



FPST 1213 Fire and Safety Hazard Recognition

Fire Behavior – Part 2

1



Fire Behavior



- Air present, fuel present and source of ignition ignites fuel
- Air in the compartment provides adequate oxygen to continue fire development
- During this initial phase of fire development (incipient stage), radiant heat warms adjacent fuel and continues the process of pyrolysis (chain reaction)

2



Fire Behavior



- A plume of hot gases and flame rises from the fire and mixes with the cooler air within the room (convection)
- This transfer of energy begins to increase the overall temperature in the room

3



Fire Behavior



- As flames near the ceiling, the layer of hot gases becomes more clearly defined and increase in volume. The fire has moved beyond its incipient phase and hot gases begin to ignite (roll over)
 - Only the gasses ignite, not the room contents
- Rapid transition from growth stage to fully developed stage (flashover)
 - All contents in the room ignite
- When all fuel is consumed, the fire will go out (decay stage)

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Video – Stages of Fire

STAGES OF FIRE

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Incipient Stage




- Fuel, heat, and oxygen are present
- Fuel is heated to its ignition temperature
- Transition beyond the incipient stage is difficult to define in precise terms


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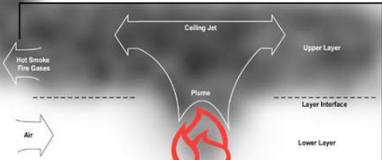
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Growth



- Additional fuel is involved
- Fire grows larger
- Convection draws more air into fire
- Thermal layering
 - Superheated gases collect near ceiling
 - Temperatures are lowest near the floor



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Rollover



- A warning sign of imminent flashover
- Smoke particles and gasses ignite briefly in upper layers of smoke

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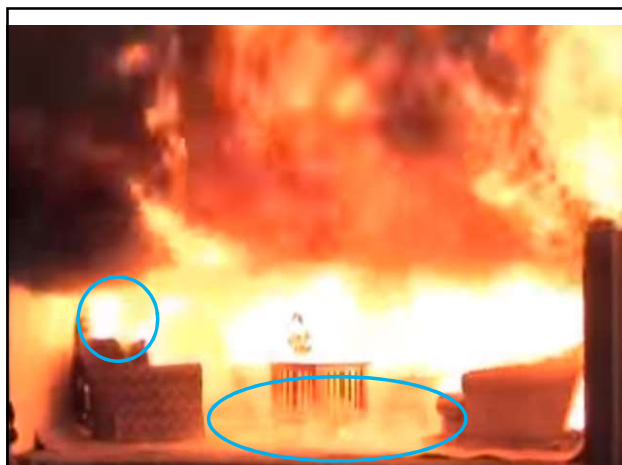


Flashover

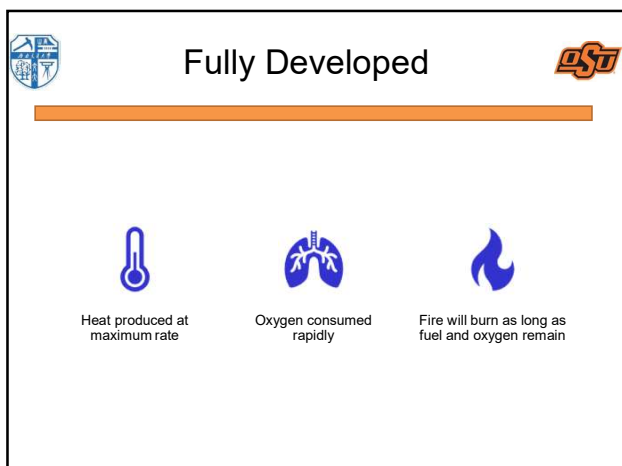


- Point between growth phase and fully developed phase
- Sudden ignition of all contents at once
- Temperatures can reach 1000°F
- Flashovers are deadly. Minimal chance of survival
- Flashover often occurs just as fire fighters arrive on the scene

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Decay



- Fuel is nearly exhausted
- Intensity reduces
- Eventually fire will go out
- Smoldering

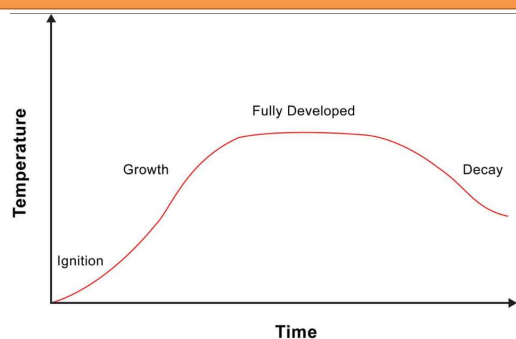
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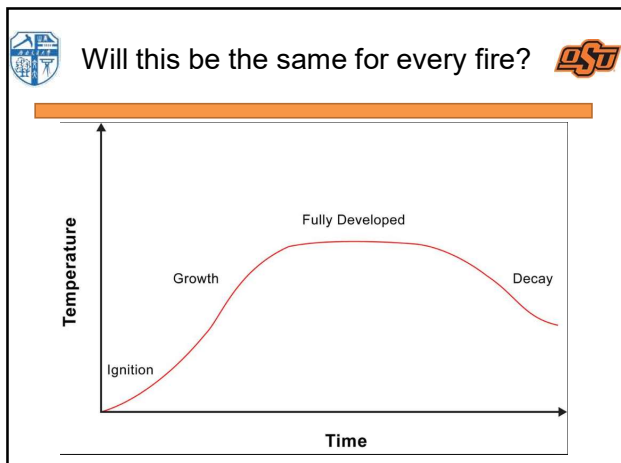
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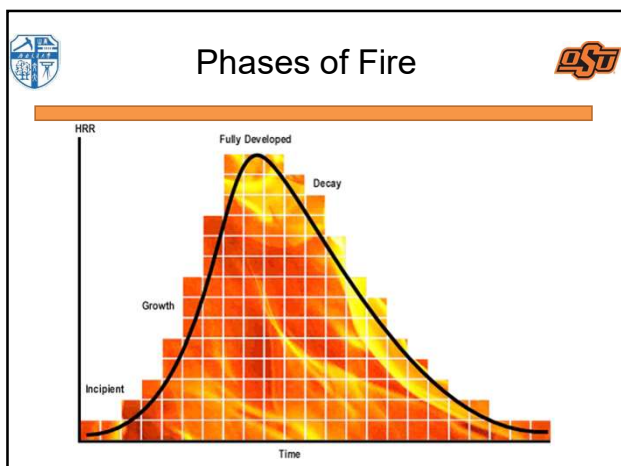
Fire Behavior



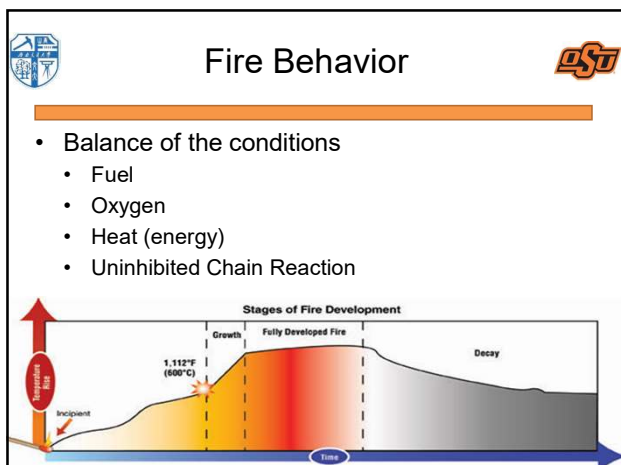
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Short or long incipient stage? 



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Slow or rapid growth? 



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Length of fully developed stage? 



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Short or long incipient stage? 



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Slow or rapid growth? 



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Length of fully developed stage? 



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Key Principles of Solid-Fuel Fire Development



- Hot gases and flame tend to rise
- Convection is the primary factor in spreading the fire upward
 - P 93
 - Figure 3.23
- Downward spread occurs primarily from radiation and falling chunks of flaming material
- If there is no remaining fuel, the fire will go out

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Backdraft



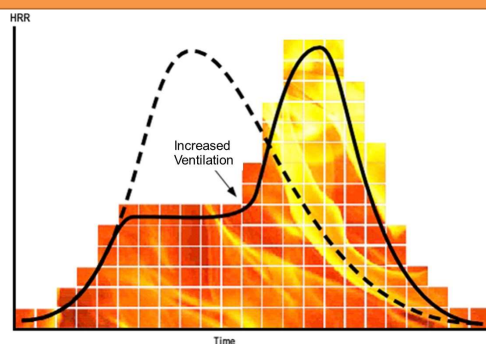
- Explosion that occurs when oxygen is suddenly admitted to a confined area that is very hot, oxygen starved and filled with combustible vapors
 - Usually occurs when a fire is smoldering
 - Room is filled with carbon monoxide and other products of combustion
 - Sudden introduction of air will explosively feed the fire
 - video



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Phases of Fires



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Explosions



- A rapid release of high pressure gas accompanied by a shockwave
 - Speed of sound = 1,088 ft/s or 332 m/s
 - Subsonic = less than
 - Supersonic = more than
- Bursting of an enclosure due to internal pressure.

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Physical Explosion



- No change in chemical composition of reactants
- External heating of gases, liquids, solids
 - BLEVE
 - Boiling Liquid Expanding Vapor Explosion
 - video
- Boiler Explosion

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Detonation and Deflagration



- Detonation
 - A reaction with a speed of propagation at or in excess of the speed of sound (supersonic) resulting in a shock wave
- Deflagration
 - A reaction with a speed of propagation less than the speed of sound (subsonic) in the unreacted medium
 - If you contain a material that deflagrates, you can have an explosion.

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Theory of Dust Explosions



- Fine combustible dust suspended in air and flame will be propagated through the dust cloud
- Oxygen must surround the particles of dust
- Strength and duration of the ignition source must be adequate
 - video

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Prevention and Protection



- Deflagration Protection
 - Reduce Oxidizer – Inert the Environment
 - Deflagration Suppression
 - Reduce Combustibles
 - Contain, Ventilate, Purge
 - Control Ignition Sources
 - Friction, Electrostatic, Hot Surfaces
- Pressure Containment
- Deflagration Venting

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