TOPIC: Wildland Fire Behavior - Fire Intensity and Spread

TIME FRAME: 1 Hour

LEVEL OF INSTRUCTION:

BEHAVIORAL OBJECTIVE:

Condition: A written quiz

Behavior: The student will list and describe the important modes of fire spread and the basic concepts of fire behavior.

Standard: With a minimum of 70% accuracy

MATERIALS NEEDED:

- Appropriate visual aids
- Audio visual equipment

REFERENCES:

- Heat and Wildland Fire, C. Countryman
- Pacific Southwest Forest and Range Publication
- Wildland Firefighting, Clayton, Day and McFadden, Chapter 5

PREPARATION: Understanding fire behavior is important to a Firefighter tasked with conducting a safe and efficient control operation. It is important to CDF that every firefighter have a basic understanding of wildland fire behavior. This understanding is the basis for all suppression activities and places the firefighter in a position to look after his or her safety.

PRESENTATION	APPLICATION

I. INTRODUCTION

A. Fire Behavior Varies Greatly and Often Suddenly Between Wide Extremes:

1. Creeping fires produce small flames
2. Rapidly moving walls of flame higher than the trees

B. Fire Behavior Dictates Our Actions

1. Control methods that can be used
2. Fireline safety considerations

C. Knowledge of Fire Behavior Builds on Observing Fire Behavior and Knowing the Conditions that Produce It

II. SPREAD PROCESS

A. Heat is Produced by the Burning of Vegetation

1. The rate of heat production depends on:
   a. The quantity of fuel consumed
   b. The fuel's moisture content
   c. The rate at which it is consumed
2. Most of the heat goes up in the convection column rising from the fire
3. A fraction of the heat is transferred to new fuel ahead of the fire via:
   a. Radiation from the flame front
   b. Convection
   c. Direct flame contact

PRESENTATION	APPLICATION
B. Heat is Absorbed by New Fuels Until They Reach Ignition Temperature	
1. Finer fuels are ignited more readily than coarser fuels	
2. Drier fuels are ignited more readily than wetter fuels	
III. RATE OF SPREAD (ROS)	
	What is your most common measurement?
A. Rate of Spread, Is the Rate at which the Flame Front Advances Through the Fuel	
1. Common measures of rate of spread include feet/minute, miles/hour and chains/hour	
2. Can be observed directly by estimating fire travel in a known time interval	
3. "Spread component" is a prediction of rate of spread in feet/minute	
B. Rate of Spread Is Controlled by the Rate at Which New Fuel Can Be Ignited. Greater Rate of Spread Results When New Fuel is Ignited More Rapidly	
1. Greater heat output from burning fuel heats new fuel more rapidly	
2. More easily heated new fuel reaches ignition temperature more rapidly	
3. More efficient heat transfer due to wind and/or slope causes new fuel to heat up more rapidly	
C. The Rate of Spread Influences the Choice and Timing of Control Actions	

PRESENTATION	APPLICATION

1. Will hose lays or mobile attack catch the fire?
2. Will proposed control lines be completed and/or fired out in time?
3. How soon will the fire reach structures or more hazardous fuels?

D. The Rate of Spread Influences Safety

1. How soon will the fire threaten personnel or equipment?
2. When might potential escape routes be cut off?

E. Measurement Terms of Rate of Spread

1. Low (slow) - very little spread; spread of no consequence
2. Moderate - spread less than 1 mph
   a. Less than 80 feet per minute
3. Dangerous - spread is 1-3 mph
   a. 80 - 264 feet per minute
4. Critical (rapid) - spread is over 3 mph
   a. Over 264 feet per minute

IV. FIRE INTENSITY

A. Intensity Refers to the Rate at Which Heat Is Being Produced by a Section of Flame Front

B. A Useful and Readily Observed Measure of Intensity Is "Flame Length"

1. Flame length is measured from the center of the flaming zone out to the tip of the flames
2. Flame length is commonly expressed in feet

PRESENTATION	APPLICATION
3. Though it varies continuously flame length does convey an idea of how intense the heat is near the flame front	
C. Control Difficulty and Effectiveness of Control Techniques Can Be Related to Flame Length	
1. 0' to 4': Handtools and handlines can probably control the fire	
2. 4' to 8': Hose lines, retardant and dozer line will probably be required	
3. 8' to 11': Direct control of the fire is only marginally possible	
4. Over 11': Indirect control methods will be needed	
D. Higher Intensity Fire (i.e., Longer Flame Length) Generally Poses a Greater Threat to the Firefighter	
1. A greater working distance from the fireline is necessary	
2. Burn injuries may be more frequent	
3. May damage safety clothing or fire shelters	
4. Requires safe zones of greater size	
5. Subjects firefighters to greater radiant heat as they work	
E. Increases in Intensity, Often Abrupt, Can Arise in Several Ways	
1. Fire is driven more rapidly by wind or slope	
2. Fuel moisture levels decline	
3. Fire moves into a different fuel type	

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4. Fire involves new levels in the fuel complex, such as moving into tree crowns

V. SPOTTING

A. Spot Fires are Ignited by Firebrands Carried Aloft in the Convection Column that Fall Out into Receptive Fuels Ahead of the Fire

1. Spots occur anywhere from just ahead of the fire to a mile or more away from it

2. Longer range spotting is favored by strong convection and significant winds

3. Common firebrands include leaves, needles, bark scales, branch tips, cone scales, thistles, and moss

   a. Firebrands are commonly produced when fire flares up in trees or brush

   b. Firebrands likely to cause spot fires are rarely produced by burning grass

4. Spot fires are more likely to ignite when the fine fuel is dry and warm

   a. Ignition components or the nearly equivalent probability of ignition is a guide to the likelihood of spot fires

   b. If ignition component is:

      (1) Below 50: Infrequent spot fires

      (2) 50 to 80: Spot fires quite possible

      (3) Above 80: Spot fires quite likely

B. Spot Fires Can Easily Frustrate Control Efforts

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1. New fires can ignite well beyond the reach of equipment or personnel

2. Established control lines can be jumped by even short range firebrands

C. Spot Fires Can Create a Hazard to Personnel and Equipment

1. By igniting fire near them well before the main fire is expected, or in areas it was not expected to reach

2. By surrounding them with multiple fires

VI. CROWNING

A. Crown Fires Are Those that Consume the Foliage (and Sometimes the Branches) of Trees or Brush. The Term Applies Most Commonly to Fires in Tree Crowns, Especially Conifers

B. Crown Fires are Initiated by the Heat Rising Above Burning Surface Fuels

1. Heavy surface fuels, sometimes in accumulations called "jackpots", are more likely to ignite the crowns above

2. The fuel arrangement that bridges the gap between the surface fuels and aerial fuels is called a "ladder fuel". It assists the spread of fire into the crowns.

C. Crown Fires Fall into Three Classes:

1. Passive - Isolated and intermittent torching of crowns over concentrations of surface fuel

a. Flareups near the line and spotting create control problems

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2. Active - Crown fire and surface fire reinforce each other and move together

    a. Direct control efforts are usually futile, and fireline personnel are threatened.

3. Independent - Crown fire is driven ahead of the surface fire, usually requiring winds of at least 15 miles/hour

    a. Control of the fire is hopeless, and fireline personnel are in great danger

D. Several Factors Can Contribute to a Greater Chance of Crown Fire

1. Extensive ladder fuels and/or heavy surface fuels

2. Long term dry conditions

3. Closely spaced, continuous crowns

4. High winds and/or steep slopes

VII. AREA IGNITION

A. A Broad Area of Fuel Is Ignited Nearly Simultaneously. Heat Is Released Much More Rapidly than if the Firefront Moved Gradually Through the Same Fuel

B. Area Ignition (While Possible on a Smaller Scale) Is Often Associated with Extreme Fire Behavior, or "Blowups"

1. Very high intensities

2. Extensive spotting

3. Powerful convection columns that can lead to firestorms or intense whirls

PRESENTATION	APPLICATION
C. Area Ignition Though Not Easy to Anticipate, Seems to be Frequently Preceded by: 1. Preheating of fuels by radiation 2. Numerous spot fires, scattered throughout the fuel and acting much like pilot lights 3. Area ignition frequently results from the intentional ignition of management burns	

SUMMARY:

Understanding the spread process, and concepts such as rate of spread and fire intensity can help a firefighter predict spotting, crowning, and area ignition. By being able to anticipate these phenomena the firefighter can conduct safer and more efficient fire control operations.

EVALUATION:

A written quiz.

ASSIGNMENT:

To be determined by instructor(s).