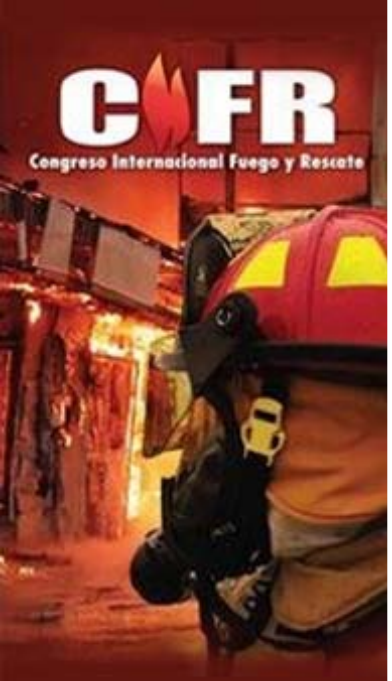

Extreme Fire Behavior

Understanding the Hazard

Valdivia, Chile
January 2010

CFBT-US
Not just what and how, but why!

For what is experienced judgment except opinion based on knowledge acquired by experience? If you have fought fires in every type of building with every different configuration and fuel load, under all types of conditions, and if you have remembered exactly what happened in each of these combinations your experienced judgment is probably very good.

Paraphrased from
Fundamentals of Fire Behavior
Gisborne, 1948

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Not just what and how, but why!

Learning Outcomes

- Recognize the hazards presented by extreme fire behavior.
- Explain how the following extreme fire behavior phenomena occur:
  - *Flashover*
  - *Backdraft*
  - *Smoke Explosion*
  - *Flash Fire*

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Not just what and how, but why!

Extreme Fire Behavior

Phenomena that result in rapid fire progression and present a significant threat to firefighters

Rapi
susta

Ignit
explo

Fue
Contro

H
Full Surface Involvement

ft

Air
ion

Knowledge and Skill

What knowledge and skill becomes critical to your safety when faced with these conditions?

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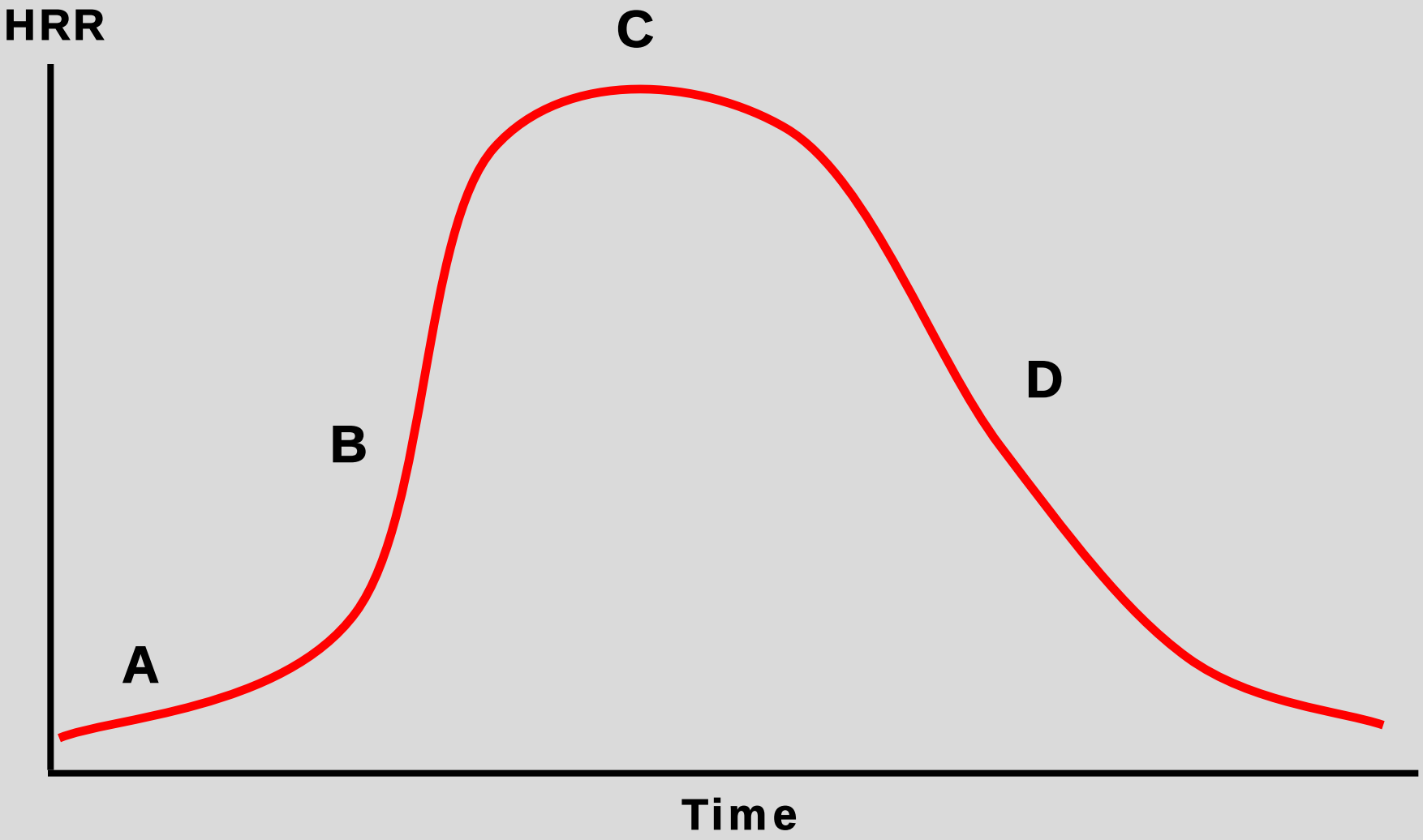
Not just what and how, but why!


HRR
C
B
D
A
Time

Flashover

- Flashover is a rapid transition to the fully developed stage of a compartment fire.
- Heat flux increases the temperature of additional fuel packages within the compartment.
- Sufficient transfer of heat to other fuel packages can result in flashover
  - *Radiant Heat Flux at the Floor: 15-20 kW/m^2*
  - *Temperature: 500^o-600^o C (932^o-1112^o F)*

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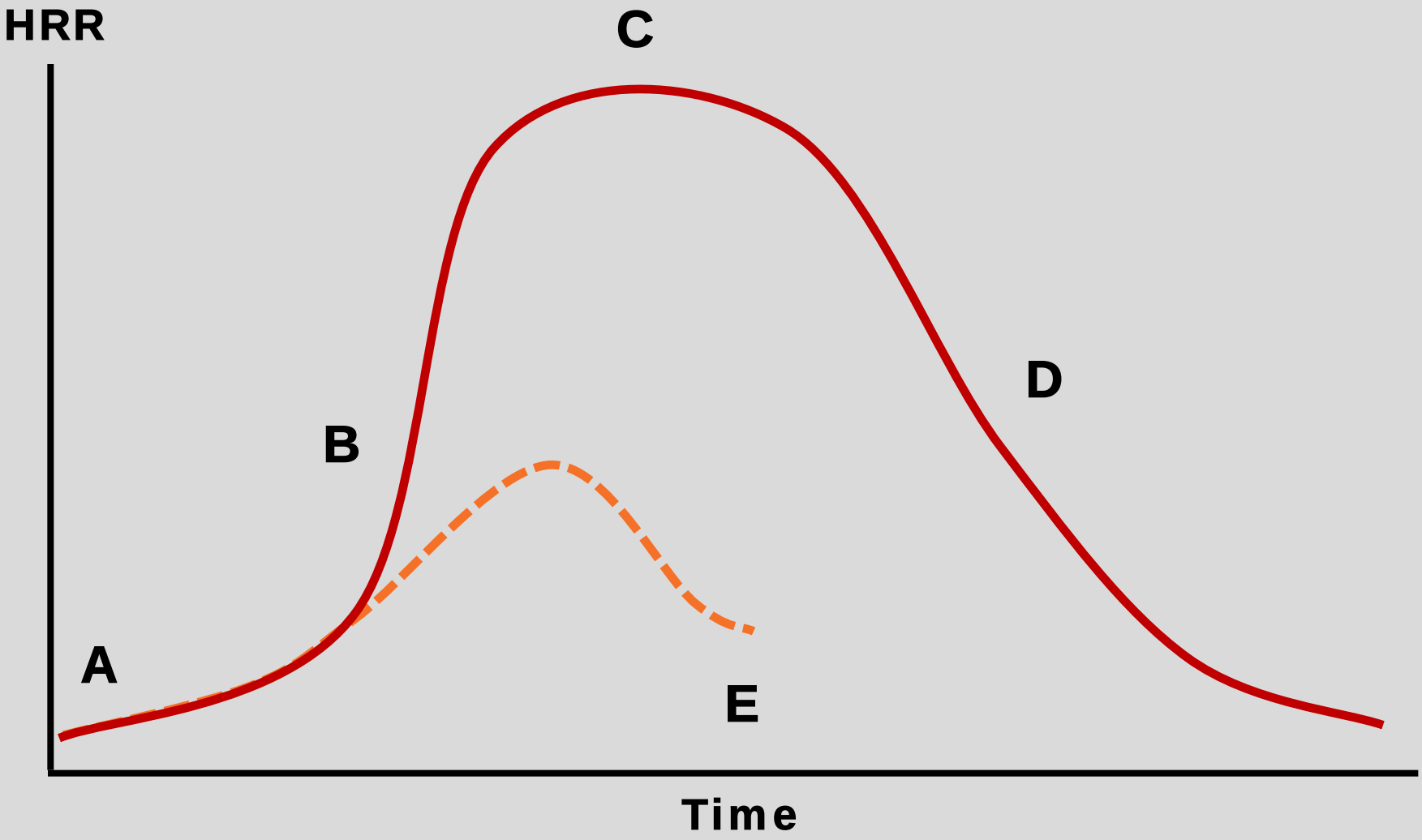
Not just what and how, but why!


HRR
C
B
D
A
E
Time

Flashover

- Given adequate ventilation flashover occurs as part of normal fire development
- If ventilation is limited, the fire may become ventilation controlled prior to flashover
- A subsequent increase in ventilation may result in flashover

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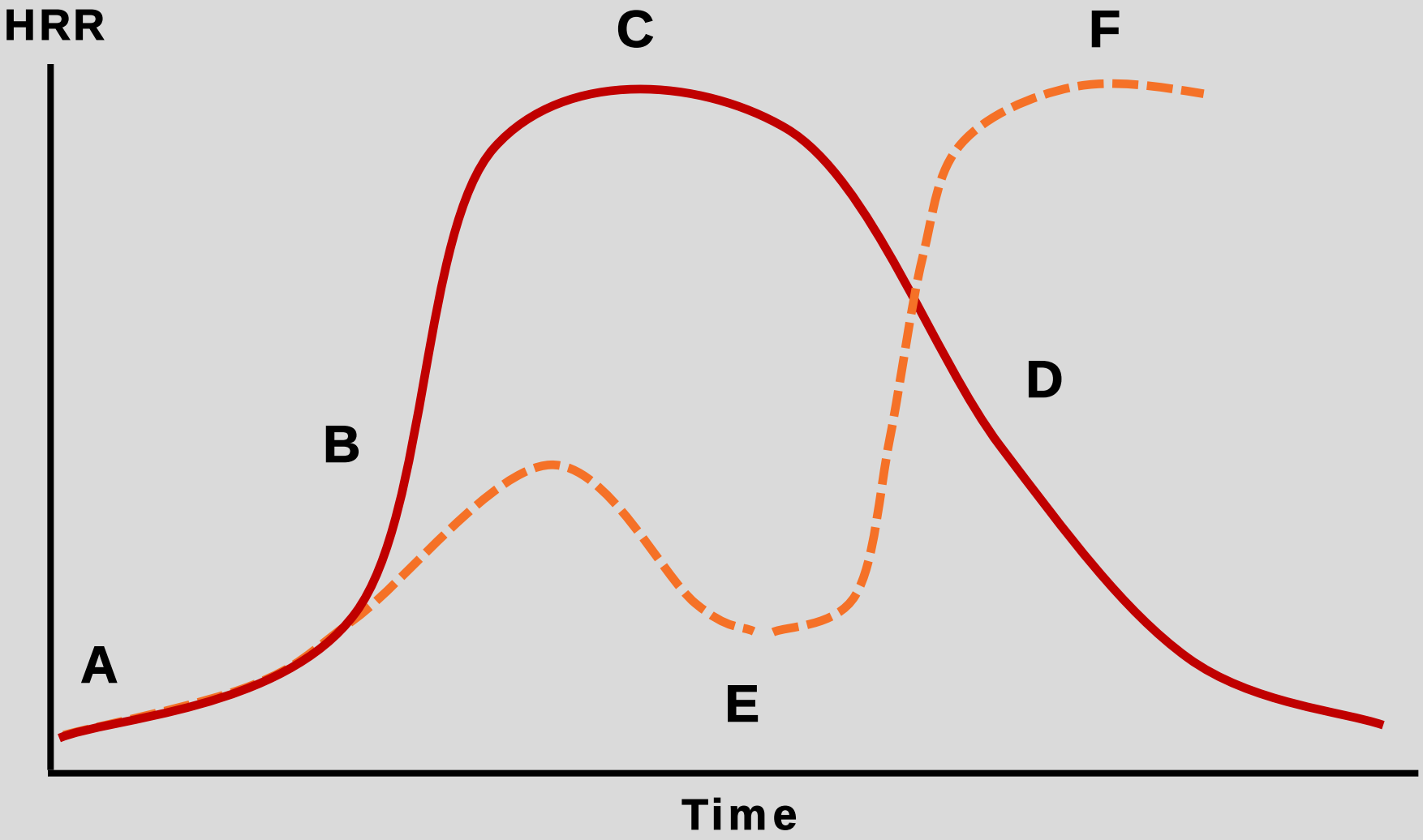
Not just what and how, but why!


HRR
C
F
D
B
A
E
Time

Activity

Vent Induced Flashover

These video clips show recreation of conditions involved in the fatality of two firefighters involved in a live fire training exercise.

- *Fuel load included pallets, a polyurethane foam mattress, carpet, and carpet padding.*
- *Describe your observations and explain the observed phenomena*

Another view…

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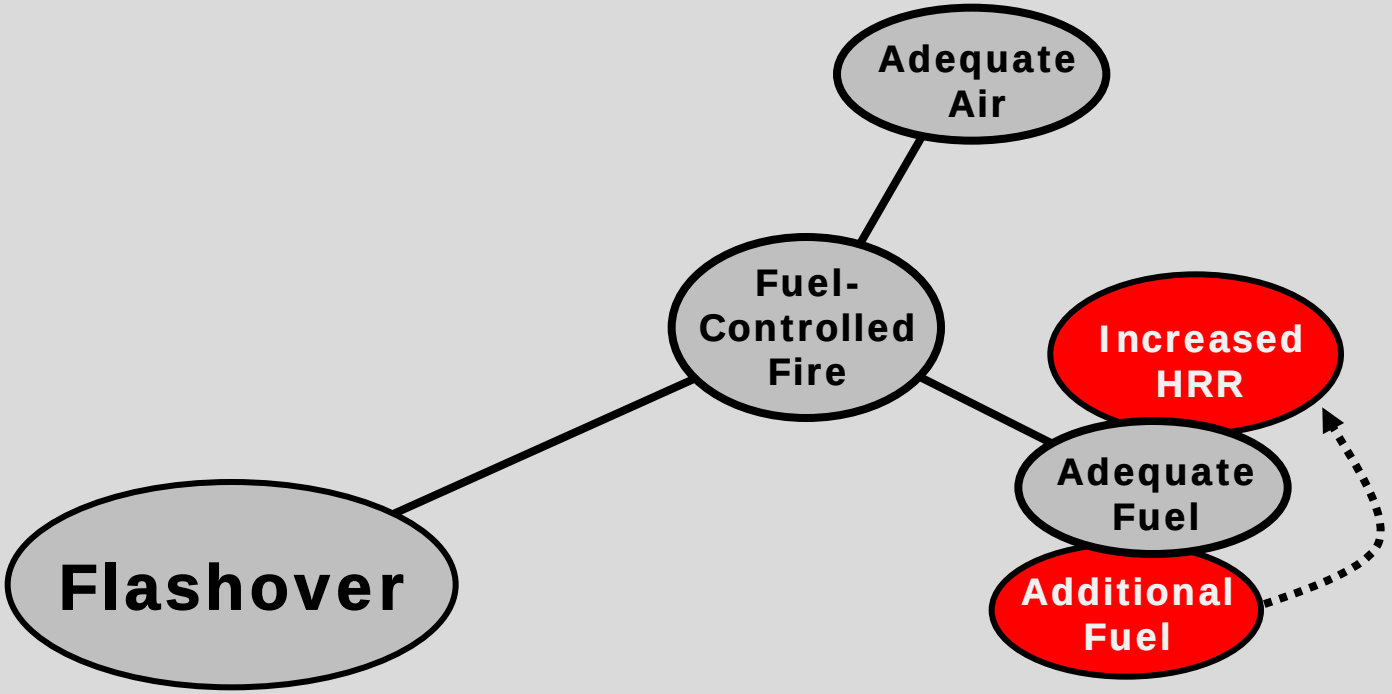
Not just what and how, but why!



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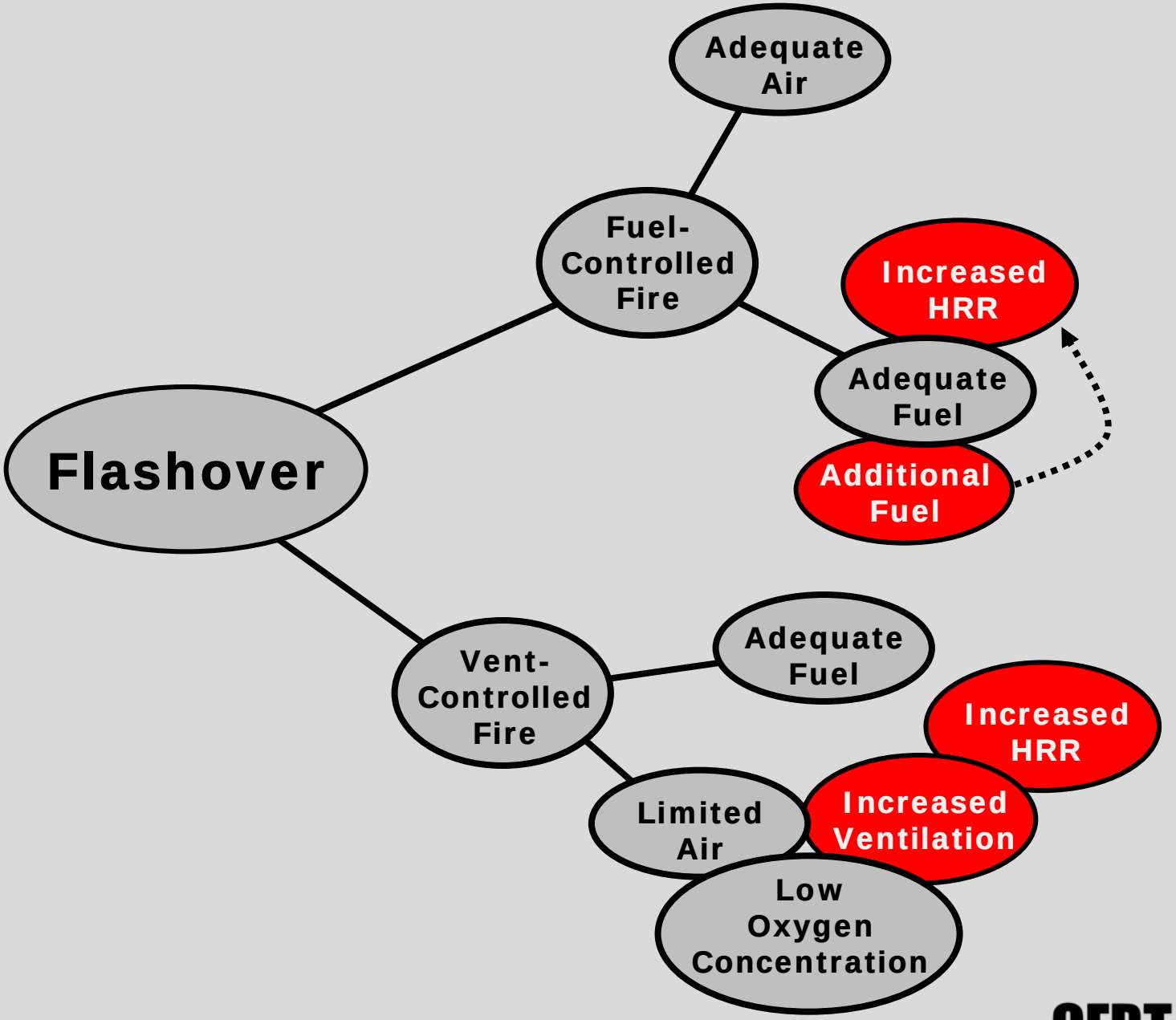
Not just what and how, but why!



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Not just what and how, but why!

Backdraft

- Backdraft is where an under-ventilated fire receives a sudden supply of air, and an ignition source causes the mixing fire gases to ignite, sometimes with explosive force
- Backdraft generally results in an extremely rapid, but transient increase in energy release.

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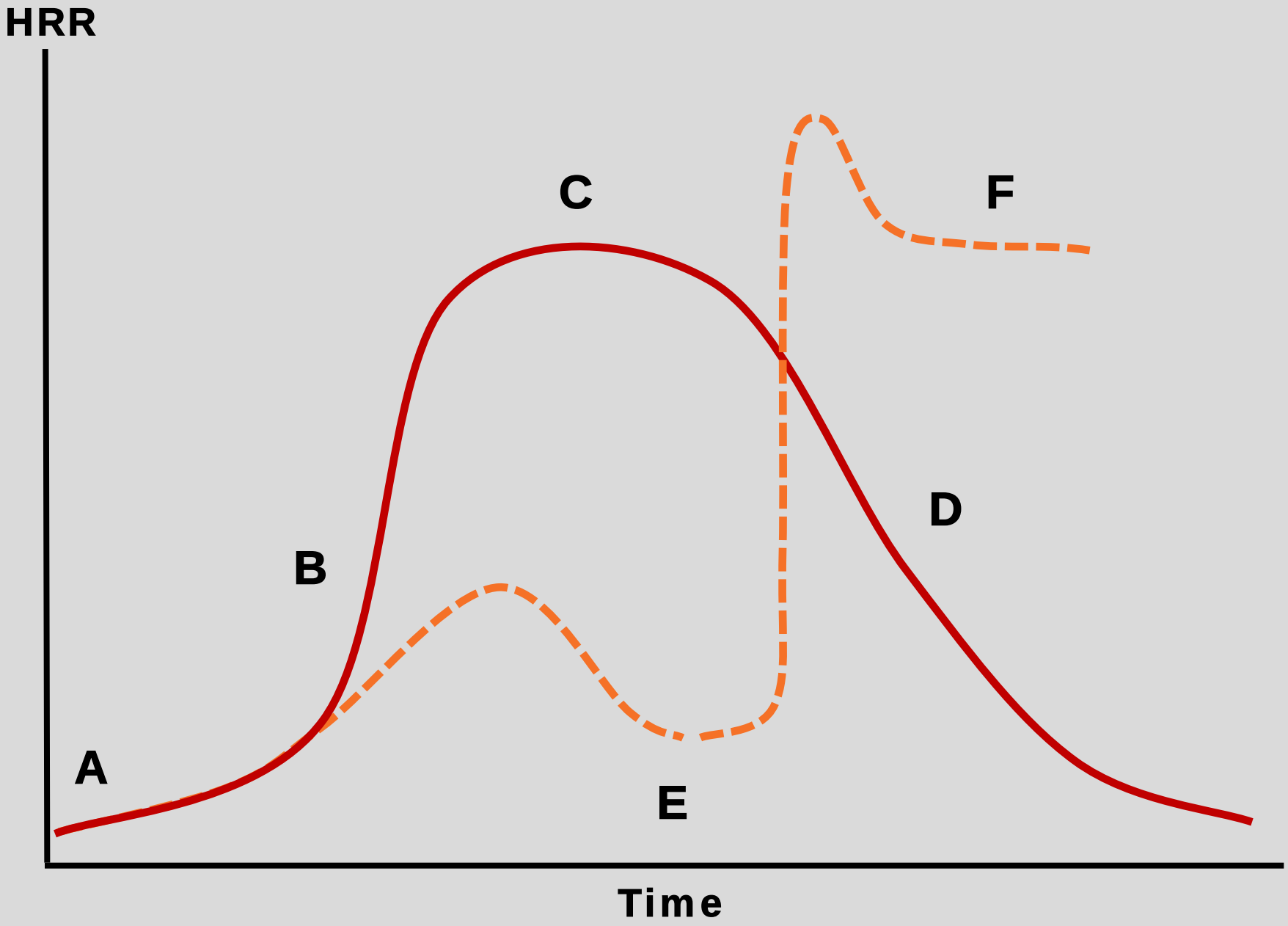
Not just what and how, but why!


HRR
A
B
C
D
E
F
Time

Activity

Backdraft

This video clip illustrates a backdraft in a window cell.

- Watch closely for fire behavior indicators that may point to backdraft potential
- Why do you think there is a difference in outcome in this series of demonstrations?

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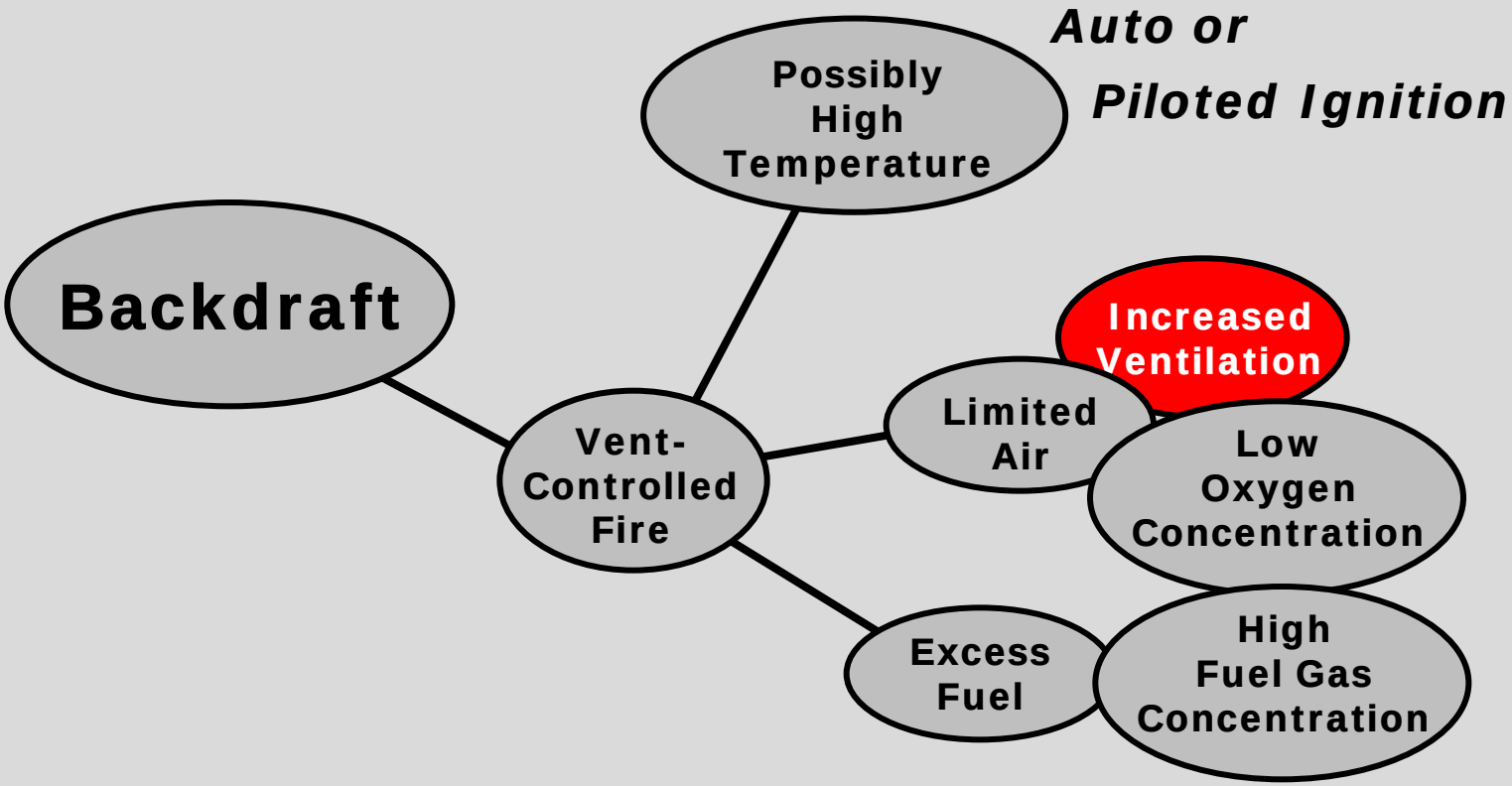
Not just what and how, but why!



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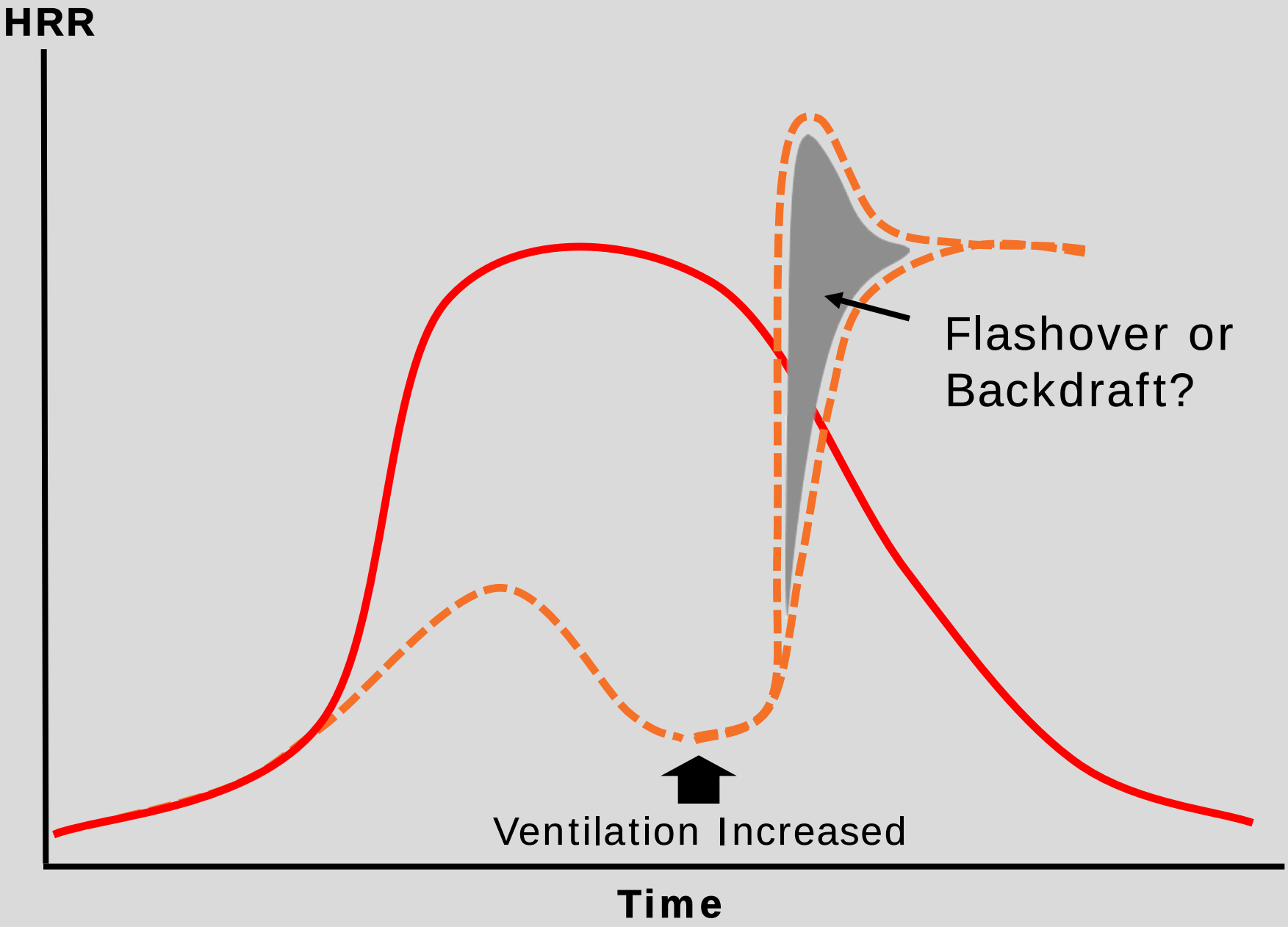
Not just what and how, but why!


HRR
Flashover or
Backdraft?
Ventilation Increased
Time

Sequential Effects

Transient fire behavior in and of itself does not generally result in a sustained increase in fire intensity. However...

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Not just what and how, but why!

Sequential Effects

- Fire in the basement of a five-story, heavy timber meat packing plant
- Yellowish brown smoke pushing with high velocity from floor four
- A backdraft followed horizontal ventilation of floor four
- Flashover of all floors lead to full involvement with extension to other buildings

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Not just what and how, but why!

Smoke Explosion

- Smoke Explosion involves ignition of an accumulated mass of flammable fire gases and pyrolysis products existing in a room or compartment
- The ignition source may be flames, embers, or may even be unrelated to the fire.
- Addition of oxygen is not necessary as the gases already mixed with air and within their flammable range

A smoke explosion is similar to ignition of propane or natural gas inside a structure

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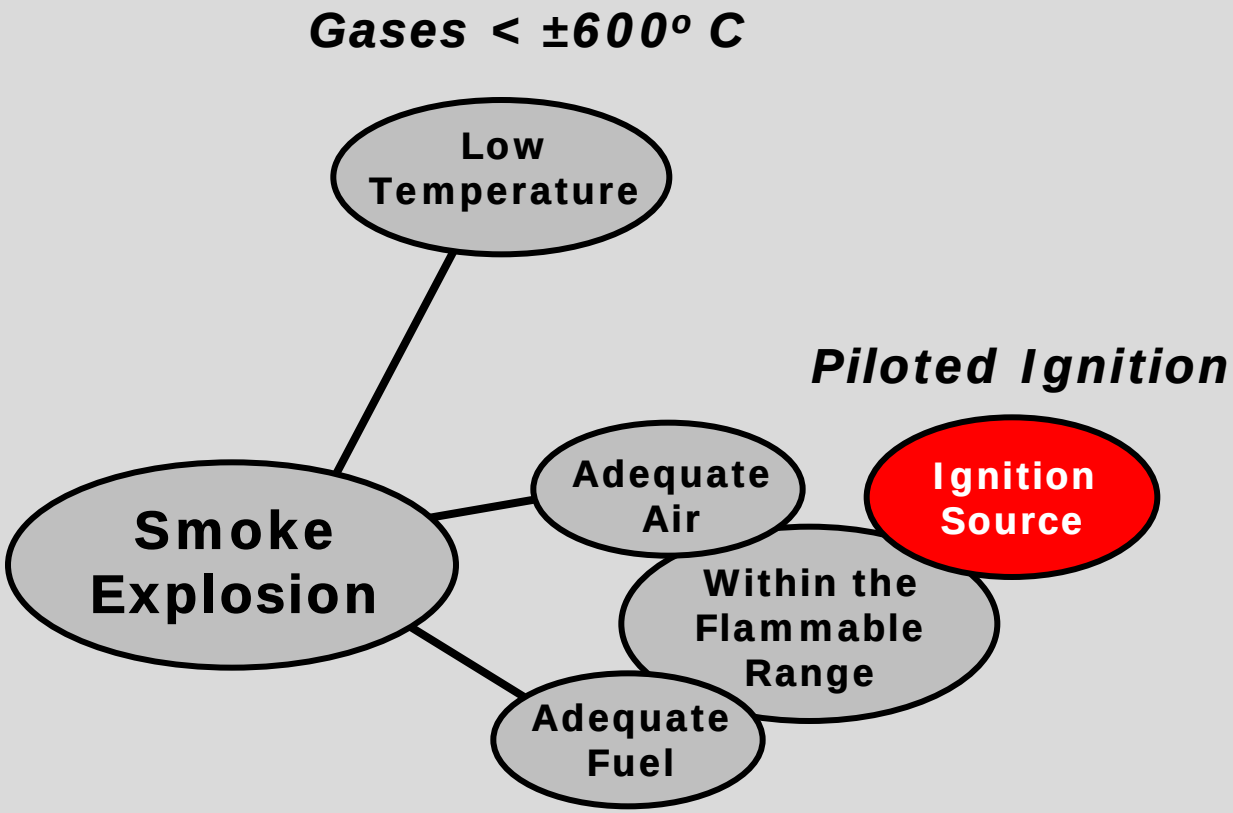
Not just what and how, but why!



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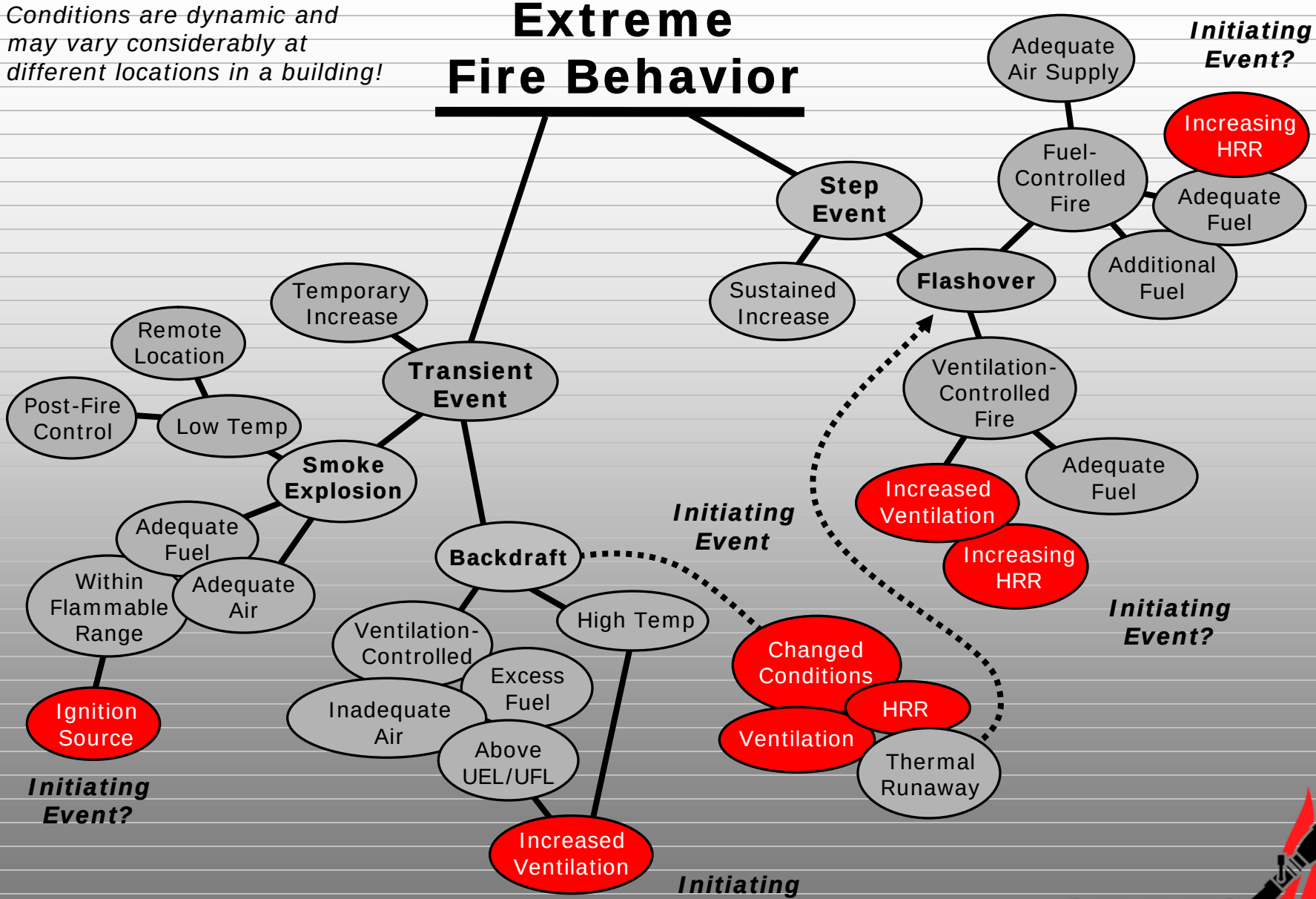
Not just what and how, but why!

Flash Fire

- Flash fire involves ignition of accumulated pyrolysis products and flammable products of combustion
- The mass of gas phase fuel or confinement is limited, minimizing the overpressure resulting from combustion

Conditions are dynamic and may vary considerably at different locations in a building!

Extreme Fire Behavior



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Extreme Fire Behavior

Phenomena that result in rapid fire progression and present a significant threat to firefighters

Rapid transition and sustained increase in HRR

Ignition and rapid or explosive combustion

Step Events

Fuel Controlled

Ventilation Controlled

Flashover

Vent-Induced Flashover

Moderate Fuel/Air Concentration

HRR Sufficient to Result in Full Surface Involvement

Transient Events

Overpressure

Confined

Smoke Explosion

Backdraft

Pre-Mixed Flammable Fuel/Air Concentration

High Fuel/Air Concentration

Flash Fire

Pre-Mixed Fuel/Air Concentration Limited Mass or Confinement

Minimal Overpressure

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