshire, said: "We were extremely proud of her. She died doing what she wanted to do. Our only consolation is we have been told she knew nothing of what happened.

"She achieved the extremely high distinction of being the first female fire officer to be awarded the Silver Axe." The honour goes to each 15-week training course's best recruit.

Rob Seaman, 27, the officer in the building with Miss Lombard, was recovering at home last night with his wife, Sarah, and their six-month-old daughter. Mrs Seaman, a nurse, said: "He was very lucky to get out alive. Physically his wounds are superficial but mentally the scars will go much deeper."

John Terry, Avon deputy chief fire officer, said: "Our job was to get in straight away and that was what she did. She died doing her job. Everyone in the brigade is absolutely devastated."

Andrew Smith, 29, a fireman who served with Miss Lombard in Derbyshire, said she was "the best firefighter I have ever seen". He added: "She was brilliant and excelled at everything she did."

The alarm was raised about midday by Sylvia Anstey, 45, who said: "I saw a blanket of thick black smoke gushing through the windows. A couple were climbing out of ground-floor office windows."

Staff cleared the building within minutes of flames being seen. Miss Lombard was with the first two units to arrive from the Speedwell station, about a mile away.

It took four hours to bring the blaze, fought by 60 firefighters with eight fire appliances and a turntable ladder, under control. The building was gutted.

Last night, the shell was still burning and the cause of the fire was being investigated. The brigade confirmed that investigators were looking at the possibility that a flashover, or rolling wall of flame, caused by spirits from the drinks section, had exploded and brought the roof down.

Since 1990, some 21 firefighters have been killed in Britain. The tragedy came three days after two who served part-time — Stephen Griffin, 42, and Kevin Lane, 32 — died in Blaina, Gwent. They had gone back into a house for a child who had been saved.

Aim

Understand the burning characteristics, development and behaviour of fire, and recognise and assess the risks involved when dealing with compartment fires.

Also:

To enable you to implement the control measures to protect yourselves from the effects of fire and to control and extinguish fires.

Objectives

- Describe the characteristic development and behaviour of a compartment fire
- Describe the combustion process within a compartment and the contribution made by fuel to a fires growth and development
- Describe the characteristics and effects of flashover and backdraught conditions
- Experience the visual and physical conditions of a typical developing fire

Objectives

- Recognise the signs and symptoms indicating the potential for a flashover or backdraught to occur
- Predict the effects of water as an extinguishing agent and extinguishing techniques for compartment fires
- Describe the control measures used to provide protection from the effects of fire

Course Syllabus Day 1

- Introduction / Health and Safety
- Candle Demonstration
- Combustion
- Triangle of Fire
- Pyrolosis

Course Syllabus Day 1

- Passive Agents
- Fire gases
- Limits of flammability
- Bang box demonstration
- Demo 1

Course Syllabus Day 2

- Backdraught theory
- Flashover theory
- Fire Gas explosion theory
- Aquarium demonstration
- Extinguishing with water

Course Syllabus Day 2

- Gas cooling
- Direct
- Indirect
- General Principles at an Incident
- Compartment entry
- Window Box
- Demo 2

Health and Safety

- All students fit and well to take part?
- Anyone on any medicine or drugs?
- Is your PPE in good order?
- If you feel unwell or receive any injuries during the course you must inform one of the instructors.
- Remove all watches, rings and jewellery.
- No mobile phones, lighters or metal objects to be taken into the units.

Health and Safety for Fire Development site

- Keep on the site at all times
- Keep on the tarmac area at all times
- Do not enter any disused buildings
- Do not handle any spent ammunition
- Be aware of FOD, take any rubbish away with you
- Fluid intake – little but often

Candle Demonstration

Questions

1. Why does the flame grow when it’s placed in a corner?
2. When the gauze is placed over the flame, why are the gases blackened?
3. When the gauze is placed over the flame at a lower level, why are the gases lighter?
4. When the gauze is placed over the flame, why doesn’t the flame penetrate the gauze?
5. With the gauze placed over the flame and looking from above, the area immediately around the wick isn’t burning, why?


COMBUSTION

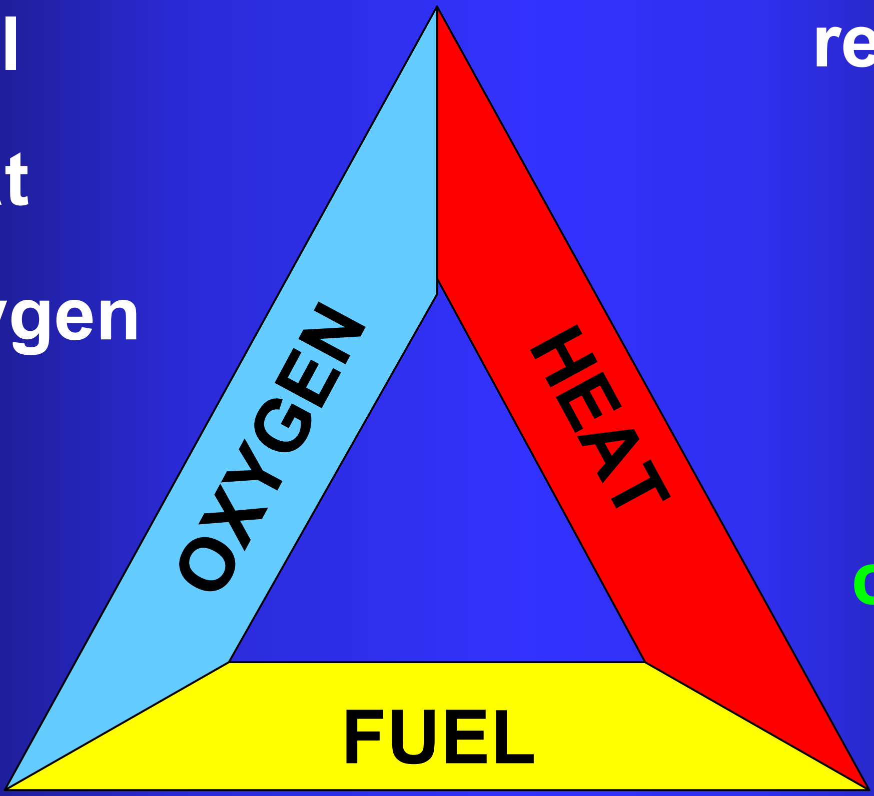
Combustion

Fire is a chemical reaction in which fuel combines with oxygen. This reaction (combustion) requires energy (heat) to enable it to work and emit light.

Combustion

For combustion to take place you require;

1. Fuel
2. Heat
3. Oxygen



This is often referred to as the Triangle of Combustion

Take any side away and combustion will not continue

Combustion

For a candle to burn, an impulse of energy is required to start the process (i.e.match). Heat from the lighted match melts the wax to form a liquid which is drawn up the wick.

The heat from the match turns the liquid into a flammable vapour. The vapour is ignited by the match, forming a flame. The flame now produces heat and light which melts more wax, and the cycle continues.

Combustion

However, there are certain factors which can affect the Process of Combustion such as:

- Pyrolosis
- Passive agents
- Fire Gases
- Limits of flammability

Pyrolosis

What is Pyrolosis?

Pyrolosis is the decomposition of a substance by heat.

If a substance (solid or liquid) is heated, gases will be given off. At the right temperature and mixture these gases are flammable.

Pyrolosis

The contents and structure (paint, timber, plastics, textiles etc.) of a compartment will all give off gases due to pyrolosis when heated. The amount of pyrolosis taking place will increase as the temperature rises.

Passive Agents

As mentioned previously there are three sides to the triangle of fire, which requires that fuel, heat and oxygen must be present for combustion to occur.

However there is a further factor which will affect the triangle. This factor can be termed as "Passive Agents"

Passive Agents

These passive agents are present in any combustion process and take no part in the chemical reaction of combustion, but the fact that they absorb heat energy will have an affect on the fire's behaviour.

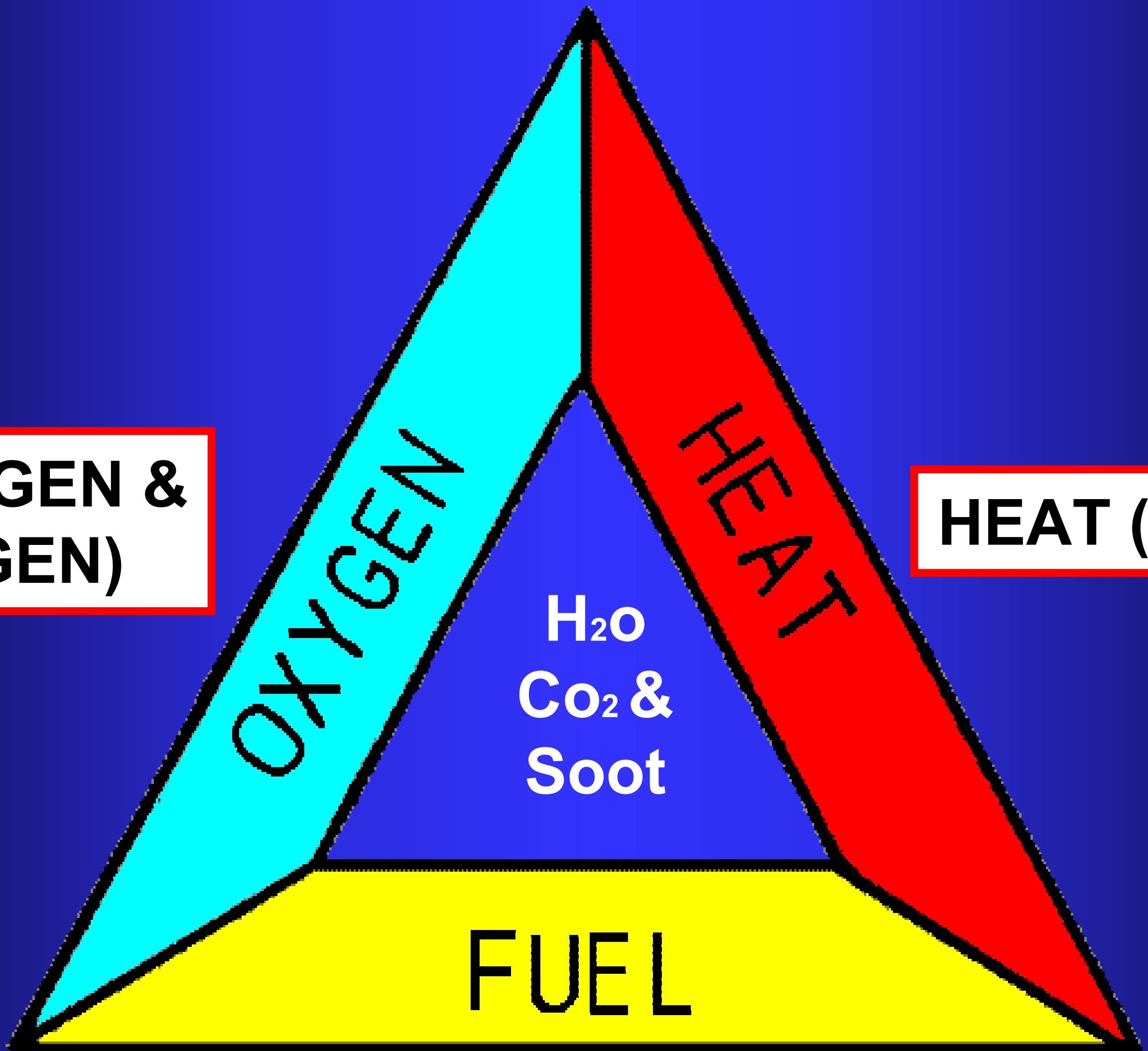
Passive Agents

Passive agents are:

- **Non-flammable gases-(carbon dioxide, water vapour)**
- **Soot-carbon particles**
- **Nitrogen-a constituent of air that remains inert throughout combustion**

Passive Agents

AIR (OXYGEN & NITROGEN)



HEAT (ENERGY)

FUEL (GASES)

Fire Gases

The products of combustion (smoke) are known as Fire Gases and consist of:

- Non Flammable Gases – mainly carbon dioxide and water vapour
- Flammable Gases – due to pyrolosis and incomplete combustion, includes carbon monoxide
- Air – entrained in by rising temperature
- Soot - mainly carbon particles

Fire Gases

FIRE GASES, NO MATTER WHAT COLOUR OR TEMPERATURE CAN BE FLAMMABLE, AND IN CERTAIN CONDITIONS, POTENTIALLY EXPLOSIVE.

BEWARE!!!

Limits of Flammability

A flammable gas will only burn in air if its composition lies between certain limits.

If too little or too much fuel is present, burning will not take place; the mixture is either too lean or too rich.

These limits are referred to as the lower explosive limit (LEL) and the upper explosive limit (UEL).

Limits of Flammability

The lower limit is defined as the lowest concentration of fuel that will just support a self-propagating flame.

The upper limit is defined as the highest concentration of fuel that will just support a self-propagating flame.

Between these limits, which are given as percentages, is the flammable range of the gas.

Limits of Flammability

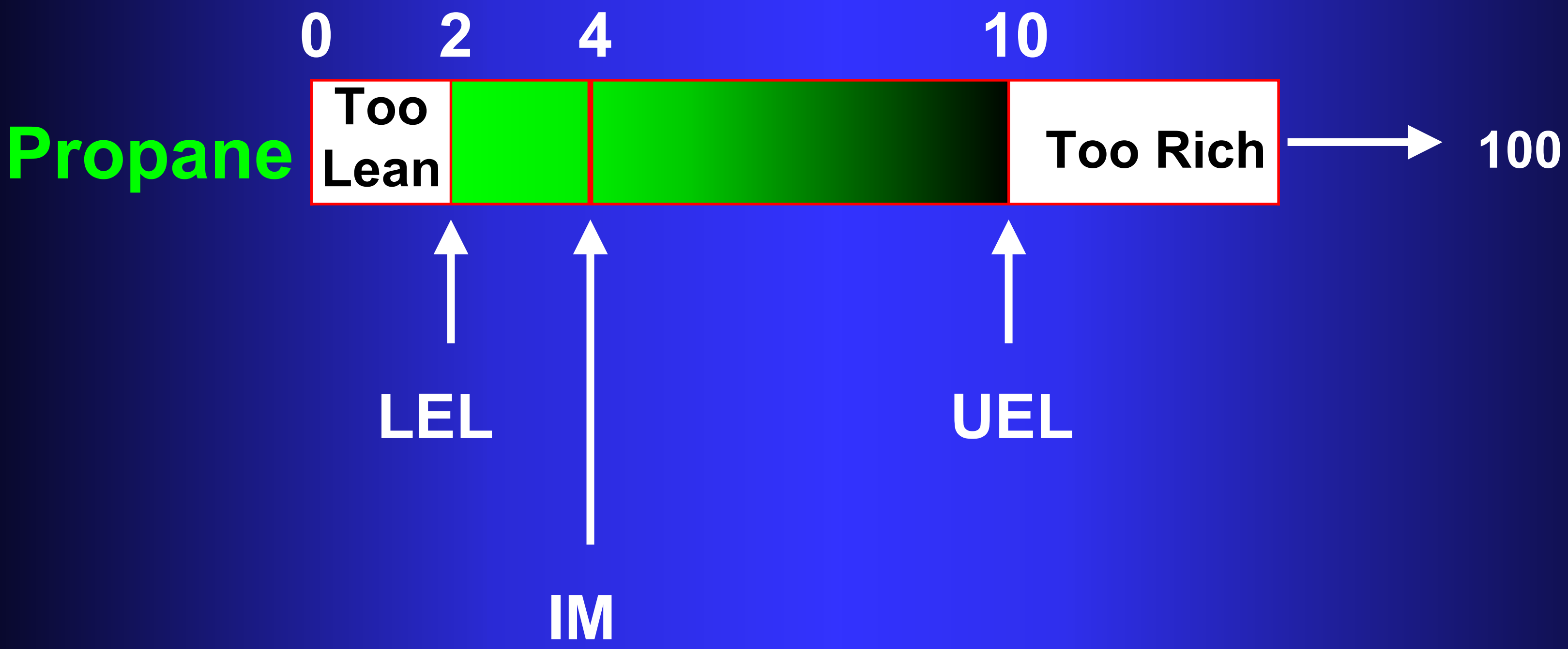
For every gas there is a particular concentration where the amount of gas is exactly right in relation to the amount of oxygen in the air for combustion to occur.

This is known as the ideal mixture (IM), and is found, between the lower and upper limits.

Combustion occurs at the ideal mixture with maximum force.

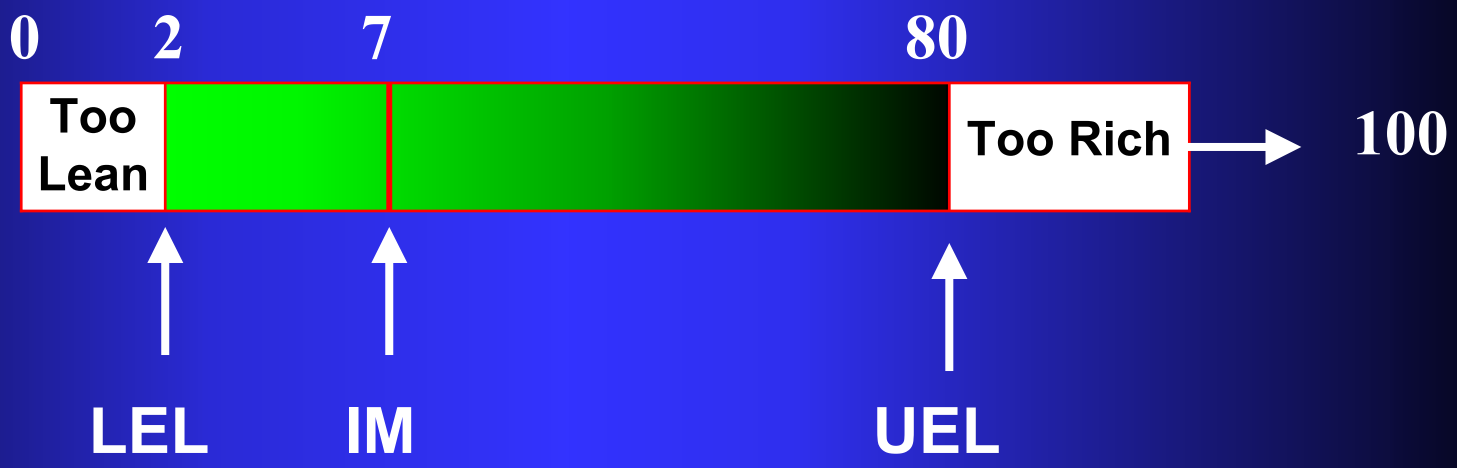
Limits of Flammability

On a scale from 0 – 100% the flammable range for any gas can be marked e.g.



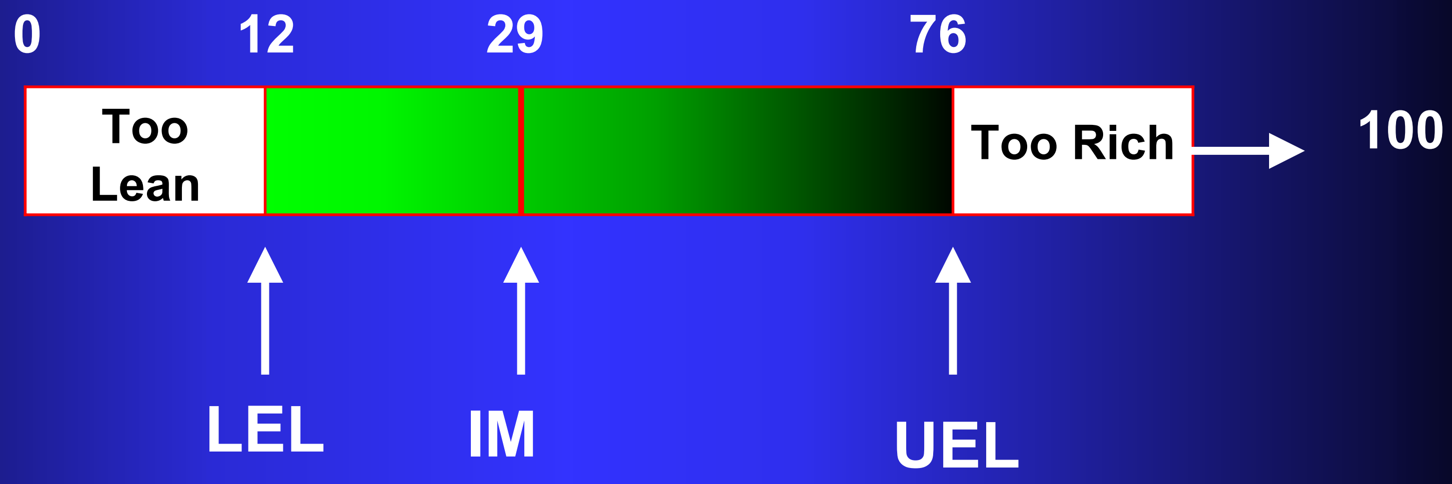
Limits of Flammability

Acetylene



Limits of Flammability

Carbon Monoxide

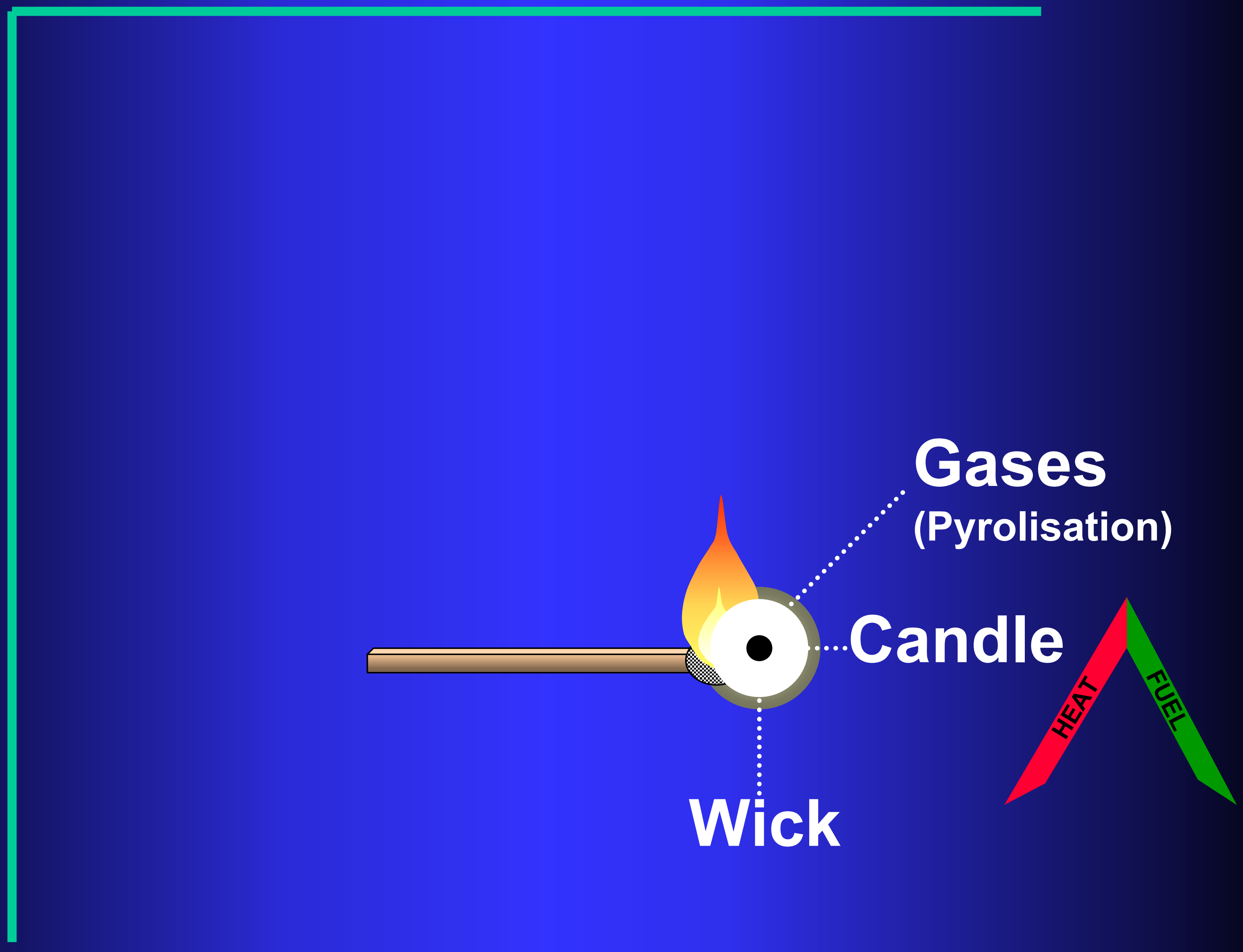


Bang Box Demonstration

Answers for candle demonstration

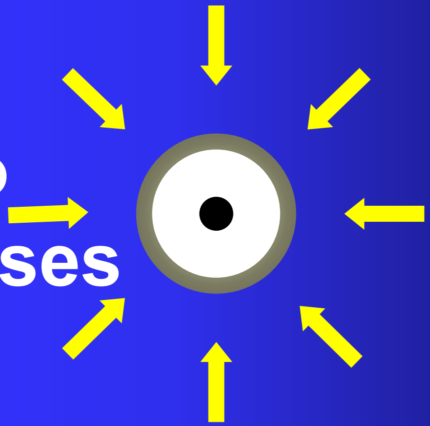
1. Why does the flame grow when it’s placed in a corner?

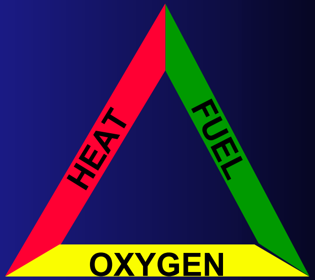
Top View



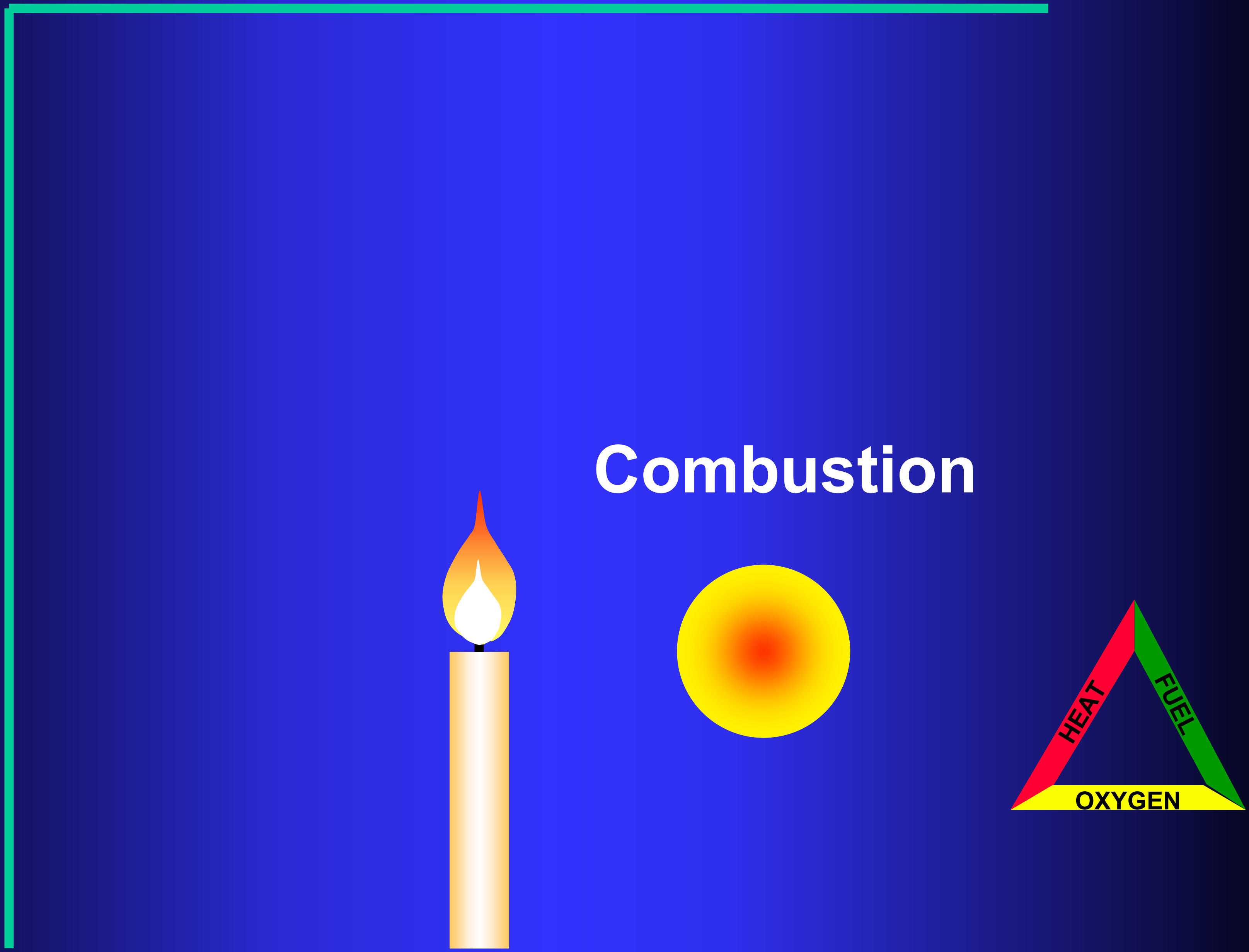
Top View

Air is drawn in to replace rising gases

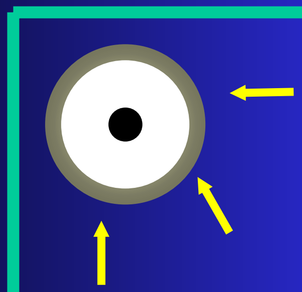




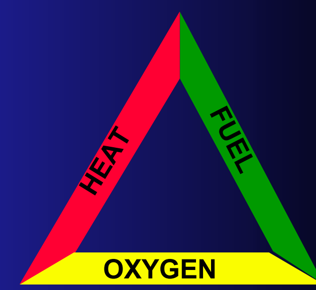
Top View



Top View

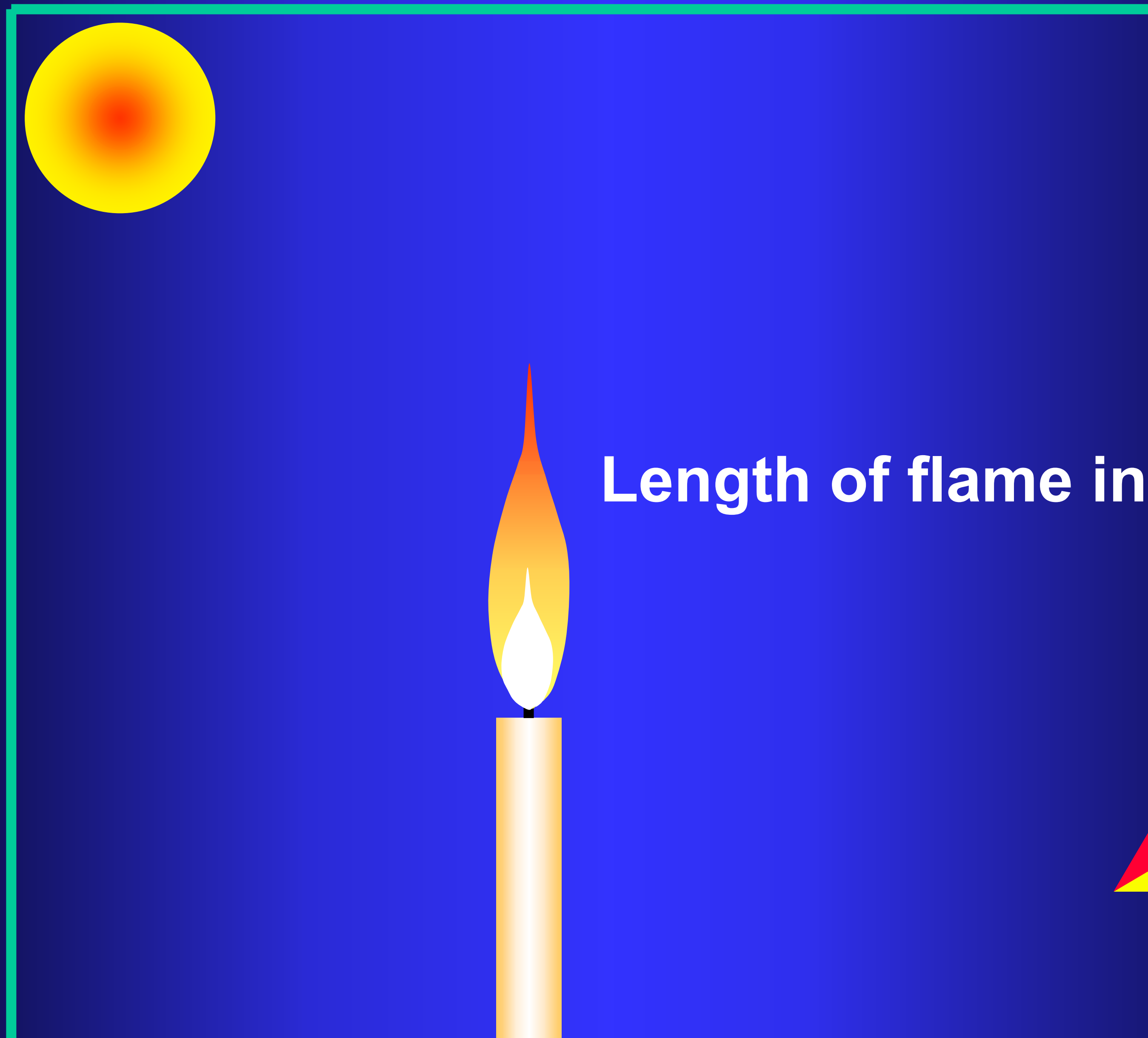


The amount of oxygen is now limited.
The combustion requires more oxygen.
How is this achieved?

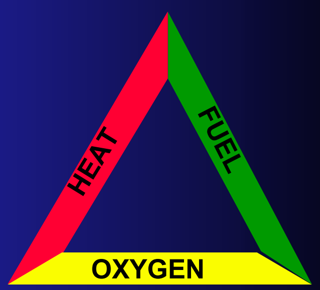


Candle is now placed in the corner

Top View

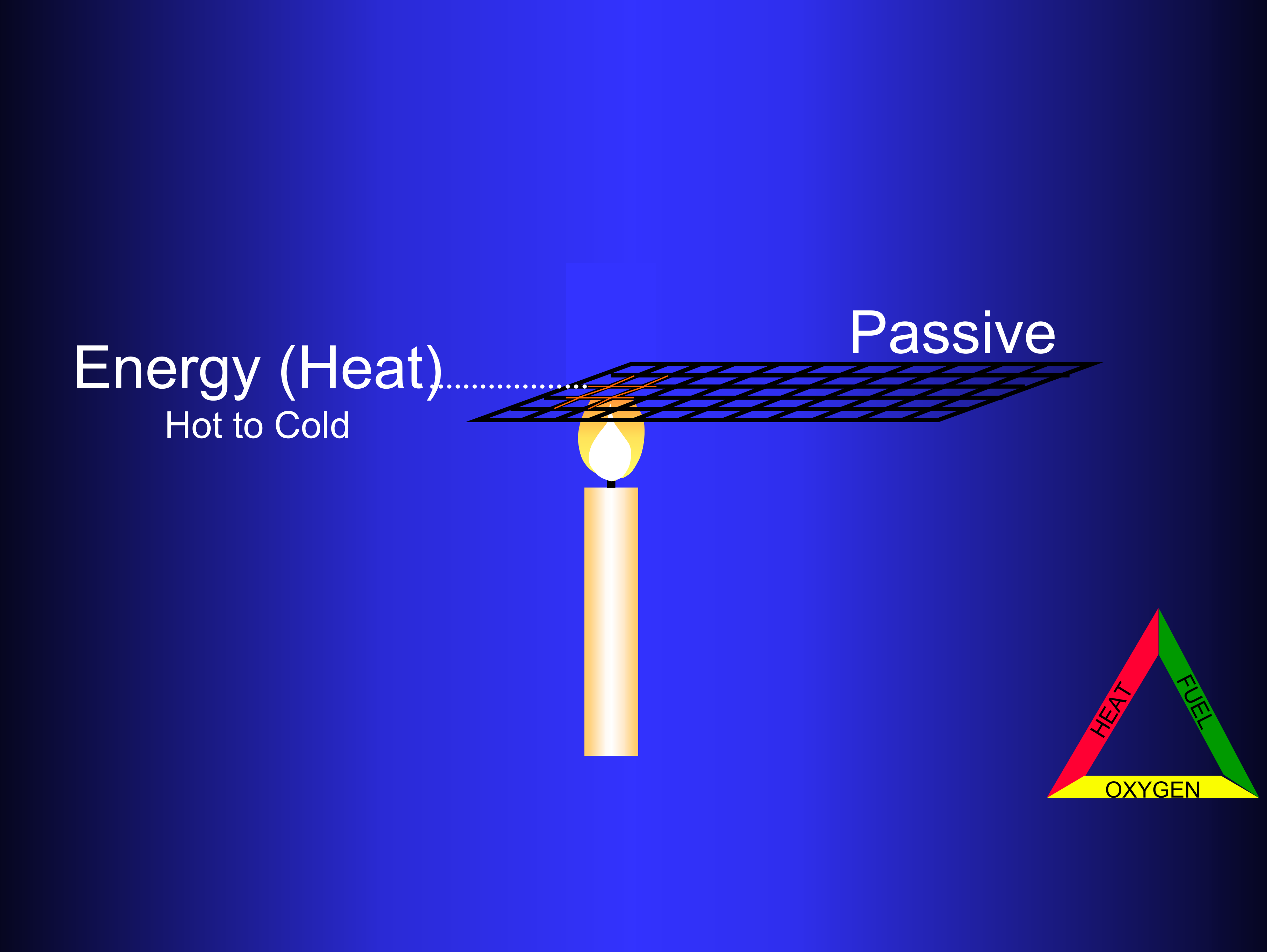


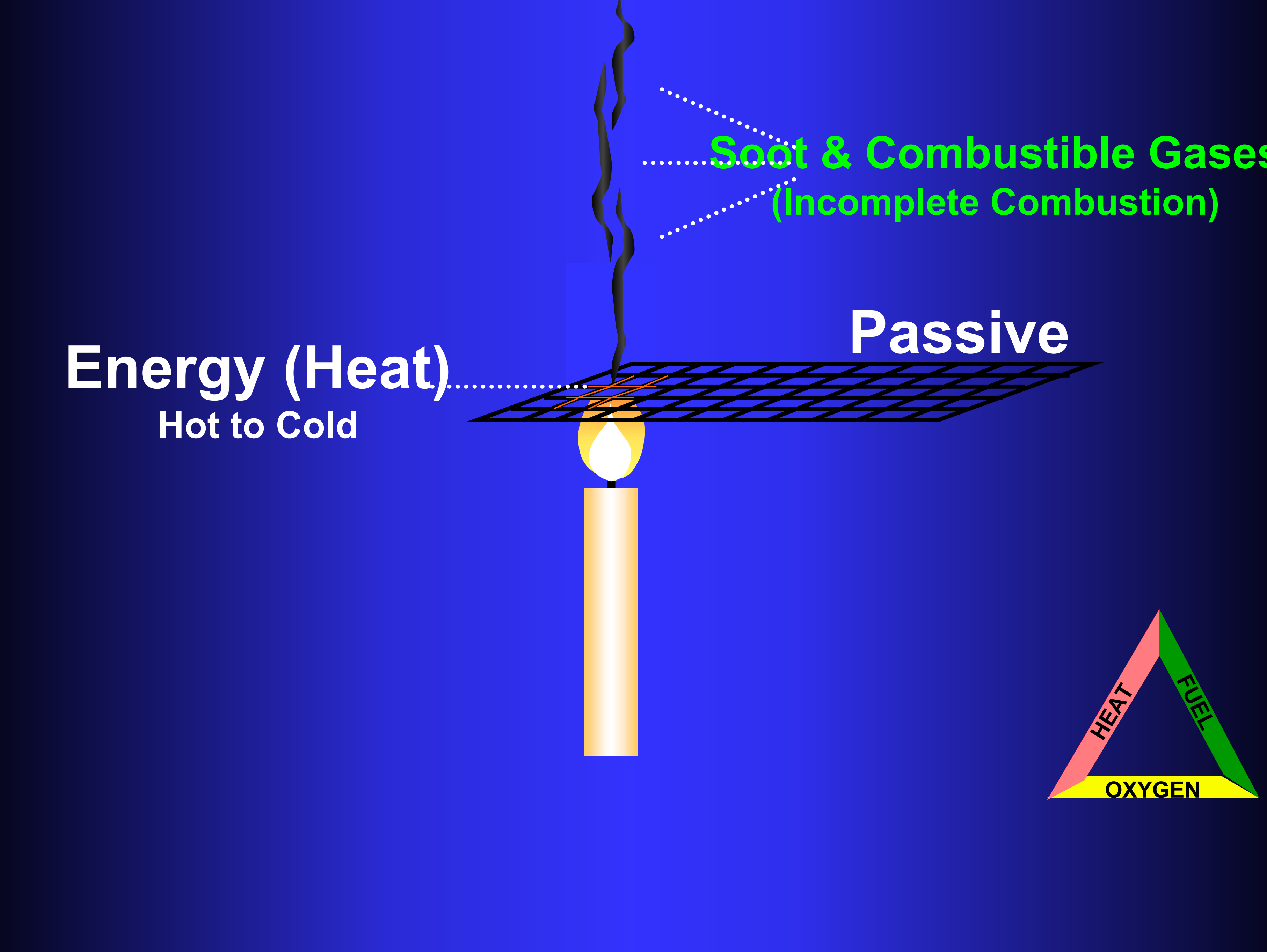
Length of flame increases



Answers

2. When the gauze is placed over the flame, why is the smoke blackened?


Passive
Energy (Heat)
Hot to Cold
HEAT
FUEL
OXYGEN


Soot & Combustible Gases
(Incomplete Combustion)
Passive
Energy (Heat)
Hot to Cold
HEAT
FUEL
OXYGEN

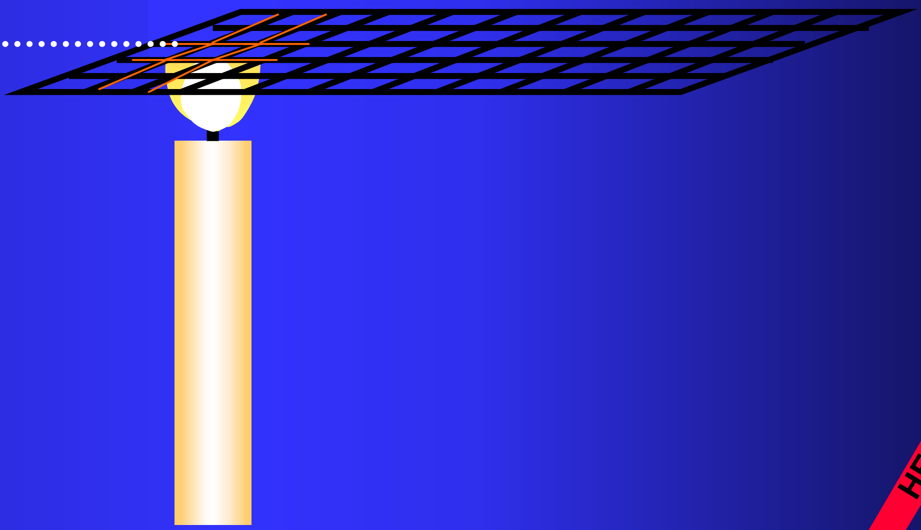
Answers

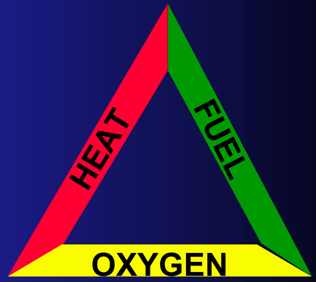
3. When the gauze is placed over the flame at a lower level, why are the gases lighter?

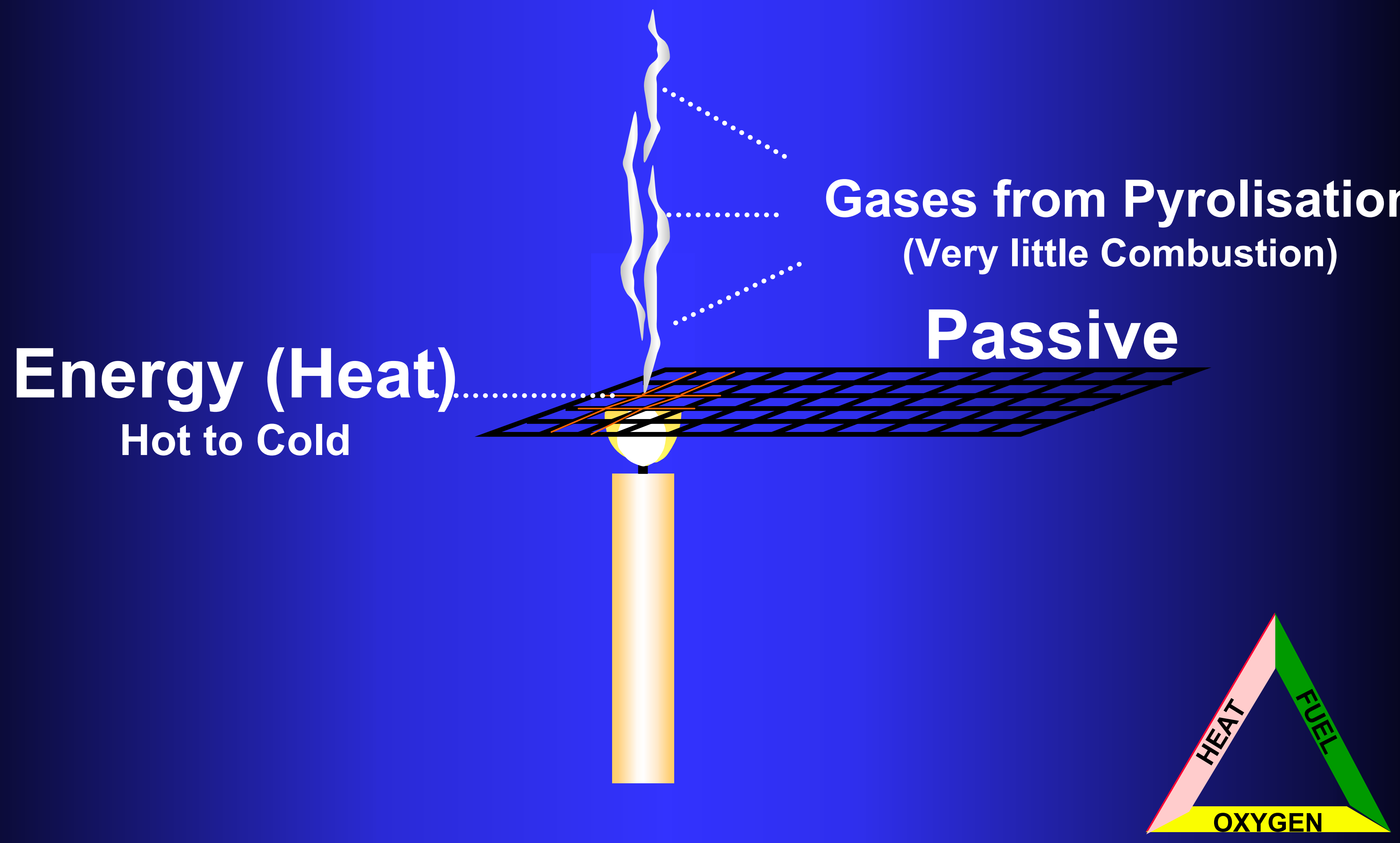
Passive

Energy (Heat)

Hot to Cold






Gases from Pyrolisation
(Very little Combustion)
Passive
Energy (Heat)
Hot to Cold
HEAT
FUEL
OXYGEN

Answers

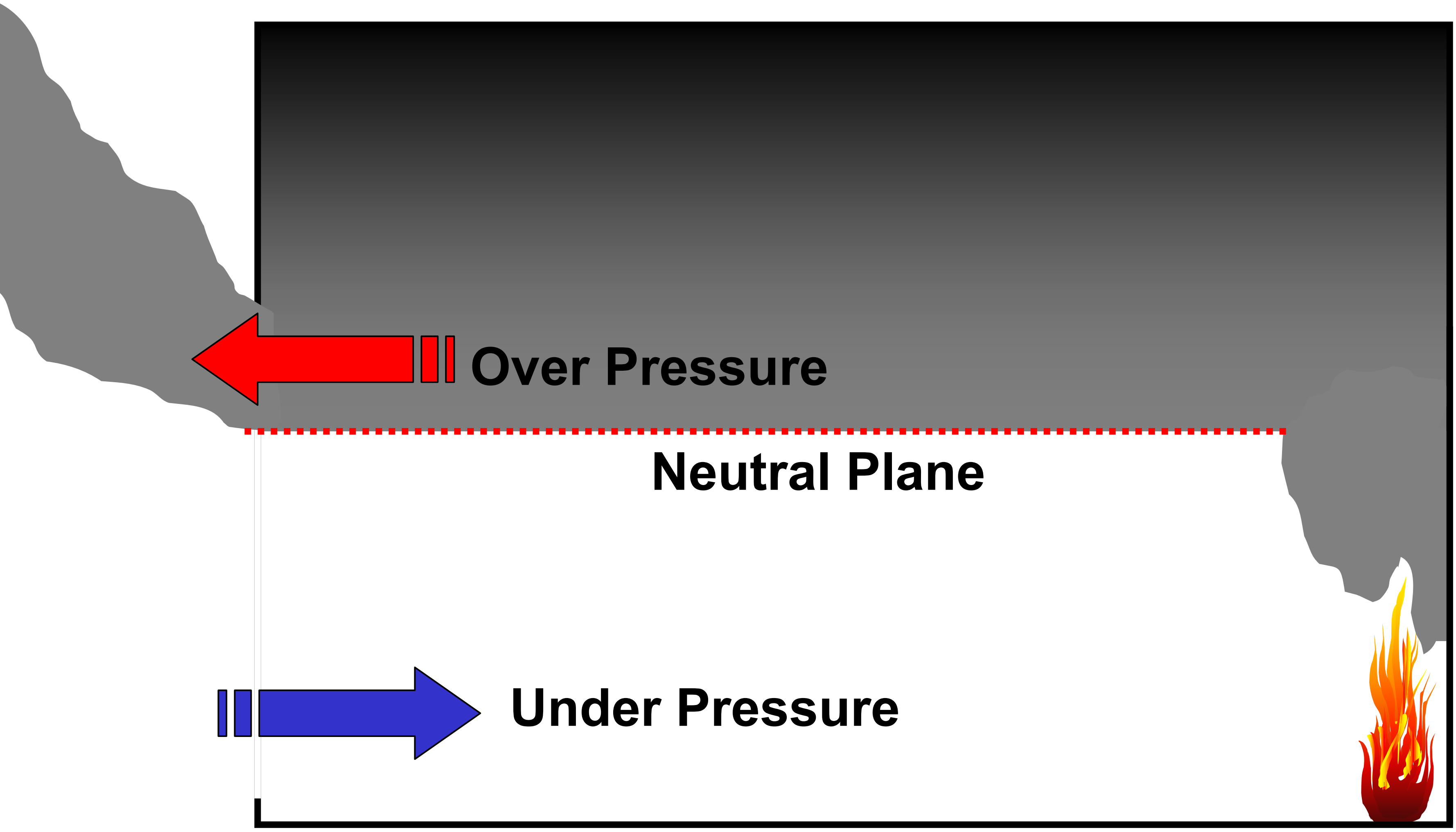
4. When the gauze is placed over the flame, why doesn't the flame penetrate the gauze?

   The gauze itself is acting as a passive and absorbing the heat energy from the flame, therefore the gases above the gauze will not ignite due to a lowering of heat energy

Answers

5. With the gauze placed over the flame and looking from above, the area immediately around the wick isn't burning, why?

   The gases given off immediately around the wick are too rich, when the gases mix with the air that is being drawn up, an area called the reaction zone is formed, the ideal mix is created and ignition takes place


Over Pressure
Neutral Plane
Under Pressure

Backdraught

Definition

"the explosive or rapid burning of heated gases (un-burnt pyrolysis products) that occurs when oxygen has been introduced into a compartment or building that has a depleted supply of oxygen (limited ventilation) due to an existing fire".

Signs & Symptoms

- Fire with limited ventilation.
- Lack of a visible flame.
- Blue flames
- Thick black smoke.
- Thick yellow smoke.
- White cold smoke.
- Soot blackened windows.
- Hot door and windows.
- Air being drawn in (whistling).
- Smoke pulsating.


HEAT
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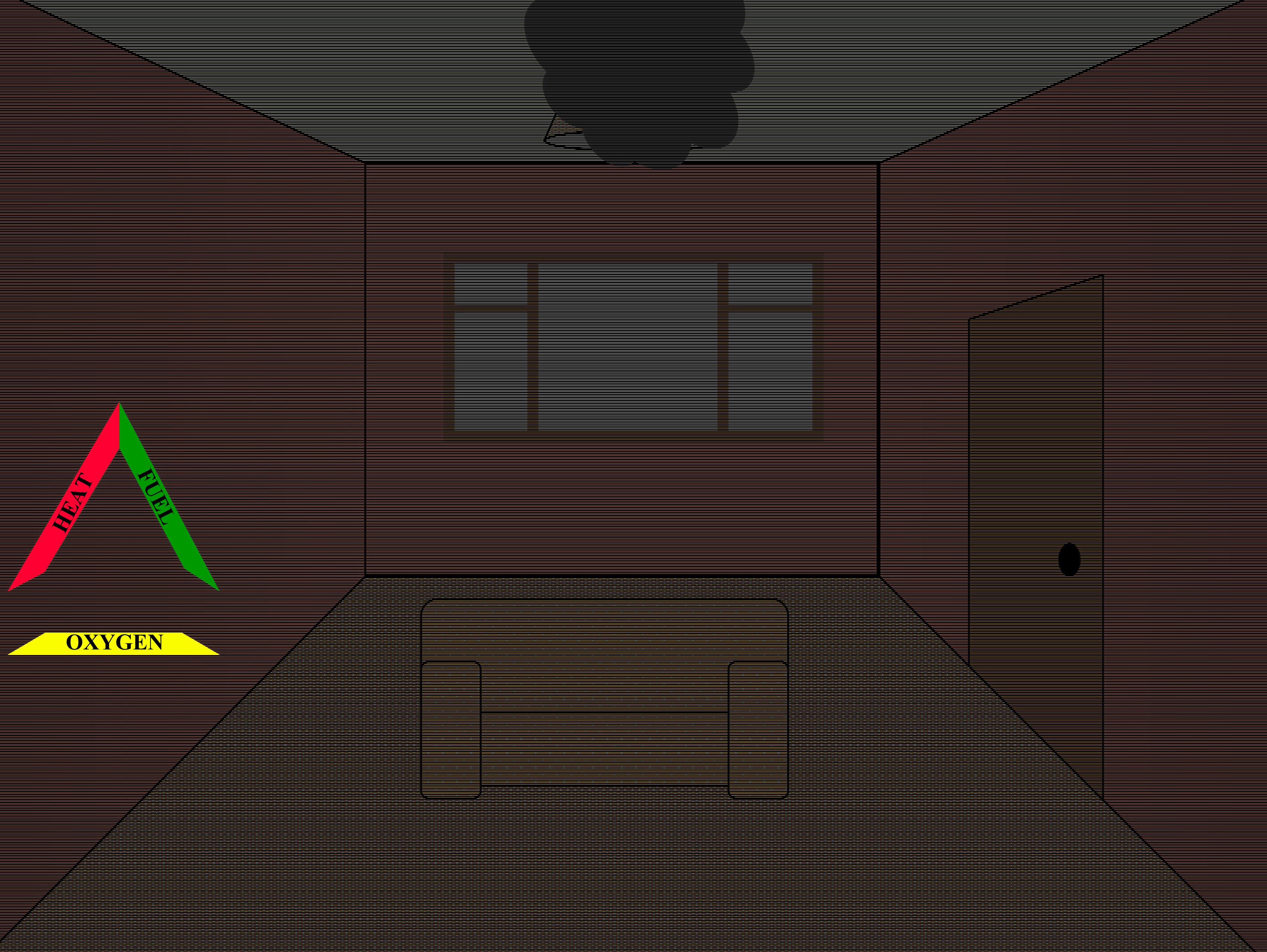
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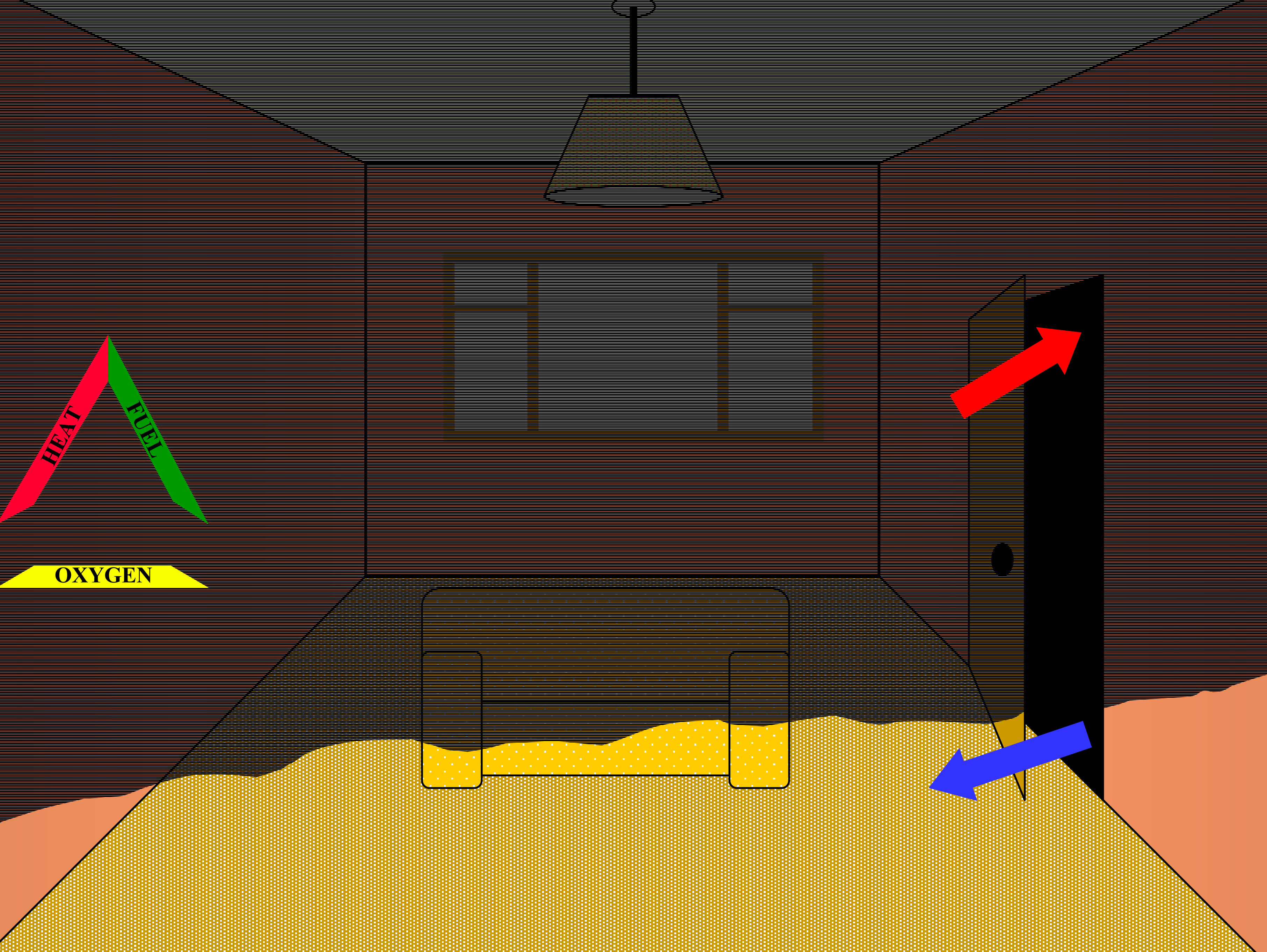
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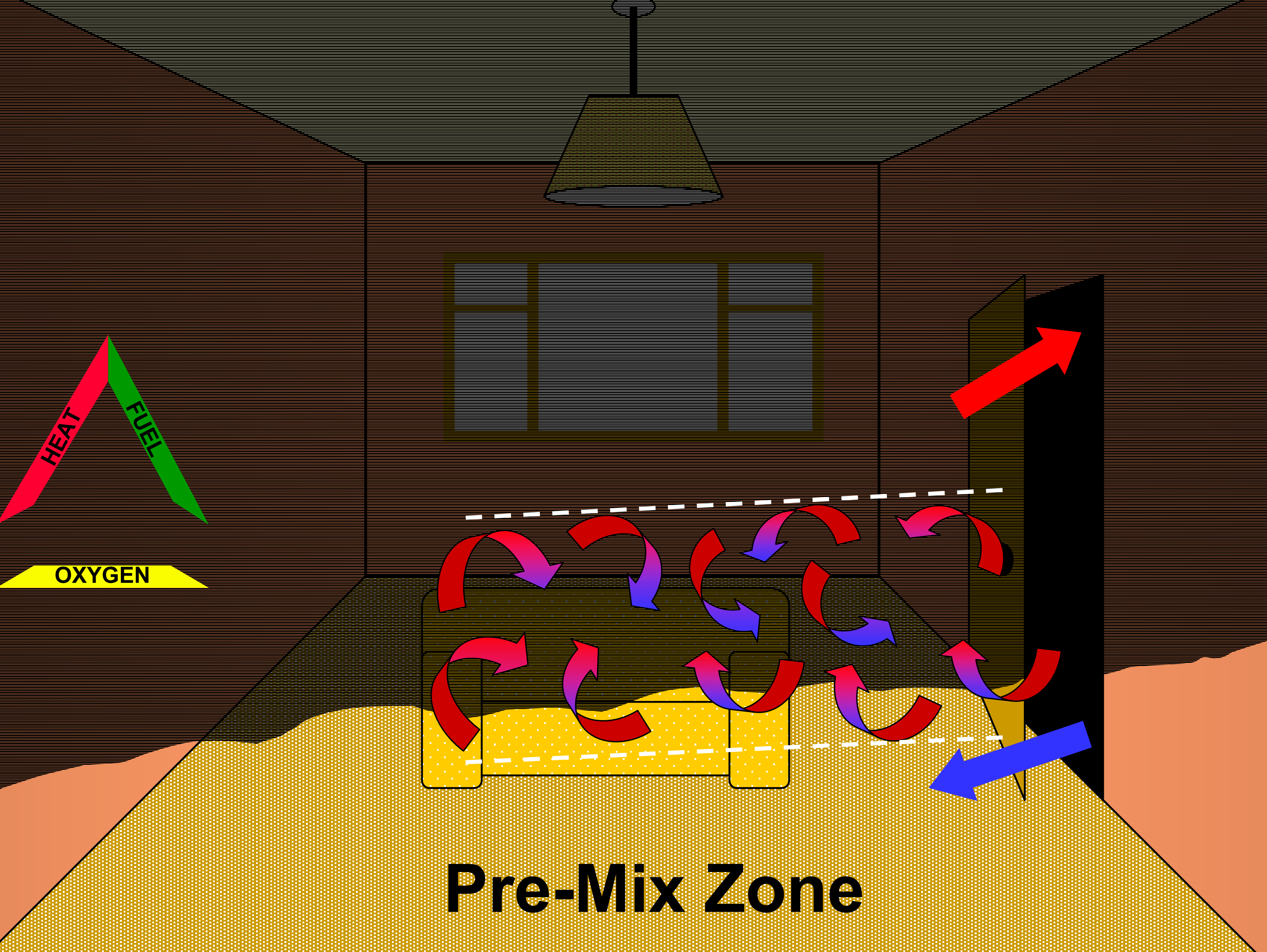
HEAT
FUEL
OXYGEN
Pre-Mix Zone


Backdraught

Flashover

Definition

"In a compartment fire there can come a stage where the heat from the fire, gases and boundaries causes the ignition of all exposed surfaces. This sudden and sustained transition to a fully developed fire is Flashover".

Signs & Symptoms

- Well ventilated free burning fire
- Painful radiant heat
- Rapid rise in temperature
- Crews forced low by high temperature
- Hot surfaces
- Lowering of neutral plane
- Increased turbulence in neutral plane
- Materials starting to pyrolise
- Flickers of flame in smoke layer
- (Dancing Angels – Ghost Flames)


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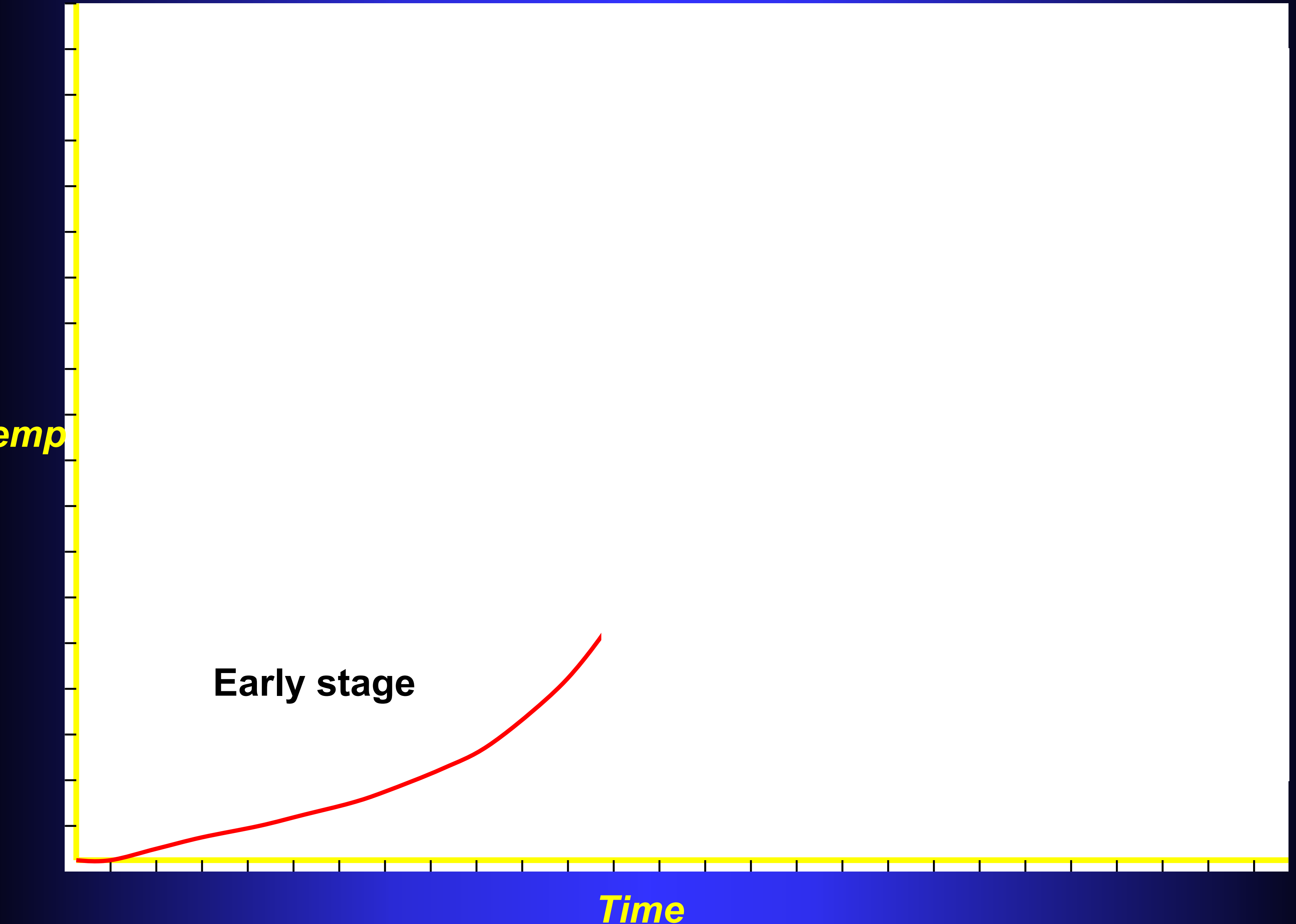
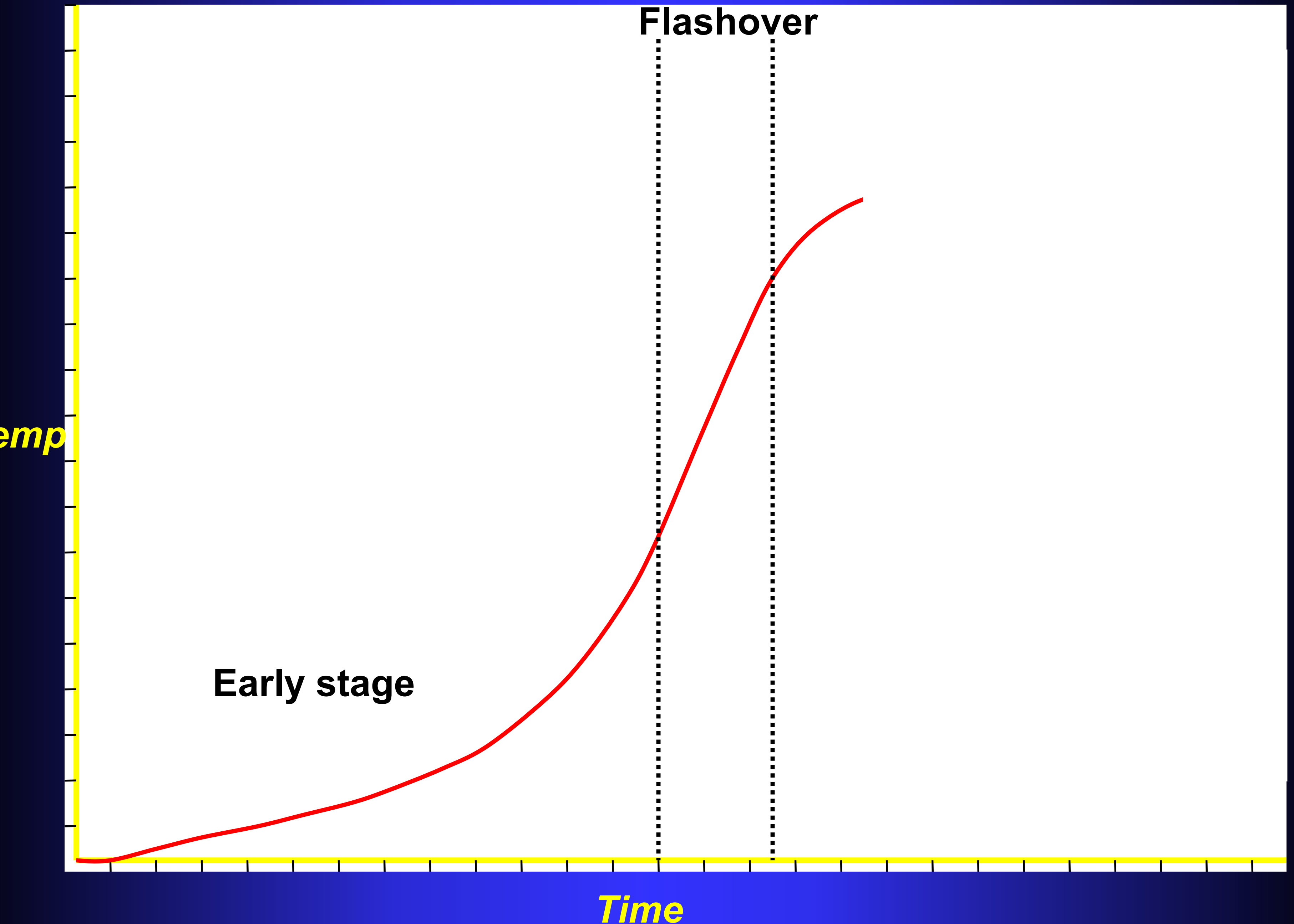
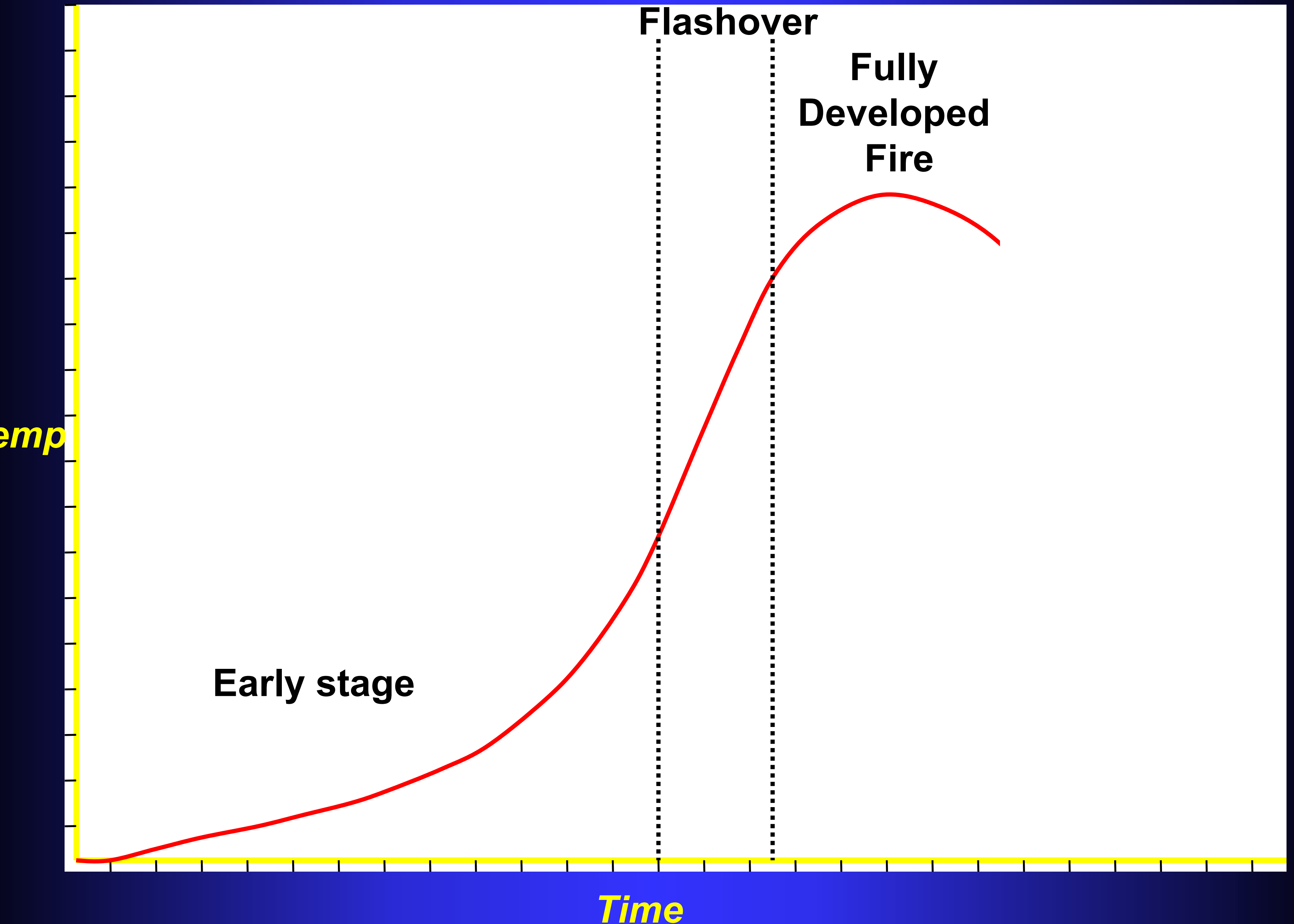
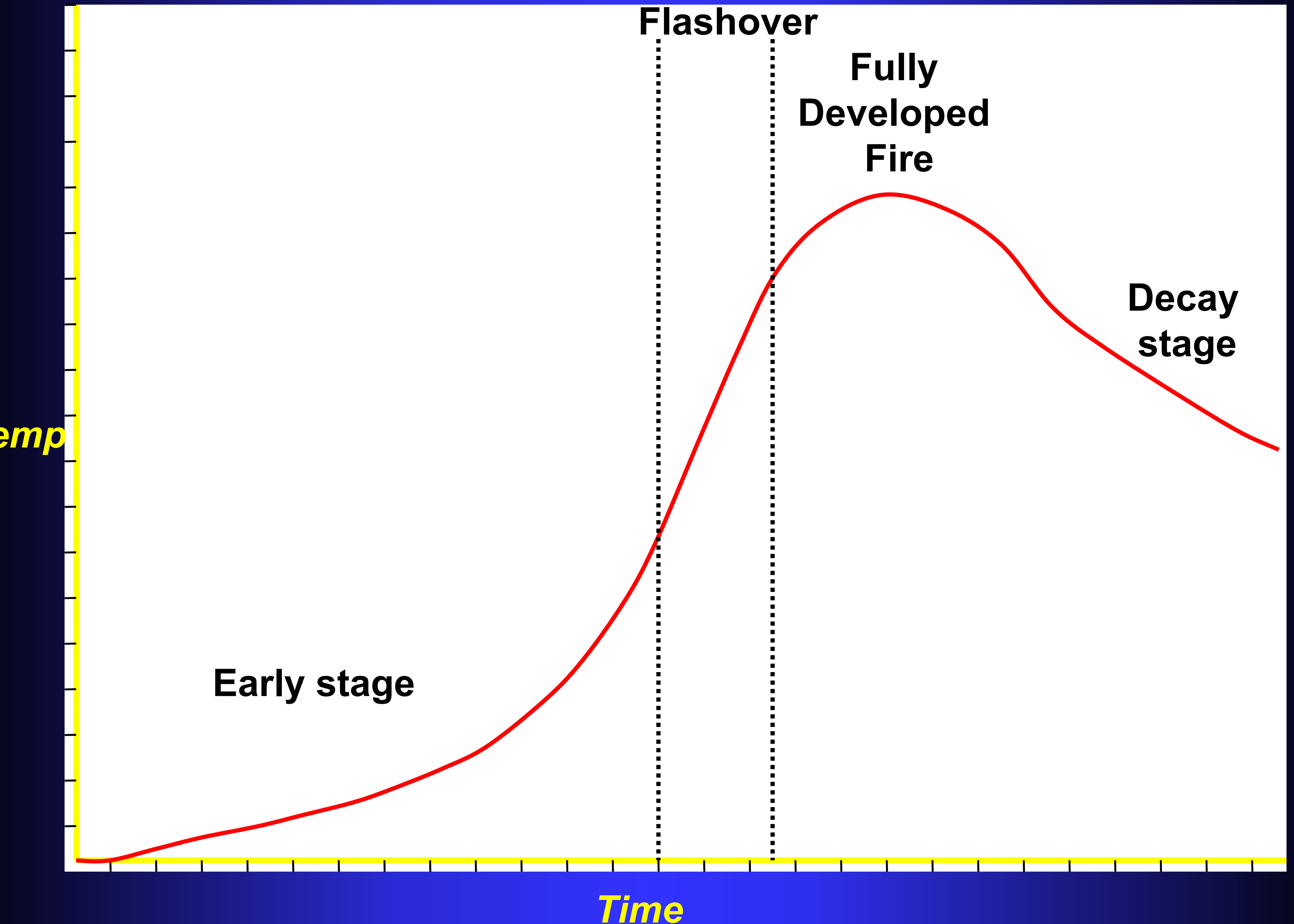
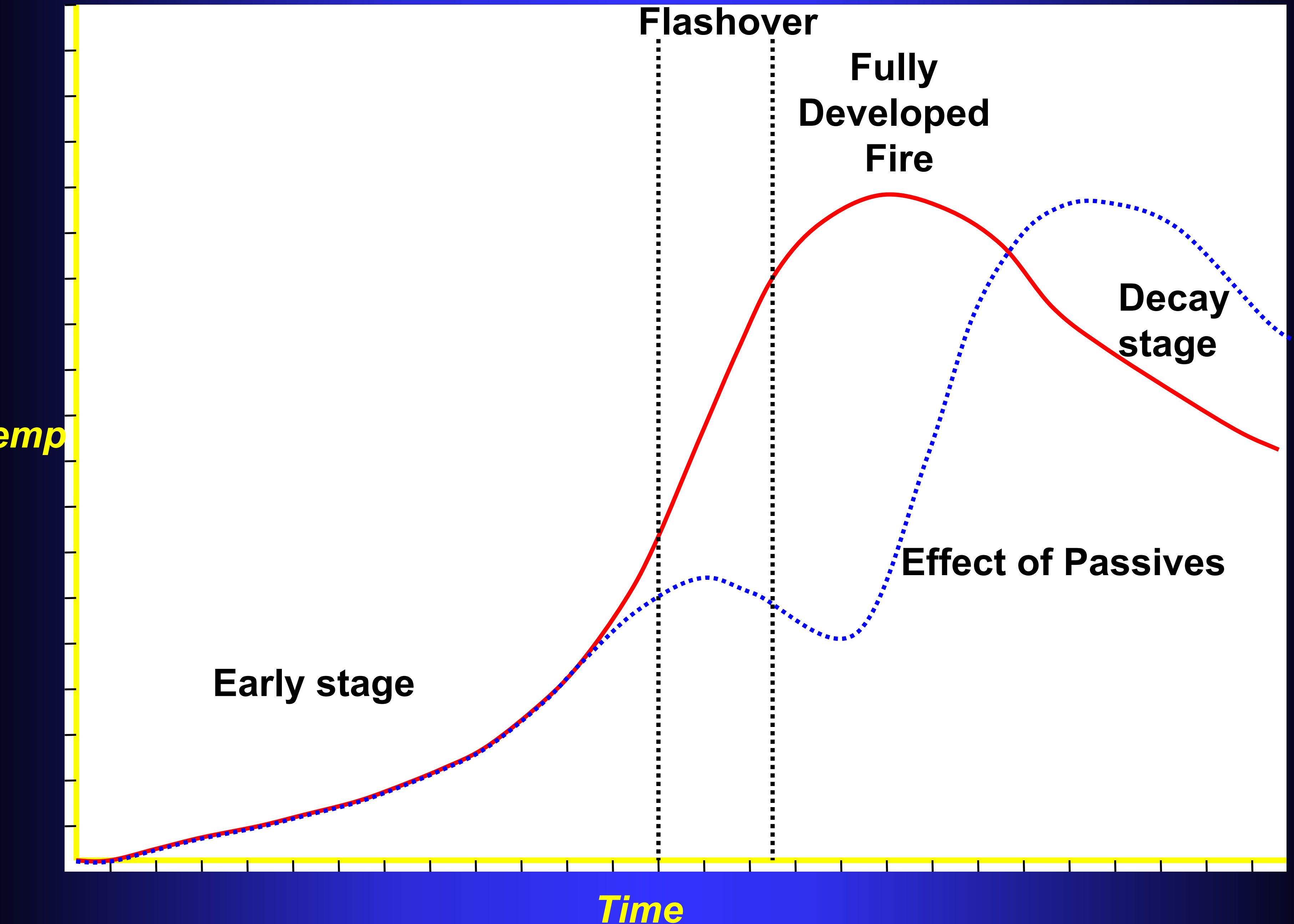

emp
Early stage
Time


Flashover
Early stage
emp
Time



Flashover
Fully
Developed
Fire
Early stage
emp
Time


Flashover
Fully
Developed
Fire
Decay
stage
Early stage
emp
Time


Flashover
Fully
Developed
Fire
Decay
stage
Effect of Passives
Early stage
emp
Time

Room Fire Video

Points to observe

- Flame reaching upwards
- Fire gases at ceiling level
- Turbulence of fire gases
- Neutral plane
- Pyrolisation
- Ignition of furniture
- Increase in temperature = increase in Pyrolisation

Fire Gas Explosion

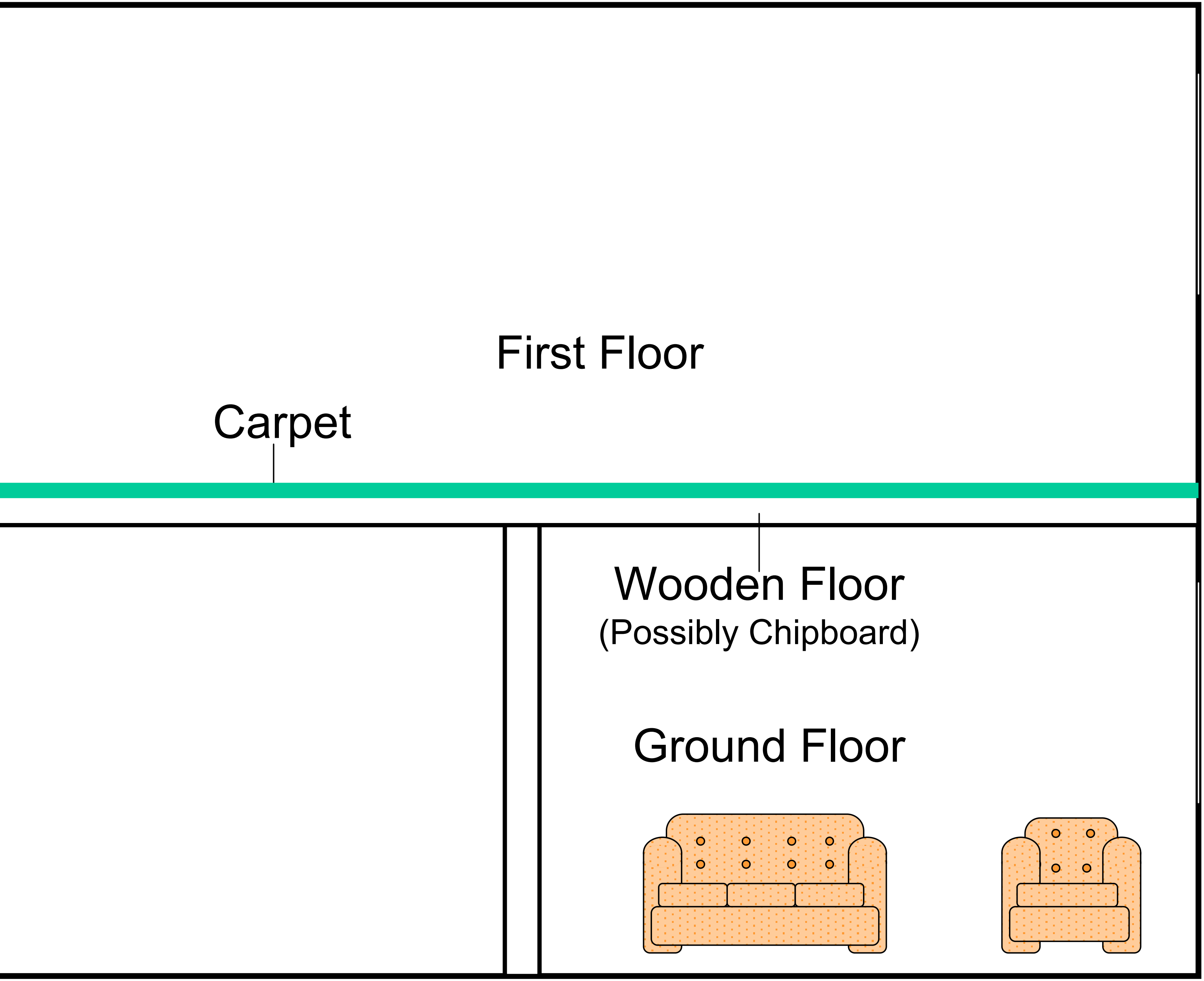
Fire Gas Explosion

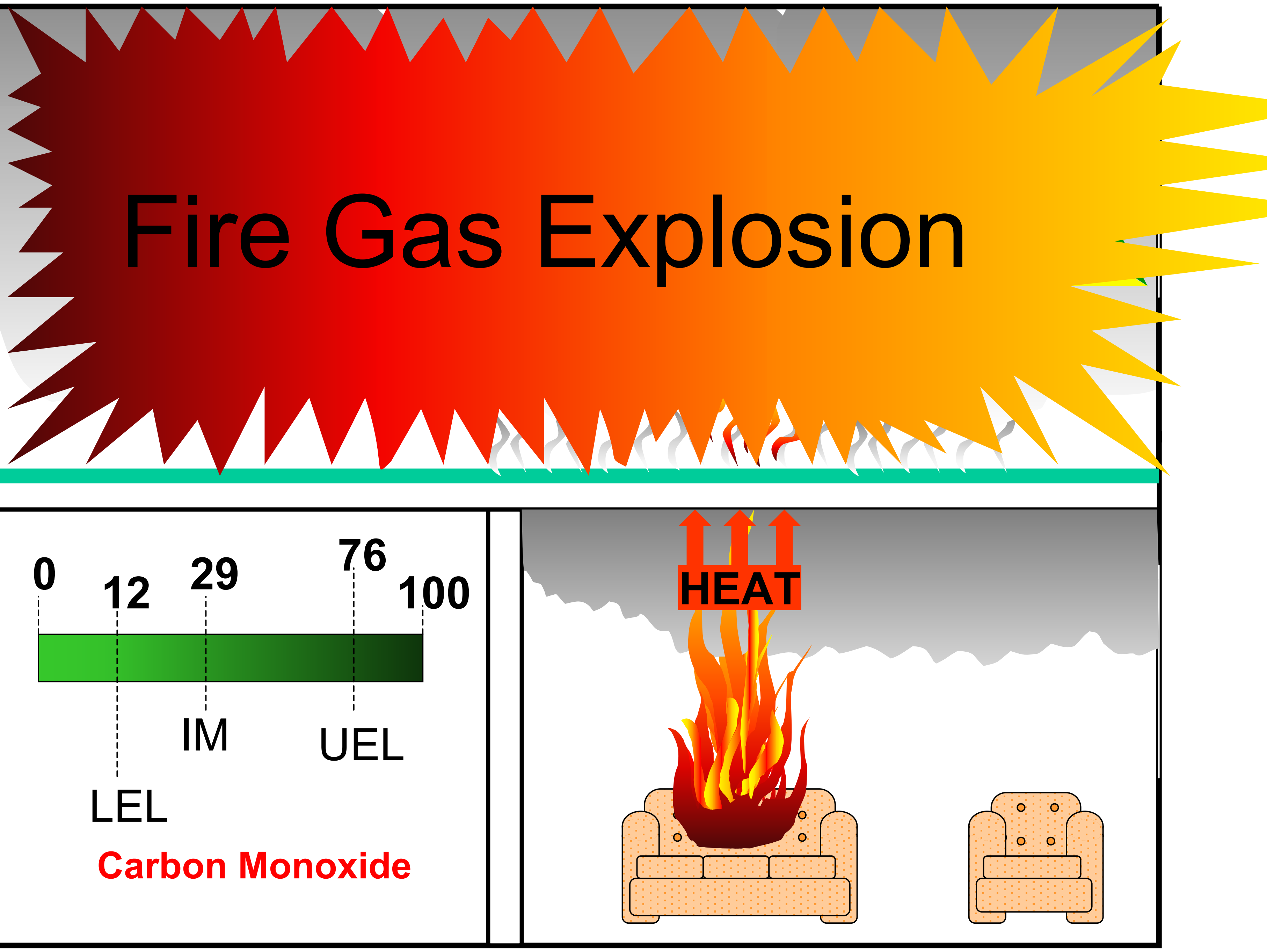
When fire gases are transported into an enclosure adjacent to the fire compartment, these can mix with fresh air. This mixture can, in time, occupy the whole volume and can be close to the (Ideal) mixture concentration.

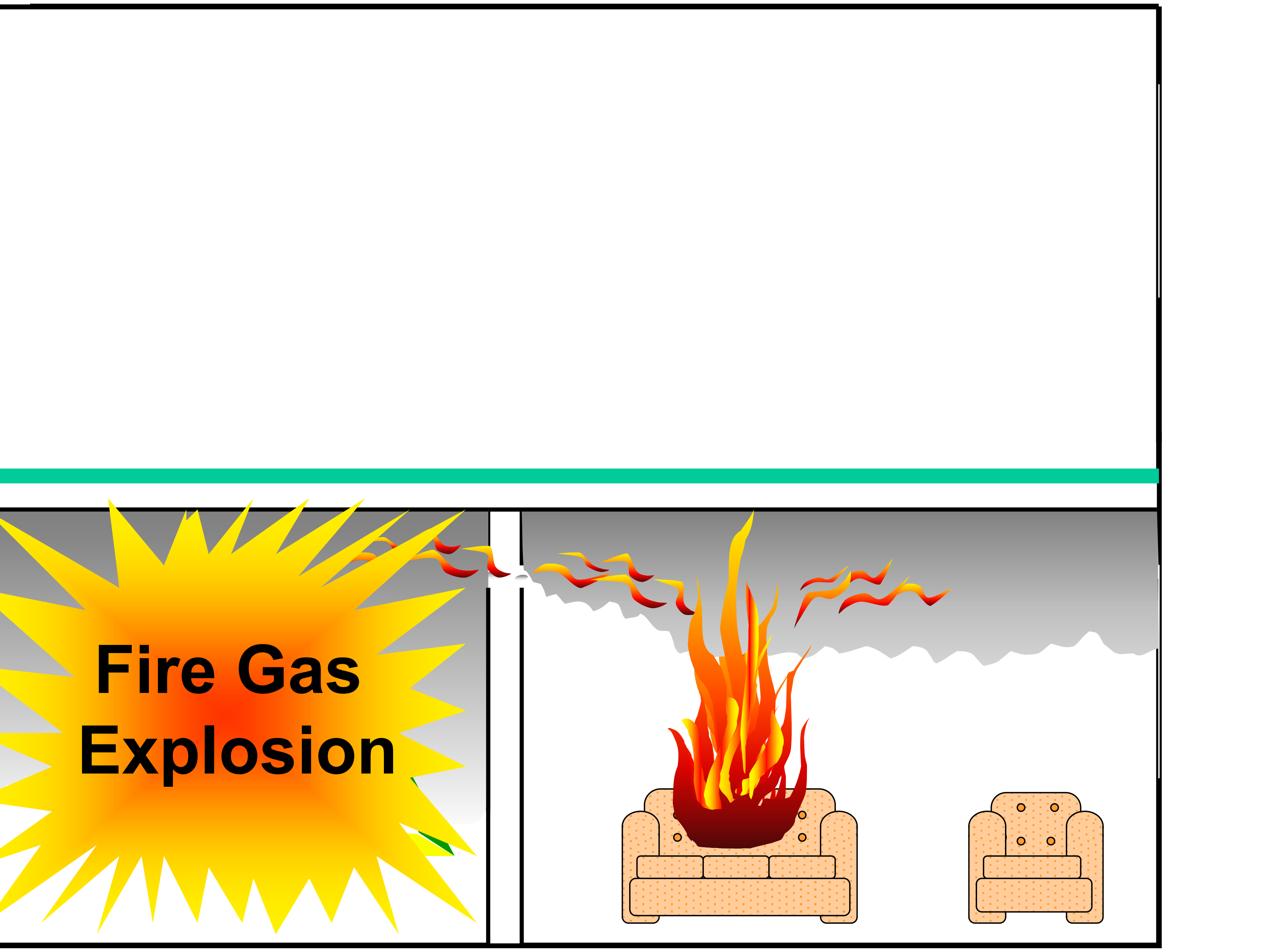
Fire Gas Explosion

If the mixture is ignited by, for example, a spark from a light bulb it may result in a fire gas explosion.

The whole volume of gas ignites instantaneously with massive increases in temperature causing structural damage to the building and loss of life to any persons involved.


First Floor
Carpet
Wooden Floor
(Possibly Chipboard)
Ground Floor


Fire Gas Explosion
0
12
29
76
100
IM
UEL
LEL
Carbon Monoxide
HEAT


Fire Gas Explosion

Aquarium Demonstration

Effective use of water

Effective use of water

Water is an ideal extinguishing medium as it is readily available and when applied to a fire it attacks all sides of the triangle i.e.

Reduces Fuel: The rapid expansion of water to steam dilutes the flammable gases.

Reduces further production of flammable gases by Pyrolysis (cooling effect).

The expansion of water to steam drives out some of the existing fire gases.

Effective use of water

Reduces Heat: Absorbs heat when turning to steam. Approximately 80% of the fires energy will be absorbed by water turning to steam.

Reduces Oxygen: The steam limits the amount of oxygen reaching the fire by smothering.

1 litre of water at 100° C = 1700 litres of steam
1 litre of water at 450° C = 3500 litres of steam

Effective use of water

To extinguish a fire BA wearers must maintain a fine balance between small quantities of water to keep steam produced to a minimum but sufficient water to extinguish the fire

Effective use of water

Too much water produces large amounts of steam, pushing down the neutral plane and deteriorating the conditions for firefighters by reduced vision, exposure to steam and rising temperatures.

Effective use of water

To cool down the maximum amount of gases with the minimum amount of water, the droplet size from the branch must be kept as small as possible, thereby increasing the amount of surface area of water available for cooling as they enter the hot gases.

Effective use of water

These small droplets applied in small pulsations will provide rapid cooling as they pass through the hot fire gases producing the minimum amount of steam, ensuring conditions inside the compartment are as comfortable as possible.

Extinguishing Techniques

Extinguishing Techniques

- Gas cooling
- Indirect (defensive)
- Direct
- Painting

Gas Cooling

Gas cooling- A spray that is aimed directly into hot fire gases, but does not reach the boundaries of the compartment or its contents.

Purpose

- Cool and dilute fire gases.
- Effective for rescues.

Indirect Cooling

Indirect (defensive)- A spray aimed directly into the fire gases and at the hot compartment boundaries.

Purpose

Defensive:

- Used from outside the fire compartment.
- Cool and dilute fire gases.
- Cool the boundaries.

Direct Cooling

Direct- The branch is open, a narrow jet aimed directly at the seat of the fire.

Purpose

- May be applied in the early and later stages of a fire.
- Used directly on the seat of the fire.

Painting

Painting- Small trickle of water. Using the least amount of water as possible, depending on the penetration required. Aimed directly onto all combustible substances and materials

Purpose

To cool all combustible materials and substances, thus preventing pyrolysis.

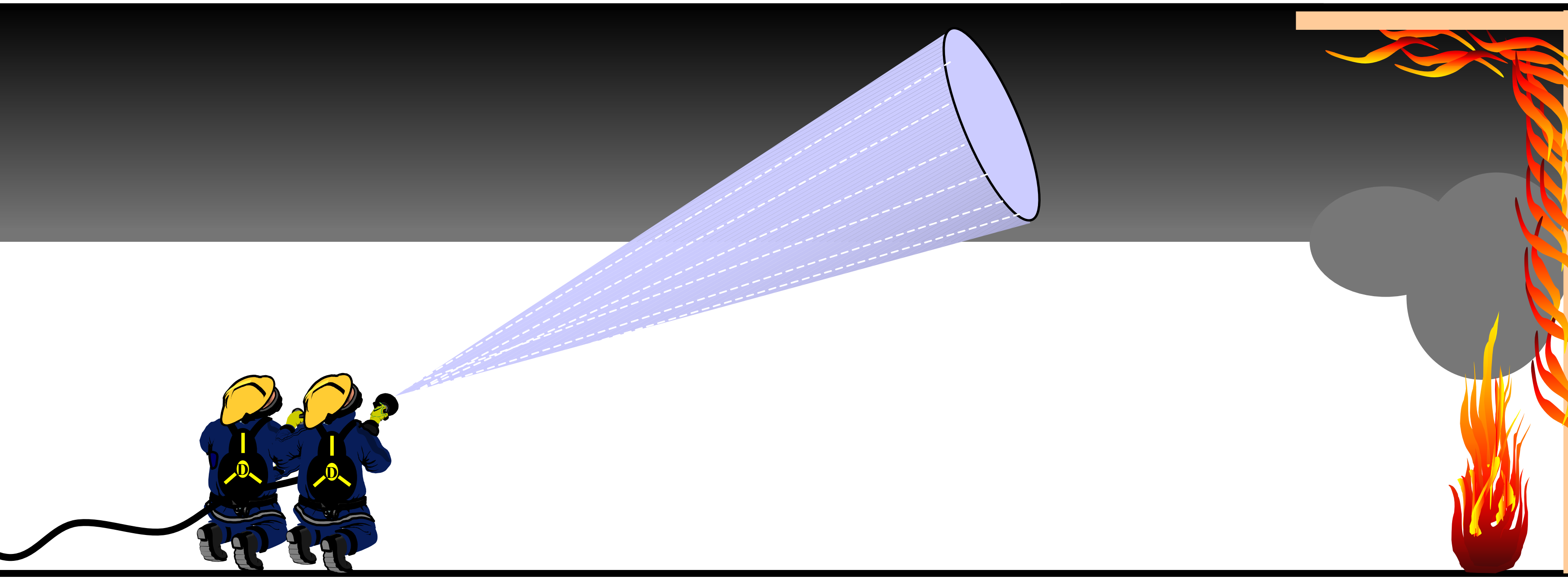
Branch Techniques

Spray setting : dependent on compartment size

depth of penetration required

Gas Cooling
(Short Pulse)

Length of pulsation : dependant on fire intensity

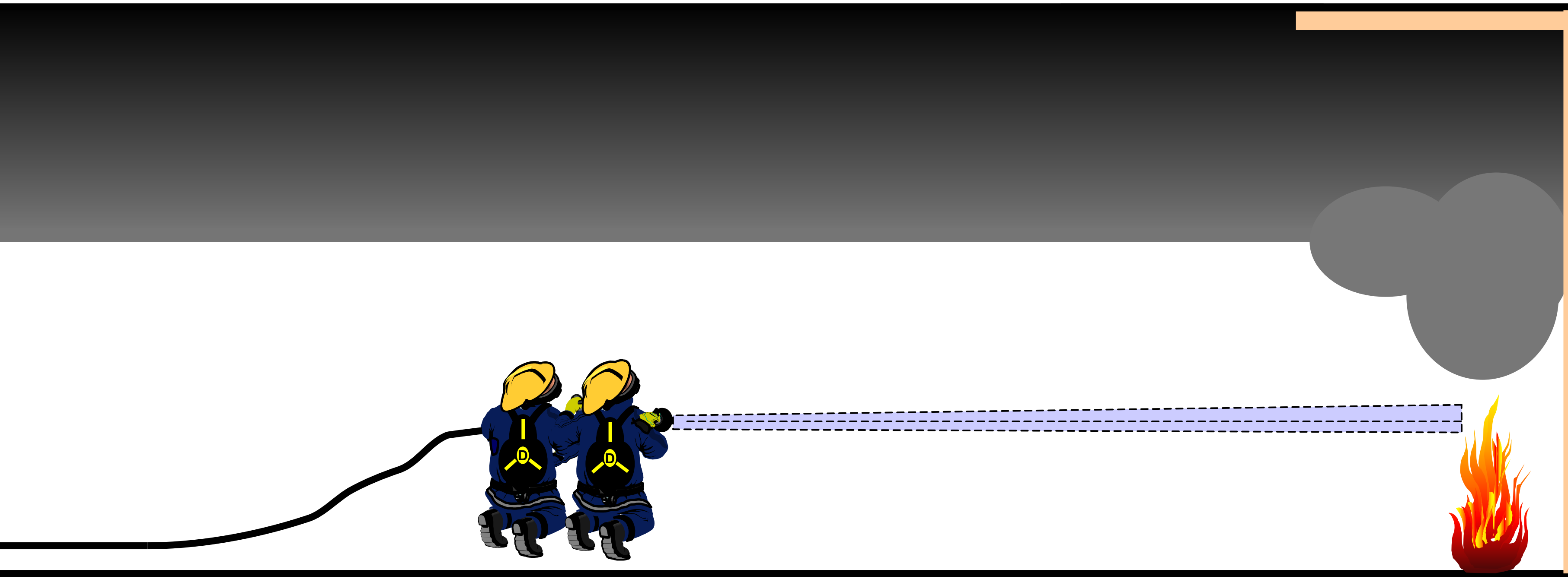


Gas Cooling

(long pulse)

Branch setting : dependent on compartment size.

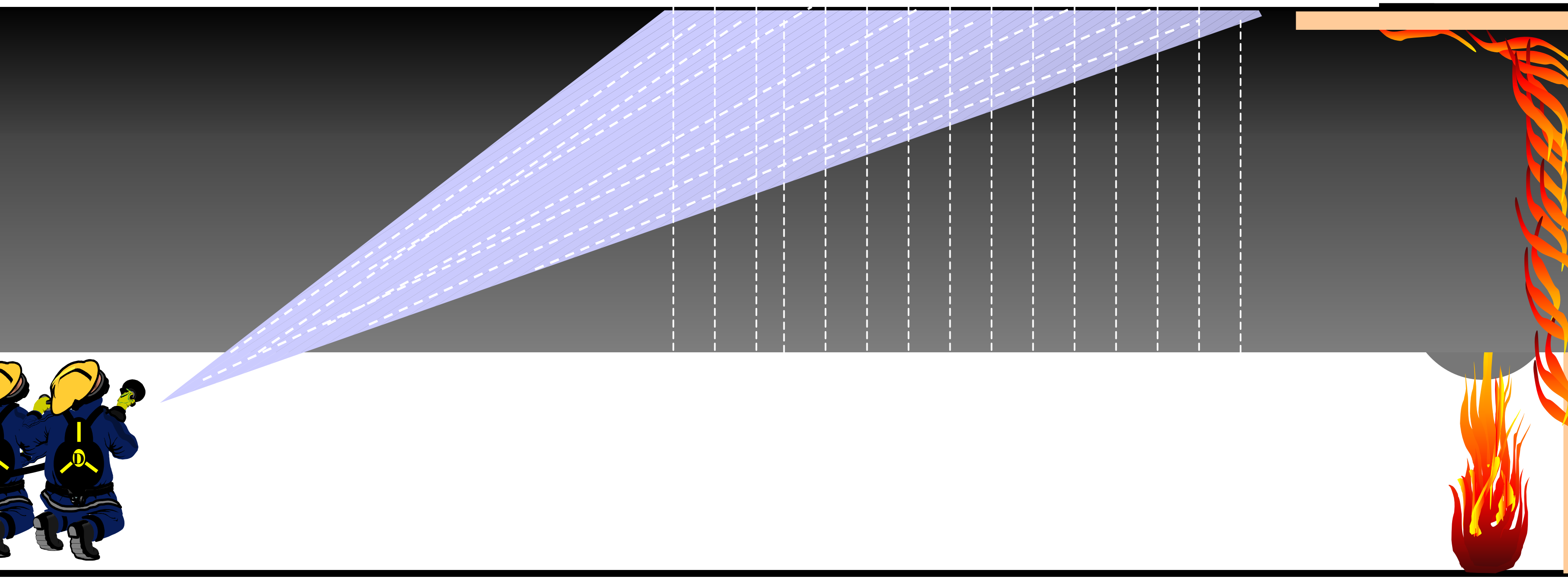
Length of Pulsation : dependant on amount of cooling required.



Direct Cooling

Spray setting : dependent on compartment size and depth of penetration required.

Length of Pulsation : dependant on severity of fire

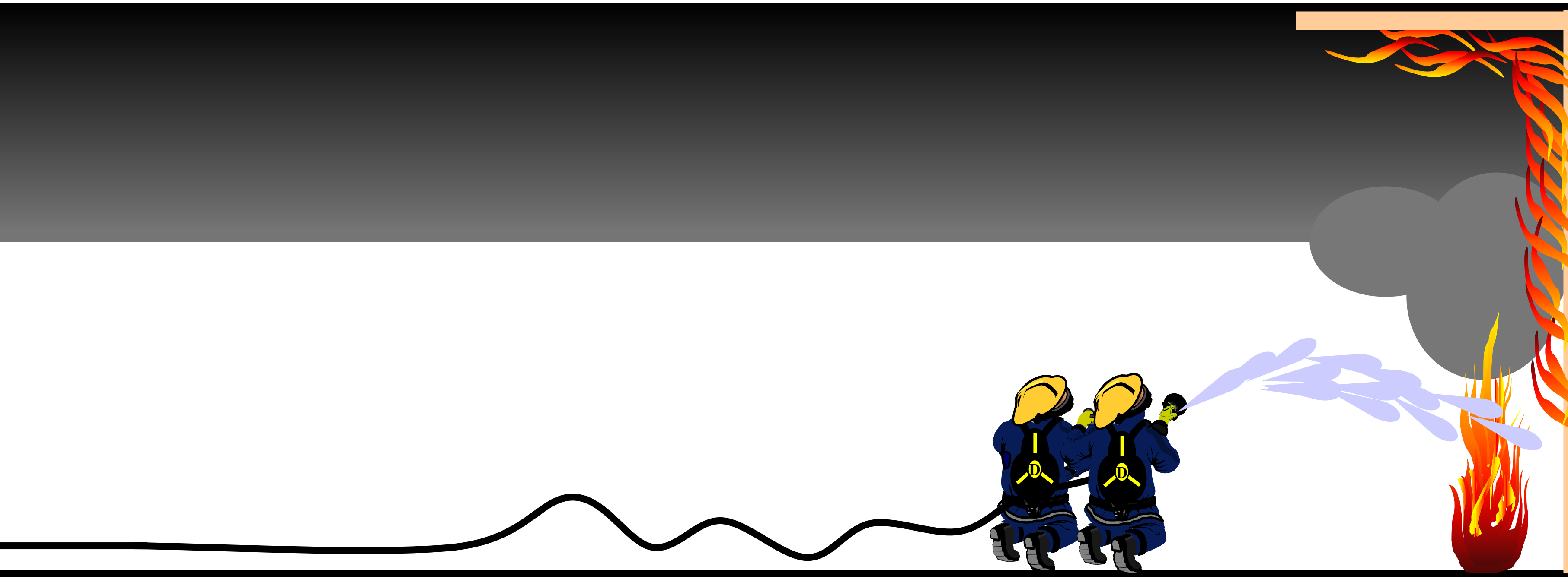


Indirect Cooling

(Defensive)

Branch setting : Very small (trickle)

Length of Pulsation : dependant on amount of cooling required



Painting

Associated Problems
Indirect Cooling

Neutral Plane will be lowered causing problems for Fire-fighters and any casualties

Visibility impaired

Water Droplets Coming Down Soak PPE

General Firefighting Principles

General Firefighting Principles

When firefighters are inside a compartment they should always consider the following three options:-

- **Maintain Position – protect their position using gas cooling**
- **Move Forward – attack fire gases using gas cooling with short or long pulsations**
- **Withdraw – if conditions deteriorate withdraw protecting themselves with gas cooling**

General Firefighting Principles

Firefighters should try to use the minimum amount of water as effectively as possible, ensuring the neutral plane is kept as high as possible, whilst cooling the maximum amount of gases.

If the gas cooling and indirect method is applied correctly then the fire gases will be reduced and cooled sufficiently to take them out of the flammable range.

General Firefighting Principles

Applying water on hot surfaces with a small jet will cool surfaces and reduce the amount of gases given off by pyrolosis (painting)

When inside a compartment fire fighters must keep a constant check on their surroundings, particularly the fire gases at ceiling level

Compartment Entry

Maintaining escape route

- Gas cool on-route to compartment
- Check temperature of all doors before opening
- Before entering compartment fire, spray the door and surrounding surfaces
- Keep fire kit as dry as possible
- Carry out correct door entry procedure

Door procedure

- Purpose

  To assess conditions prior to entry
- Spray Setting

  For gas cooling
- Length of Pulsation

  Minimum required to enable assessments to be made
- Observe movement of fire gases

Door Entry Procedure

- Assess which way the door opens
- Adopt appropriate safe position
- Upon opening keep control of the door
- Glance quickly into compartment
- Observe layout and any casualties
- If unable to enter use:
  long or short pulse into the gas layer
- Close the door
- Repeat as necessary

Effect entry when safe

- Upon entry move to one side of the door
- Pull in sufficient amount of hose
- Close door behind
- Carry out temperature check
- Carry out the appropriate cooling technique

Continually assess the situation

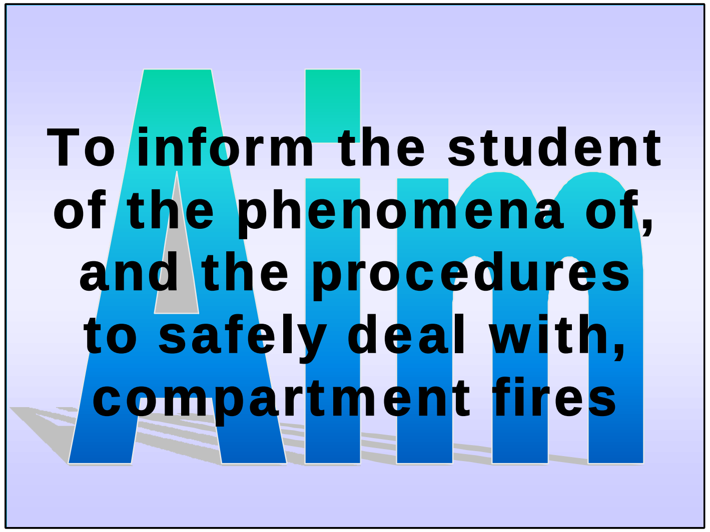
If in doubt, get out!!!

End

NORTHERN IRELAND

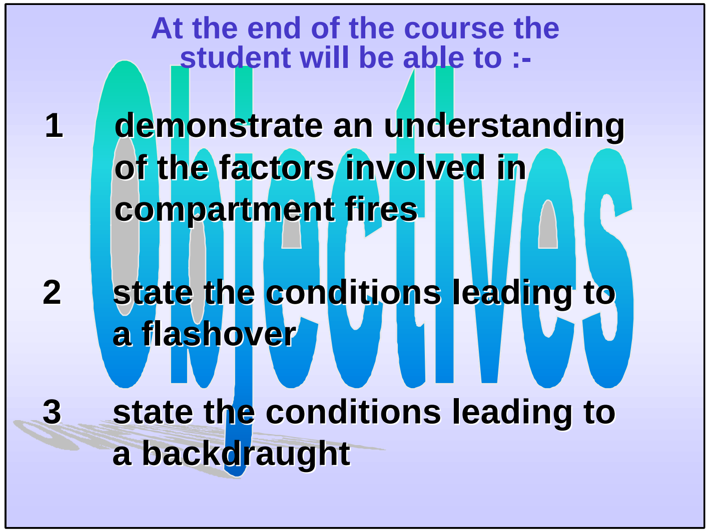
FIRE BRIGADE

Fire Behaviour Training



By the end of this two day course the student will:-

I	**have an understanding of the mechanism of compartment fires**
II	**be able to recognise the signs and symptoms associated with flashover and backdraught**
III	**be aware of the tactics and techniques involved with compartment fire extinction**



By the end of this two day course the student will:-

I **have an understanding of the mechanism of compartment fires**

II **be able to recognise the signs and symptoms associated with flashover and backdraught**

III **be aware of the tactics and techniques involved with compartment fire extinction**

Objectives

At the end of the course the student will be able to :-

4 state the protective measures to be taken when dealing with a potential flashover

5 state the protective measures to be taken when dealing with a potential backdraught

6 demonstrate the tactics and techniques required to deal with compartment fires

By the end of this two day course the student will:-

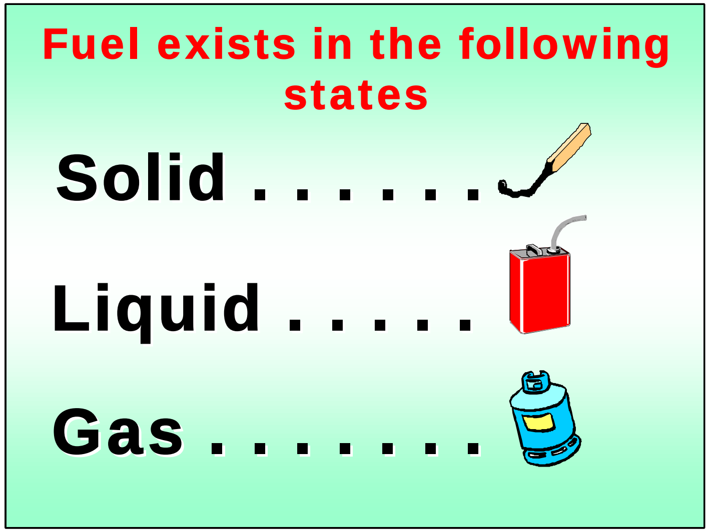
I **have an understanding of the mechanism of compartment fires**

II **be able to recognise the signs and symptoms associated with flashover and backdraught**

III **be aware of the tactics and techniques involved with compartment fire extinction**


Course
Outline

Session One



Solid Wood, coal etc.

Liquid Petrol, oil etc

Gas Butane, propane, acetylene etc.

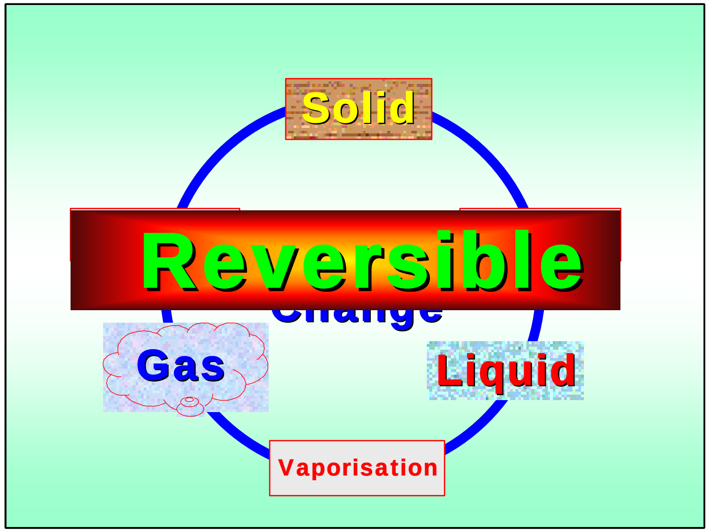
For combustion to take place the fuel must be a gas or vapour

What is the difference between a gas and a vapour ?

Solid	**Wood, coal etc.**
Liquid	**Petrol, oil etc**
Gas	**Butane, propane, acetylene etc.**

Under normal conditions a vapour will be a solid or liquid

Solid	**Wood, coal etc.**
Liquid	**Petrol, oil etc**
Gas	**Butane, propane, acetylene etc.**



Physical Change

To enable a fuel to burn it must first be converted to a gas.

This process can follow the familiar route of:-

liquefaction to vaporisation

or the less common ------ sublimation

Being a physical reaction these changes are <u>REVERSIBLE</u>

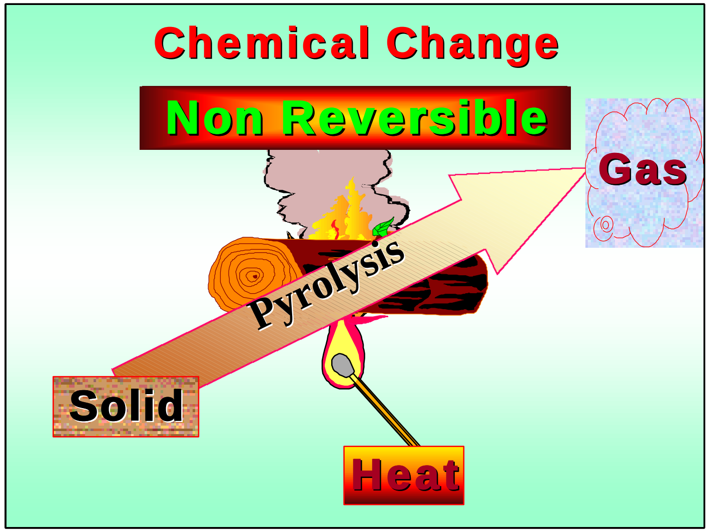
Combustion

When you put a match to a candle it lights, this is a relatively simple operation, however the process that must take place before the candle will light is complex.

What happens when a candle is lit?

The candle is made up of wax and a wick. This is of course designed to burn, but the wax is a solid and as such will not burn in that form .Why?

To burn all fuel must be a gas or vapour. What is the difference?



Chemical Change

When a flammable solid (e.g. wood) is heated it begins to decompose, that is, gives off combustible gases.

This process is known as pyrolysis and is:

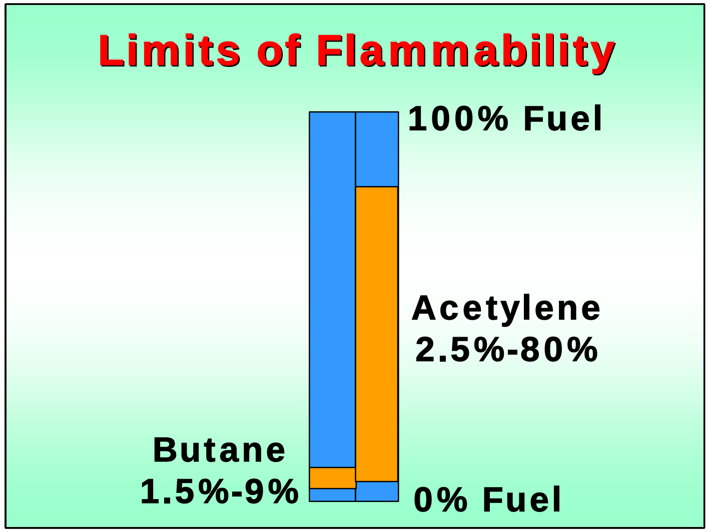
<u>NON REVERSIBLE</u>

Pyrolysis

When the temperature reaches sufficient levels almost every material found in the modern home will begin to give off products of combustion.

In the film clip you will see the seat covers producing smoke, this would not seem out of the ordinary, however it is not a common sight to see aluminium ‘steaming’ and bursting into flames.

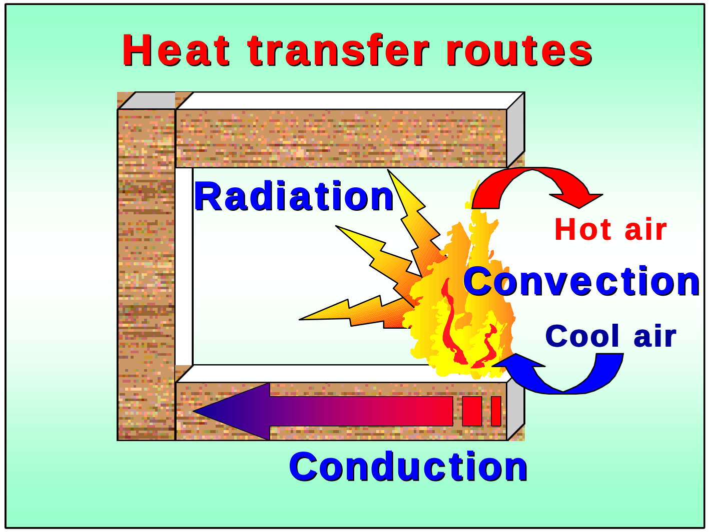
With temperatures likely to be found in a compartment fire, steam would be invisible, the smoke seen is in fact a cocktail of highly flammable gases.



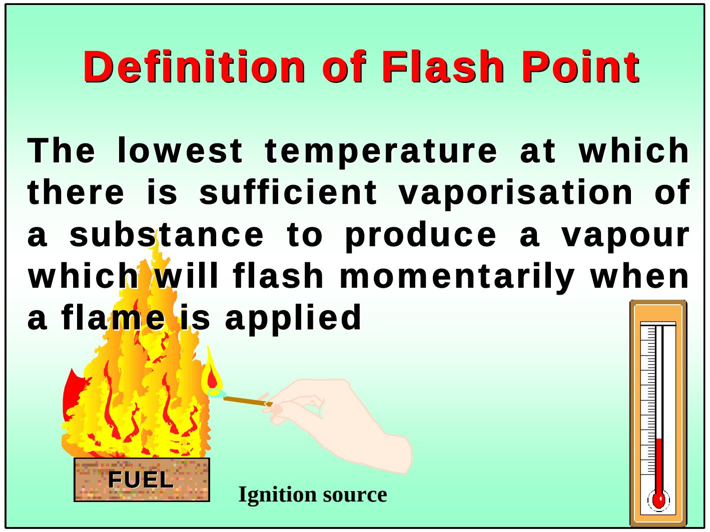
The limits of flammability of a substance is the ratio of fuel to air, this can vary considerably.

We think of gases like Butane as dangerous but for combustion to take place the ratio of fuel in air is only 1.5% & 9% whereas,

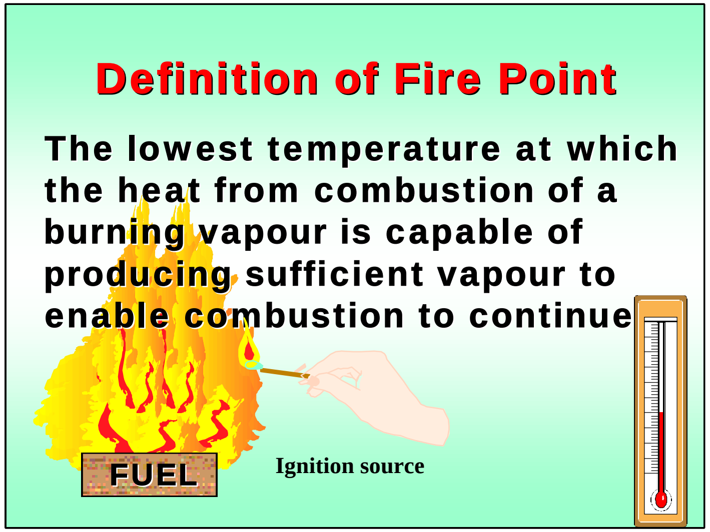
Acetylene is an extremely dangerous substance, it will burn if it's fuel to air ratio is between 2.5% & 80%



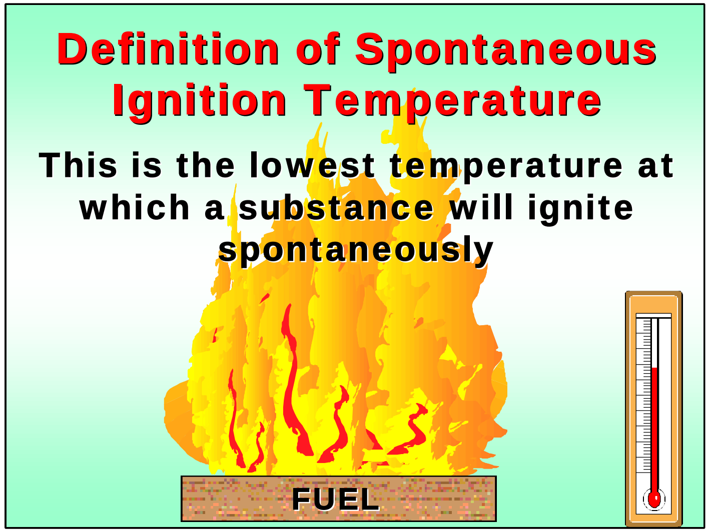
Conduction	**This does not have as great an effect on compartment fires. Most surfaces will absorb heat by conduction and give of limited volatiles.**
Convection	**The majority of the heat movement within a compartment is caused by convection.**
Radiation	**Possibly the largest contributor of heat causing pyrolysis which adds considerably to the likelyhood of flashover and backdraught.**



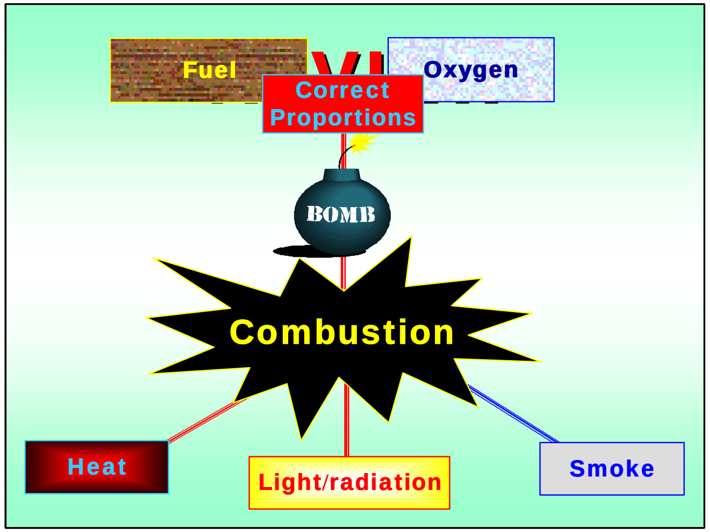
Self Explanatory



Self Explanatory



Self Explanatory



Review

If you have fuel and oxygen in the correct proportions. Introduce an ignition source you will get Combustion.

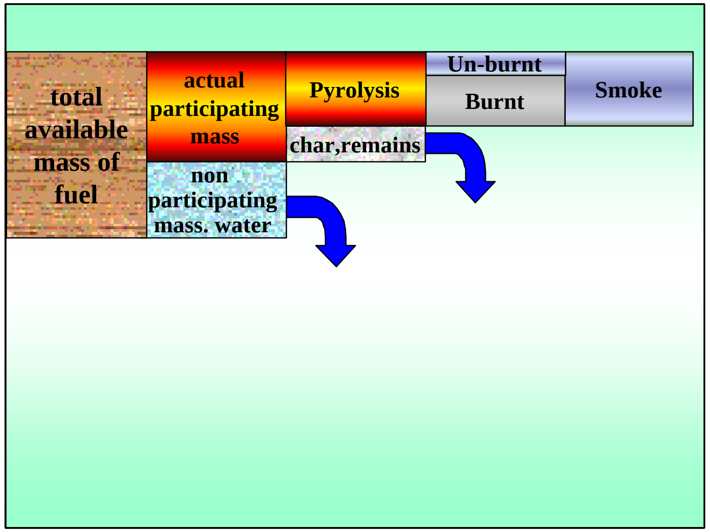
The products of combustion are:

heat

light / radiation

smoke

What is Smoke?

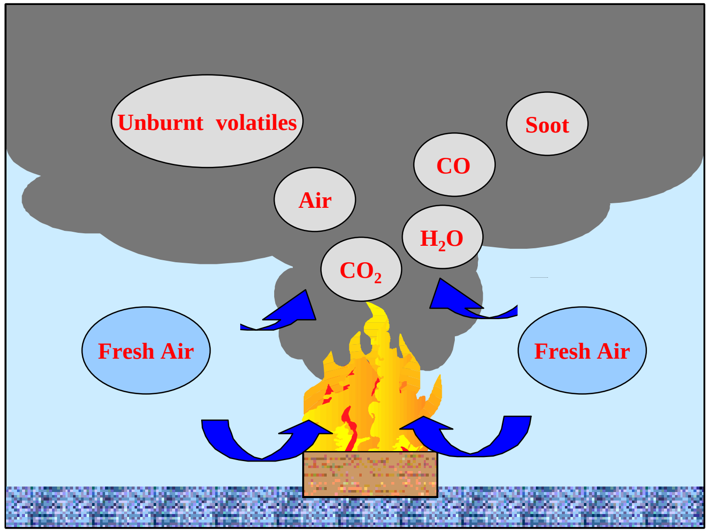


From the total available mass of fuel some of the material will not participate in combustion i.e. water

Of the remaining mass a portion will pyrolyse what's left is the charred remains.

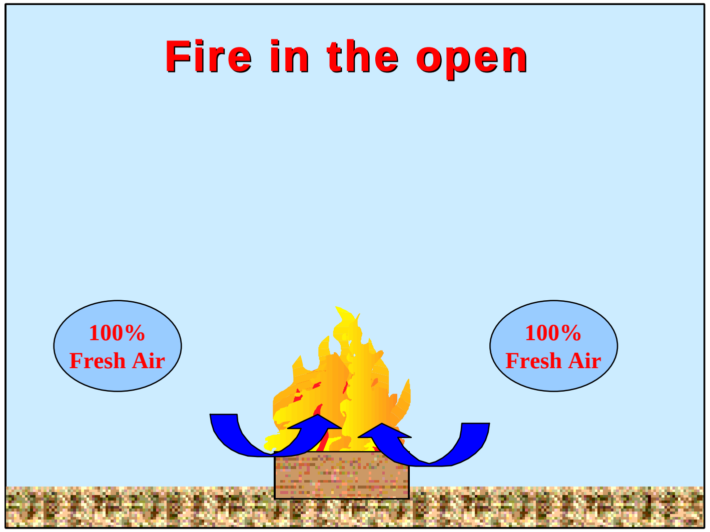
The products of pyrolisation will take part in the combustion process some of this will not however burn due to local conditions i.e. insufficient O_2.

The burnt and un-burnt products go to making smoke.



Smoke is made up from many different types of material, the most common of these are:

Carbon monoxide	**CO**
Carbon dioxide	**CO_2**
Un-burnt volatiles	
Air	
Water	**H_2O**
Soot	

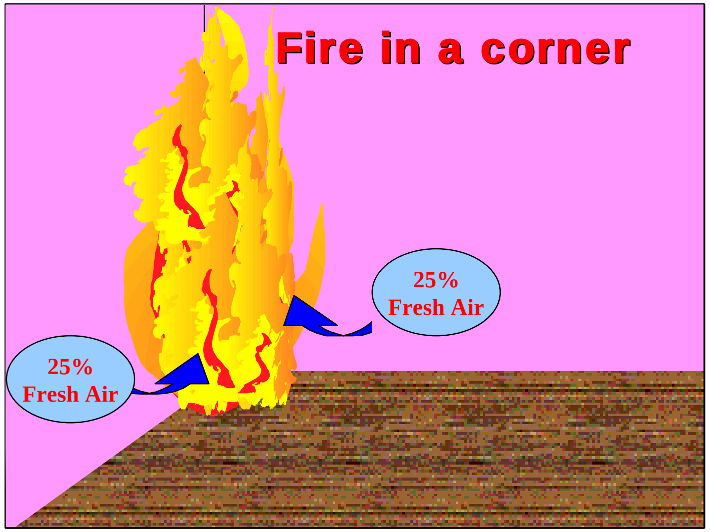


Combustion in the plume requires oxygen and the updraught from the plume draws air in towards it.

If the fire is in the centre of the compartment, air will be drawn in from all directions, although most will come from the direction of the primary air supply.

If the fire is at a wall, the plume may attach itself to it.

As air entrainment will only occur on one half of the plume, it will take longer for the flammable gases to burn and the flame height will increase



If the fire is in a corner, air entrainment can only occur over a quarter of the plume, so the flame will rise higher still.

If the wall consists of flammable materials and the plume contacts them, they will quickly become involved, further increasing the flame height.

Any Questions ?

Session Two

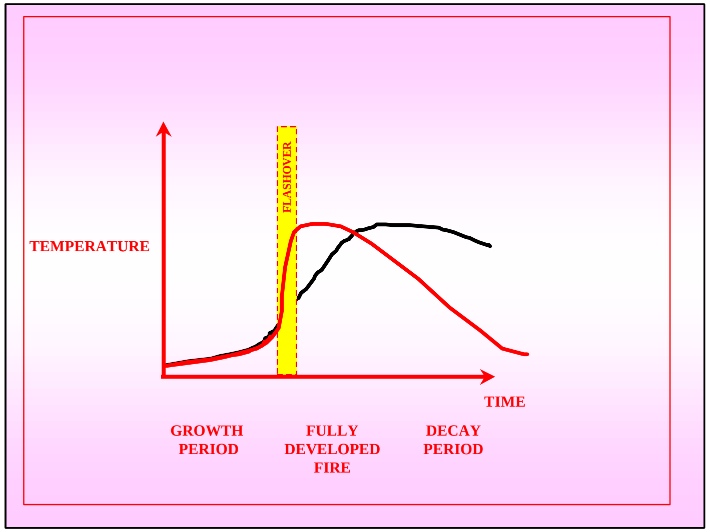
Flashover

Definition of Flashover

A sudden and sustained transition of a growing fire to a fully developed fire

Self Explanatory

Flashover


TEMPERATURE
FLASHOVER
TIME
GROWTH PERIOD
FULLY DEVELOPED FIRE
DECAY PERIOD

Signs and symptoms

- Rapid temperature rise
- Flames in smoke layer
- Materials fuming

Protection

Ensure properly protected

Ensure entrance covered by a charged branch

Protection

Check escape routes are safe

Check door for signs of heat

Protection

Stay low

Only use spray pulses on hot gases

Only ventilate when safe to do so

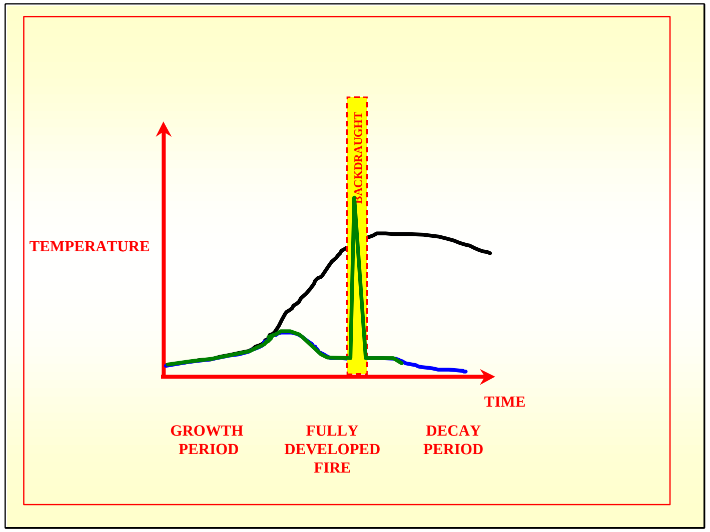
Any Questions ?

Session Three


Backdraught

Definition of Backdraught

When an opening is created providing sufficient oxygen, and there is a source of ignition, a sudden deflagration can move through the compartment and out of the opening


BACKDRAUGHT
TEMPERATURE
TIME
GROWTH PERIOD
FULLY DEVELOPED FIRE
DECAY PERIOD

Signs & Symptoms

1.	Smoke	no visible flame
2.	Windows	blackened
3.	Breathing	pulsing smoke
4.	Doors	☞whistling ☞hot handles ☞signs of heat

Protection

Ensure you are properly protected

If possible keep out of affected room and vent from outside

Protection

Check escape routes are secure and protected

Cool and ventilate outer compartment

Protection

Plan an escape route for gases before releasing them

Stay low and to the side of the door

Protection

Open door slightly, spray through gap directing spray upwards, close door. Repeat as necessary

Cool as much of the compartment as possible

Protection

Keep out of the way of hot steam and gases

Only enter if necessary, flammable gases will still be present

Any
Questions ?

Session Four

Summary

Factors involved in compartment fires

Sign & Symptoms

Protective measures

Tactics & Techniques

Any
Questions ?

Thank you
for your
attention

The end

Fire Behaviour Training

Aim

To inform the student of the phenomena of, and the procedures to safely deal with, compartment fires

Objectives

At the end of the course the student will be able to :-

1. demonstrate an understanding of the factors involved in compartment fires

2. state the conditions leading to a flashover

3. state the conditions leading to a backdraught

Objectives

At the end of the course the student will be able to :-

4 state the protective measures to be taken when dealing with a potential flashover

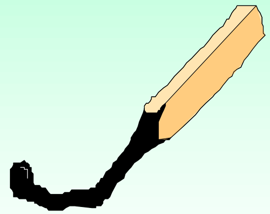
5 state the protective measures to be taken when dealing with a potential backdraught

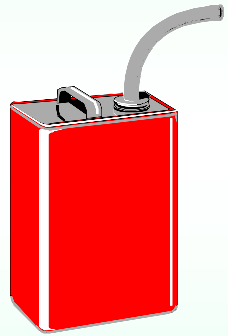
6 demonstrate the tactics and techniques required to deal with compartment fires

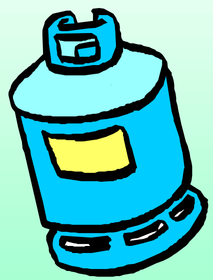
Course Outline

Session One

Fuel exists in the following states

Solid . . . . . . 

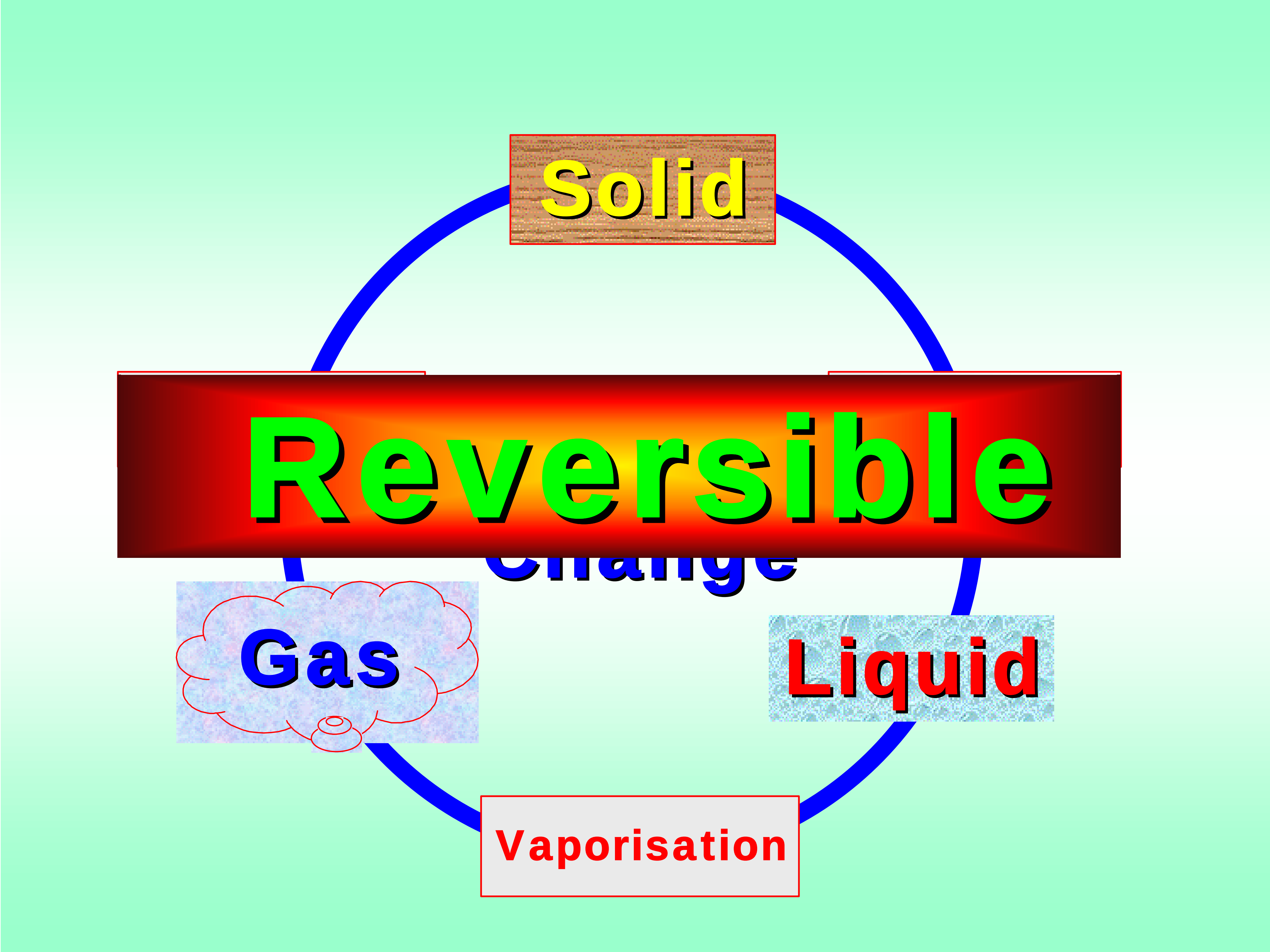
Liquid . . . . . 

Gas . . . . 

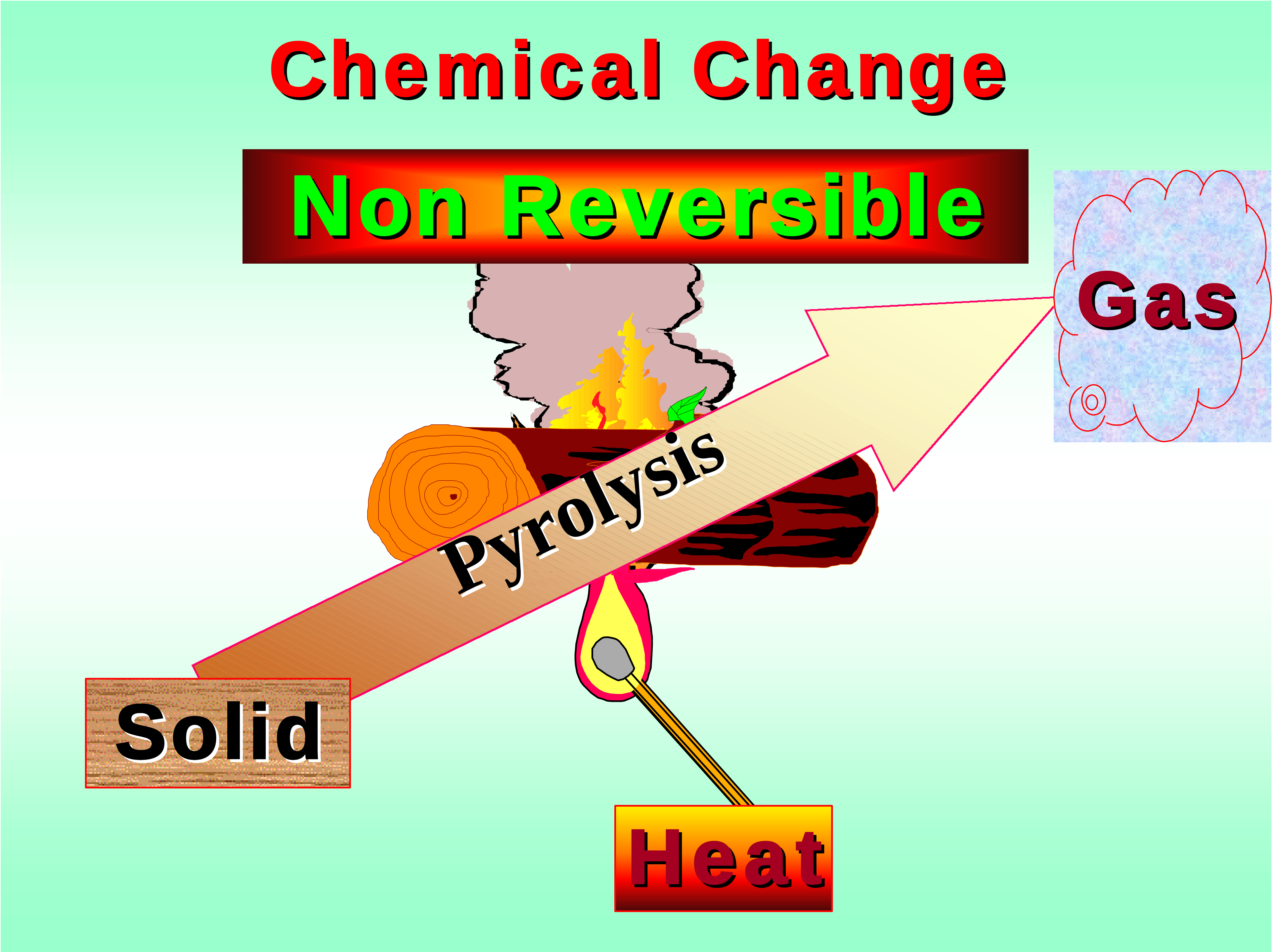
For combustion to take place the fuel must be a gas or vapour

What is the difference between a gas and a vapour ?

Under normal conditions a vapour will be a solid or liquid

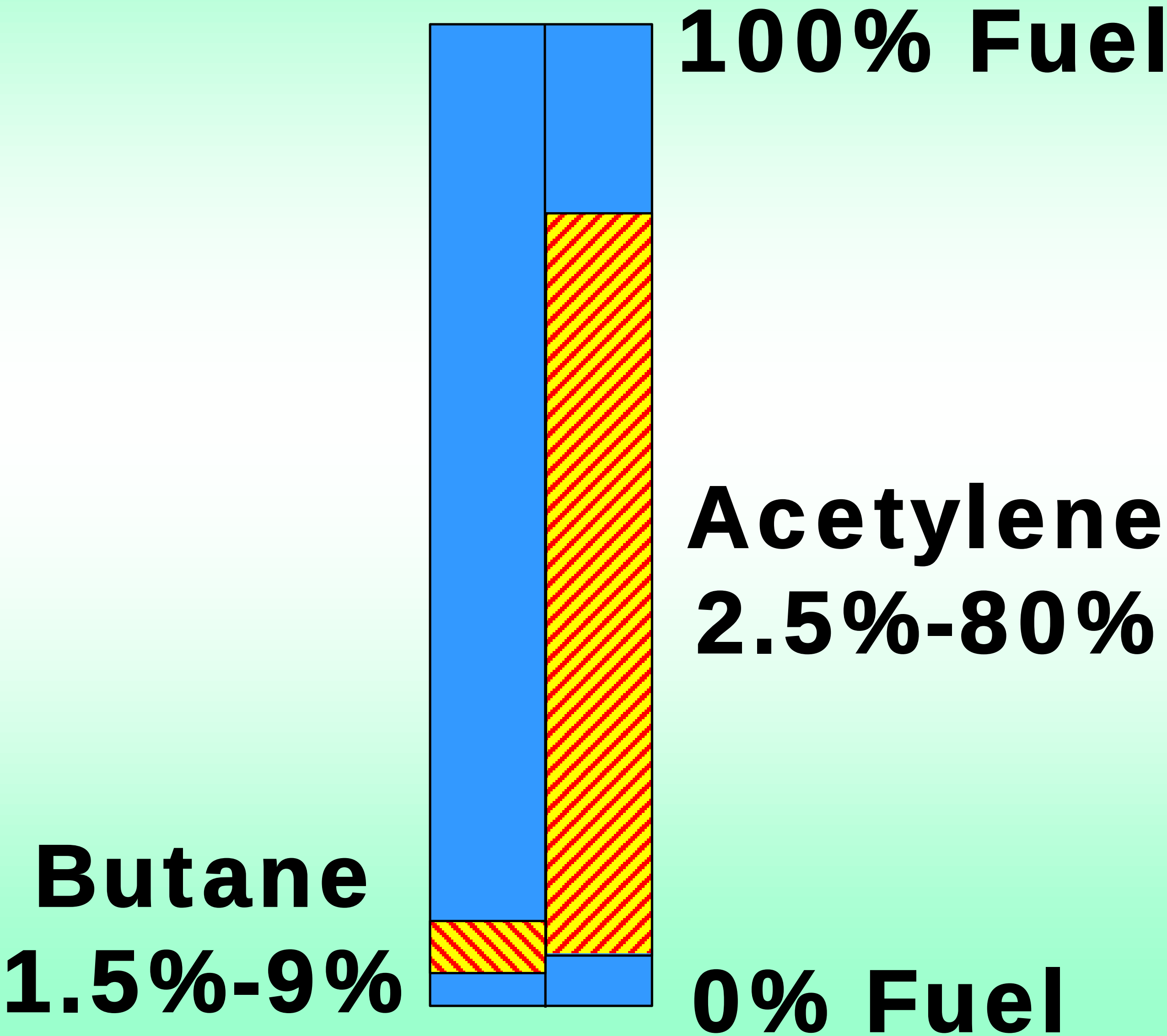

Solid
Reversible
Gas
Liquid
Vaporisation

Combustion

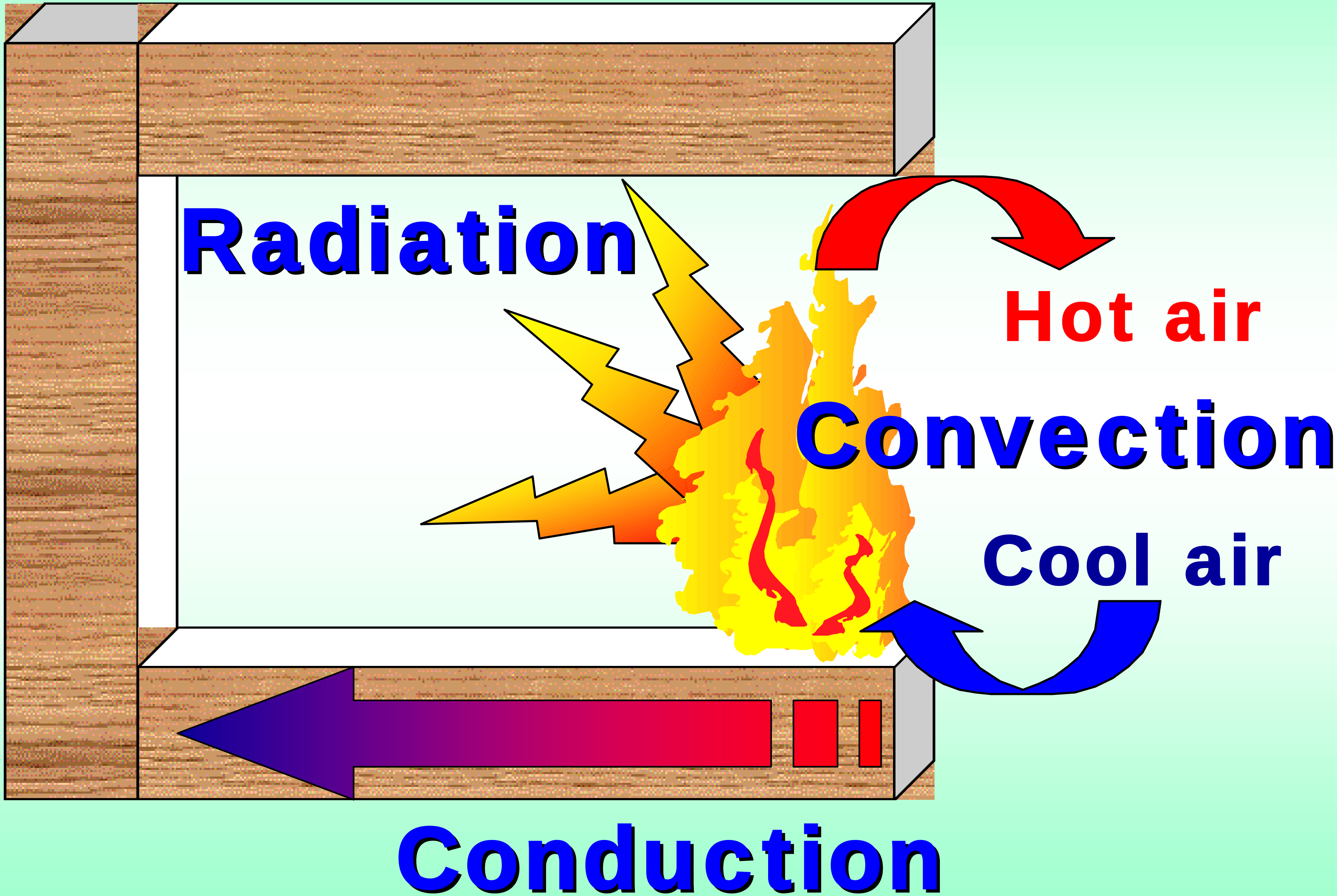

Chemical Change
Non Reversible
Gas
Pyrolysis
Solid
Heat

Pyrolysis

Limits of Flammability

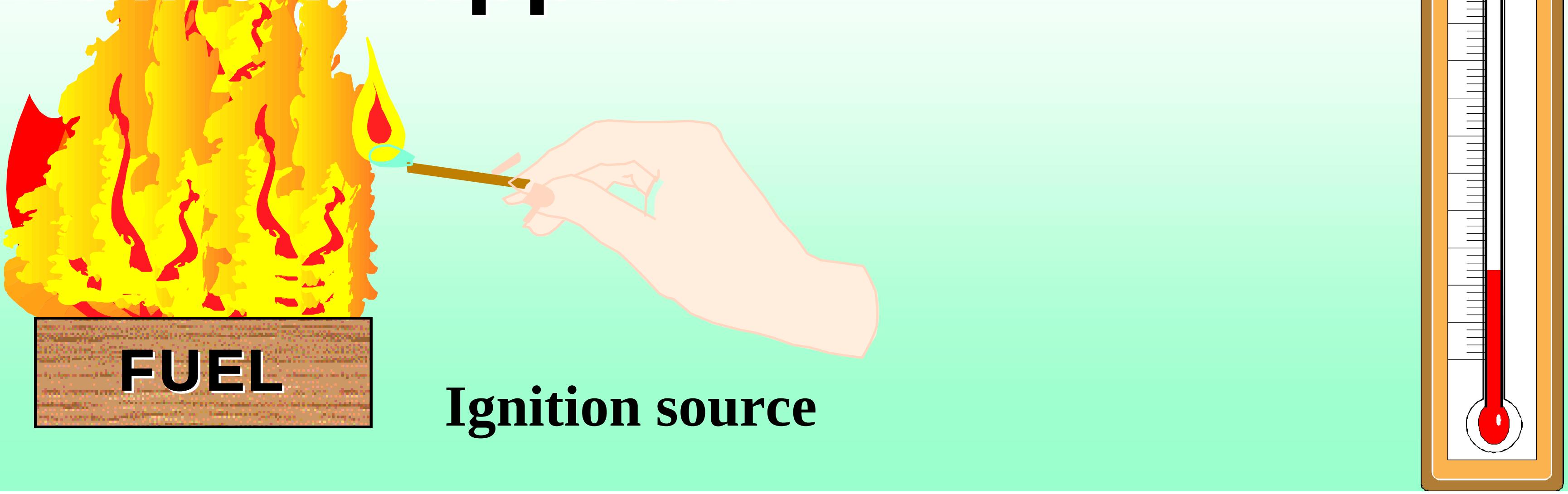


Heat transfer routes



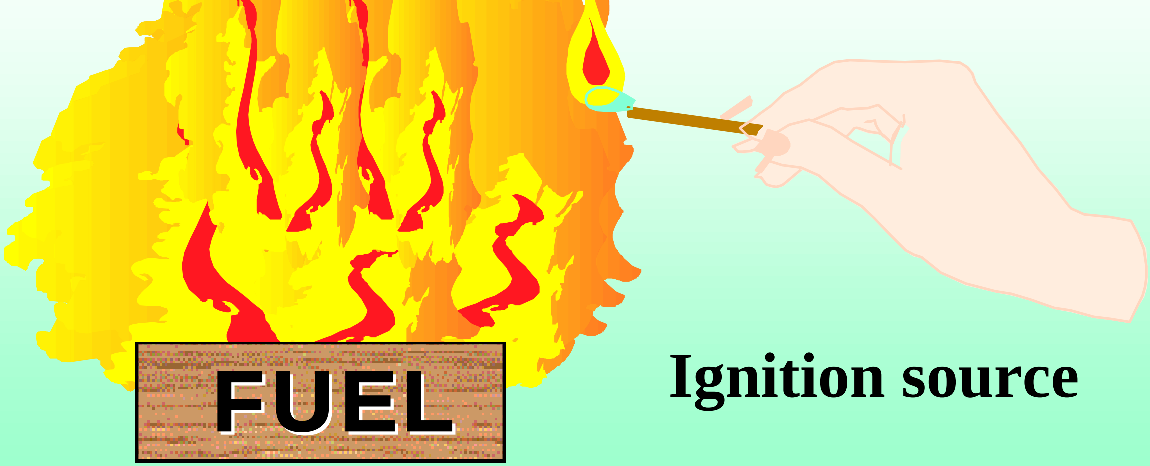
Definition of Flash Point

The lowest temperature at which there is sufficient vaporisation of a substance to produce a vapour which will flash momentarily when a flame is applied

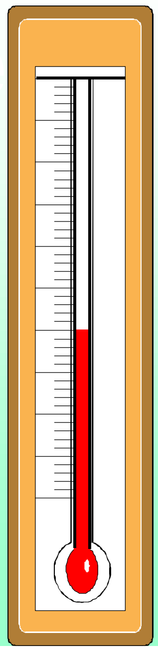


Definition of Fire Point

The lowest temperature at which the heat from combustion of a burning vapour is capable of producing sufficient vapour to enable combustion to continue

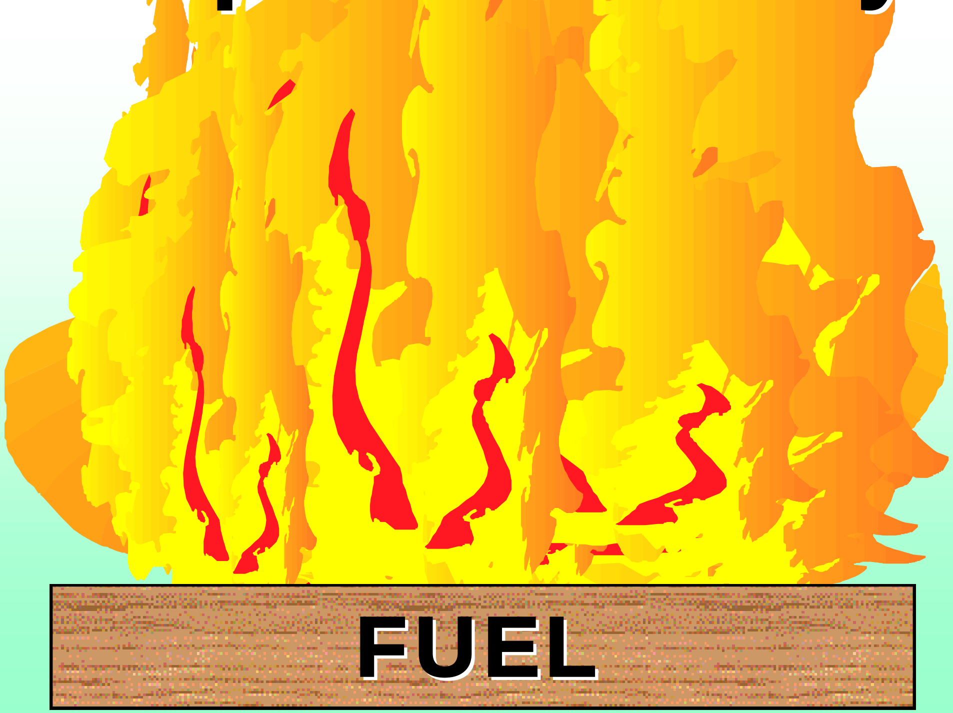


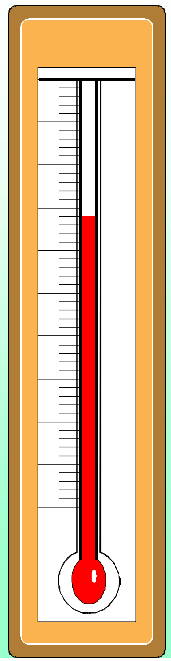
Ignition source

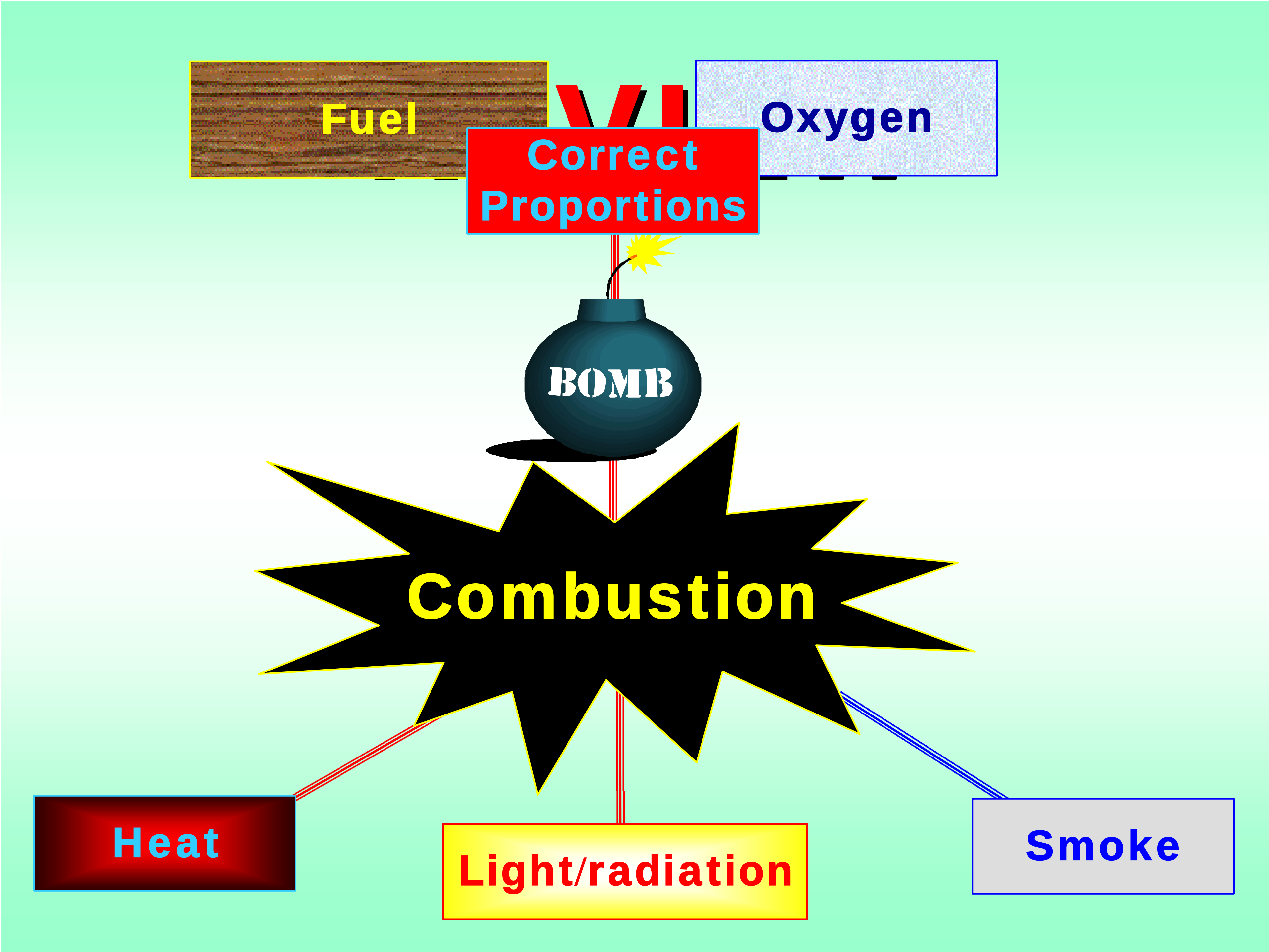


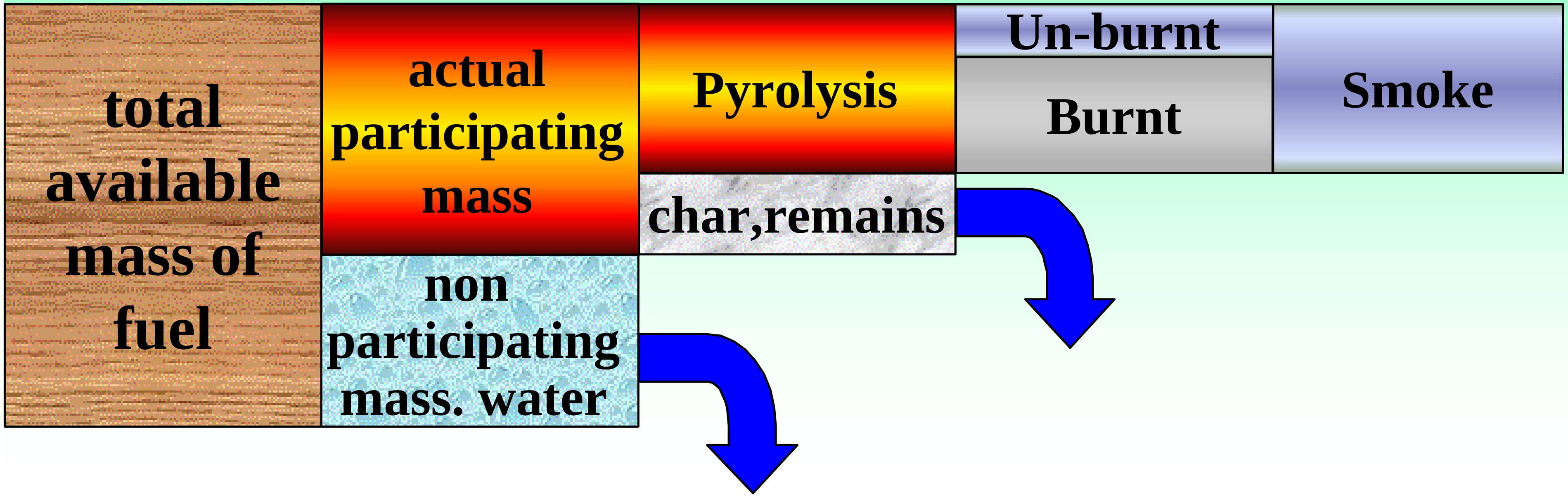
Definition of Spontaneous Ignition Temperature

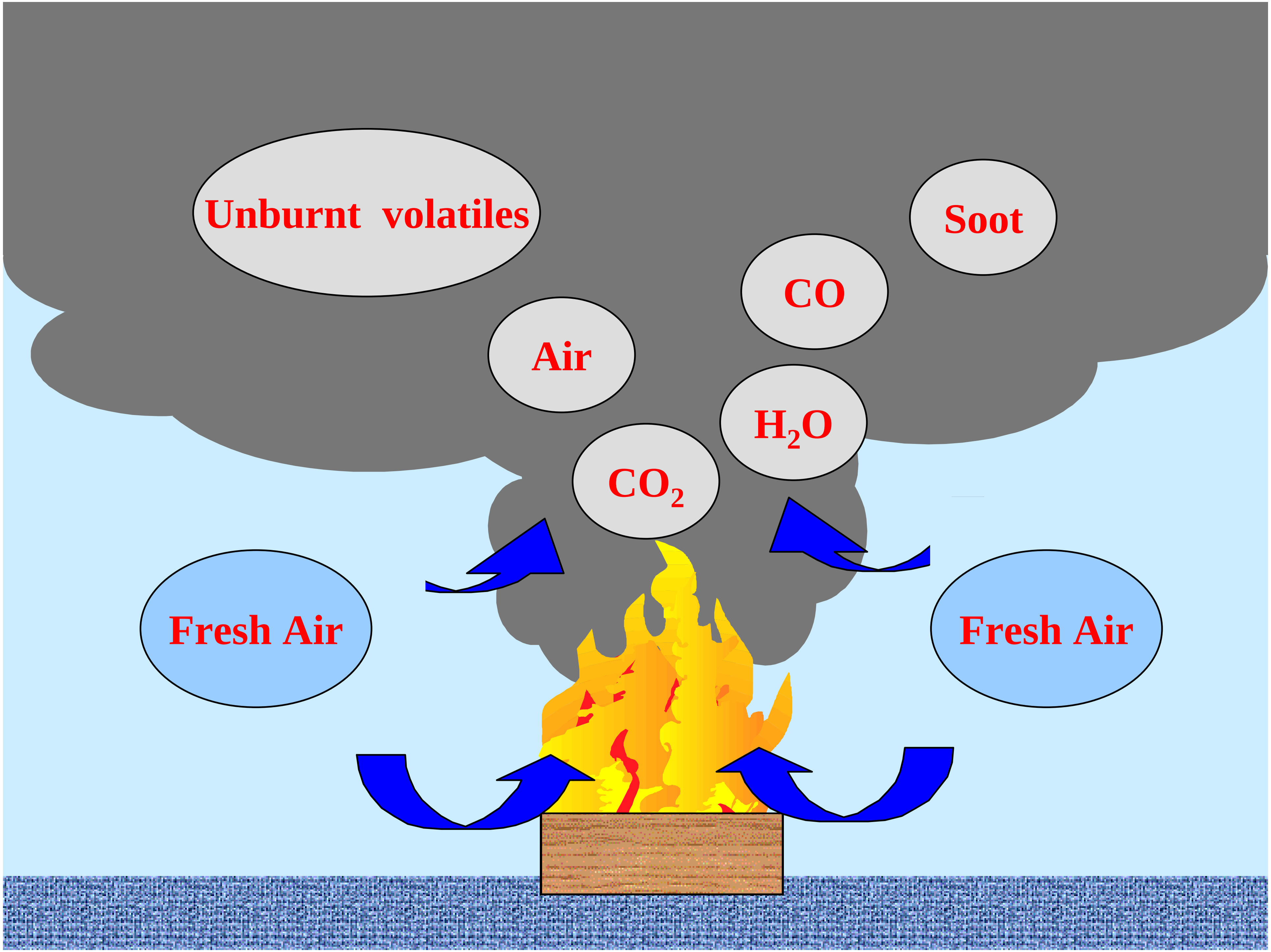
This is the lowest temperature at which a substance will ignite spontaneously





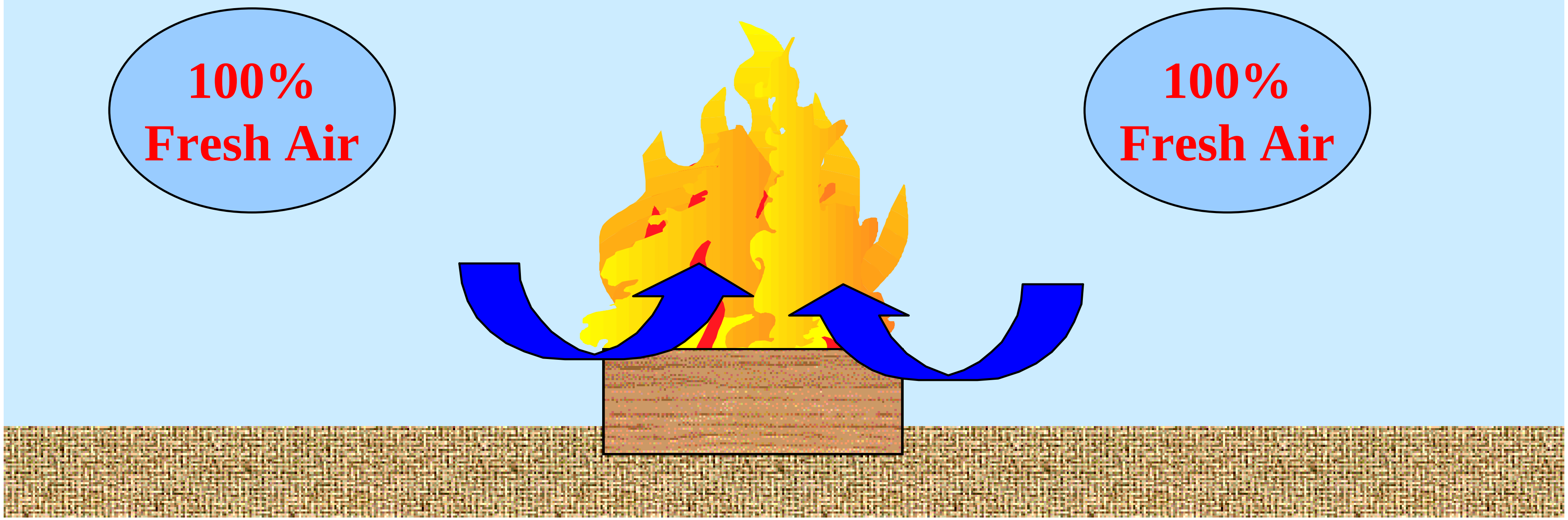

Fuel
Oxygen
Correct Proportions
BOMB
Combustion
Heat
Light/radiation
Smoke


total available mass of fuel
actual participating mass
non participating mass. water
Pyrolysis
char,remains
Un-burnt
Burnt
Smoke



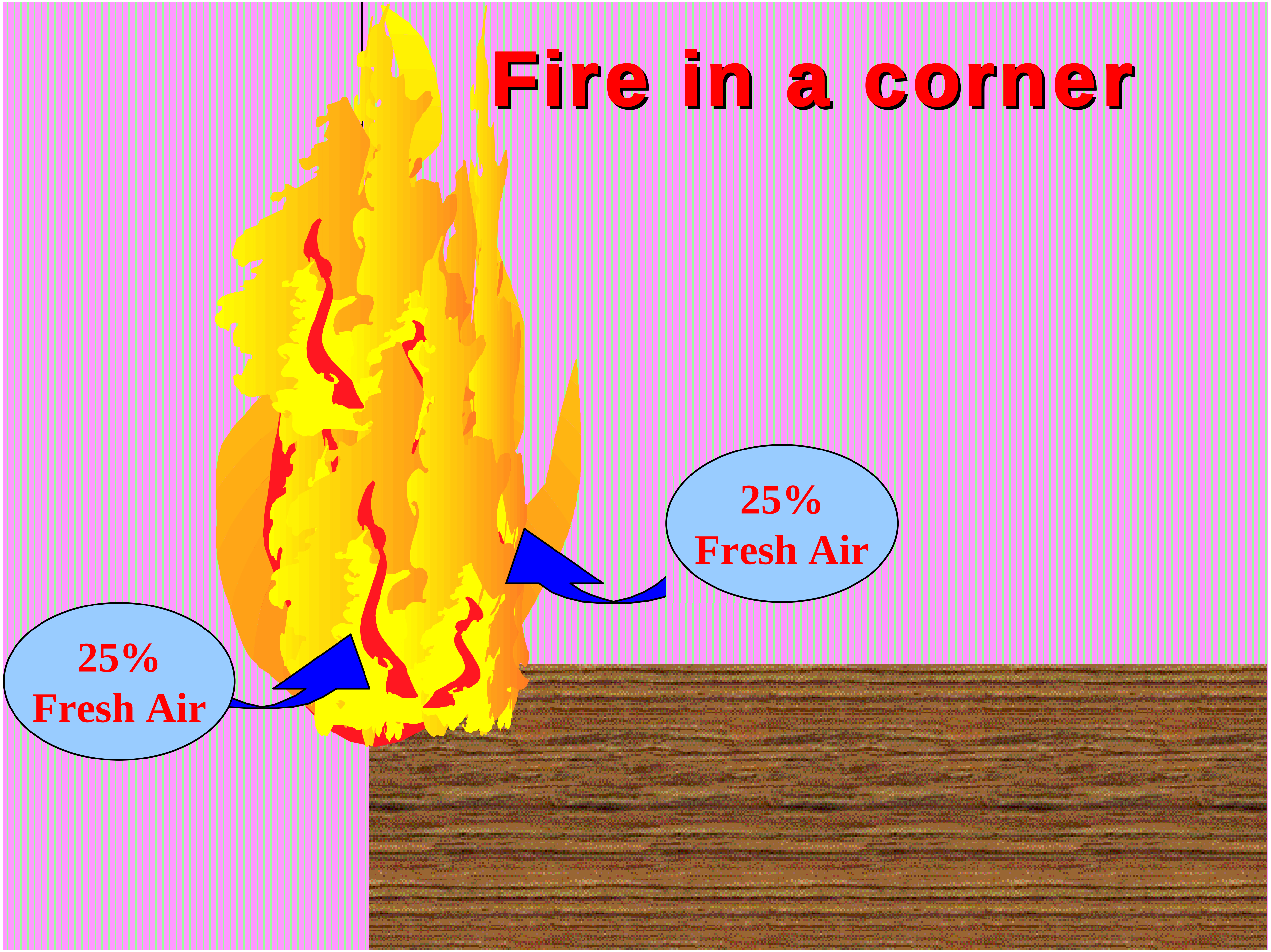
Unburnt volatiles
Soot
CO
Air
H_2O
CO_2
Fresh Air
Fresh Air

Fire in the open



Fire against a wall

Fire in a corner



Any Questions ?

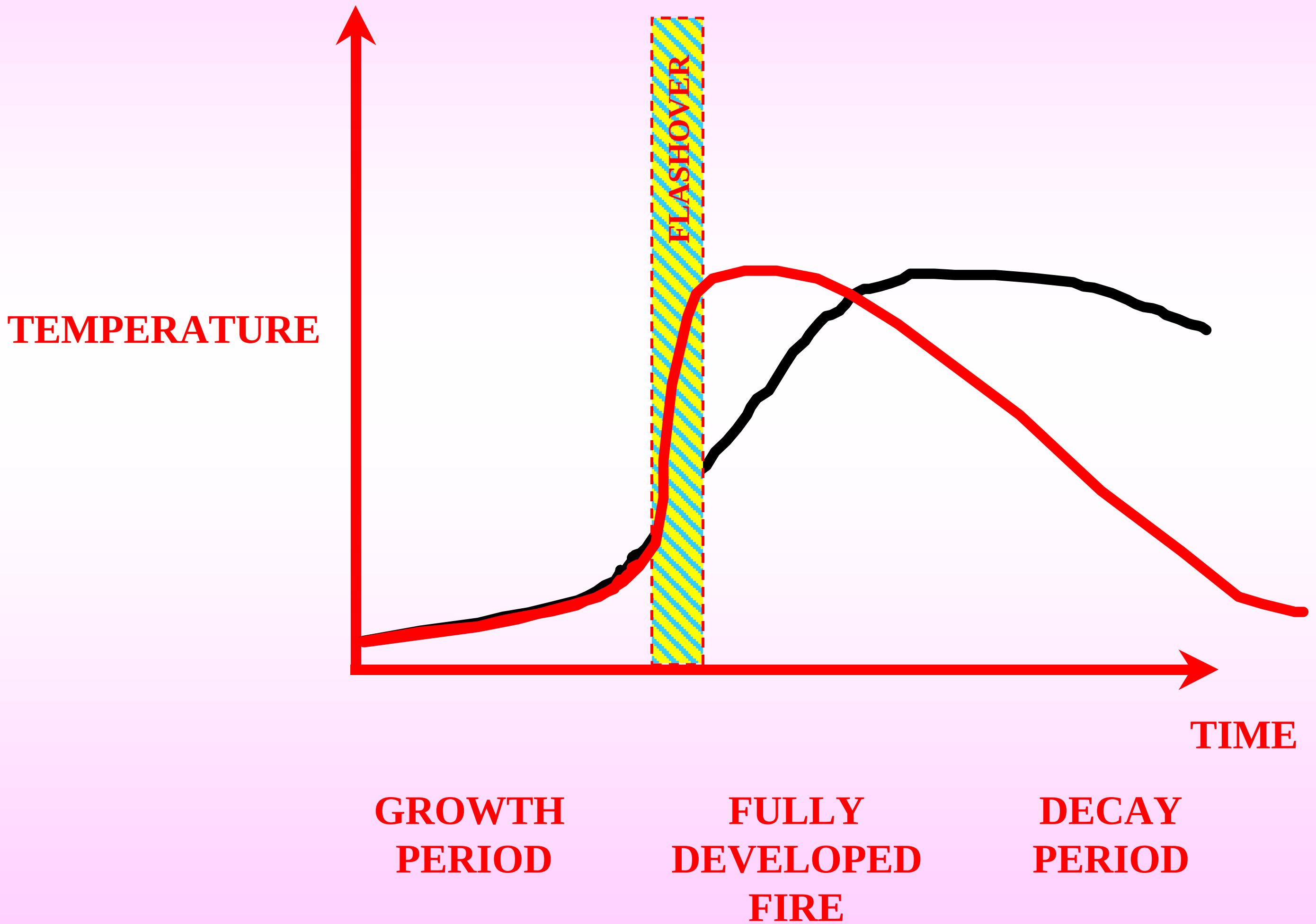
Session Two

Flashover

Definition of Flashover

A sudden and sustained transition of a growing fire to a fully developed fire

Flashover



TEMPERATURE
FLASHOVER
TIME
GROWTH PERIOD
FULLY DEVELOPED FIRE
DECAY PERIOD

Signs and symptoms

- Rapid temperature rise
- Flames in smoke layer
- Materials fuming

Protection

Ensure properly protected

Ensure entrance covered by a charged branch

Protection

Check escape routes are safe

Check door for signs of heat

Protection

Stay low

Only use spray pulses on hot gases

Only ventilate when safe to do so

Any

Questions ?

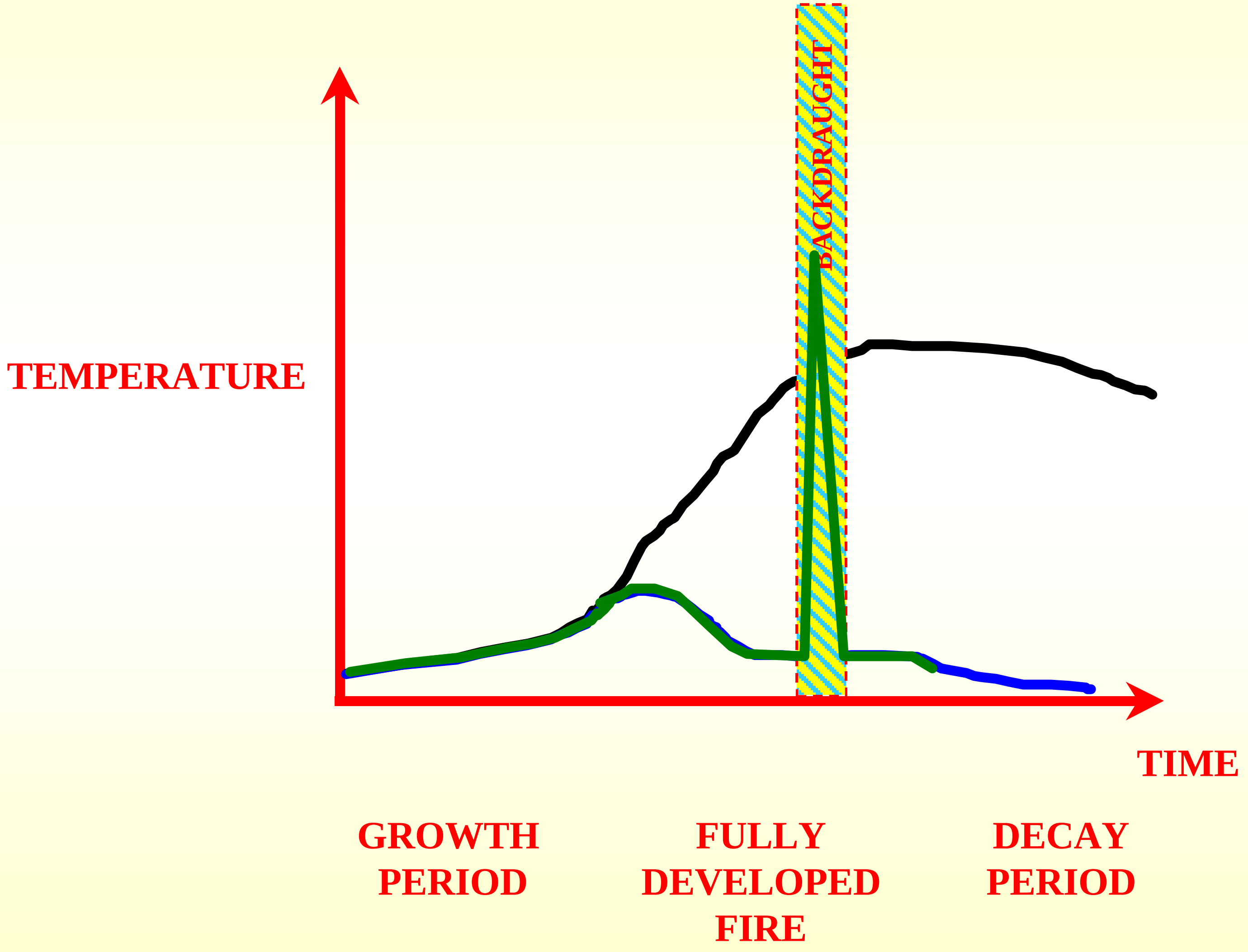
Session

Three

Backdraught

Definition of Backdraught

When an opening is created providing sufficient oxygen, and there is a source of ignition, a sudden deflagration can move through the compartment and out of the opening



BACKDRAUGHT
TEMPERATURE
TIME
GROWTH PERIOD
FULLY DEVELOPED FIRE
DECAY PERIOD

Signs & Symptoms

1. Smoke — no visible flame
2. Windows — blackened
3. Breathing — pulsing smoke
4. Doors
   - ☞ whistling
   - ☞ hot handles
   - ☞ signs of heat

Protection

Ensure you are properly protected

If possible keep out of affected room and vent from outside

Protection

Check escape routes
are
secure and protected

Cool and ventilate
outer compartment

Protection

Plan an escape route for gases before releasing them

Stay low and to the side of the door

Protection

Open door slightly, spray through gap directing spray upwards, close door. Repeat as necessary

Cool as much of the compartment as possible

Protection

Keep out of the way of hot steam and gases

Only enter if necessary, flammable gases will still be present

Any
Questions ?

Session Four

Summary

Factors involved in compartment fires

Sign & Symptoms

Protective measures

Tactics & Techniques

Any Questions ?

Thank you
for your
attention

The end

NORTHERN IRELAND
FIRE BRIGADE

GRAMPIAN FIRE BRIGADE

TRAINING CENTRE,
PORTLETHEN

IN THE EVENT OF FIRE
(or the fire alarm sounding)

AN INTERMITTENT HIGH PITCHED WAIL

- **Leave by the nearest exit and assemble in the car park where a roll call will be taken.**
- **In the event of anyone discovering a fire - raise the alarm and leave the building by the nearest exit.**
- **All incidents involving fire will be dealt with by Training Centre staff.**

SMOKING POLICY

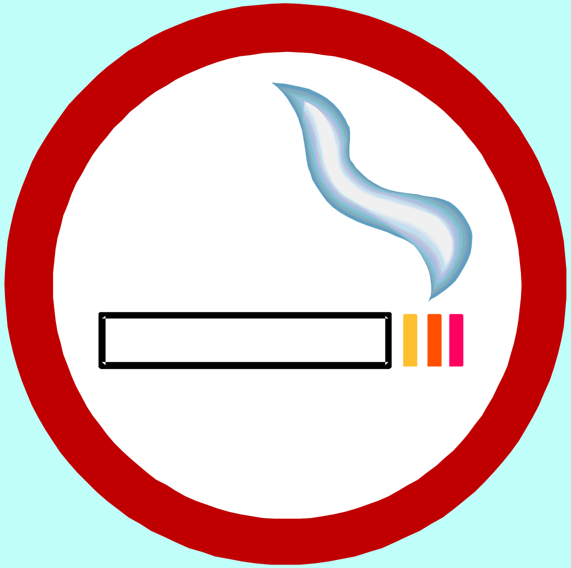
NO SMOKING

In the admin block

In the classrooms

On the training ground

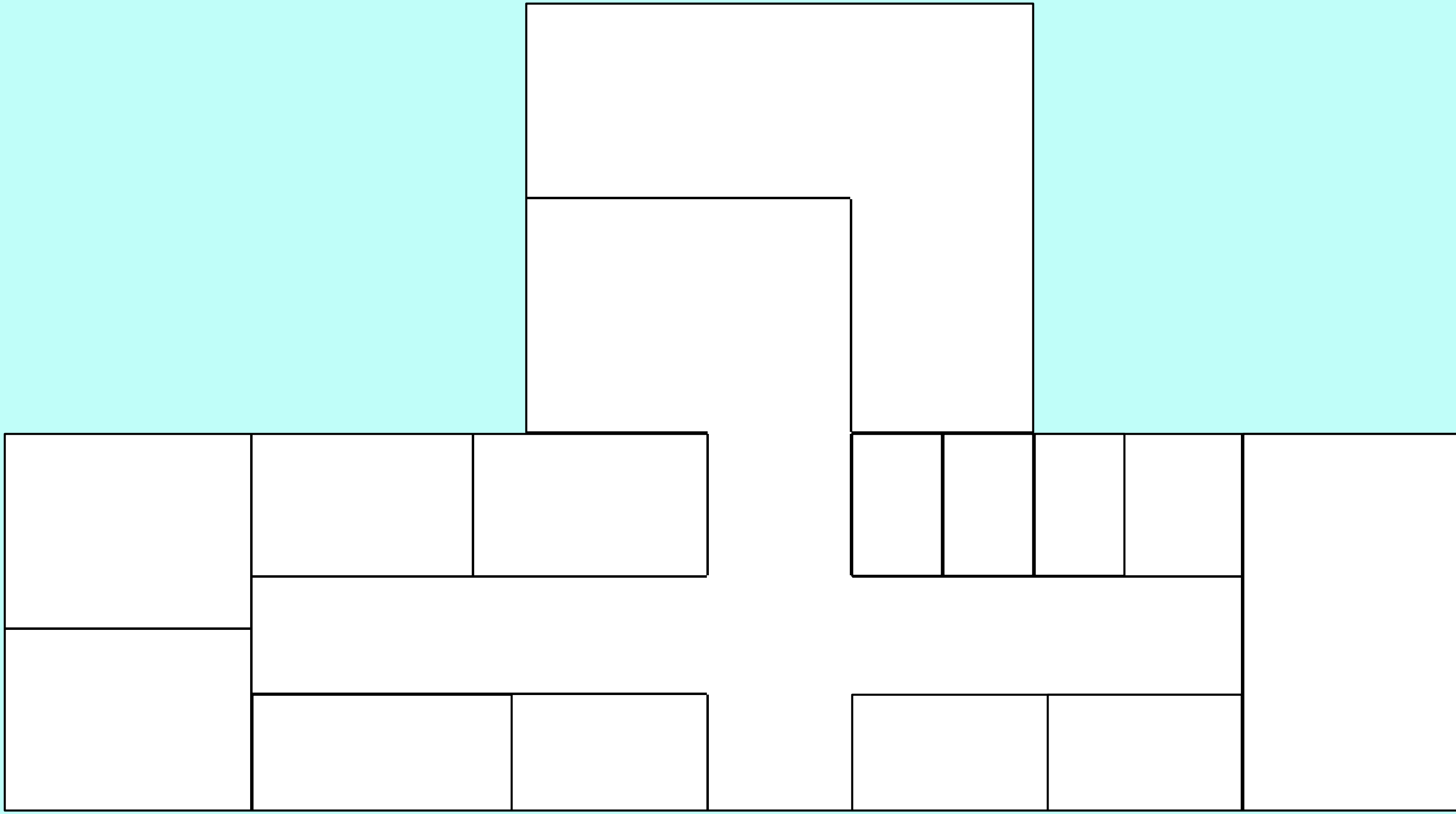
SMOKING POLICY

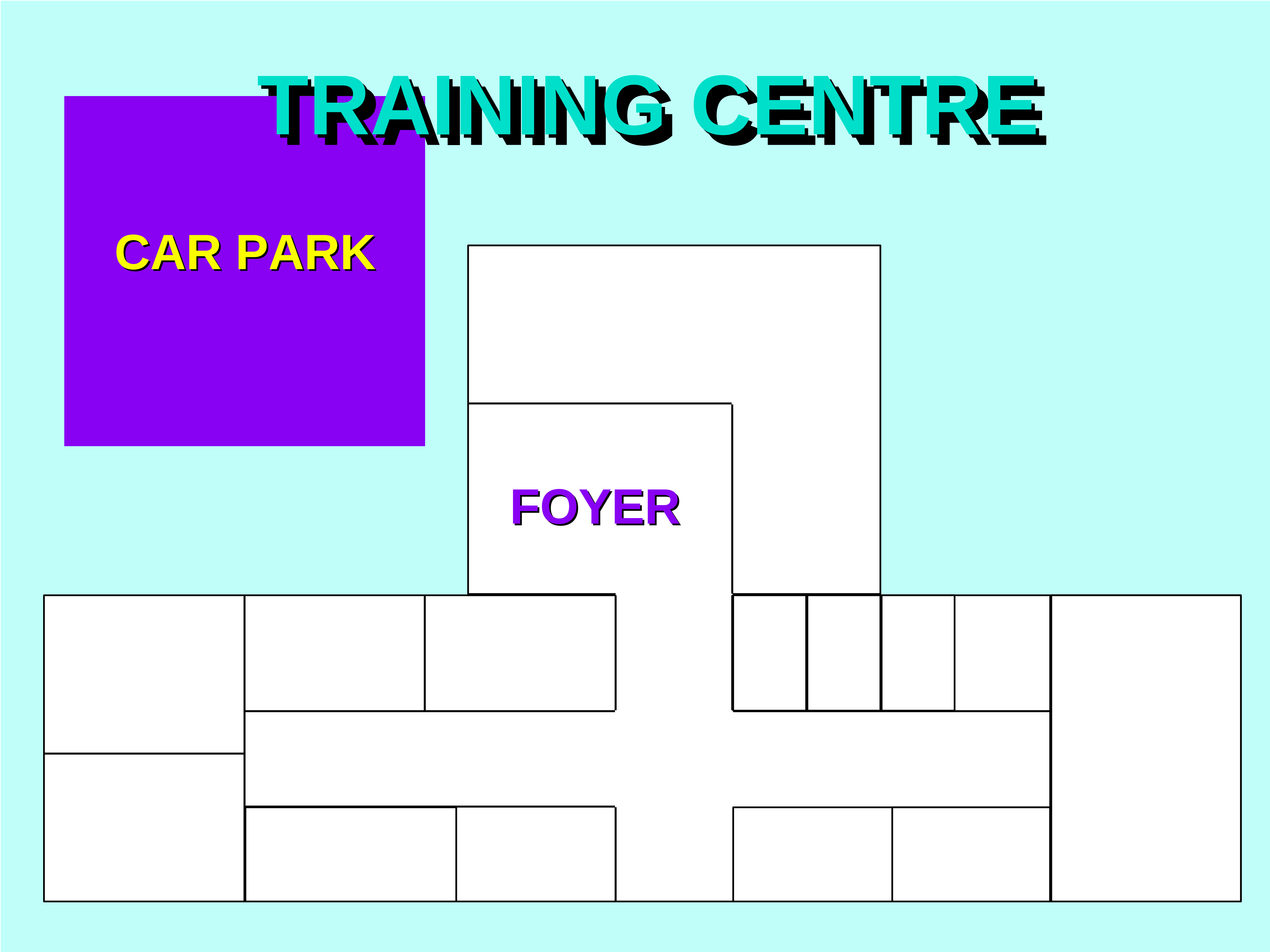


SMOKING

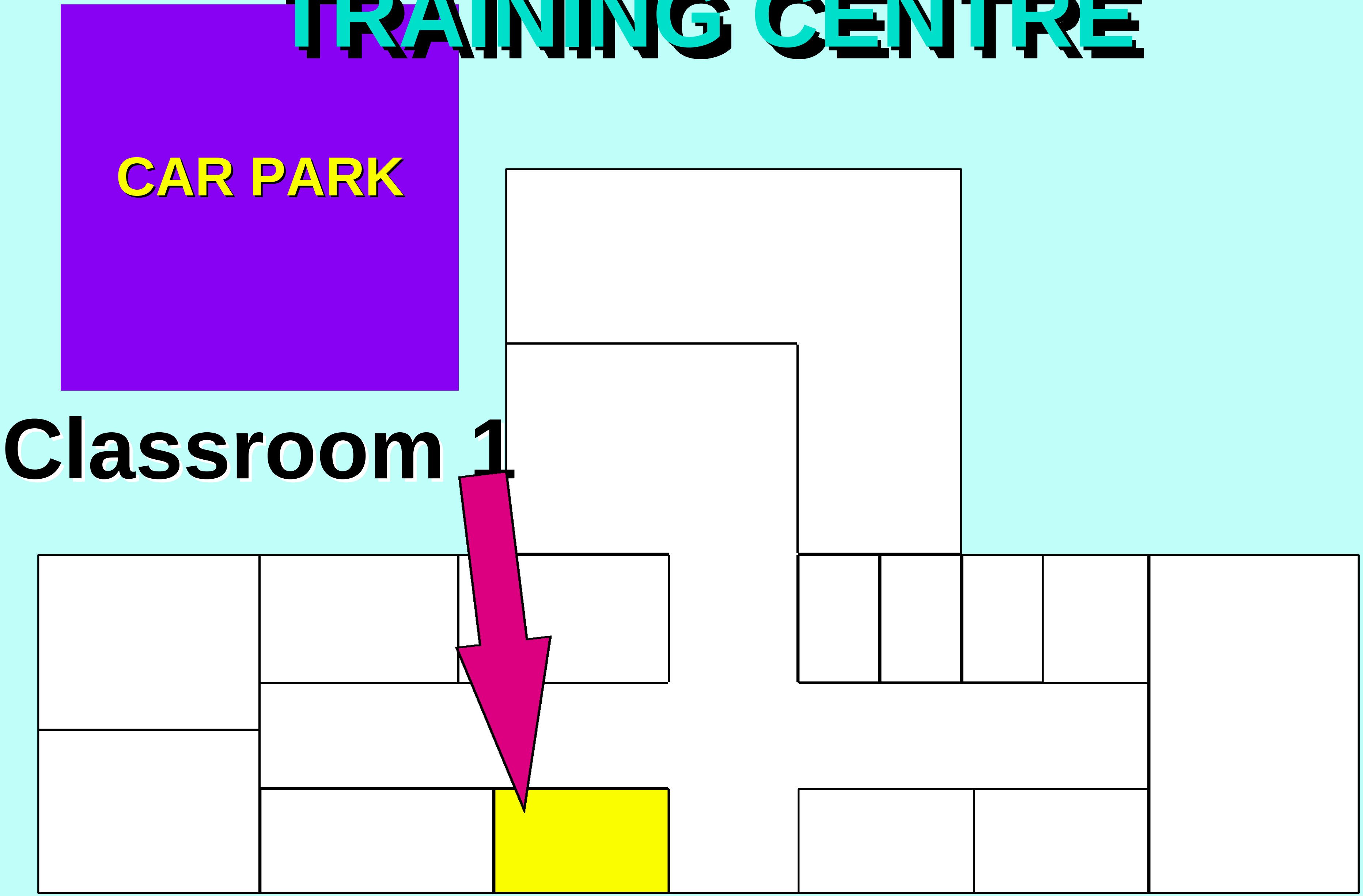
Is permitted outside during breaks

TRAINING CENTRE

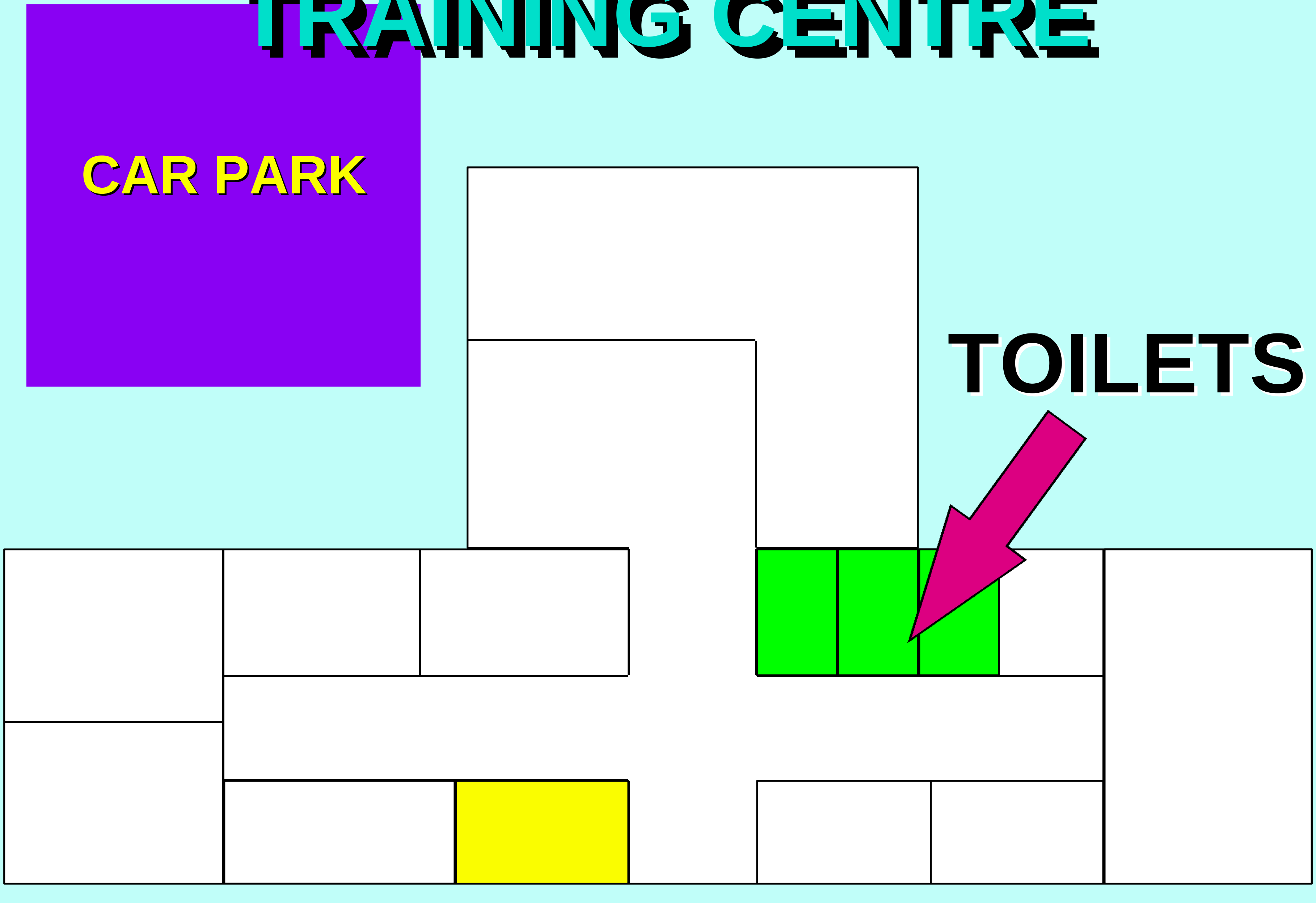


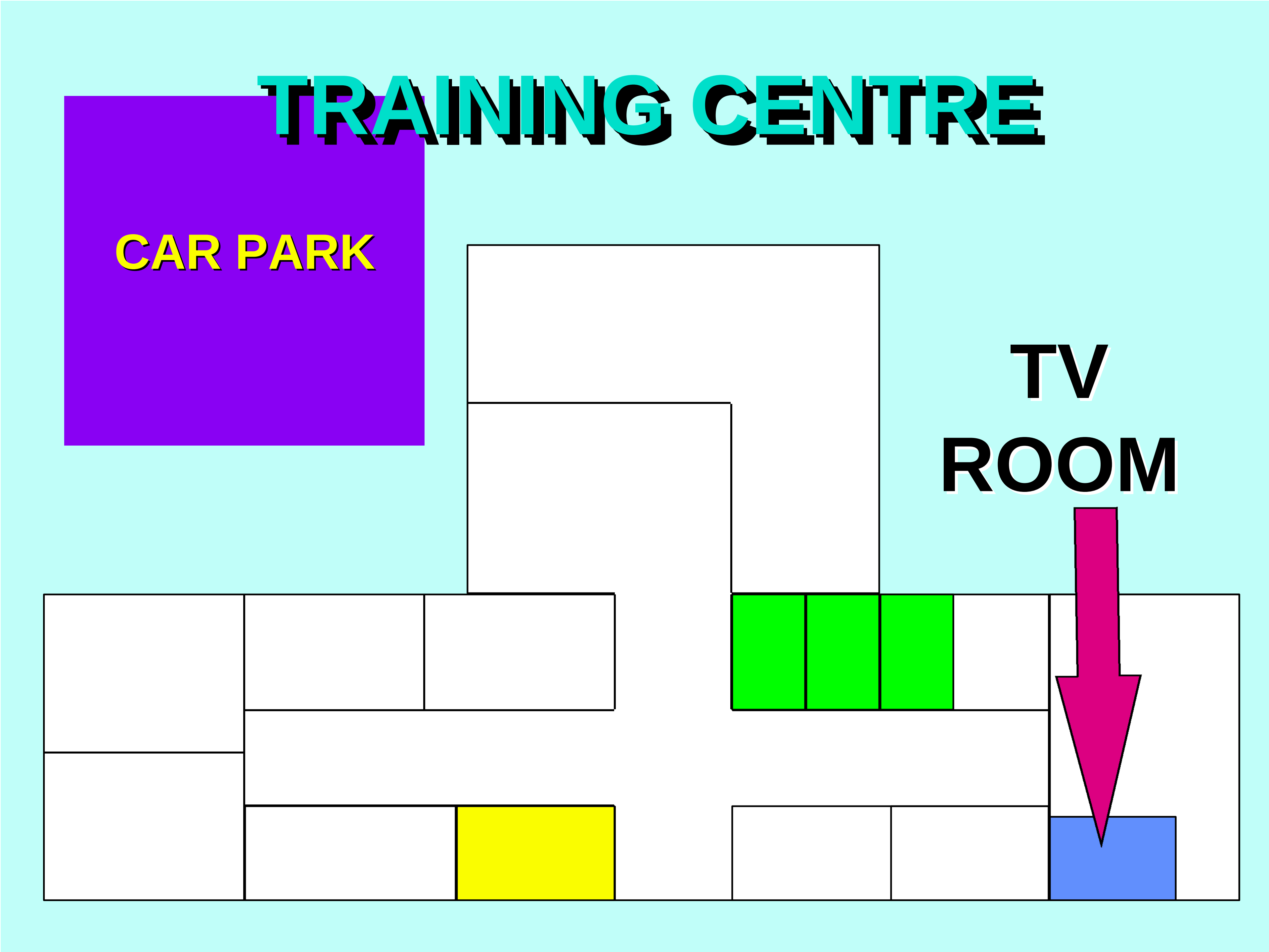

TRAINING CENTRE
CAR PARK
FOYER

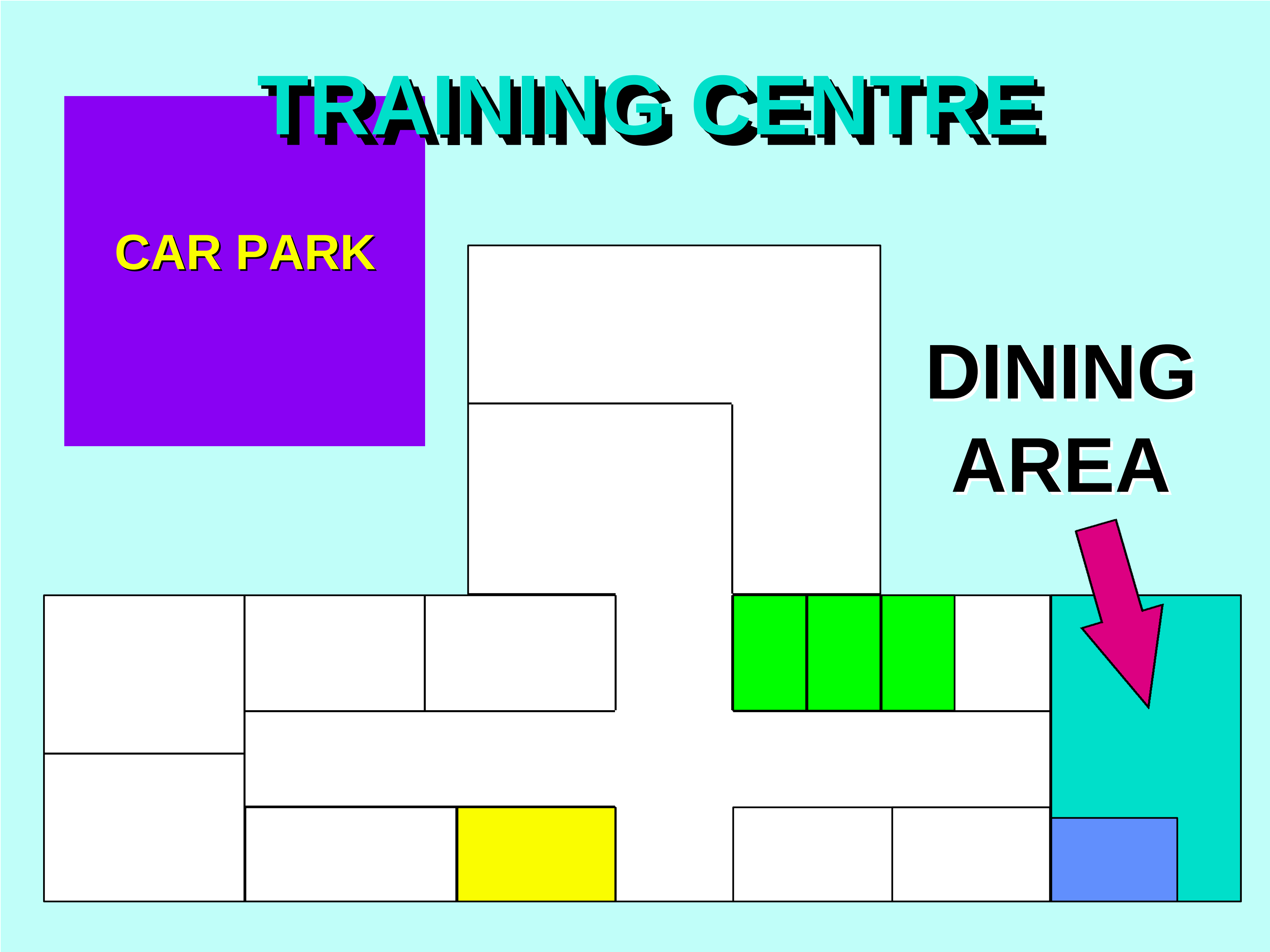
TRAINING CENTRE

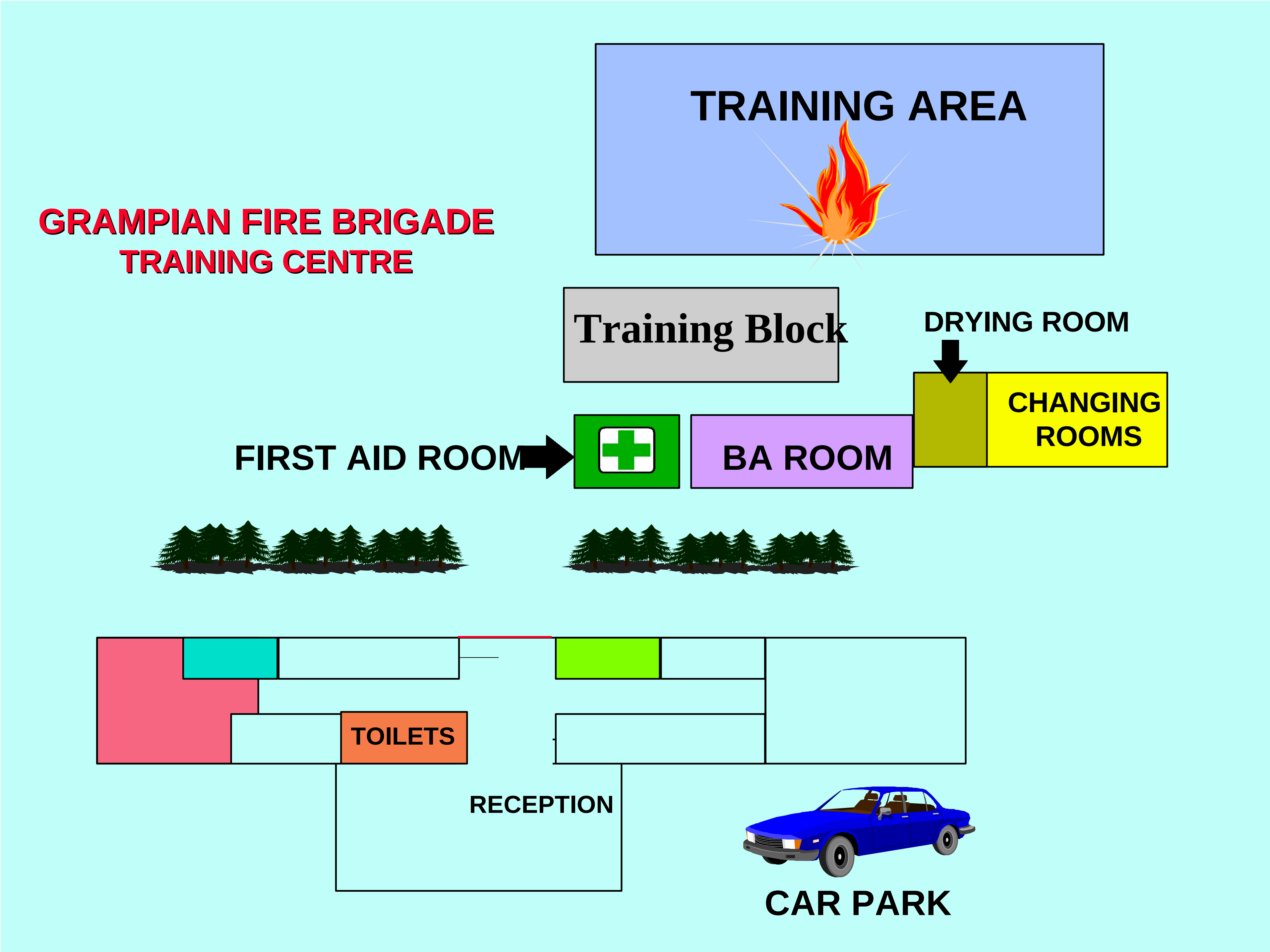


TRAINING CENTRE



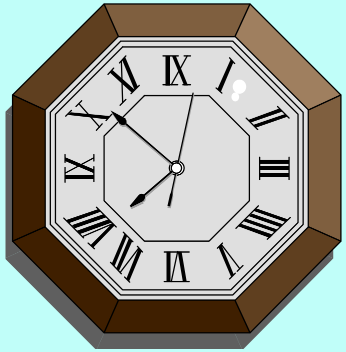

TRAINING CENTRE
CAR PARK
TV
ROOM

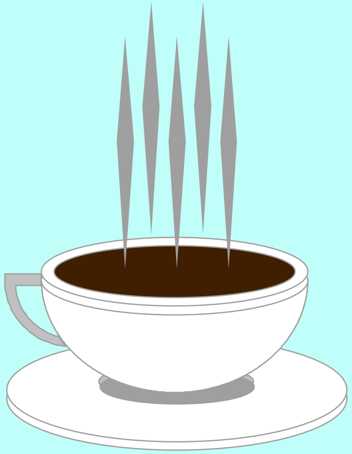

TRAINING CENTRE
CAR PARK
DINING
AREA


GRAMPIAN FIRE BRIGADE
TRAINING CENTRE
TRAINING AREA
Training Block
DRYING ROOM
CHANGING ROOMS
FIRST AID ROOM
BA ROOM
TOILETS
RECEPTION
CAR PARK

BREAKS

(approximate times)





TEA / COFFEE

(self service)

10.15 & 15.15

LUNCH

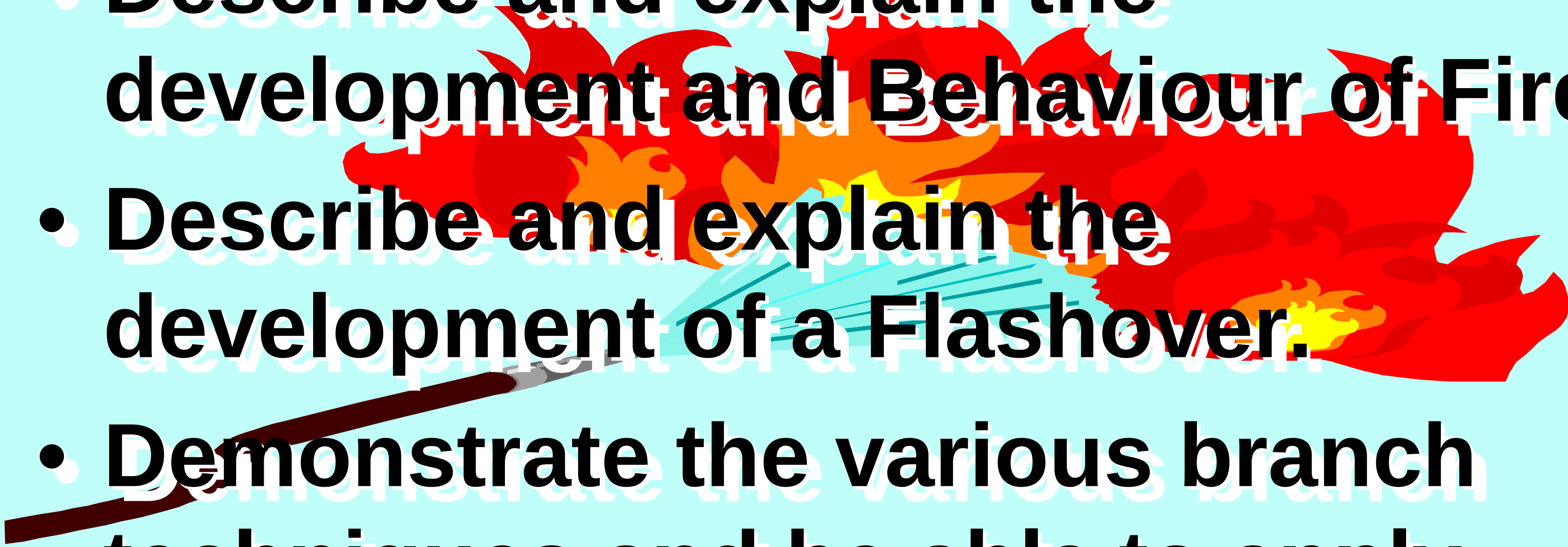
(served)

12.35

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

COURSE OBJECTIVES

At the end of the course the student will be able to :



- **Describe and explain the development and Behaviour of Fire.**
- **Describe and explain the development of a Flashover.**
- **Demonstrate the various branch techniques and be able to apply them in a fire situation.**

2 DAY BASIC
FIRE DEVELOPMENT COURSE

DAY 1						
Fire Behaviour and Development	Tea	Fire Extinguishing Branch Techniques (Practical)	Lunch	Demonstrator session	Tea	Debrief

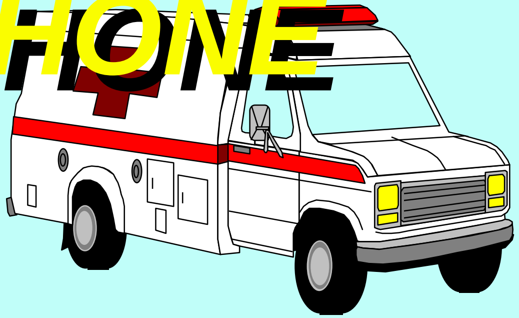
DAY 2							
Flashover at incidents Window session	Tea	Attack session 1	Lunch		Attack session 2	Tea	Debrief

EMERGENCY ACTION

In the event of any unforeseen incident that requires emergency action, the following procedures must be followed:

- **The safety officer nearest the occurrence will deal with the situation as required and inform the senior instructor.**
- **If necessary, the senior instructor will give the evacuation signal.**
- **Internal safety officers will evacuate all personnel and proceed to BA entry control for a roll call.**
- **Any casualties will be given first aid treatment.**
- **Ventilation and firefighting will be carried out by training centre staff.**
- **If necessary, the emergency telephone procedure will be initiated by the senior instructor.**

EMERGENCY TELEPHONE PROCEDURE



- A instructor will be nominated to proceed to the first aid room, where they will dial 999 and ask for the ambulance service.
- The name of the senior instructor should be given, along with a brief description of injuries. The address and telephone number of the Training Centre (beside the phone) should be given and any directions as required.
- They will then contact Brigade Control and, using the roll call sheet (beside the phone) give the name and number of the injured person.

BRIGADE TRAINING CENTRE

SCHOOLHILL
PORTLETHEN

TELEPHONE : (01224) 782596

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

FLASHOVER

- **DEFINITION:**

  The sudden and sustained transition of a growing fire to a fully developed fire.

BACKDRAUGHT
(Delayed Flashover)

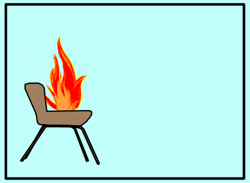
- **DEFINITION:**

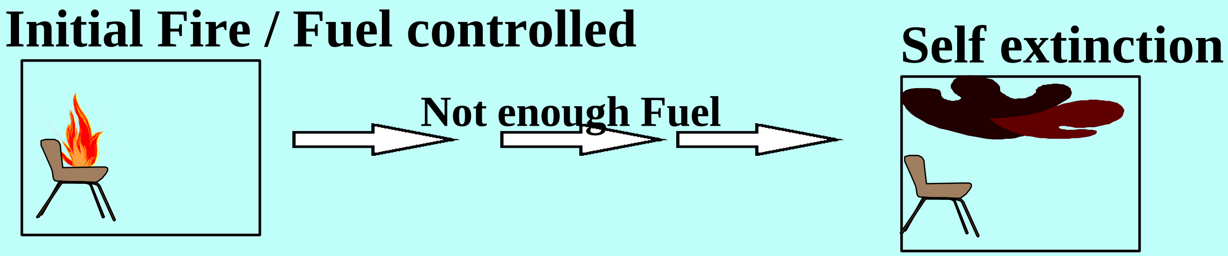
  When an opening is created providing sufficient oxygen, and there is a source of ignition, a sudden deflagration can move through the compartment and out of the opening.

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

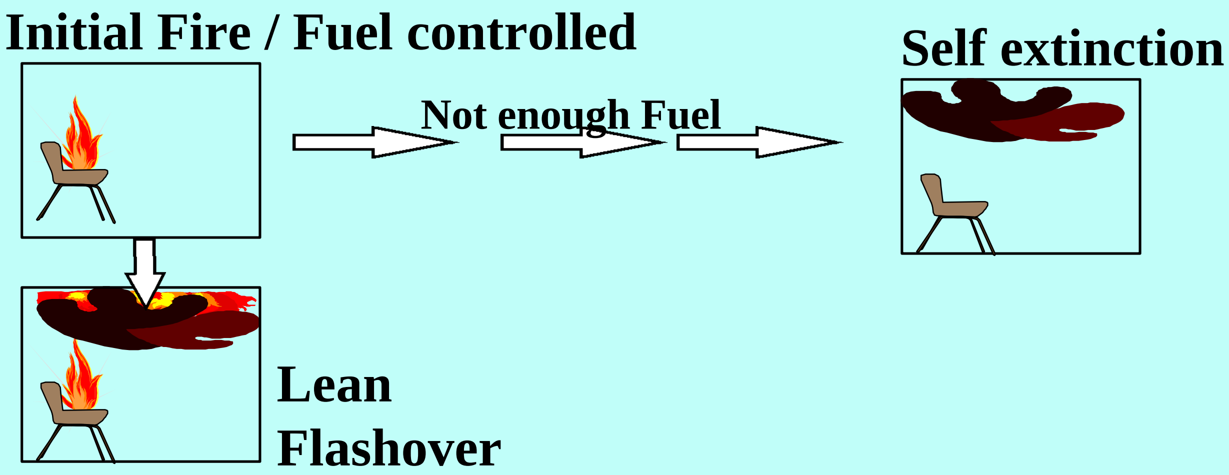
FIRE DEVELOPMENT FLOWCHART

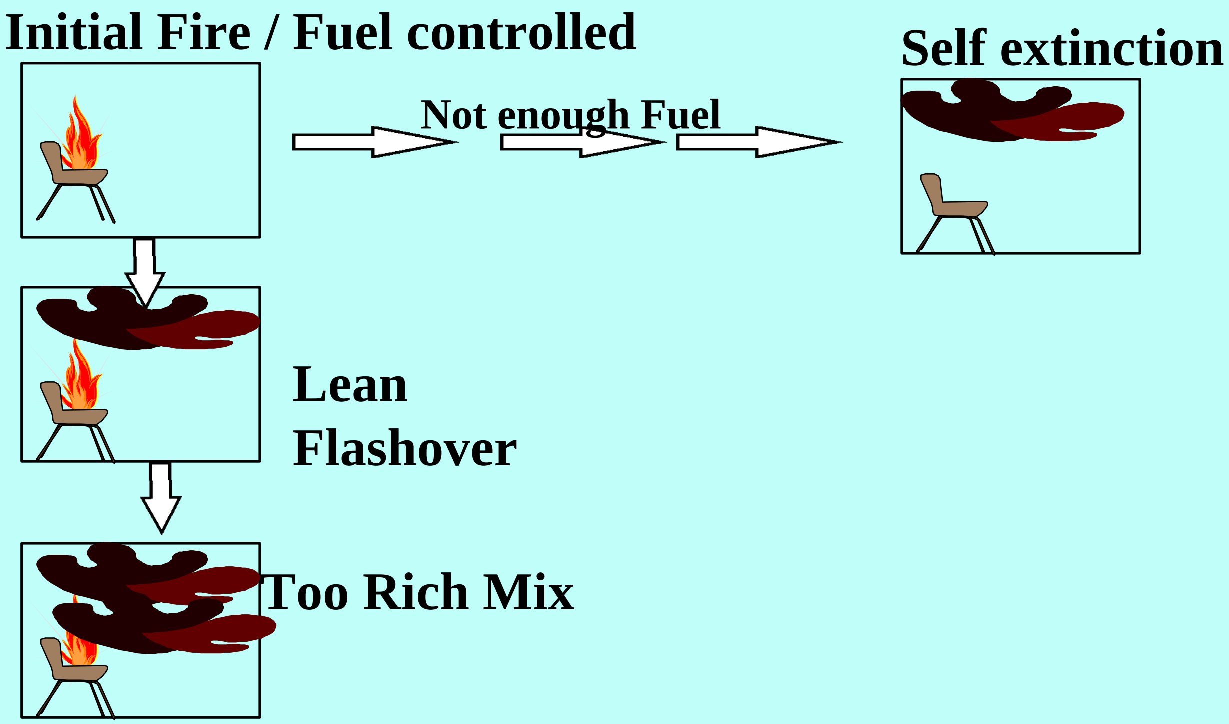
Initial Fire / Fuel controlled

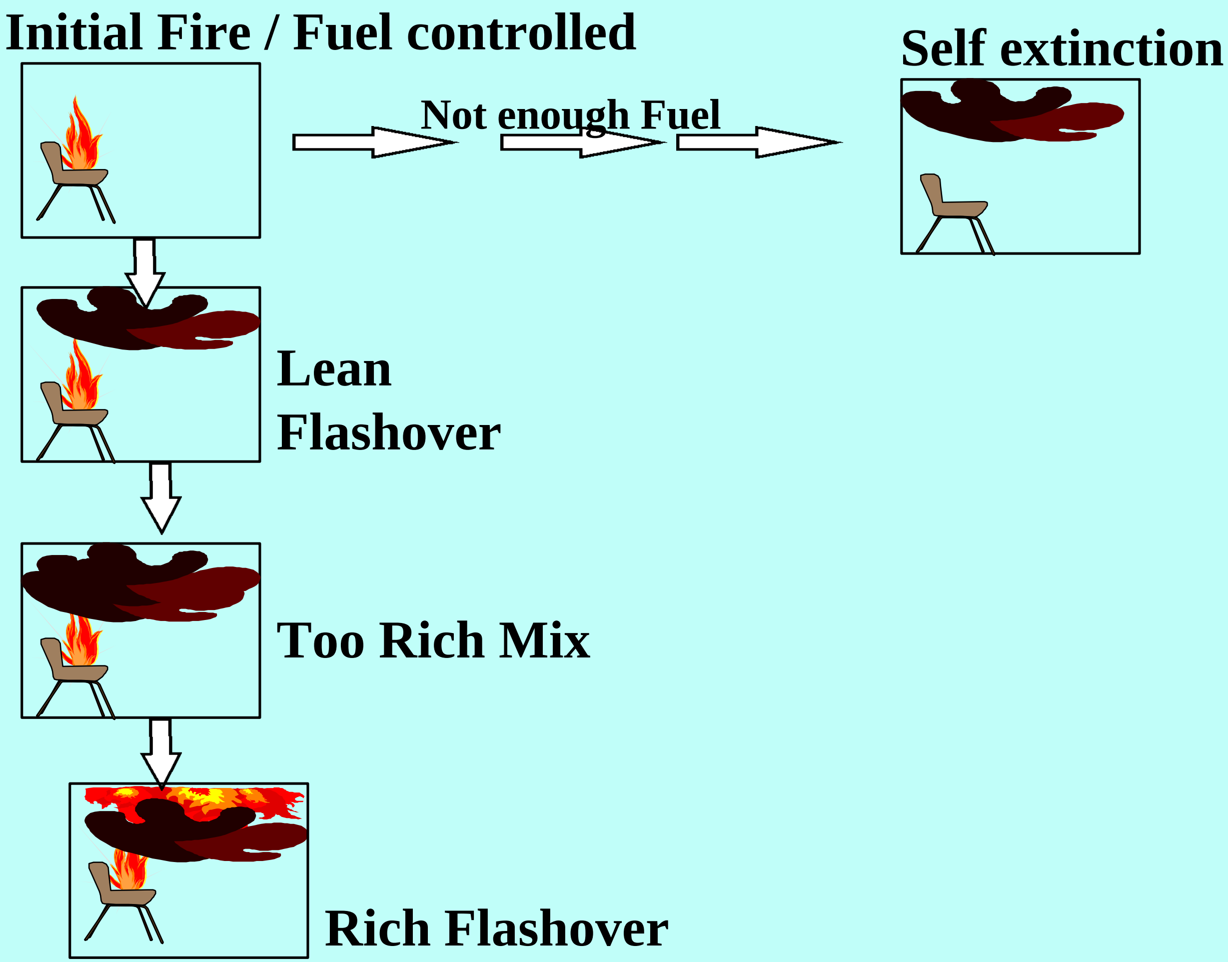


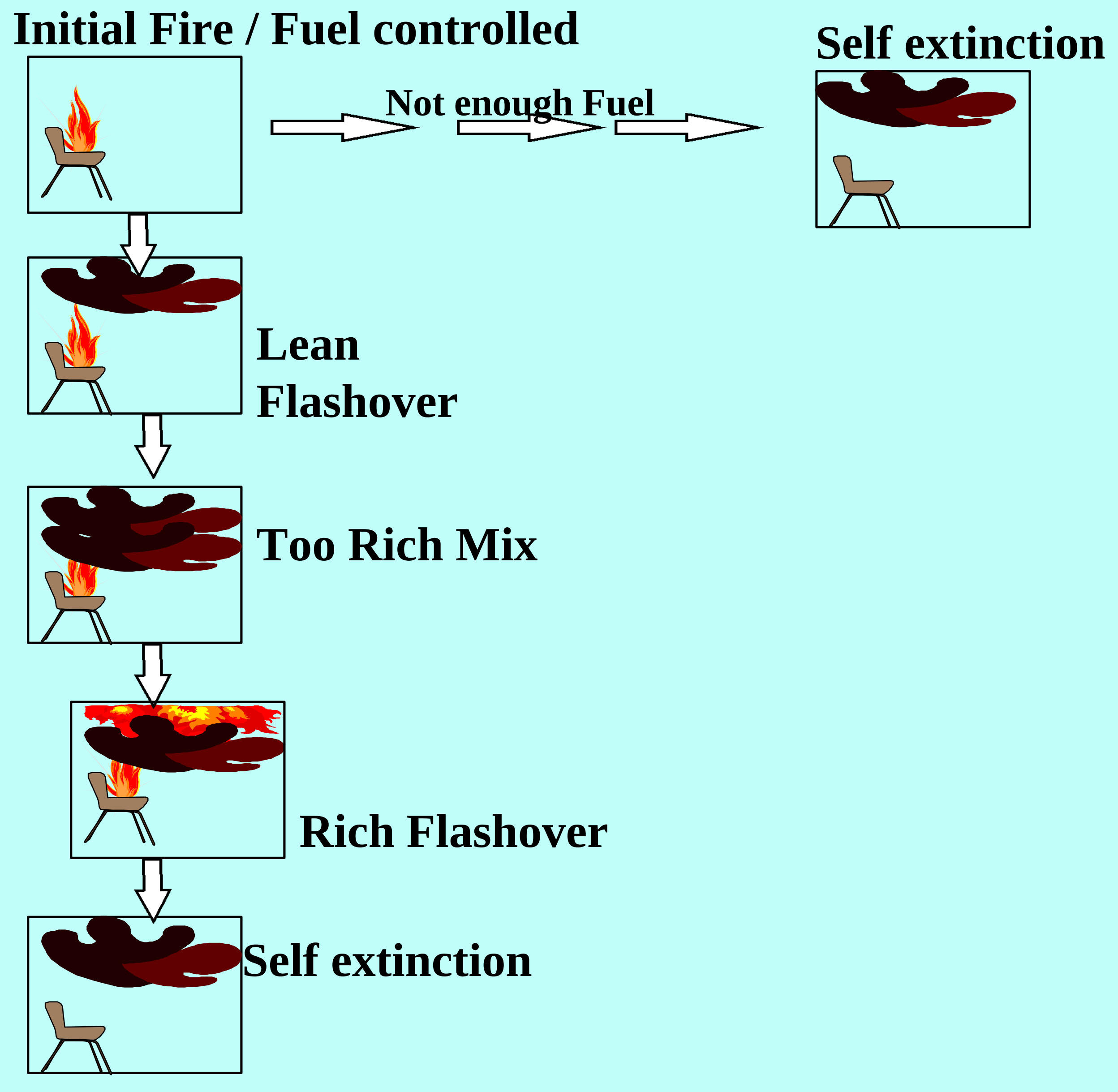


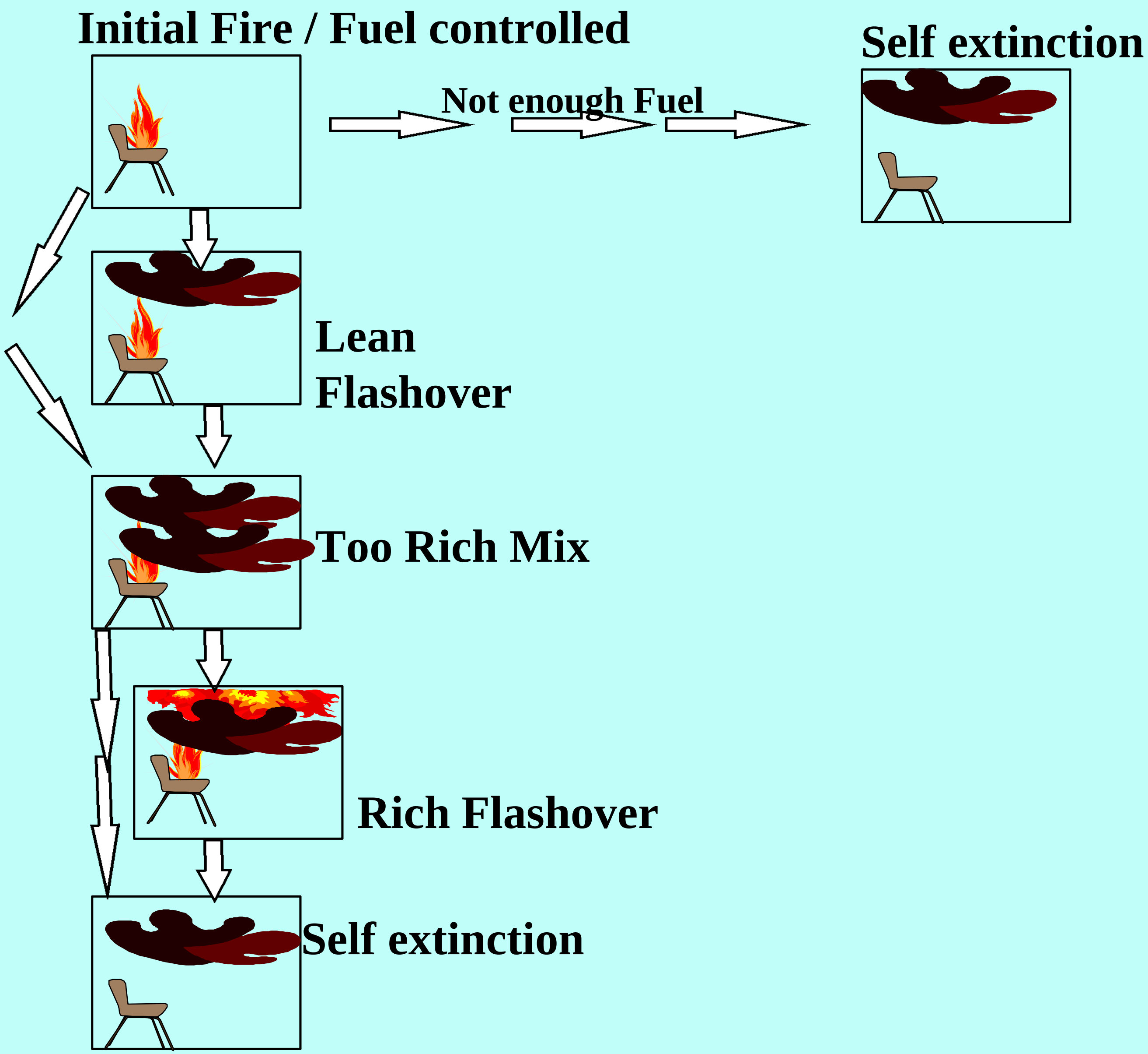
Initial Fire / Fuel controlled
Not enough Fuel
Self extinction

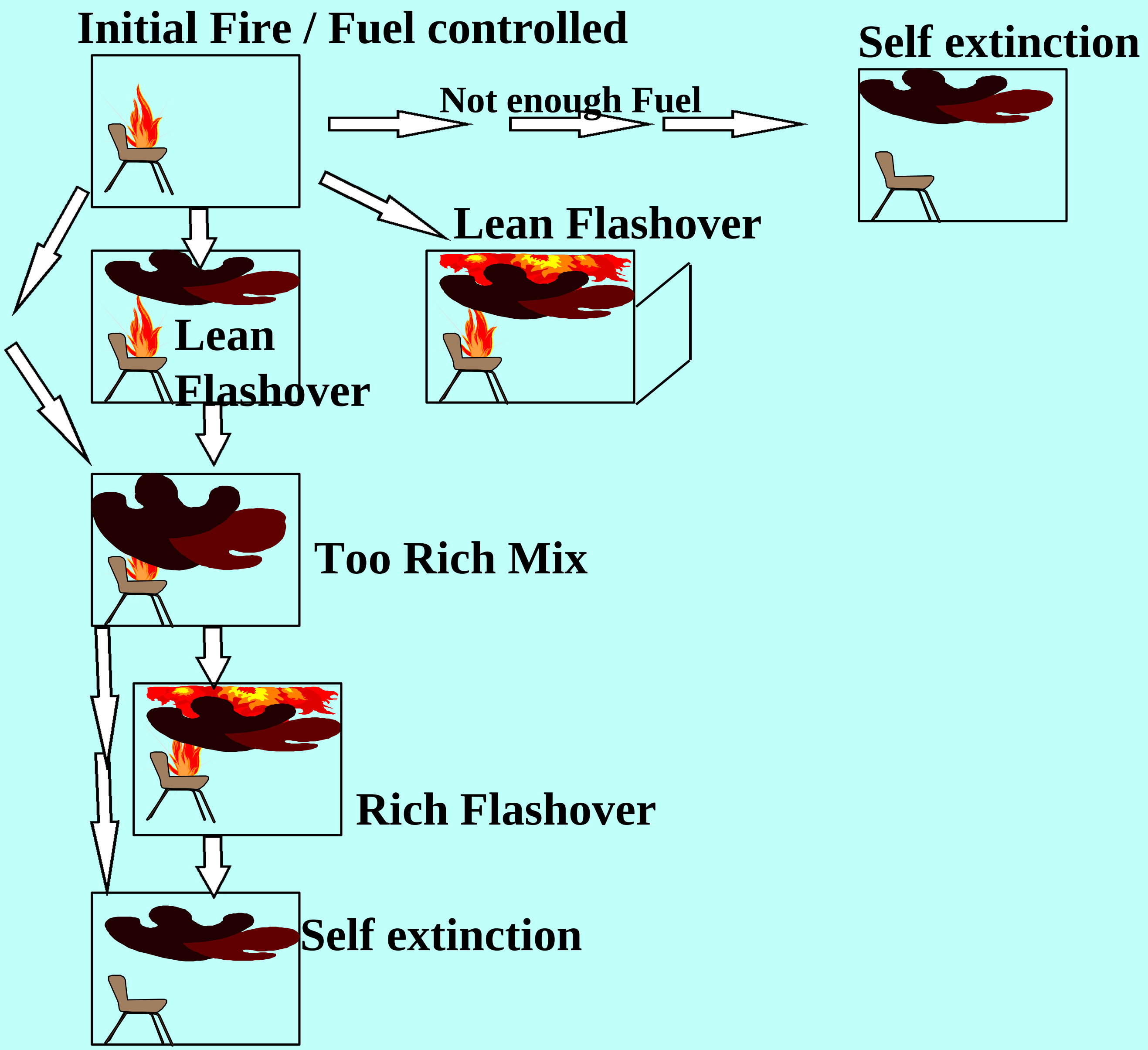

Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean
Flashover


Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean
Flashover
Too Rich Mix

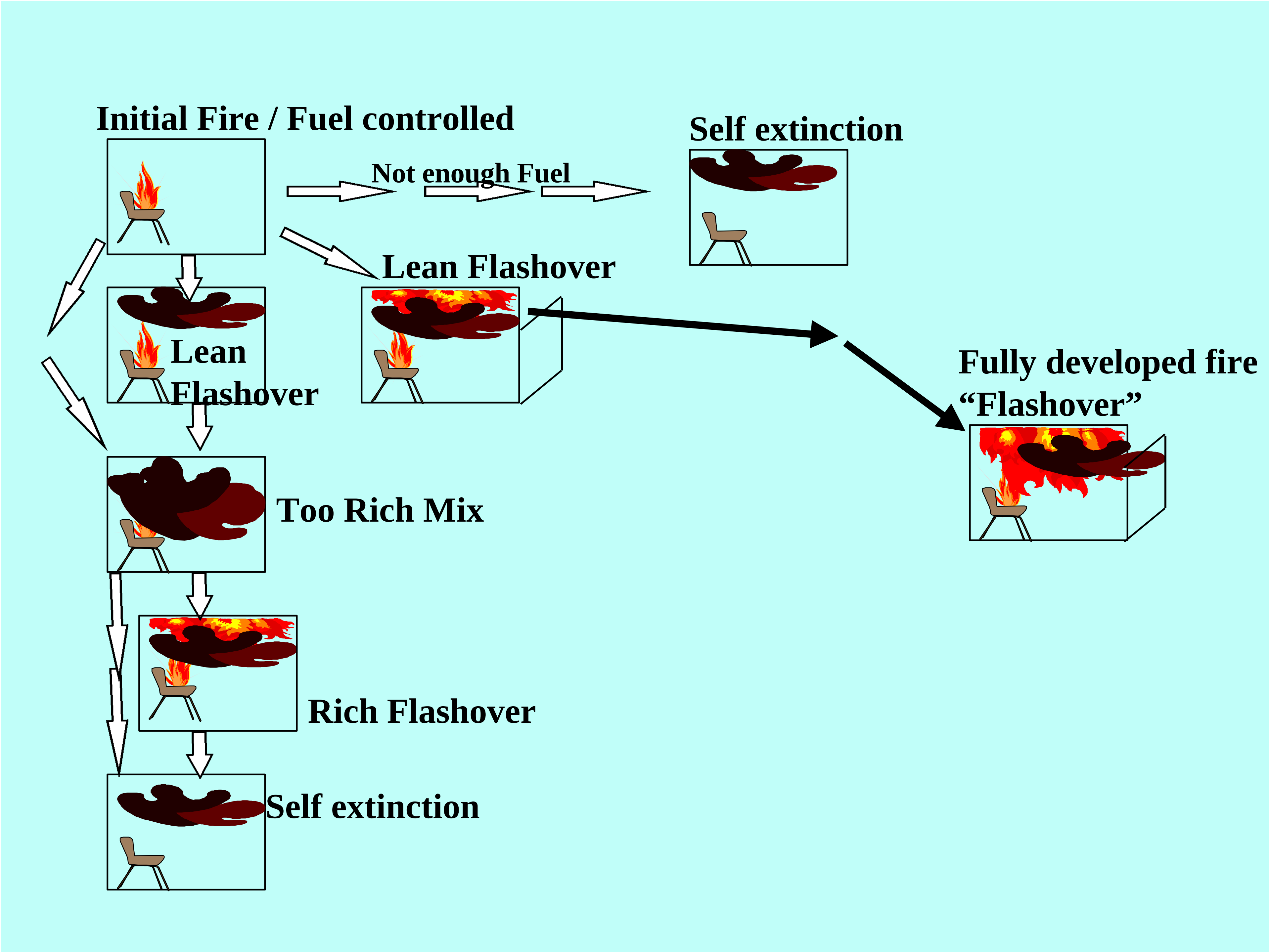

Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Too Rich Mix
Rich Flashover


Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean
Flashover
Too Rich Mix
Rich Flashover
Self extinction

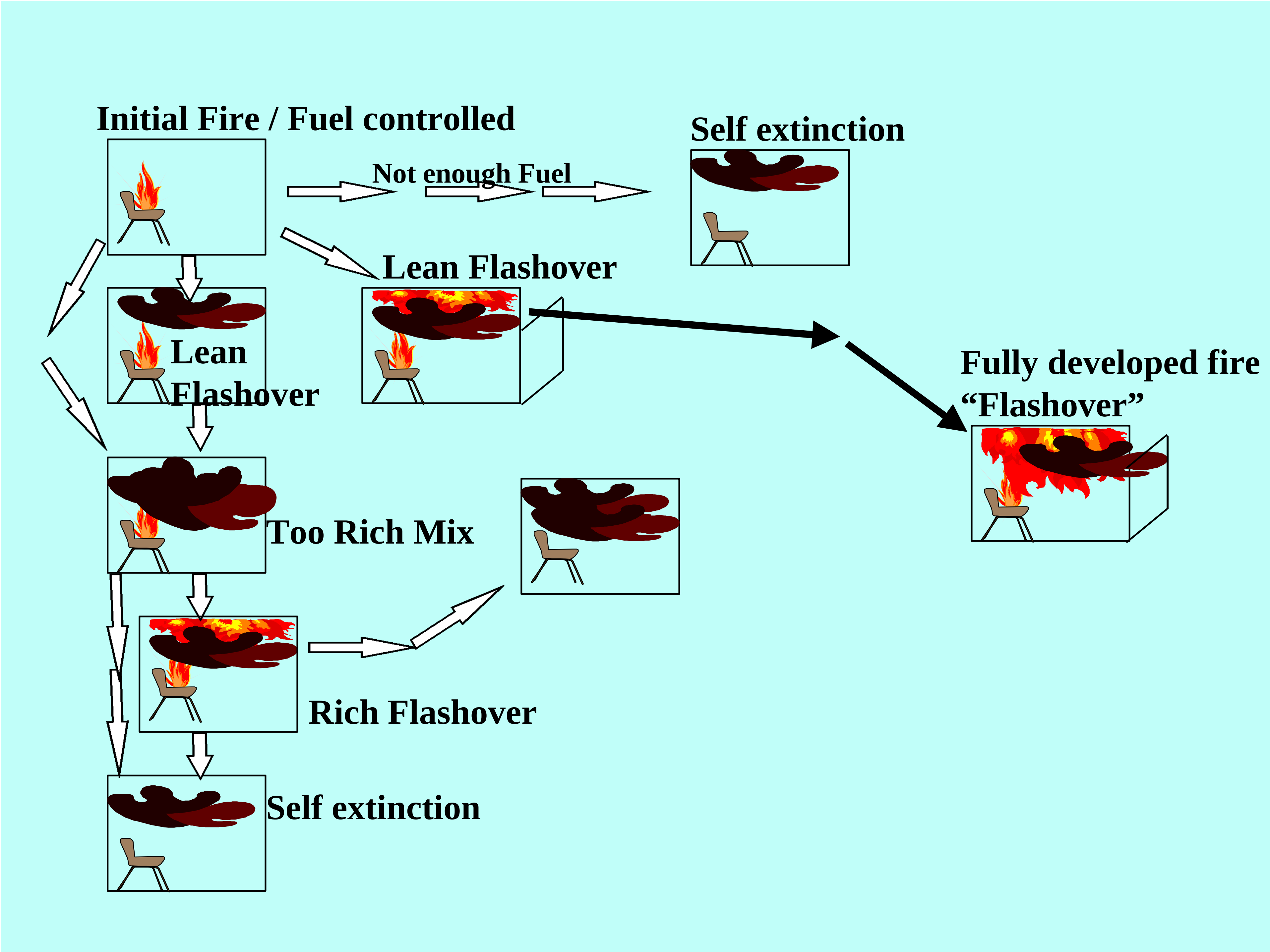

Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean
Flashover
Too Rich Mix
Rich Flashover
Self extinction

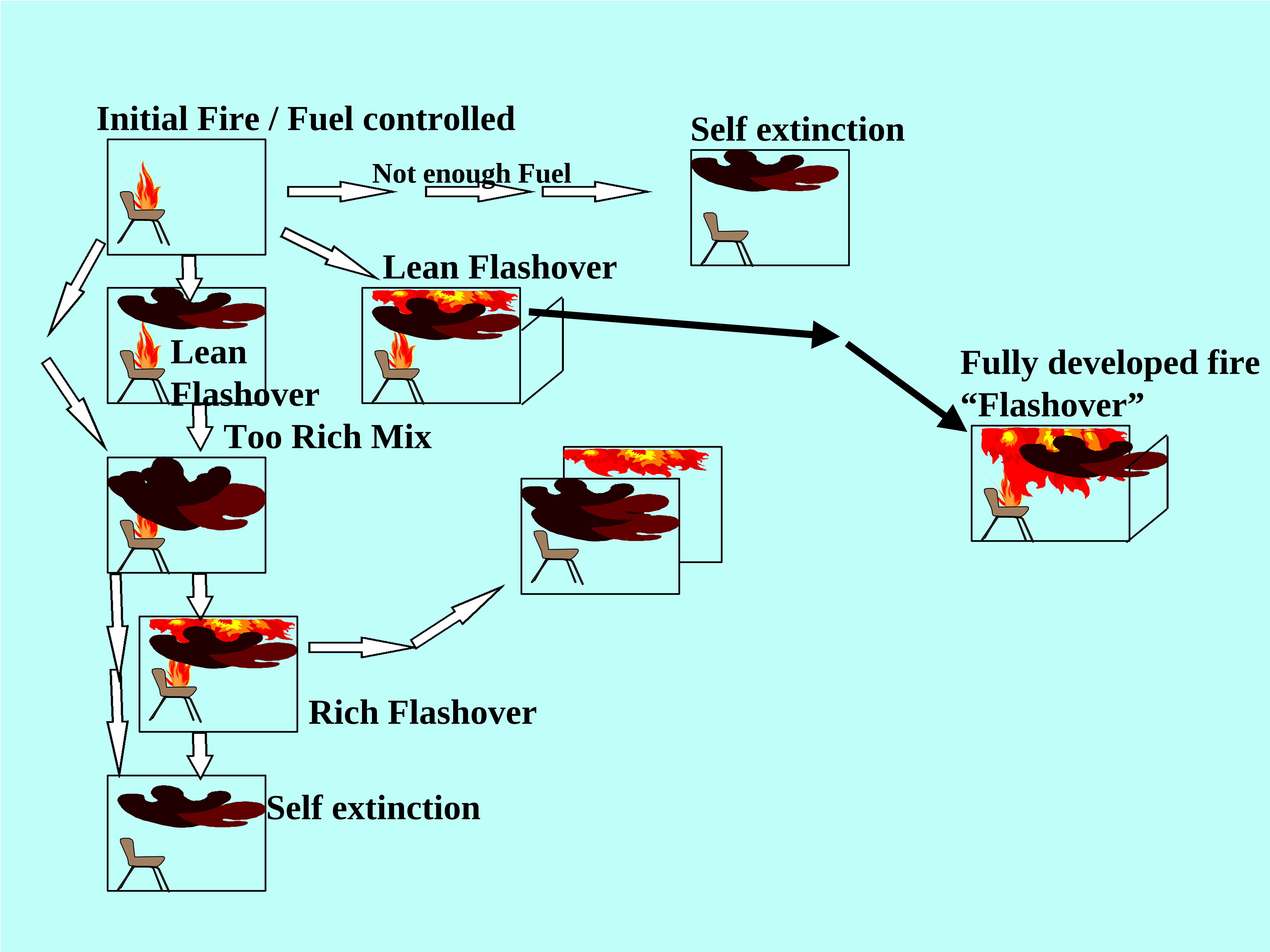


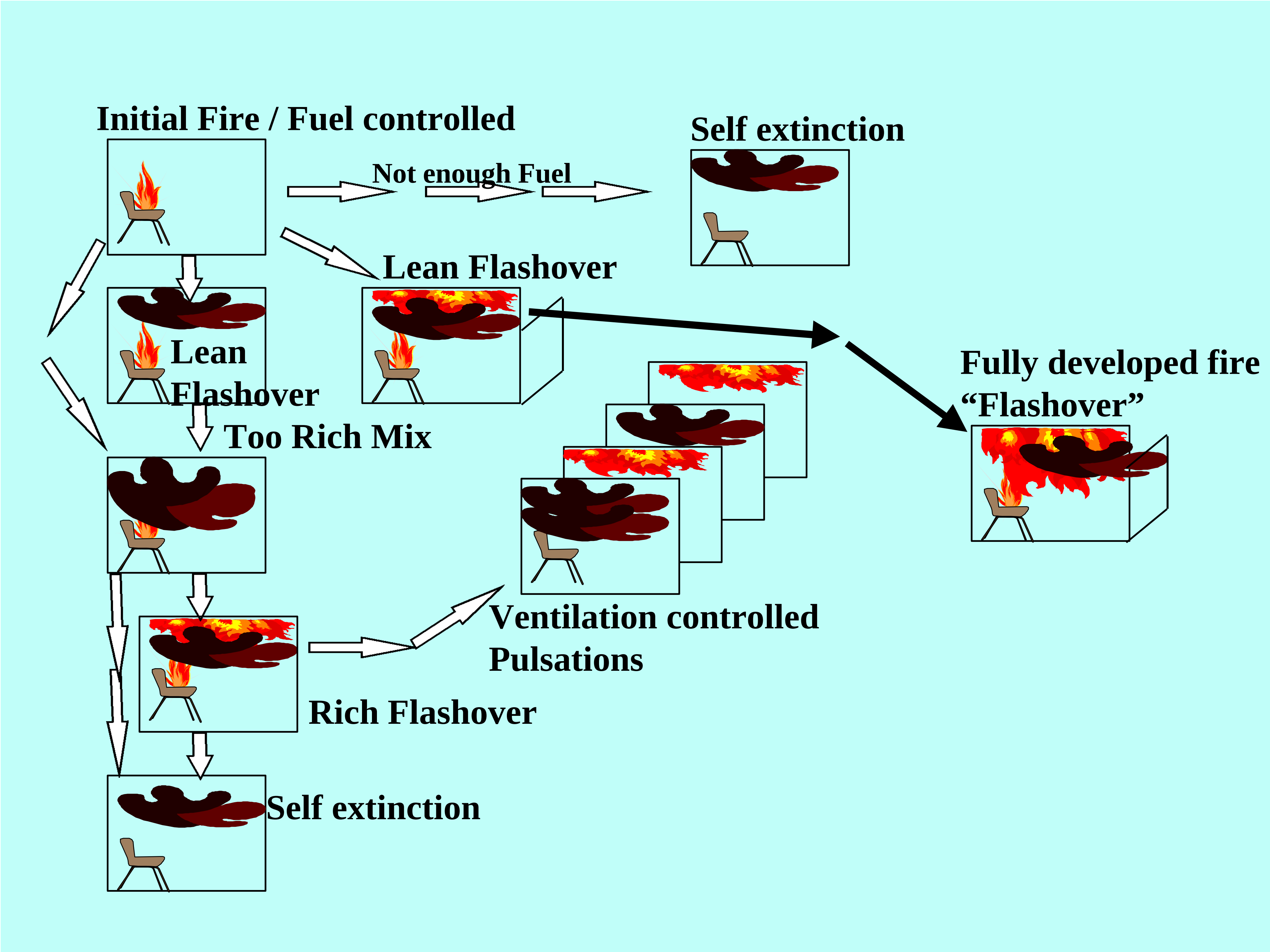
Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Too Rich Mix
Rich Flashover
Self extinction

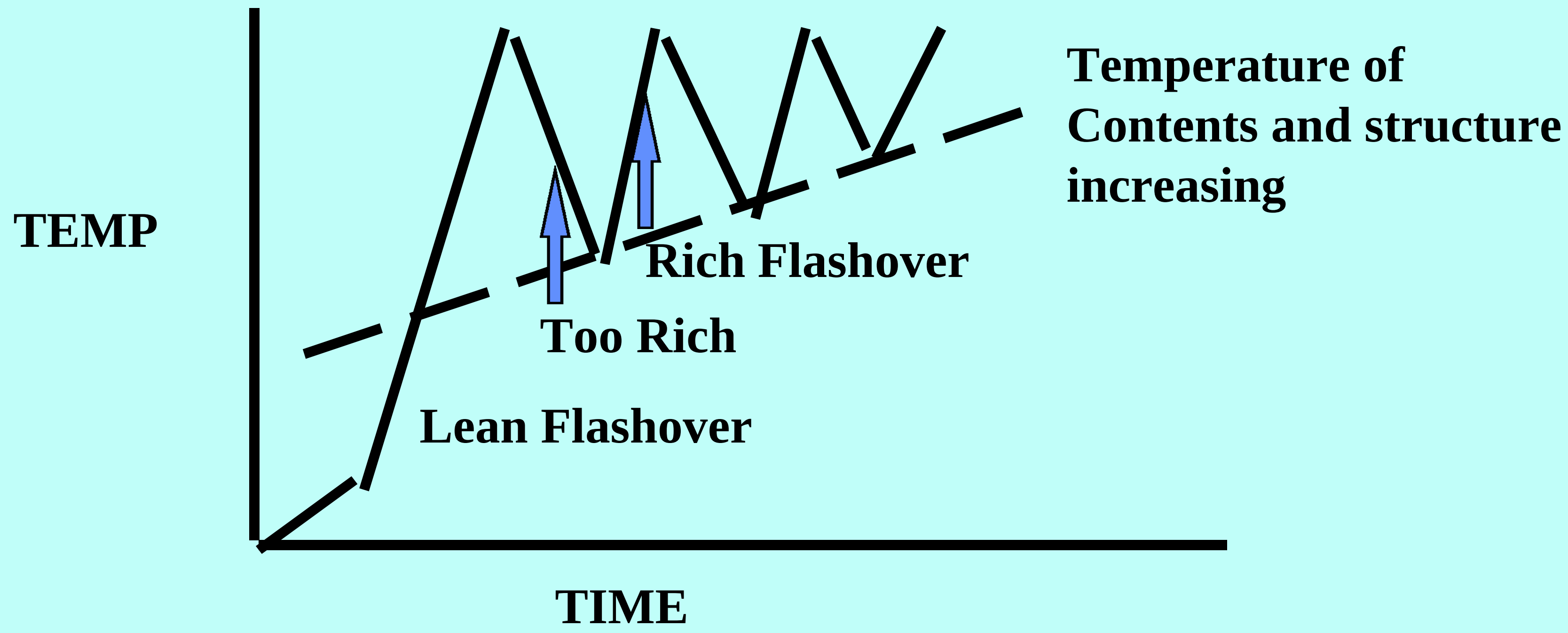


Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean Flashover
Fully developed fire
“Flashover”
Too Rich Mix
Rich Flashover
Self extinction

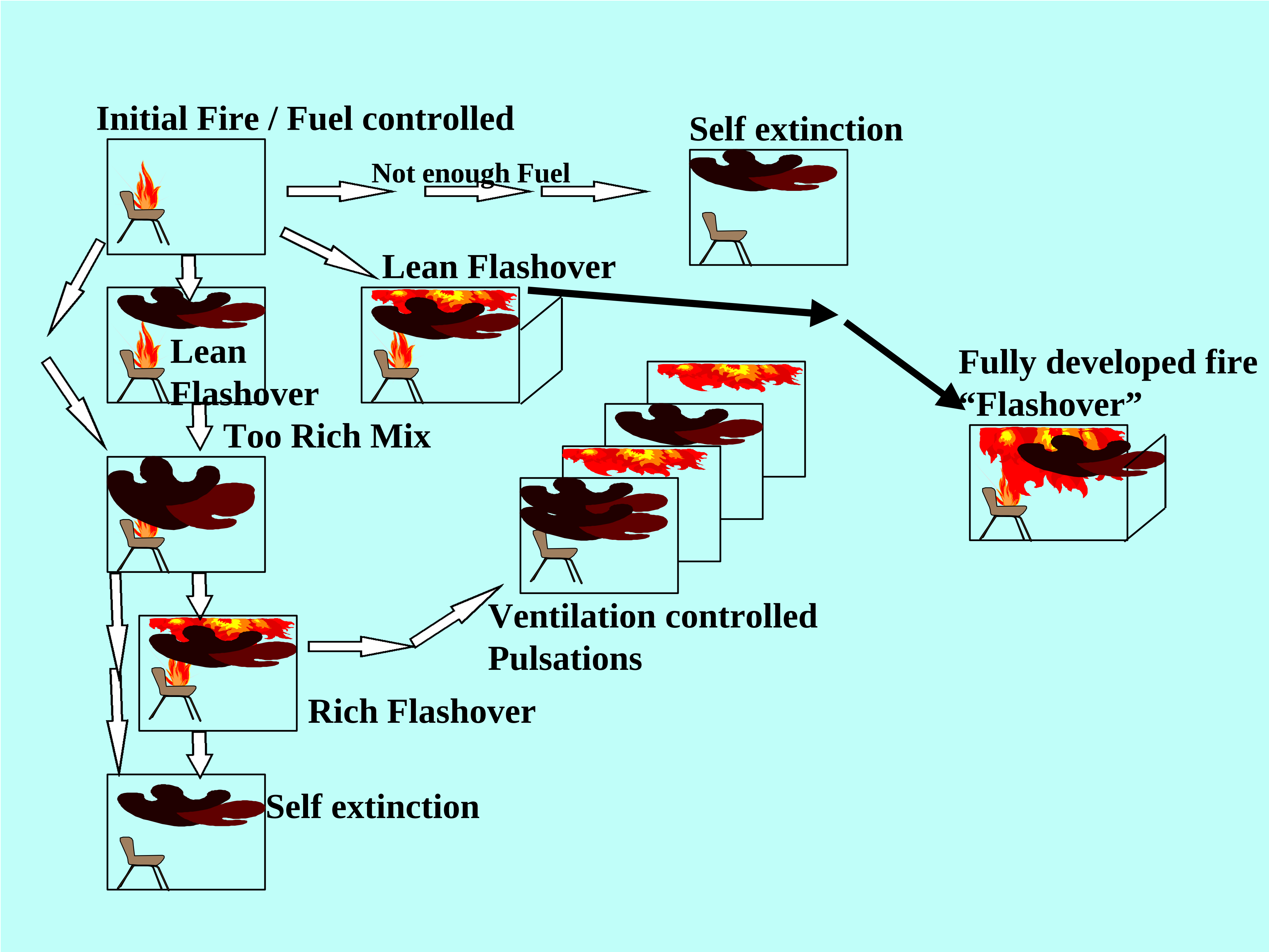

Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Fully developed fire
“Flashover”
Too Rich Mix
Rich Flashover
Self extinction


Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Too Rich Mix
Fully developed fire
“Flashover”
Rich Flashover
Self extinction


Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Too Rich Mix
Fully developed fire
“Flashover”
Ventilation controlled
Pulsations
Rich Flashover
Self extinction



VENTILATION CONTROLLED PULSATIONS


Initial Fire / Fuel controlled
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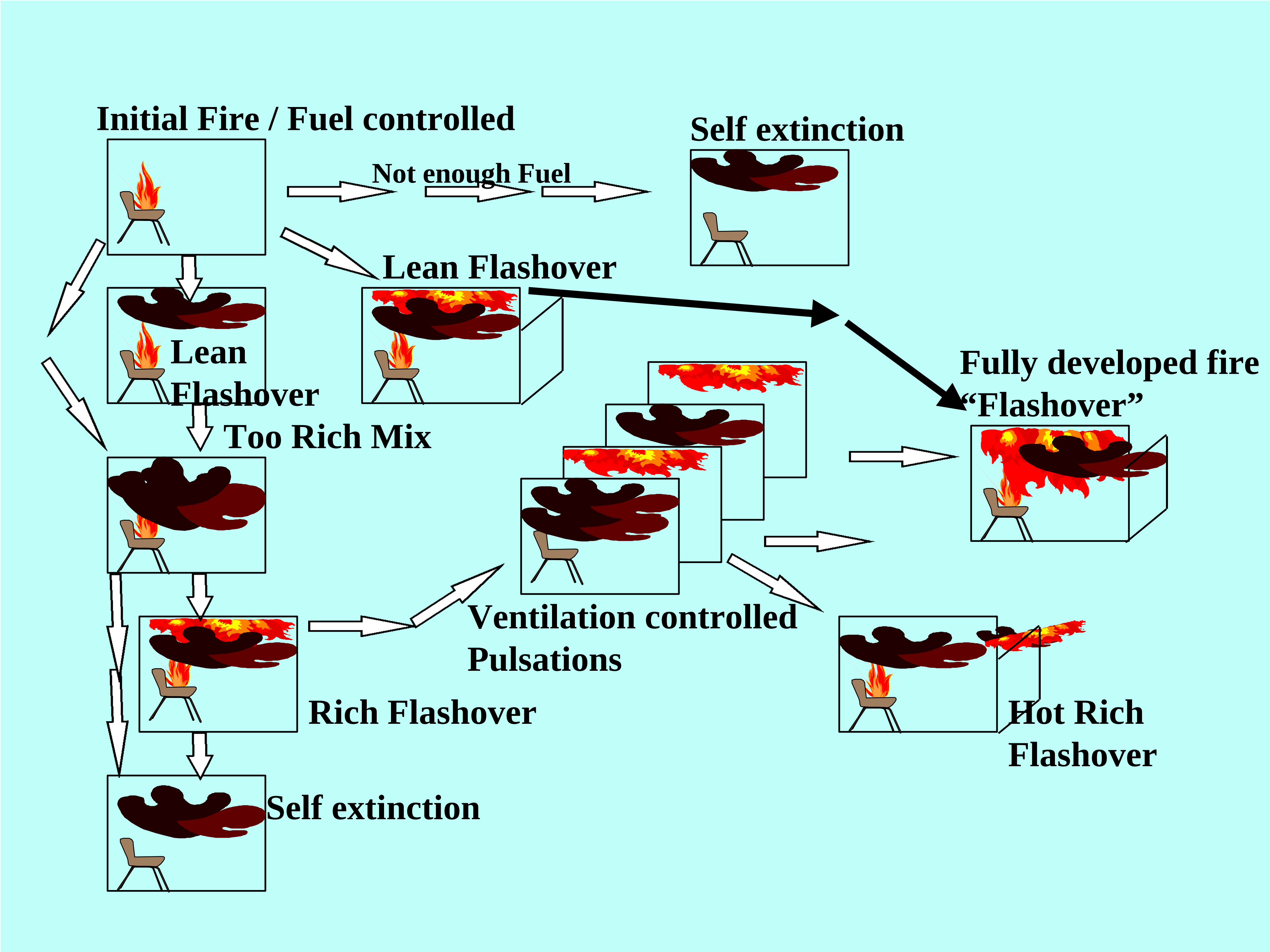
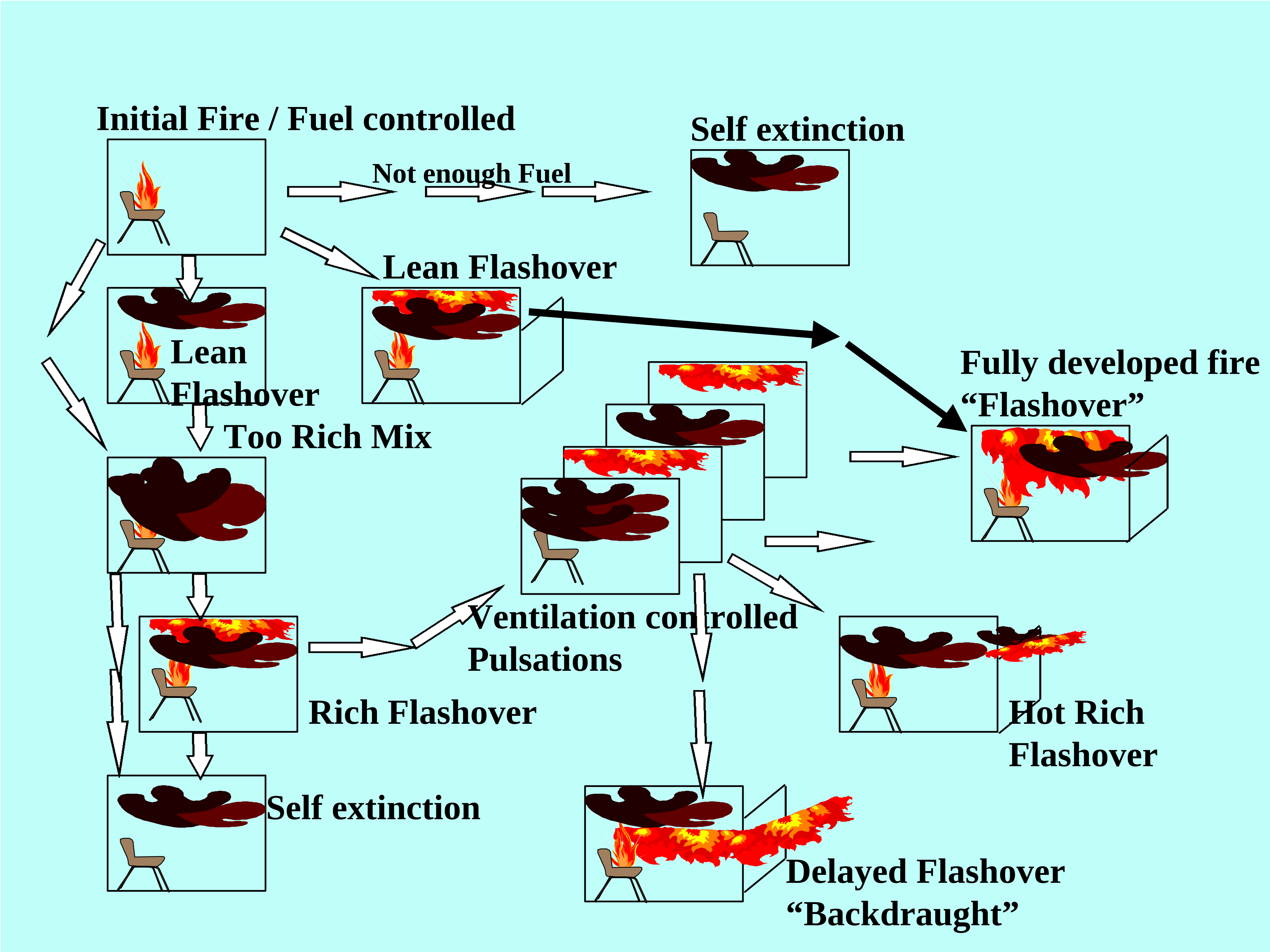
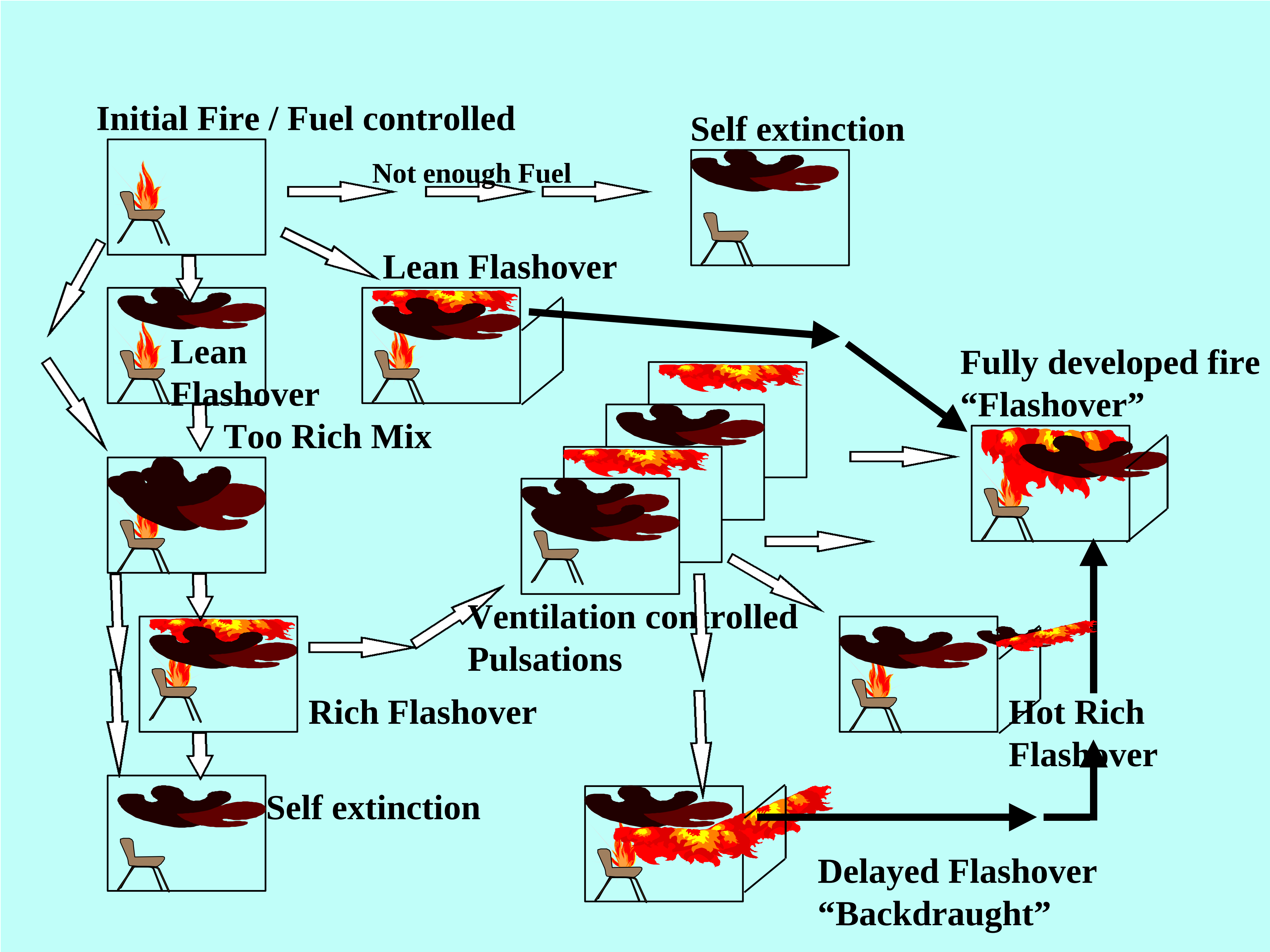

Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Too Rich Mix
Fully developed fire
“Flashover”
Ventilation controlled
Pulsations
Rich Flashover
Hot Rich
Flashover
Self extinction



Initial Fire / Fuel controlled
Not enough Fuel
Self extinction
Lean Flashover
Lean
Flashover
Too Rich Mix
Fully developed fire
“Flashover”
Ventilation controlled
Pulsations
Rich Flashover
Hot Rich
Flashover
Self extinction
Delayed Flashover
“Backdraught”


Initial Fire / Fuel controlled
Not enough Fuel
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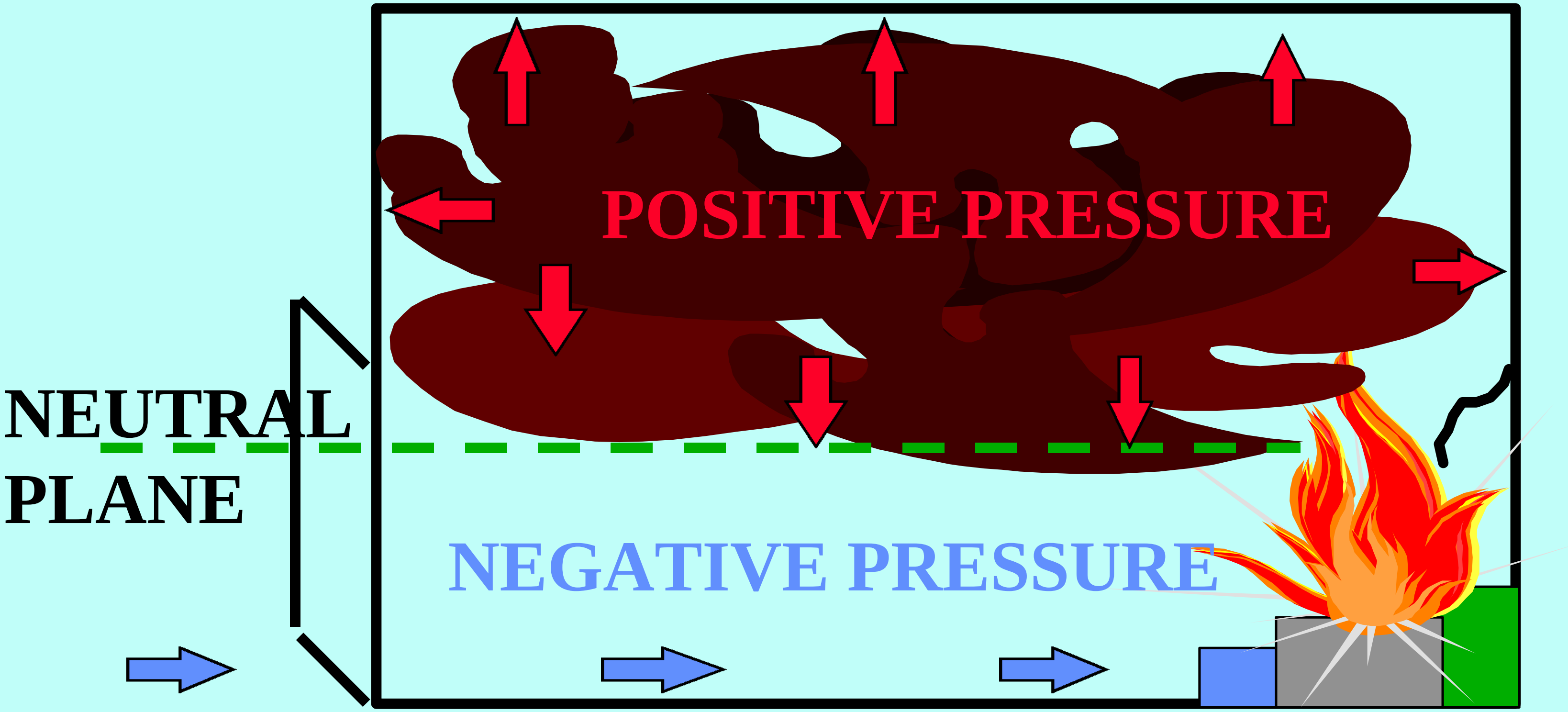
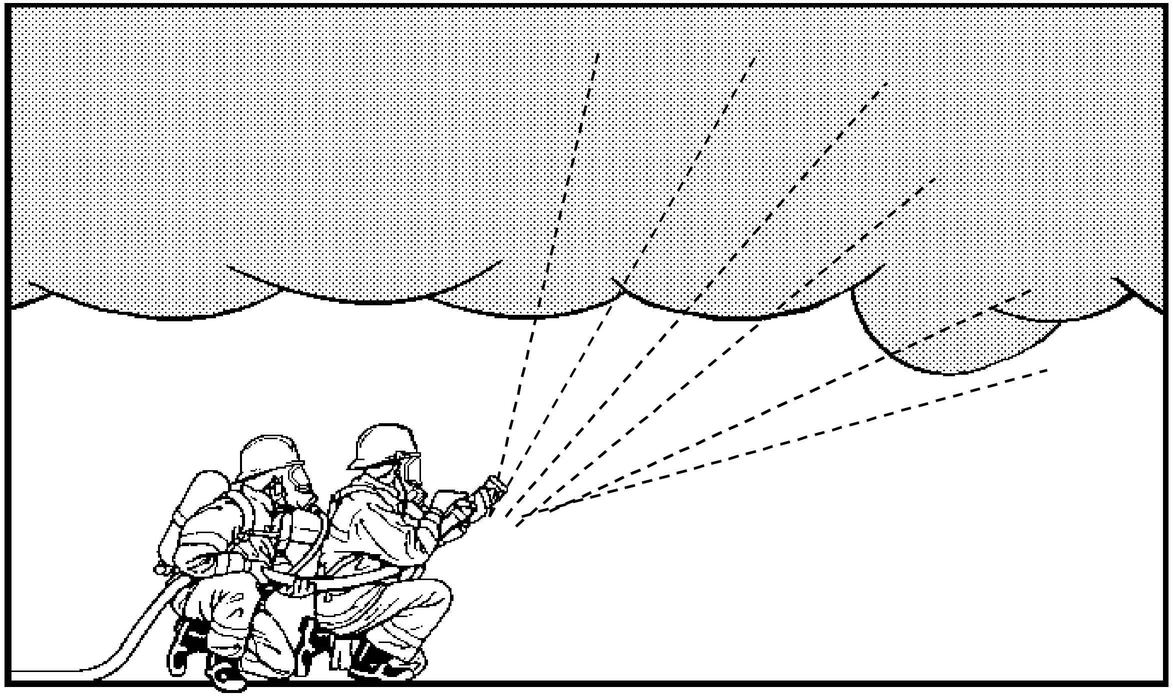
Fully developed fire "Flashover"
Ventilation controlled Pulsations
Rich Flashover
Hot Rich Flashover
Self extinction
Delayed Flashover "Backdraught"

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

EXTINGUISHING TECHNIQUES

PRESSURE INSIDE A COMPARTMENT

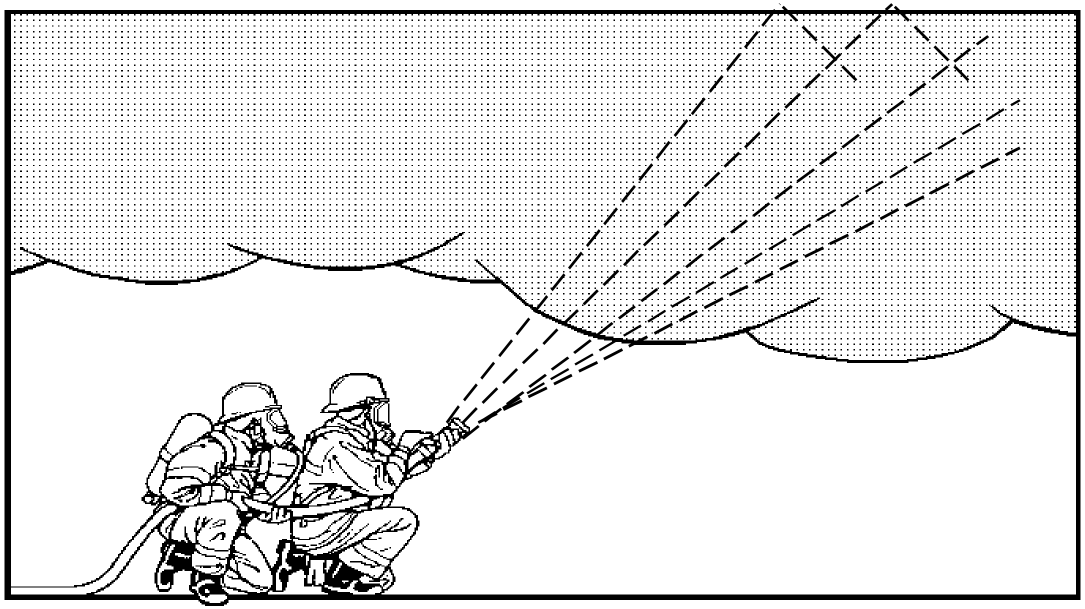




GAS COOLING

GAS COOLING

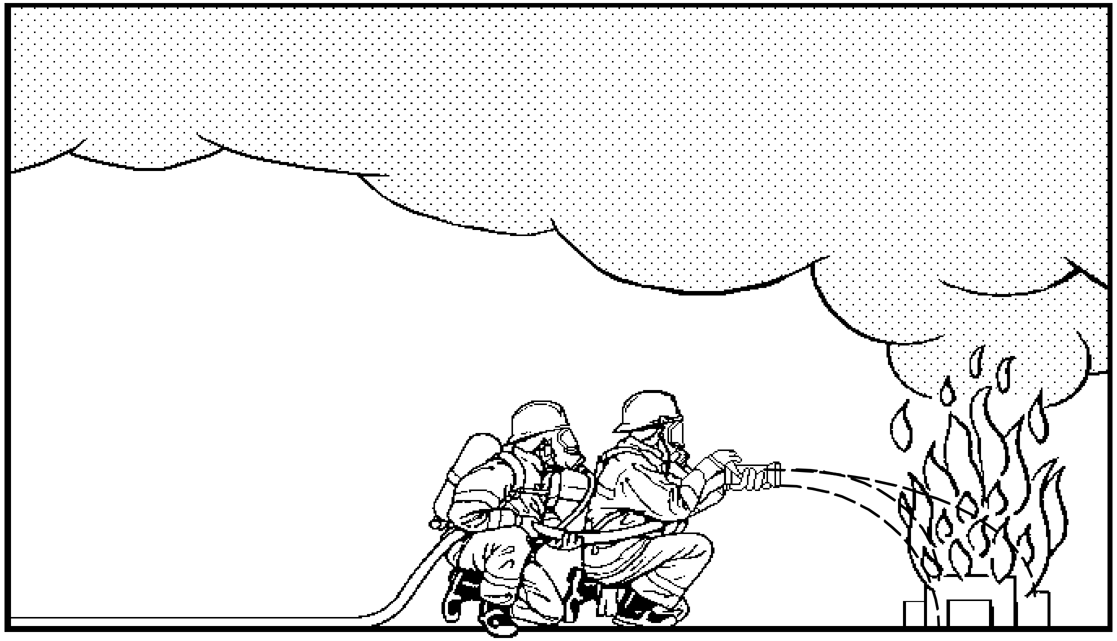
- **Purpose**: Cool and Shrink Gases,
  Protects Fire-Fighters,
  Aids rescues.
- **Branch**: Medium / Wide spray,
  Short pulsation's,
  Above and Forward.
- **Effect**: Cools gases,
  Improves conditions,
  Constant Neutral plane,
  Aids vision.



INDIRECT

INDIRECT

- **Purpose**: Attacks gases above fire,
  Cools surrounding area.
- **Branch**: Medium spray, around and
  above fire,
  Moving short pulsation's.
- **Effect**: Cools and shrinks fire gases.
  Cools structure,
  Steam smothers fire,
  Lowers Neutral plane,
  Reduces vision,
  Worsens conditions.



DIRECT

DIRECT

- **Purpose:** Directly onto base of initial fire.
- **Branch:** Jet / Narrow spray onto fire.
- **Effect :** Extinguish fire,
  Water damage,
  Entrains air, Can intensify fire,
  Produces large Quantities of
  steam if used to early.

SUMMARY

- **Combination of Techniques, mainly Gas cooling and Indirect.**
- **Varying branch settings**
- **Factors for branch setting:**
  - **SIZE OF COMPARTMENT**
  - **CONTENTS OF COMPARTMENT**
  - **EXTENT OF FIRE**
  - **RESCUES**

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

BRANCH TECHNIQUES

BRANCH TECHNIQUES

- No B.A. sets, Good vision.
- Full fire gear.
- Training block 1.
- Practice door and entry procedure.
- Practice Extinguishing techniques.
- Try to keep dry,
- If fire gear is wet inform Instructor.

DOOR PROCEDURE

- Use door for protection.
- No 1 to be ready with branch.
- No 2 opens door.
- No 1 observes gases above and below, look for signs of Flashover, Fire, Casualties, reference points.

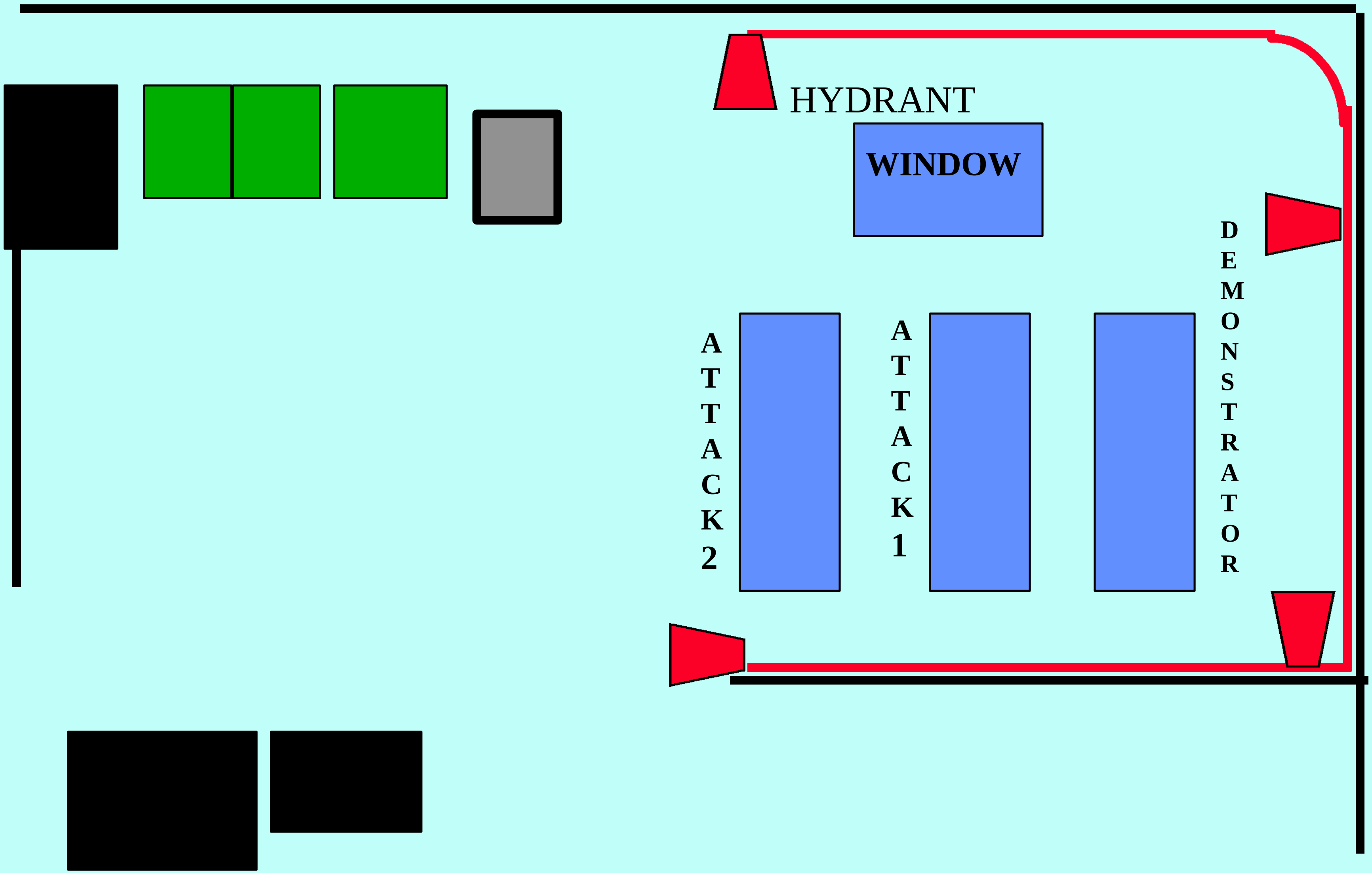
TEMPERATURE CHECKS

- Medium spray onto ceiling.
- Look, Listen, Feel for water droplets.
- If drops come down it may be cool enough to either maintain position or proceed using branch techniques.
- If no drops come down temperature is high, more pulsation's are required.

FIRE DEVELOPMENT AND FLASHOVER TRAINING

THE DEMONSTRATOR

TRAINING CENTRE SITE LAYOUT



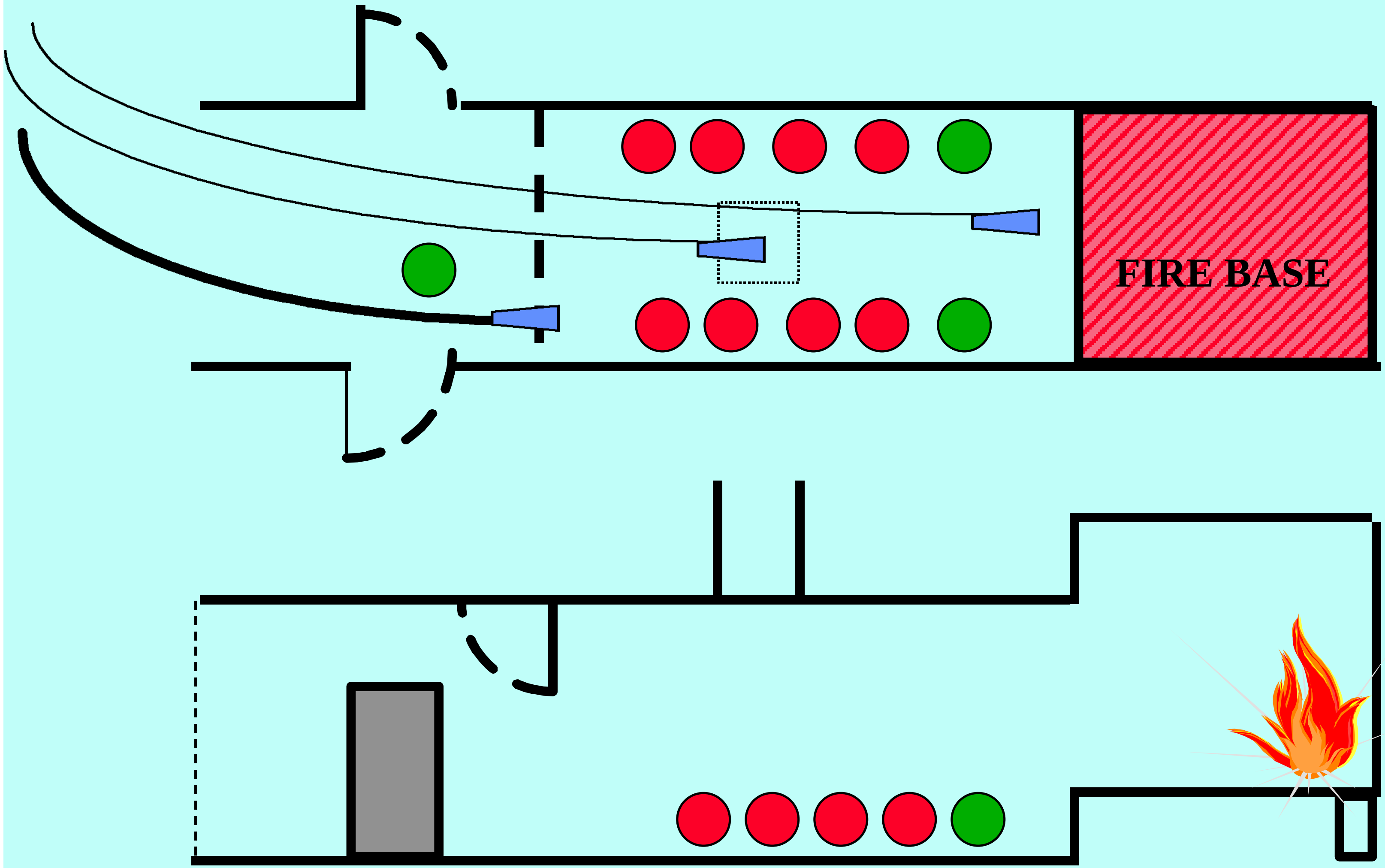
DEMONSTRATOR BRIEF

- **All fit and well.**
- **Remove jewellery etc.**
- **Fire gear, gloves and undergarments in good order and dry.**
- **Keep dry in unit.**
- **Observe all instructions**
- **Sit in two groups of four along each side.**
- **Rotate when instructed.**
- **<u>If you feel too hot inform the instructor</u>.**

DEMONSTRATOR BRIEF (cont'd)

- **Beware of hot surfaces**
- **Collect B.A. set and test comms.**
- **When instructed don set.**
- **Complete dressing and an Instructor will check for skin exposure.**
- **B.A. control.**
- **Withdraw facing fire.**
- **Drinks.**
- **Health check.**

DEMONSTRATOR COMPARTMENT



FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

FLASHOVERS AT INCIDENTS

SIGNS OF A FLASHOVER

EXTERNAL

- **LOW NEUTRAL PLANE**
- **DARKENING OF GASES**
- **PULSATION'S OF FIRE GASES**

SIGNS OF A FLASHOVER

INTERNAL

- RAPID INCREASE IN TEMPERATURE.
- FLAMES AT LOWER EXTREMITIES OF THE GAS PLUME.
- ALL SURFACES GIVING OFF FLAMMABLE GASES.

GENERAL PRINCIPLES

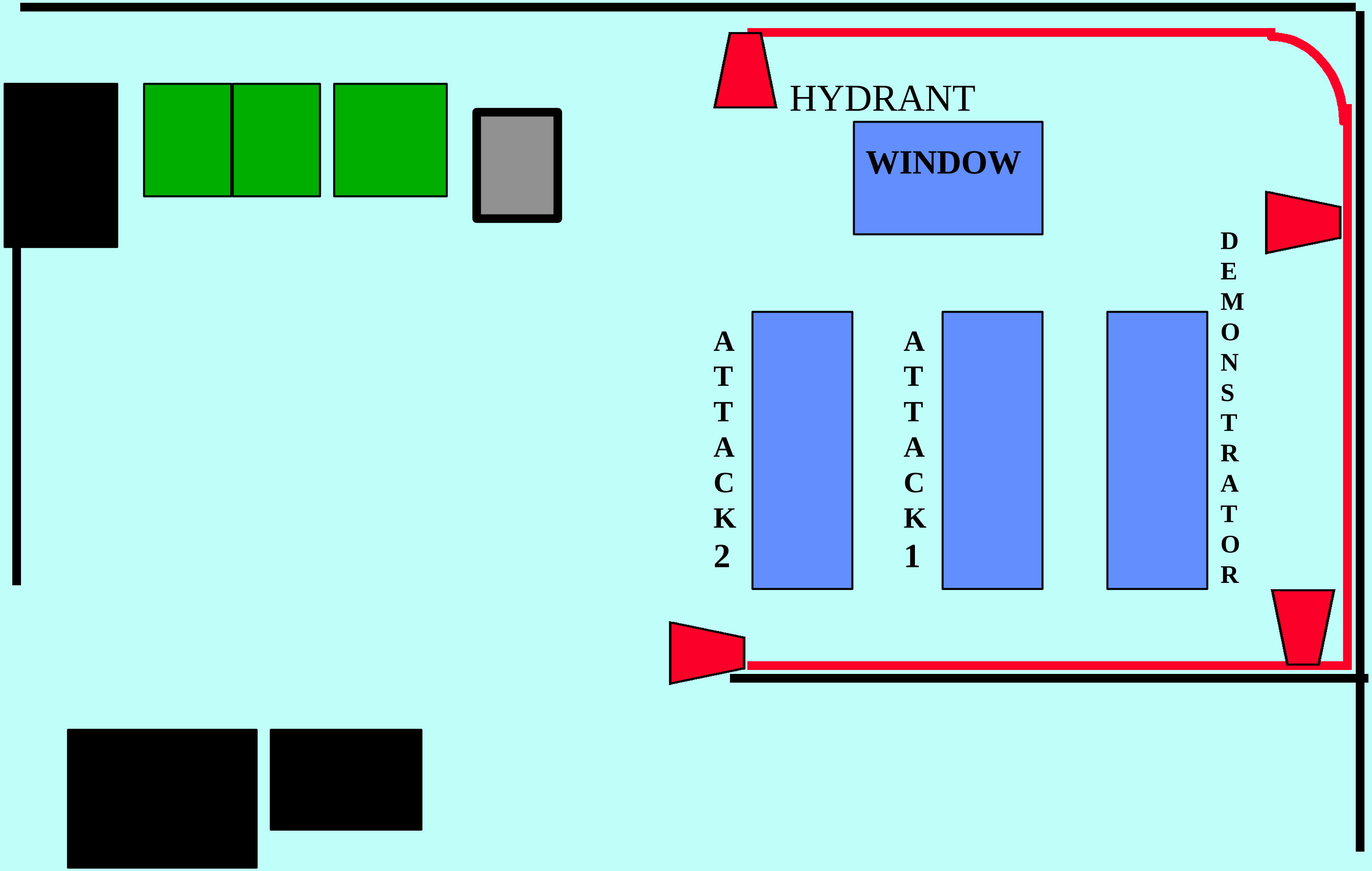
WHAT TO DO INSIDE.

- **Maintain position**
- **Move Forward**
- **Withdraw**
- **Observe gases constantly,**
  In front and above,
  Above and behind.

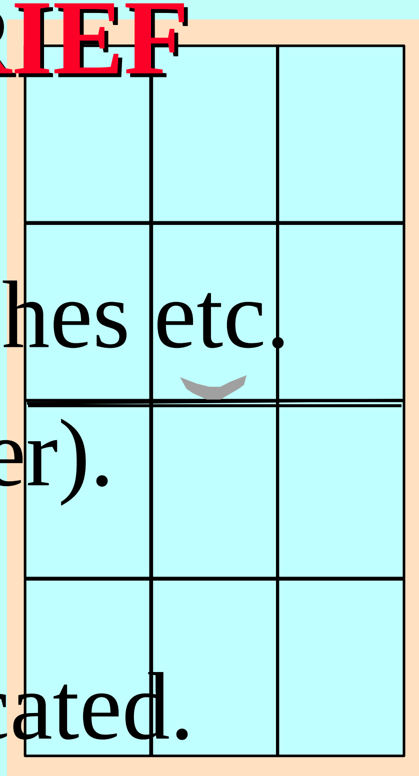
FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

THE WINDOW

TRAINING CENTRE SITE LAYOUT



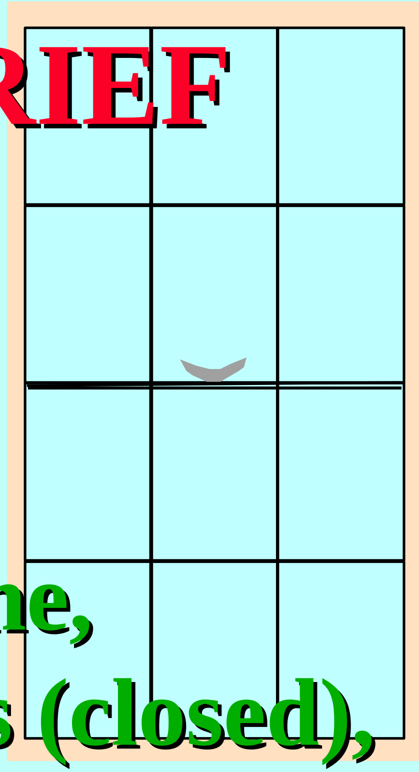
WINDOW BRIEF



- All fit and well.
- Remove jewellery , Watches etc.
- Full Fire kit (in good order).
  Safety glasses.
- Remain in positions indicated.
- First aid box, Pneu Pac, Watergel.
- Beware of hot surfaces

Cont’d

WINDOW BRIEF



- **Observe:**

  Initial Development,

  Colour of Fire Gases,

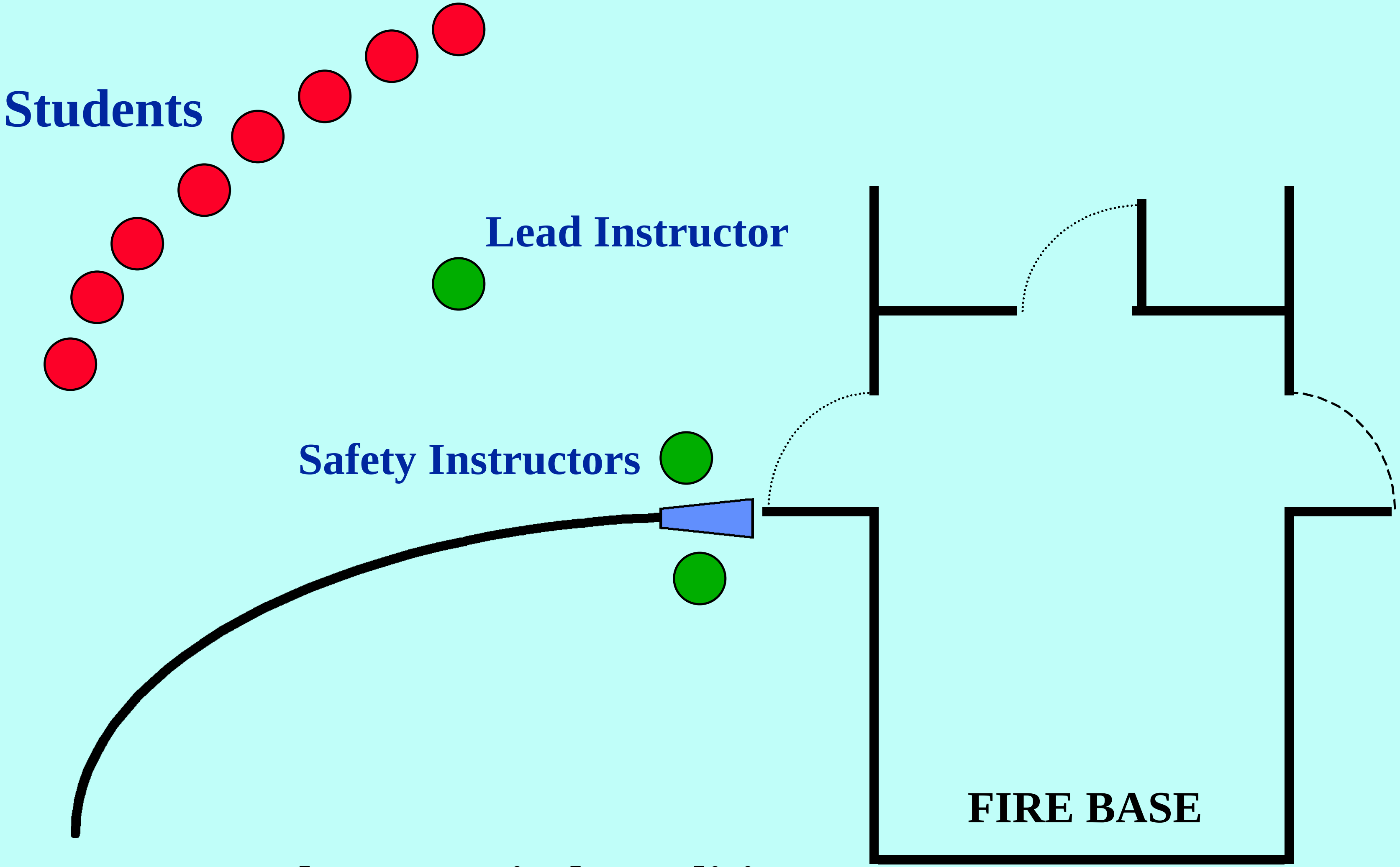
  Position of Neutral Plane,

  Gaps around Doorways (closed),

  Conditions when doorway is opened,

  Ignition of the Fire Gases.

WINDOW COMPARTMENT



*** Dependant on wind conditions.**

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

FLASHOVERS AT INCIDENTS

FLASHOVERS AT INCIDENTS

ARRIVING

1. Observe building.
2. Look for signs of a Flashover.
3. Check branch setting.
4. Door procedure.
5. Only enter when safe, cool gases from door.
6. Temperature checks.
7. Use combination of Gas cooling and Indirect to secure position.
8. Periodic Temp checks.

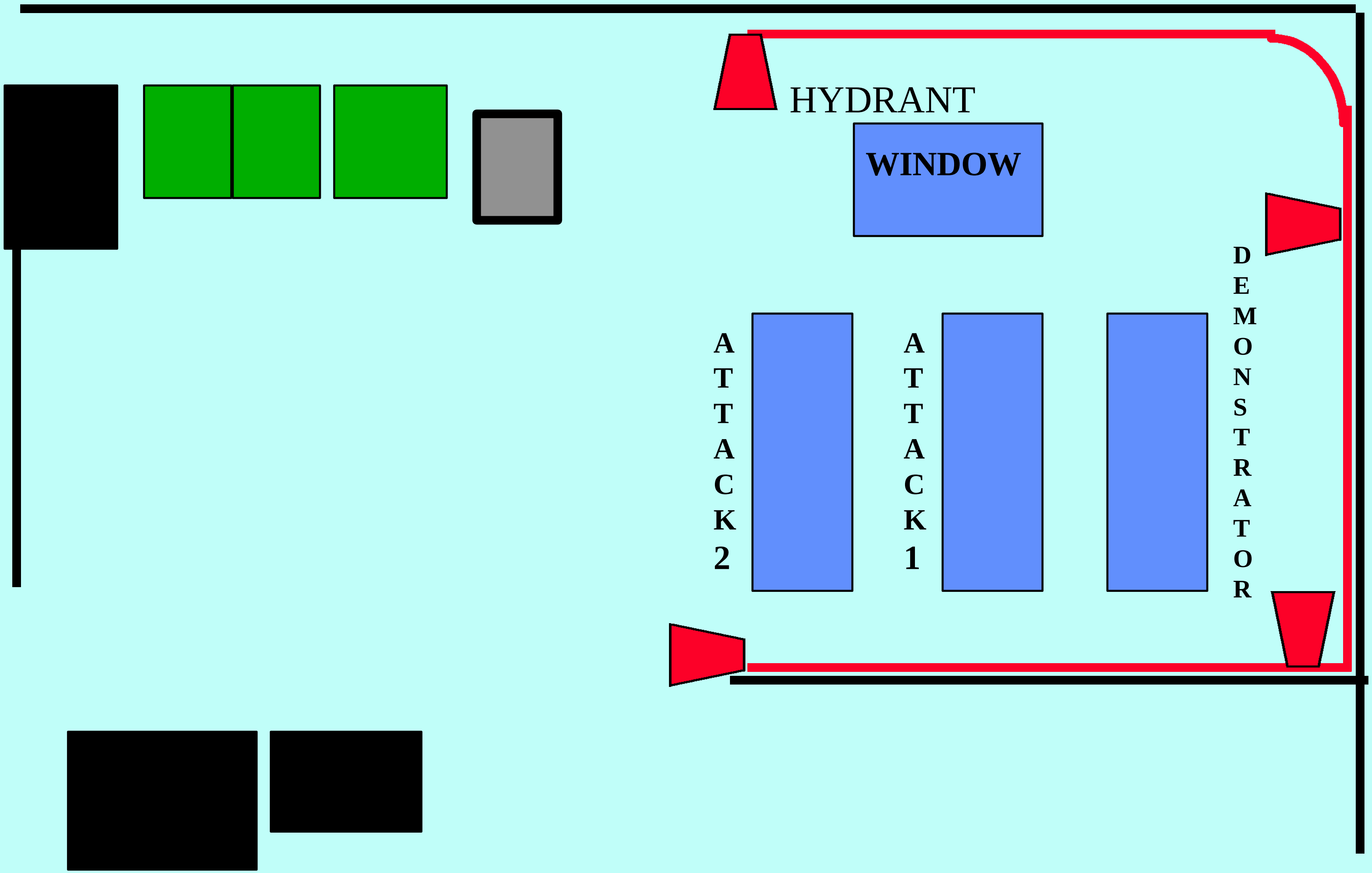
FLASHOVERS AT INCIDENTS contd

9. Observe gases at all times in Front, Above and Behind.
10. Advance when safe, using branch techniques.
11. Sprinkle water on fire base with Direct attack.
12. Withdraw if conditions deteriorate, observe gases, gas cooling.
13. Rescues - Keep Neutral plane high, gas cooling, Increase survival chances, protects Fire-fighters, Better vision.
14. Ensure compartments are safe before progressing to next compartment.

FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

THE ATTACKS

TRAINING CENTRE SITE LAYOUT



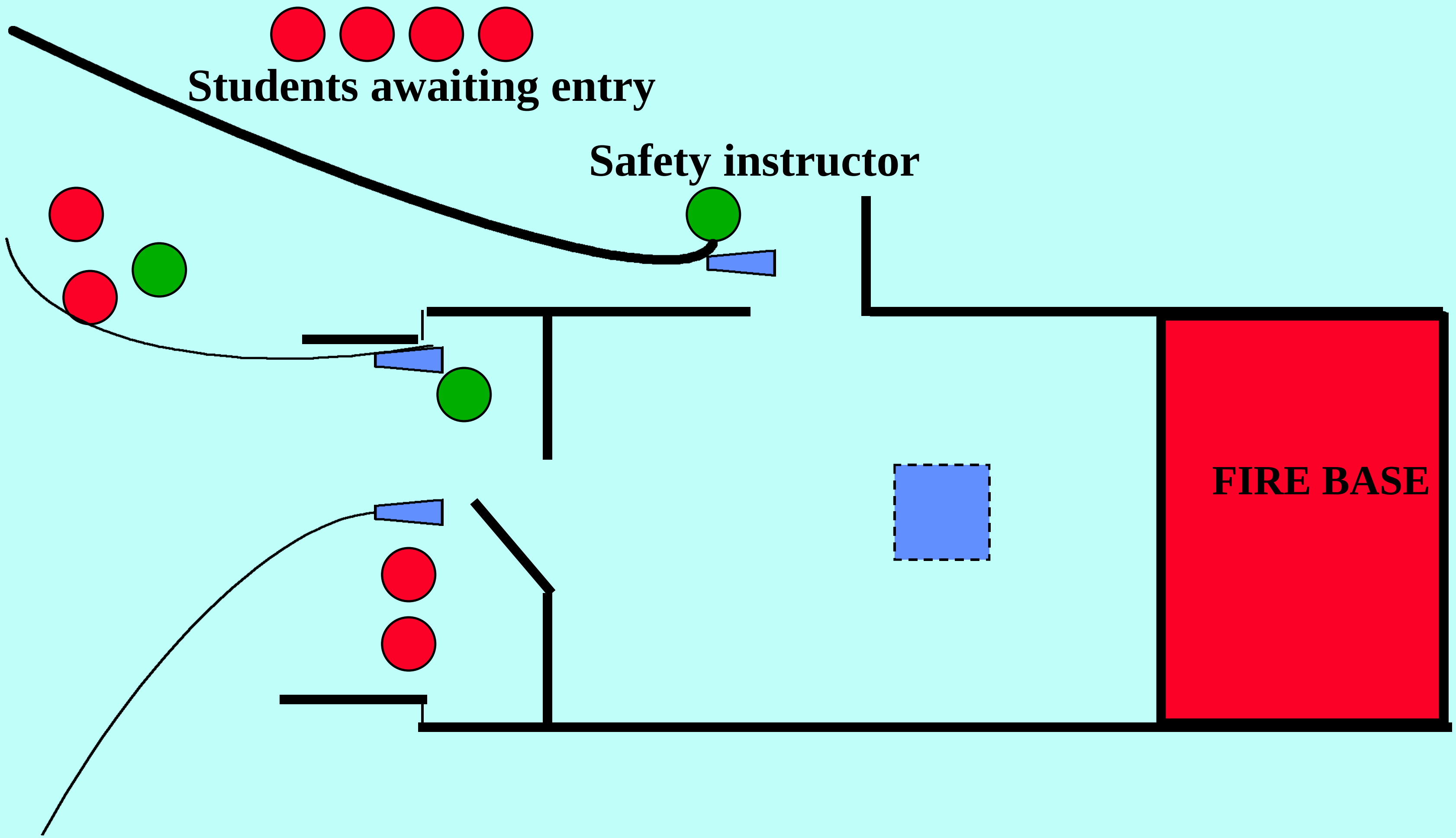
ATTACK BRIEF

- **All Fit and Well.**
- **Fire gear in good and dry condition.**
- **Remove rings, watches, Jewellery etc.**
- **Beware of hot surfaces**
- **Test Branches**
- **Check Comms**
- **Instructor to check complete Dressing.**
- **B.A. Control**
- **Only enter when instructed to do so.**

ATTACK BRIEF (contd)

- **Check Branch setting, Door Procedures**
- **Observe Fire Gases, Temperature Check.**
- **Gas Cooling, Indirect, as required.**
- **Follow all Instructions**
- **<u>If you feel hot, inform Instructor.</u>**
- **Withdraw observing fire.**
- **Short Debrief.**
- **Rotate.**
- **Fluid replacement, First Aid, Watergel.**

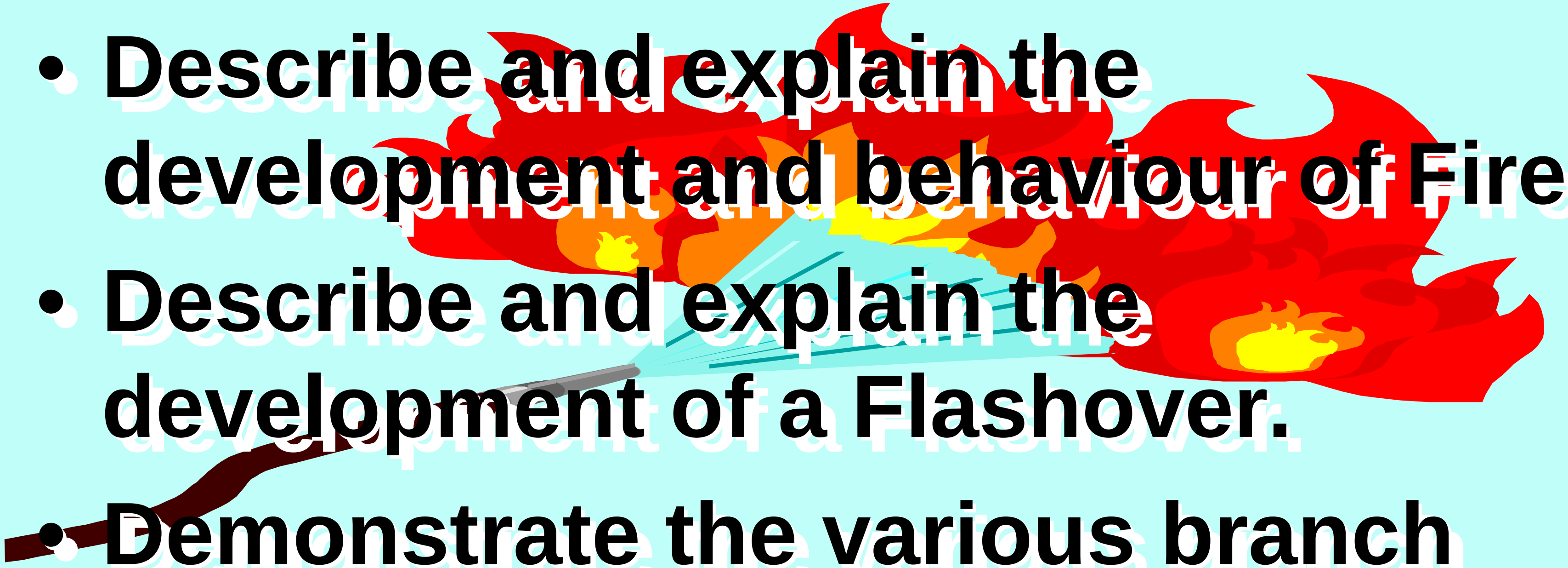
ATTACK COMPARTMENT



FIRE DEVELOPMENT
AND
FLASHOVER TRAINING

COURSE OBJECTIVES

At the end of the course the student will be able to :



- **Describe and explain the development and behaviour of Fire.**
- **Describe and explain the development of a Flashover.**
- **Demonstrate the various branch techniques and be able to apply them in a fire situation.**

FLASHOVER (ISO)

- ” The rapid transition to a state of total surface involvement in a fire of combustible materials within an enclosure “

FLASHOVER (BSI)

- In a compartment fire there can come a stage where the heat from the fire plume, gases and boundaries causes the ignition of all exposed combustible surfaces. This sudden and sustained transition of a growing fire to a fully developed fire is “flashover”.

Backdraught

- Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of partial combustion products and un-burnt pyrolysis products. If these accumulate then the admission of air when an opening is made to the compartment can lead to a sudden deflagration. This deflagration moving through the compartment and out of the opening is backdraught.

Fire gas explosion

- When fire gases are transported into an enclosure adjacent to the fire compartment, these can mix with fresh air. This mixture can, in time, occupy the whole volume and can be close to the stoichometric mixture concentration. If the mixture is ignited by, for example a a spark from a lightbulb, the increase in pressure may be extremly high. This is called fire gas explosion. It is rare that a fire gas explosion ocuurs in the fire compartment.


Attack Session

Attack 2, Preparation of container

Prepare the container with 15 sheets of chipboard:

3 left and right side wall, back wall

6 ceiling

Set a small fire approx. 100 – 150mm away from the corner of the container to illustrate fire growth.

Student brief

Brief the students with the aim, objectives of the session.

Safety brief

Student safety check

Check all students to ensure that no skin is exposed, thumb loops used etc.

<u>Light fire</u>

One instructor remains at the front of the container to point out the different phases of the fire development, while the other monitors and regulates conditions using the chimney and side doors at the rear. When the fire has developed to a suitable stage, the students are taken out of the rear of the container.

<u>Enter container</u>

On the instructions of the instructor, students enter the rear of the container in teams of two. Showing the correct branch tecniques, they advance on the fire until they are told to withdraw by the instructor inside the container.

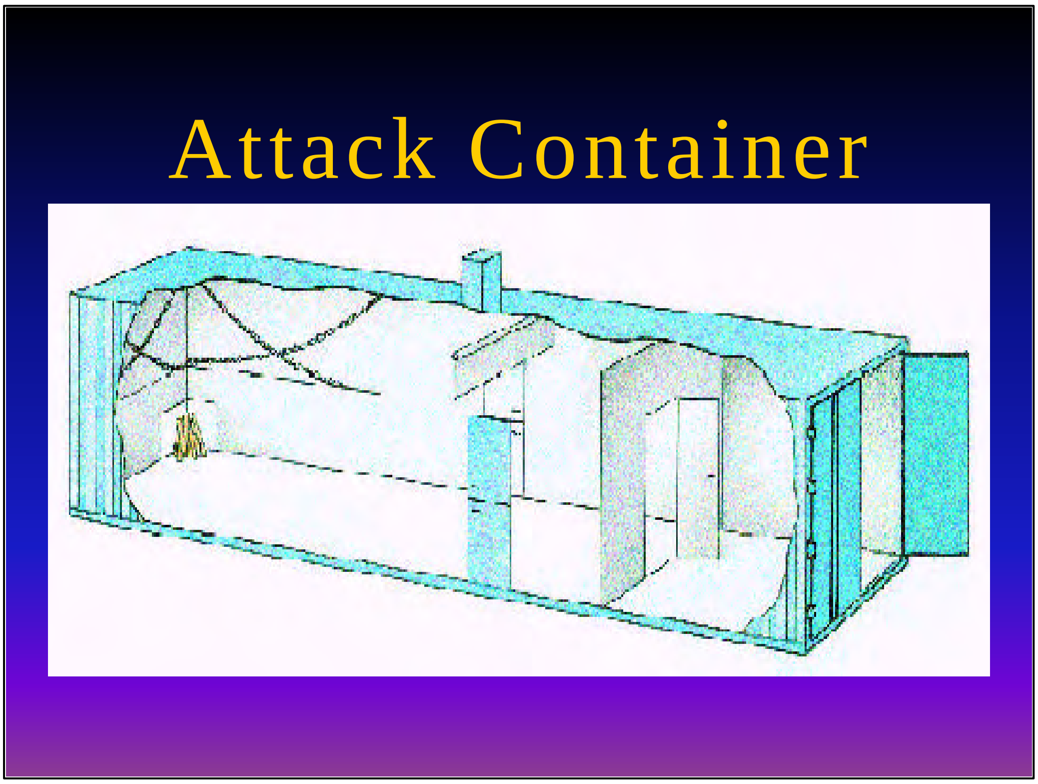
Aim

By the end of the session students will be able to demonstrate the correct operational tactics that should be adopted whilst fire-fighting in a compartment.

Objectives

By the end of the session students will have demonstrated an understanding of:

- Fire development within a compartment
- Correct branch techniques
- Correct door entry procedures



Main dif ference to demo unit- single level.

Students can observe the fire develop from the back of the container.

Q and A for students.

How will the fire develop initially? Slow lazy flame, red/yellow 600oc.

Flames grow, more radiant heat given off. 1000oc

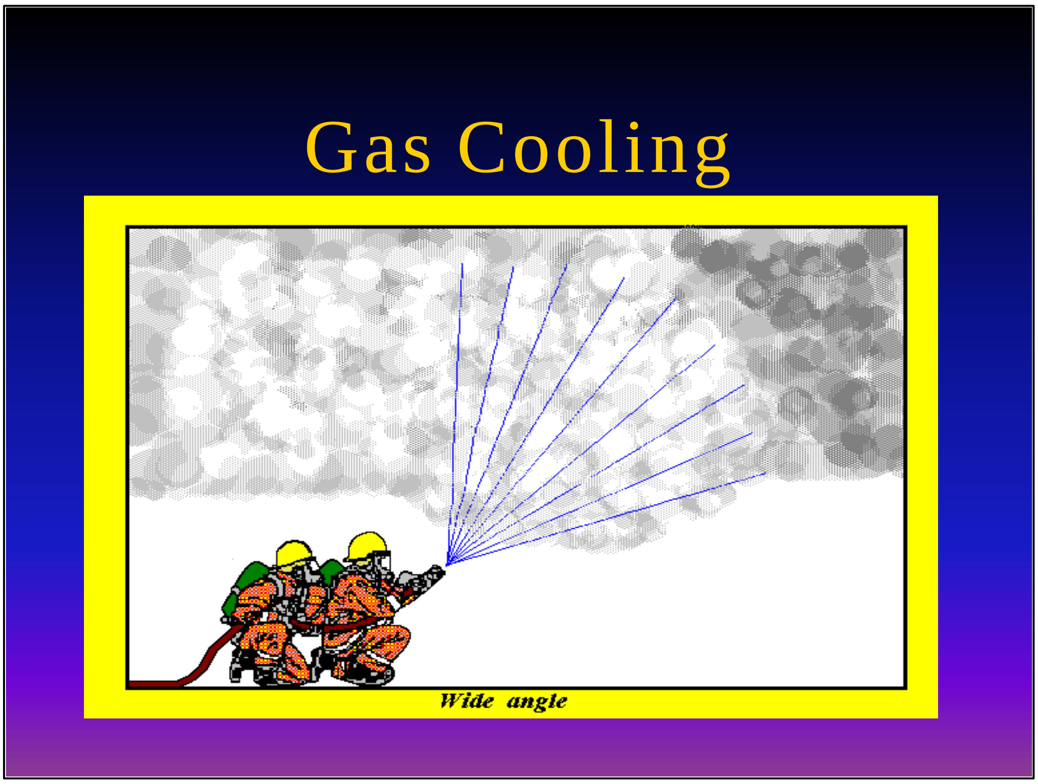
Boards begin to pyrolise more rapidly.

Neutral plane lowering, tongues of flame within gas layer.

Temperature rising rapidly

Radiated heat

Almost at flashover?



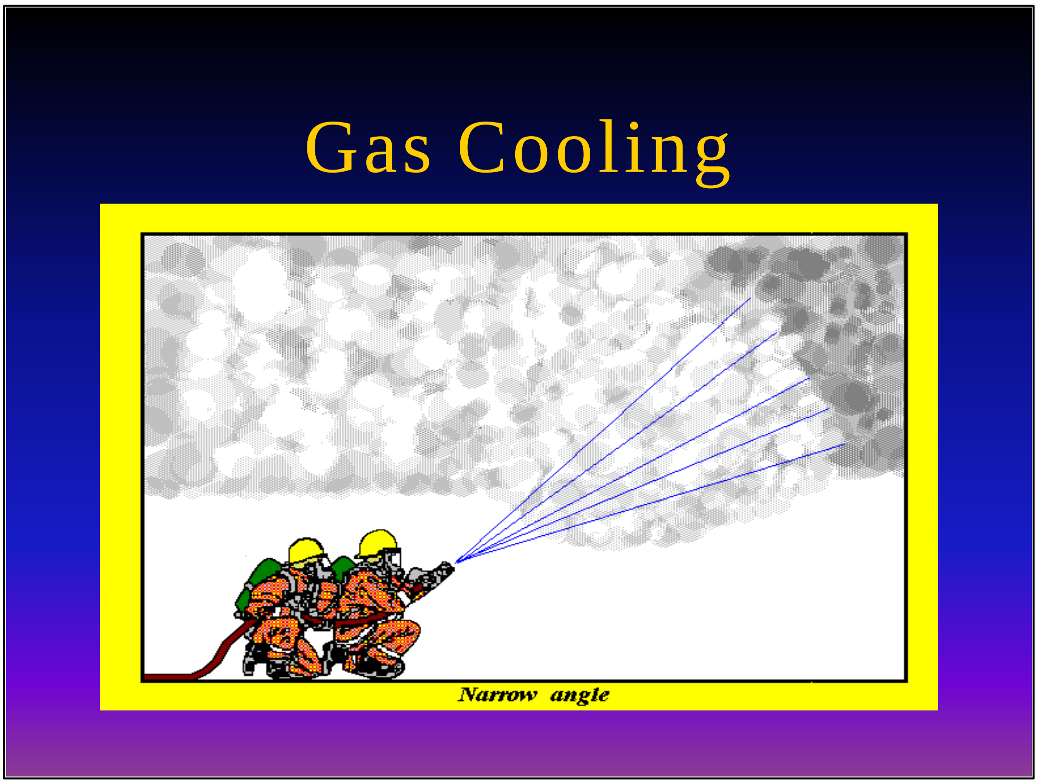
On entry- make secure- gas cool over head directly into smoke layer.

Rapid pulse keep branch moving.

Aim is to convert all the water to steam within gases.

Don,t bring neutral plane down.

1litre of water converts to 1700 litres of steam. At 100oc. At 500oc = 3400litres.



Once area above secure.

Can aim to cool gases further within compartment, longer pulse.

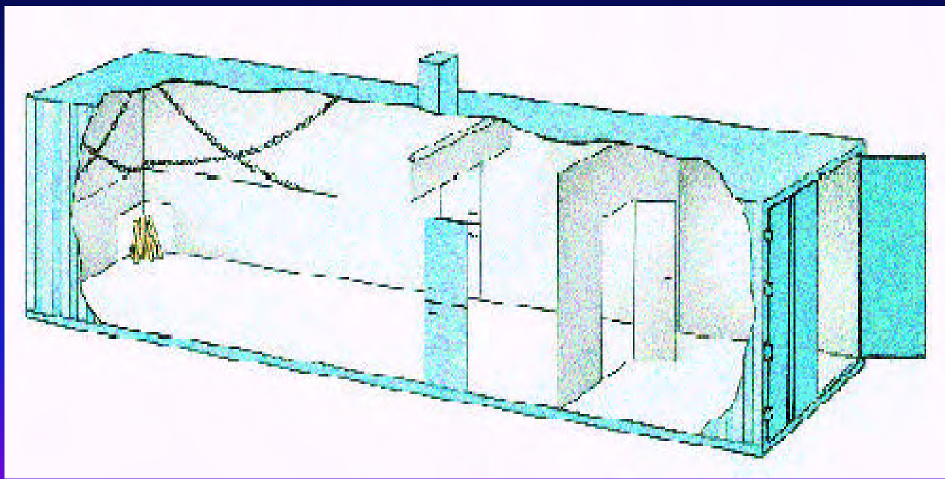
Hose reel requires longer.

Indirect- cools surfaces

Painting- stops pyrolisis.

Withdraw with wide spray for protection.

Attack Container



Entry via rear single door.

Teams of two.- no2 to assist no1 with observation of fire gases above and behind.

Second team to assist with hose from doorway.

Select branch.- second branch to be placed at side entrance for safety.

Enter on command of instructor.

Secure area above.

Move forward. Discuss different cooling techniques.

Never go under the boards.

Only paint on instruction.

Withdraw when told to do so.

Face fire at all times- keep low.


WATER SUPPLY

Safety Brief

- All fit and well
- Anybody suffering from the effects of drink or drugs
- Is anybody taking any medication
- Remove all jewelry rings, watches, studs etc
- Fire Kit in good condition full PPE to be worn (including dry under garments)

Layering- loose helps thermal insulation

several thin layers for air circulation

wet undergarments increase risk of scalding/ burns.


PPE
INTACT
CLEAN
LEAK FREE
LOOSE
FITTING

Safety Brief

- Stay low at all times within the containers
- Students will check each other before entry
- Individuals are responsible for their own health and safety as well as their team mate
- Listen to instructors within the container
- Obey any hand signals given by instructors

Demonstrate three hand signals.

Hand on shoulder- stop and think

Hand infront of branch- no more water

Forward wave- move forward

Safety Brief

- First Aid, resuscitator and water gel
- Report any injuries no matter how minor
- Ensure one branch is left by side door

Don’t forget you are hear to learn, not to suffer if you feel uncomfortable get out

Attack Session

Aim

By the end of the session students will be able to demonstrate the correct operational tactics that should be adopted whilst fire-fighting in a compartment.

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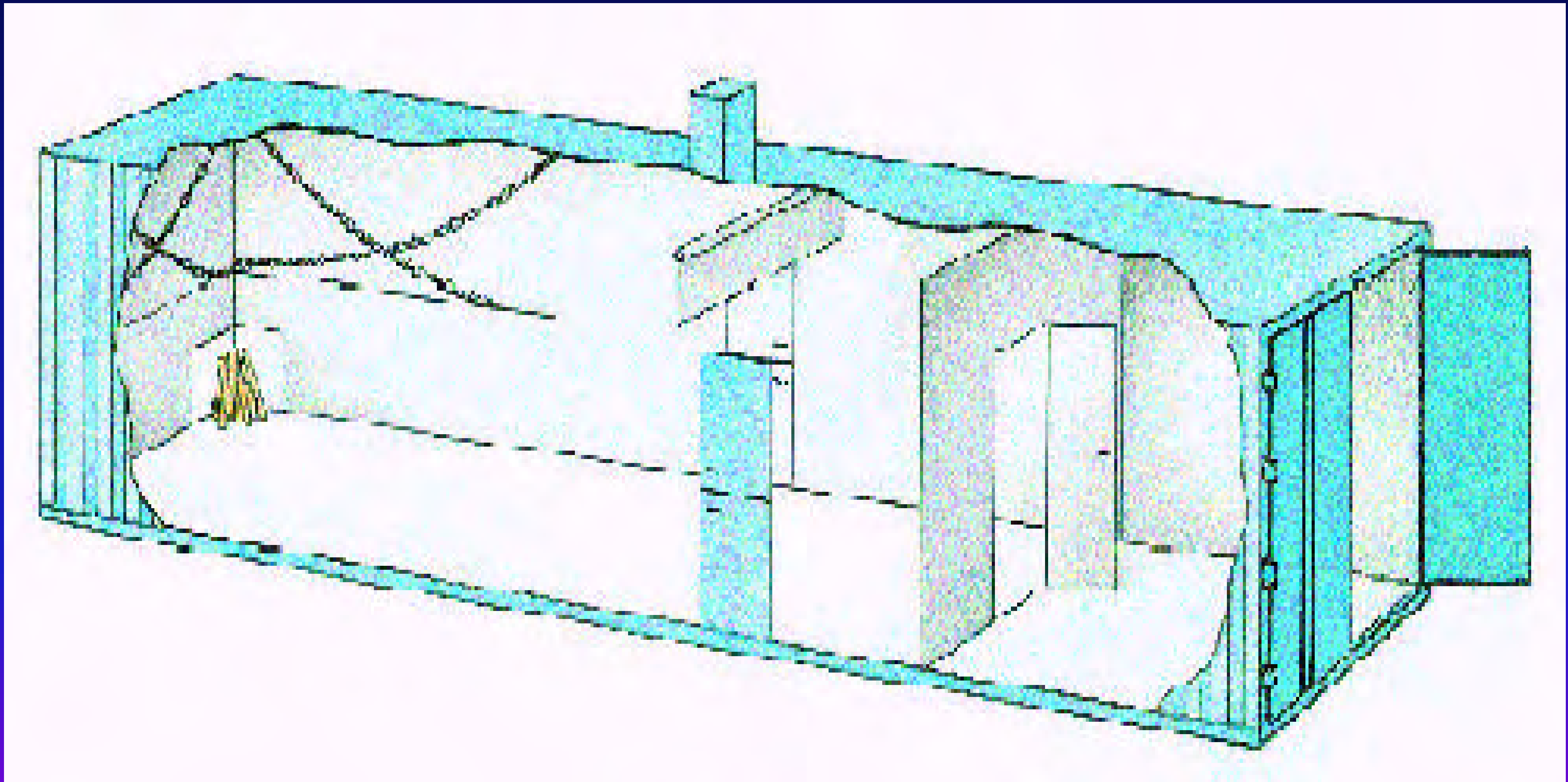
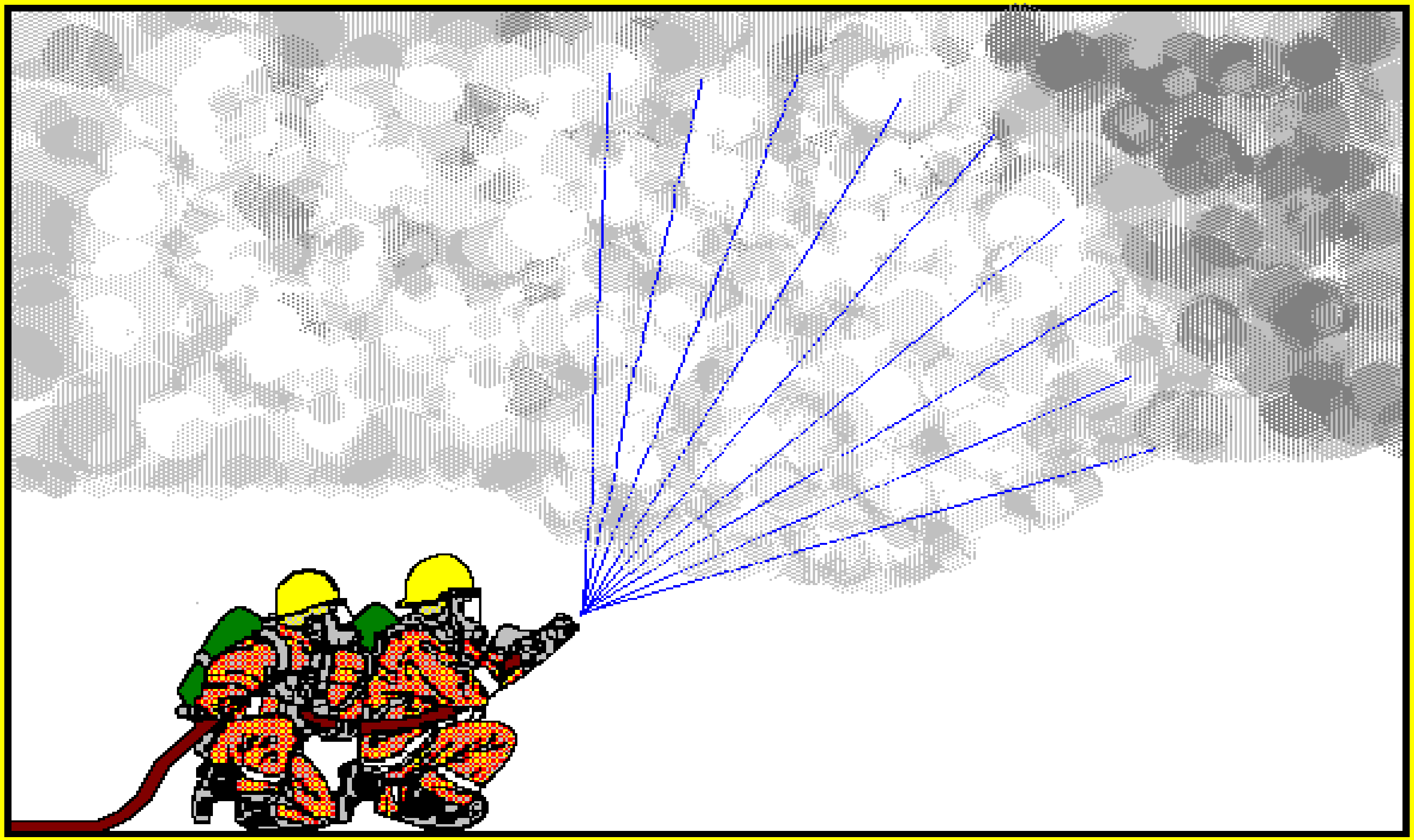
Attack Container

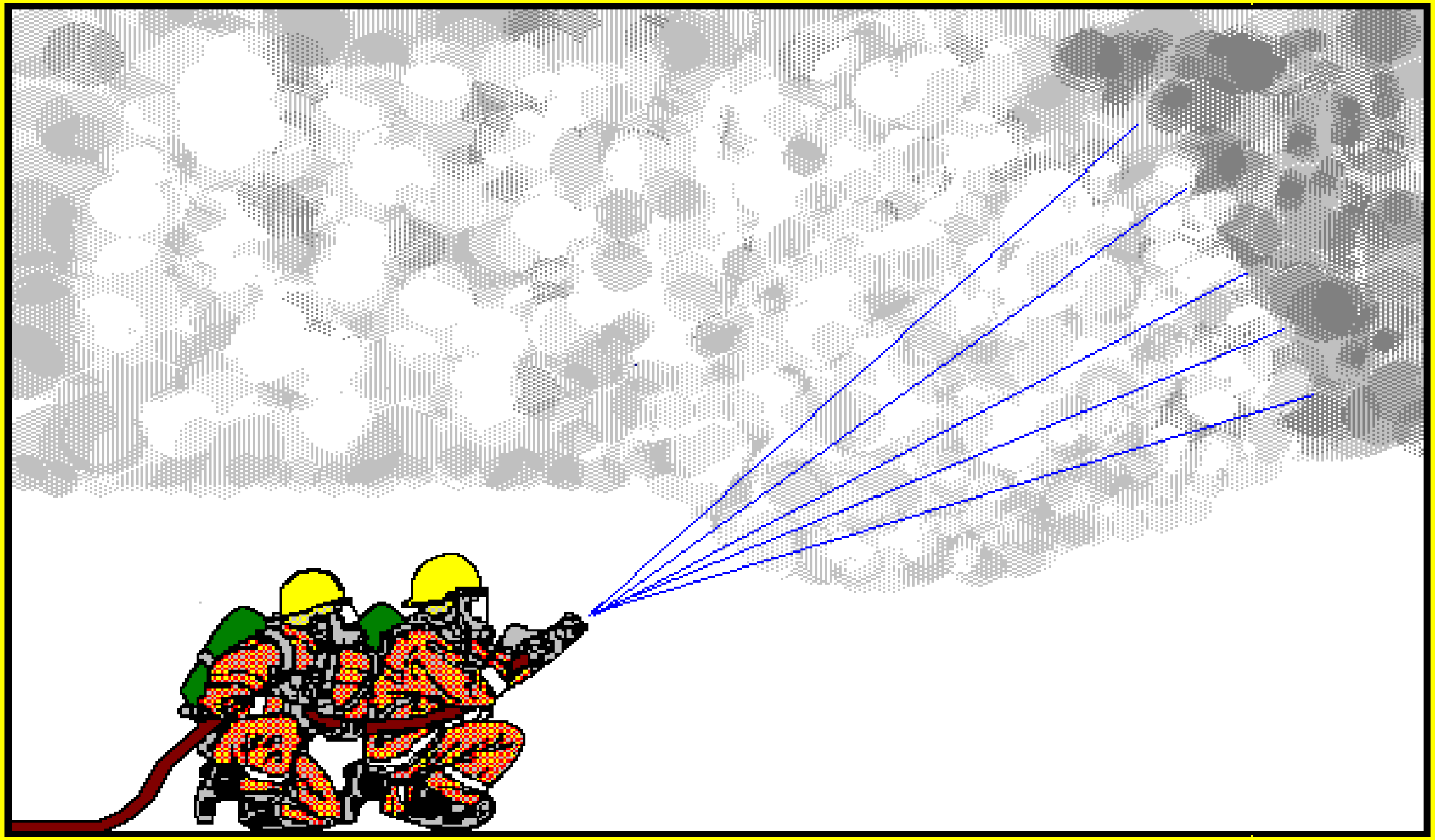


Gas Cooling



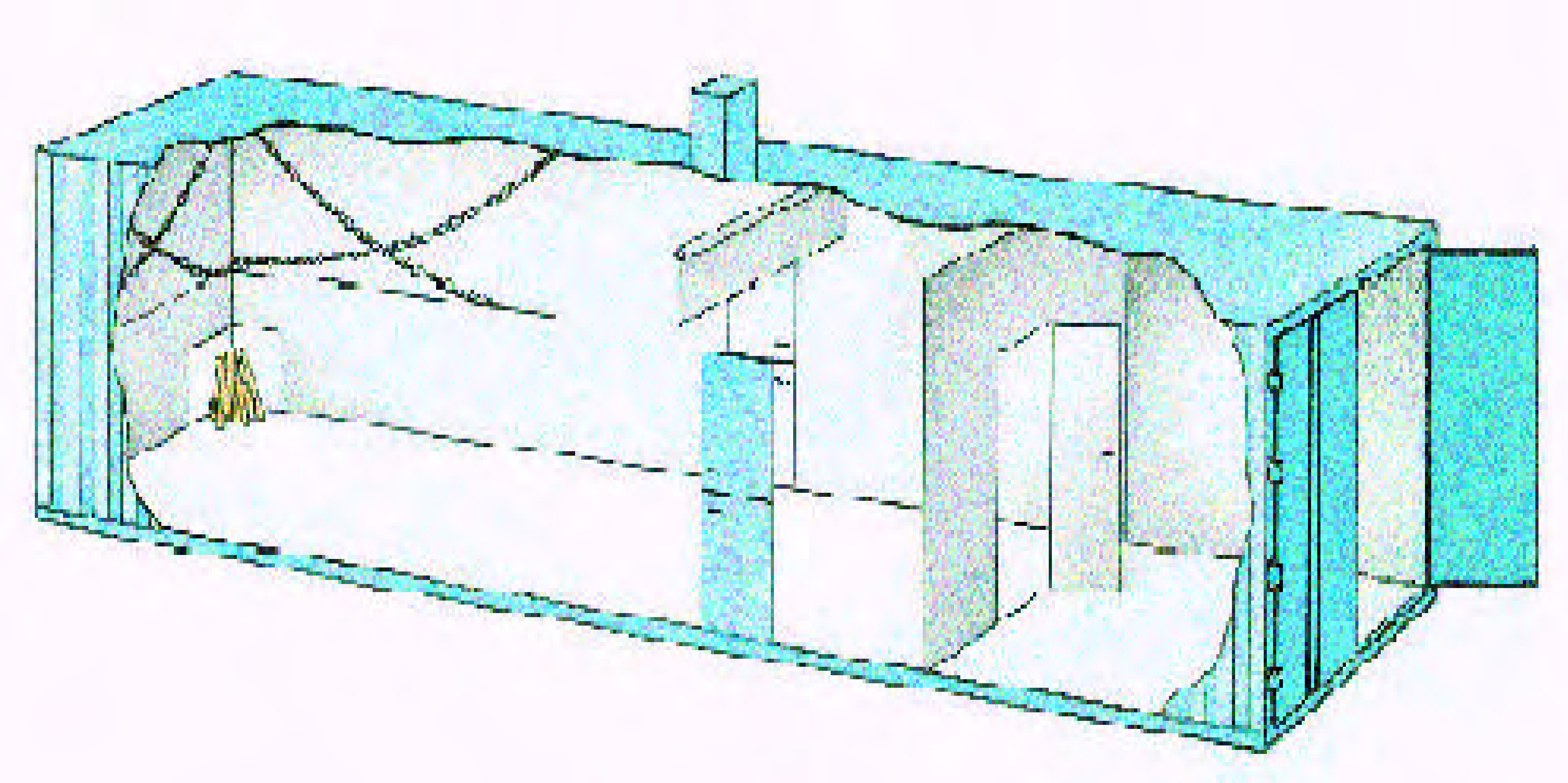
Wide angle

Gas Cooling

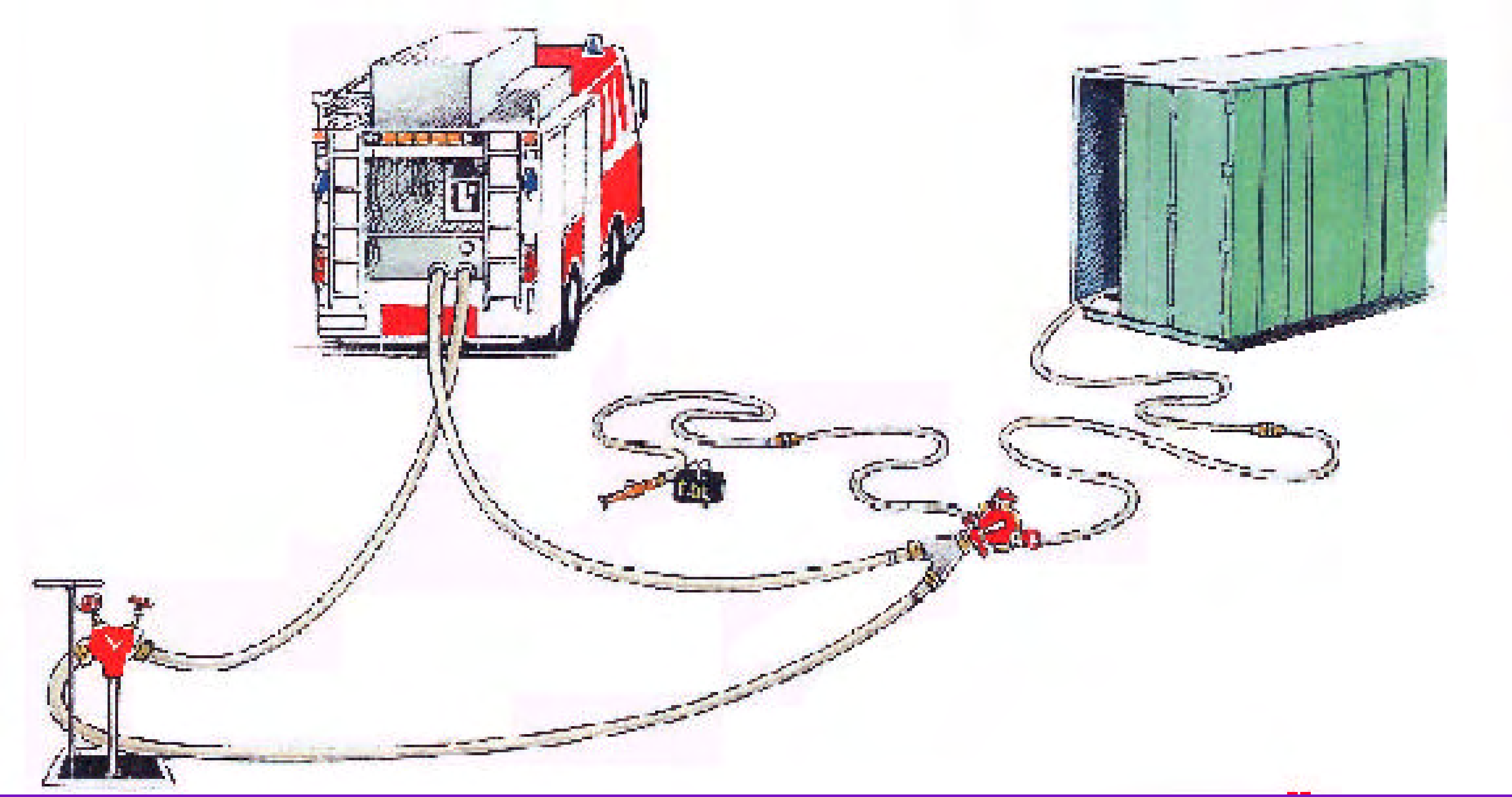


Narrow angle

Attack Container



WATER SUPPLY



Safety Brief

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- Is anybody taking any medication
- Remove all jewelry rings, watches, studs etc
- Fire Kit in good condition full PPE to be worn (including dry under garments)

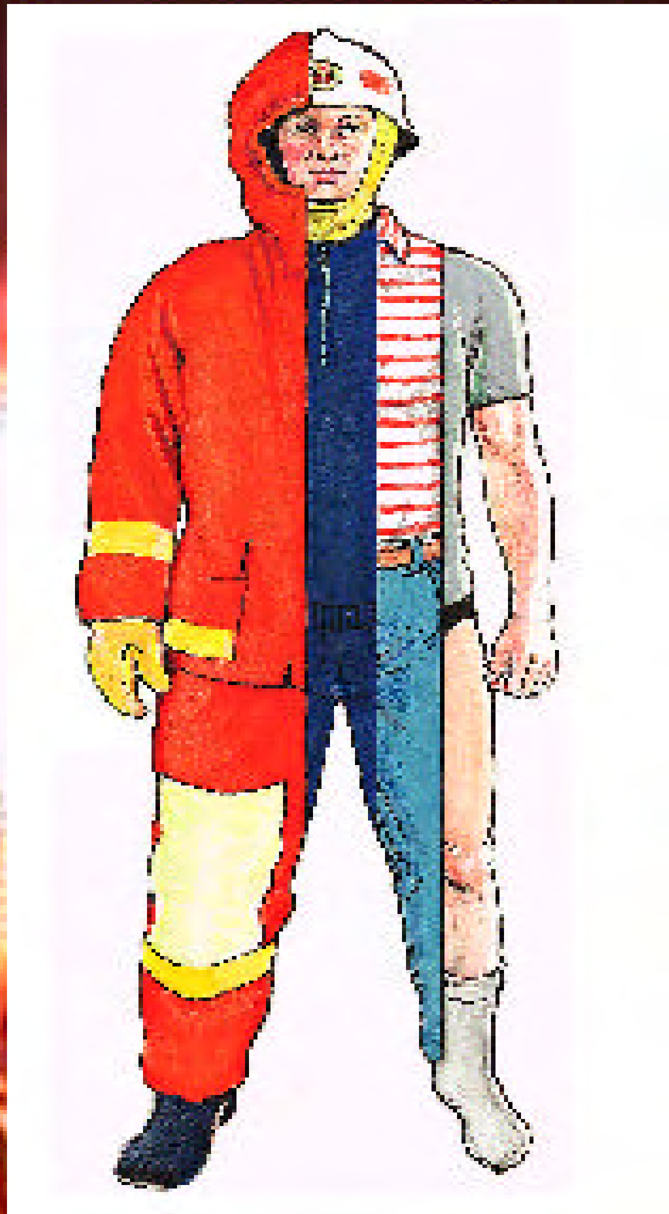
PPE

INTACT

CLEAN

LEAK FREE

LOOSE FITTING



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Safety Brief

- First Aid, resuscitator and water gel
- Report any injuries no matter how minor
- Ensure one branch is left by side door

Don’t forget you are hear to learn, not to suffer if you feel uncomfortable get out