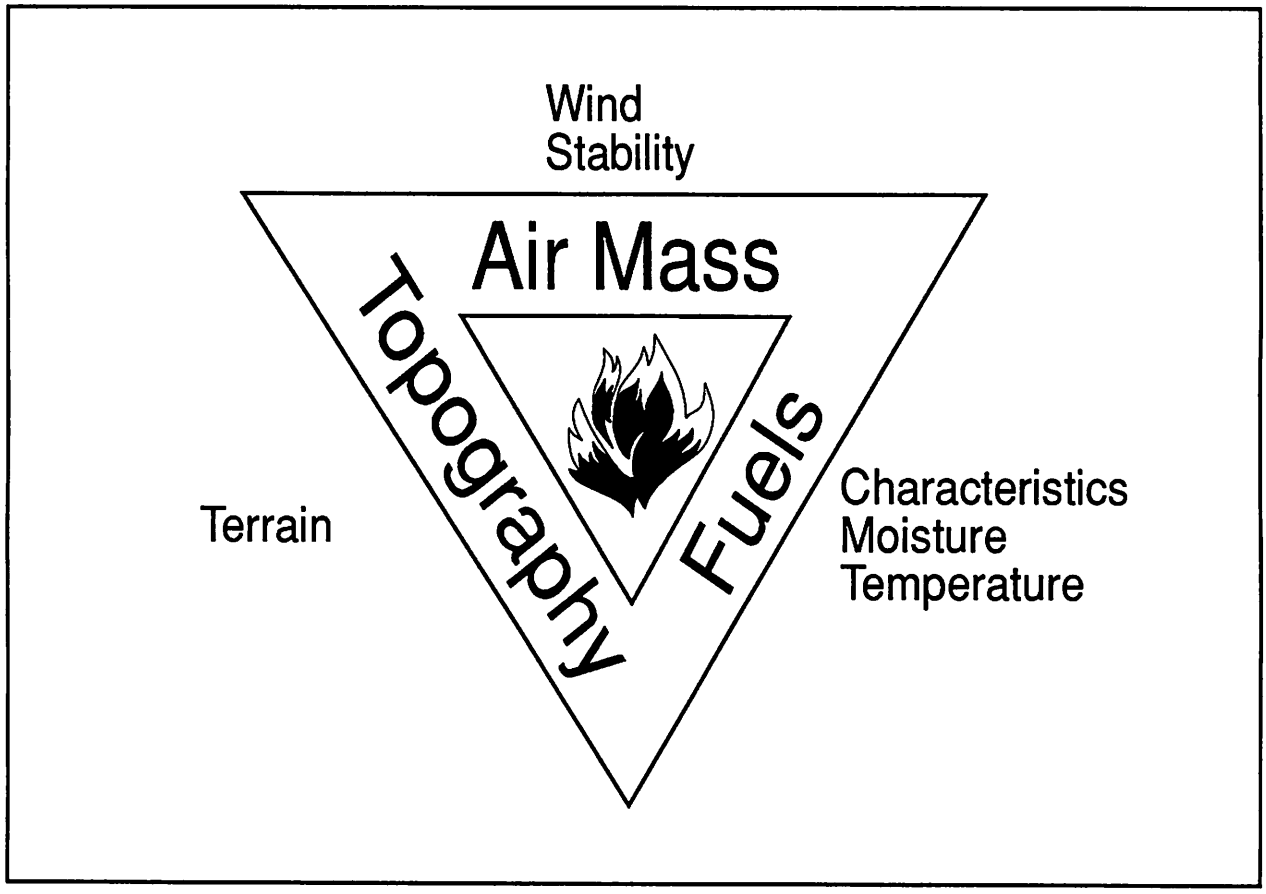
Look Up
Look Down
Look Around

PMS 427



NATIONAL WILDFIRE COORDINATING GROUP

Student Workbook

APRIL 1992

NFES 2242

CERTIFICATION STATEMENT

on behalf of the

NATIONAL WILDFIRE COORDINATING GROUP

The following training material has been determined to be of value for interagency use. It does not meet the Course Development and Format Standards - Third Edition, 1990; but has been reviewed and evaluated by the Office of Training Standards. It is known as:

Look Up, Look Down, Look Around
Certified at Level III

Roger L. Hamilton
Member NWCG and Training Team Liaison

Date 4/14/92

George R. Marty
Chairman, Training Team

Date 4/13/92

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PREFACE

Look Up, Look Down, Look Around is a training course that was designed as a refresher seminar in fire behavior for fireline personnel. Development of the course was initated in 1991 and involved an interagency work group of wildland fire management personnel. A needs assessment of major fire entrapment incidents, that occurred between 1985 and 1990, showed a need exists to improve the ability of fireline personnel to monitor the fire environment.

The following persons were responsible for the development of this training package.

Project Leader	
Jim Cook	Arrowhead IHC Superintendent, NPS/BIFC
Subject Matter Experts	
Bill Clark	Fire Management Specialist, NPS/BIFC
Randy Doman	Forest Fuels Management Officer, USFS/R-1
Paul Gleason	District Fire Management Officer, USFS/R-2
Dan Kleinman	Fulton IHC Superintendent, USFS/R-5
Mark Linane	Los Prietos IHC Superintendent, USFS/R-5
Bob Mutch	Research Applications Leader, USFS/IFSL
Dr. Rod Norum	Fire Management Specialist, NPS/BIFC
Jerry Williams	Fuels and Fire Use, USFS/WO
Video Production	
Bob Kambitsch	Audio Visual Specialist, BLM/BIFC
Computer Graphics	
Nina Walker	Audio Visual Specialist, BLM/BIFC
Dr. Geoffrey Gardner	Senior Staff Scientist, Grumman Data Systems
William Wertz	Technical Consultant, Grumman Data Systems
Text Graphics	
Laurel Simos	Illustrator, BIA/BIFC

UNIT 0 INTRODUCTION

I. Course Objectives

A. List the seven (7) fire environment factors to monitor on the fireline.

B. Recognize the indicators of the seven (7) fire environment factors.

C. Identify the effect of these indicators on fire behavior.

II. THE FIRE ENVIRONMENT

A. The fire environment is the conditions, influences, and modifying forces that determine how a fire burns. The fire environment has been described with a triangle showing fuels, topography, and air mass.

B. This triangle uses the term Air Mass instead of Weather. Some weather observations actually measure fuel conditions. This term was used in a publication by Clive Countryman that first described the fire environment.

C. There are seven FACTORS within the fire environment that fireline personnel must monitor:

*Fuel Characteristics
*Fuel Moisture
*Fuel Temperature
*Terrain
*Wind
*Stability
*Fire Behavior

D. Fire behavior is what we want to predict or anticipate; but fire behavior is also a factor to monitor.

E. INDICATORS are the clues used to size-up the fire environment and predict or anticipate fire behavior. These are visual observations or measurements made on the fireline.

III. PROBLEM FIRE BEHAVIOR

A. Problem fire behavior is fire activity that presents potential hazard to fireline personnel, if the tactics being used are not appropriate. Normal fire behavior can be problem fire behavior if fireline personnel are in the wrong location.

B. The prediction or anticipation of fire behavior is the key to safe and effective tactical decisions.

C. Extreme fire behavior is the highest level of problem fire behavior and it can be described with specific elements:

*Rapid rate of spread
*Intense burning
*Spotting
*Crowning

UNIT 1 FUEL CHARACTERISTICS

I. Fuel Characteristics Introduction

A. Fuel characteristics determine the potential fire intensity and spread rate.

B. Fuel characteristics change slowly over time ... however, fuel types can change quickly over a distance as a fire burns into new areas.

II. Fuel Characteristics Indicators

A. Continuous Fine Fuels

Continuous fine fuels provide potential for rapid rate of spread. Fine fuels are the primary carrier of fire spread.

B. Heavy Loading of Dead and Down Fuels

Accumulation of dead and down fuels provides the potential for intense burning conditions.

C. Ladder Fuels

Ladder fuels provide the potential for surface fires to move into the crowns above.

D. Tight Crown Spacing

Tight spacing of crowns provides potential for a fire to move from crown to crown.

E. Special Conditions

A special or abnormal condition may contribute unusual fuels to a fuel type.

III. Scenario One

Which fuel characteristics do you see in the scenario that are indicators of potential problem fire behavior?

UNIT 2 FUEL MOISTURE

I. Fuel Moisture Introduction

A. Fuel moisture content determines if fuels are available to burn.

B. Fuel moisture content changes diurnally, seasonally, and also in an accumulative manner over several seasons or years. Fuel size determines the rate of drying:

*1 hour fuels = less than 1/4" diameter
*10 hour fuels = 1/4" to 1" diameter
*100 hour fuels = 1" to 3" diameter
*1000 hour fuels = 3" to 8" diameter

C. Some weather observations are a measurement of fuel moisture.

II. Fuel Characteristic Indicators

A. Low Relative Humidity

1. Fine fuels (1 hour fuels) become more flammable as the relative humidity (RH) drops.

2. Use 25 percent RH as a rule of thumb; this indicator will vary in different areas of the country.

B. Low 10 hour Fuel Moisture

This is a measure of how dry the small sticks and twigs are, these play a role in fire spread.

C. Drought conditions

Drought will cause large dead and down fuels and the live fuels to become available to burn. The effect of drought is accumulative over several seasons or years.

D. Seasonal Drying

Normal seasonal drying will cause more fuels to become available to burn as time passes through the fire season. Existing drought conditions can accelerate this seasonal drying process.

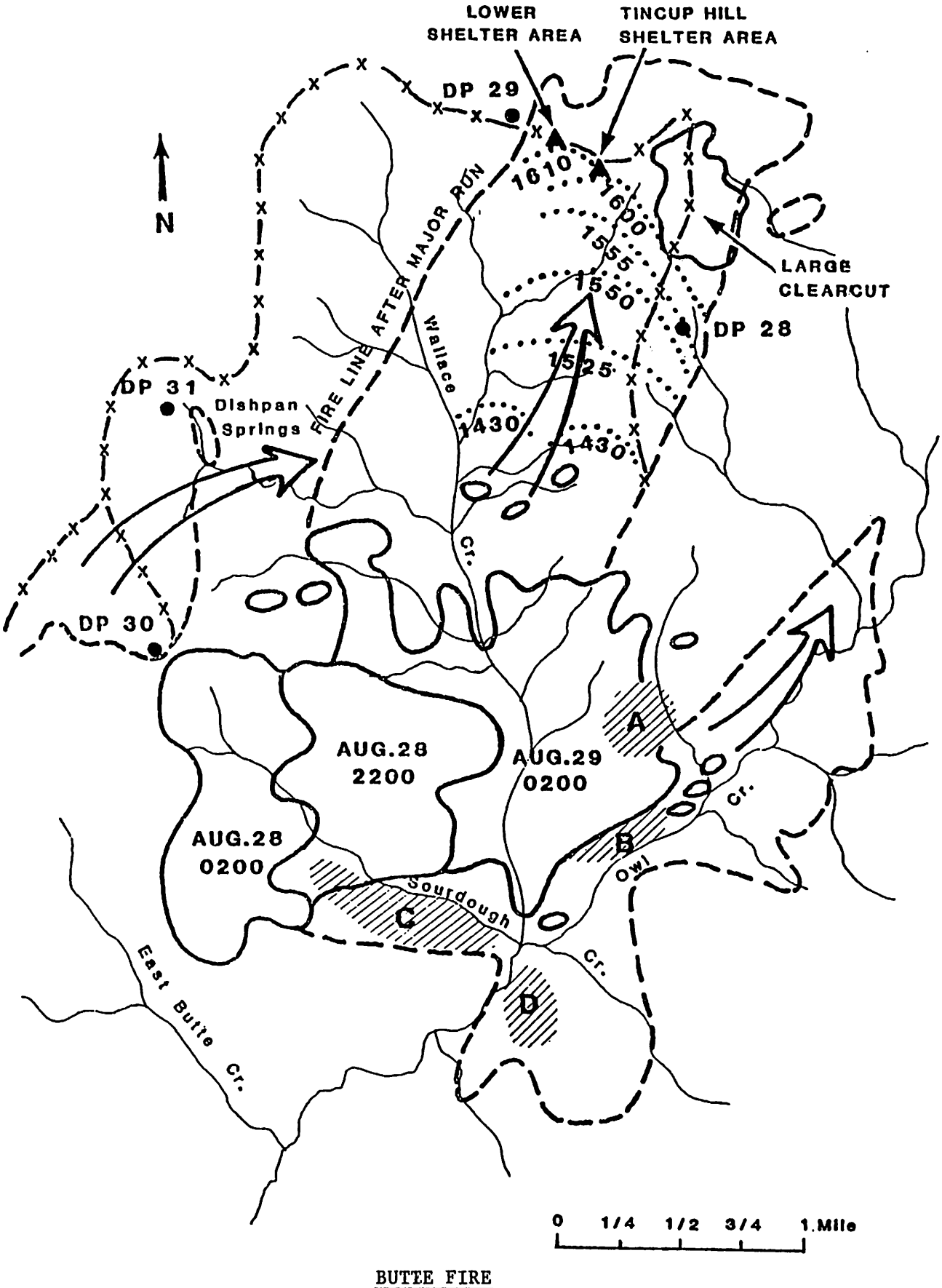
III. Scenario Two

Which fuel moisture indicator plays a key role in the decision, by these crewsupervisors, to move their crews into a good safety zone?

FIRE SEVERITY RELATED TO RELATIVE HUMIDITY AND FUEL MOISTURE

Relative Humidity %	1-Hour Fuel Moisture %	10-Hour Fuel Moisture %	Relative ease of ignition and spotting; general burning conditions.
>60	>20	>15	Very little ignition; some spotting may occur with winds above 9 mph.
45-60	15-19	12-15	Low ignition hazard, campfires become dangerous; glowing brands cause ignition when RH is <50%.
41-45	11-14	10-12	Medium ignitability , matches become dangerous; "easy" burning conditions.
26-40	8-10	8-9	High ignition hazard, matches always dangerous; occasional crowning, spotting caused by gusty winds; "moderate" burning conditions.
15-25	5-7	5-7	Quick ignition, rapid buildup, extensive crowning; an increase in wind causes increased spotting, crowning, loss of control; fire moves up bark of trees igniting aerial fuels; long distance spotting in pine stands; "dangerous" burning conditions.
<15	<5	<5	All sources of ignition dangerous; aggressive burning, spot fires occur often and spread rapidly, extreme fire behavior probable; "critical" burning conditions.

Source: Fire Behavior Field Reference



BUTTE FIRE

Arrows depict major fire runs on the Butte Fire During the afternoon of August 29, 1985. The 73 firefighters deployed fire shelters at the lower shelter area and Tincup Hill shelter area.

UNIT 3 FUEL TEMPERATURE

I. Fuel Temperature Introduction

A. Fuel temperature contributes to fuel availability. This is particularly important in fuel types that are dominated by fine fuels.

B. Fuel temperature changes frequently. Diurnal temperature changes and amount of direct sunlight will determine fuel temperature.

C. Some weather observations are a measurement of fuel temperature.

II. Fuel Temperature Indicators

A. High Temperatures

High temperature will increase the flammability of fine fuels.

B. Fuels in Direct Sunlight

Fuels that receive continual direct sunlight will have accelerated drying rates in comparison to similar adjacent fuels that are mostly or partially shaded by a canopy cover.

C. Aspect With Increasing Fuel Temperatures

Fine fuel flammability will change as fuel temperature changes. These changes will occur when slopes undergo transitions between shade and sunlight.

III. Scenario Three

If other fire environment factors remain the same, which of the two fire situations shown in the scenario will have the more severe fire behavior at 1500? Why?

UNIT 4 TERRAIN

I. Terrain Introduction

A. Terrain features will influence fire spread.

B. Terrain does not change significantly over time, but terrain can change quickly over distance as a fire burns into new areas.

II. Terrain Indicators

A. Steep slopes

Steep slopes provide potential for rapid upslope rates of spread.

B. Chutes and Box Canyons

Chutes and box canyons provide potential for very rapid upslope rates of spread by combining steep terrain with updrafts of air ... this is called the "Chimney Effect".

C. Saddles

Saddles provide potential for rapid rates of spread as fires are pushed through saddles faster during upslope fire runs.

D. Narrow Canyons

1. Narrow canyons provide potential for rapid rates of spread from two sources:

a. Radiant or convective spotting.

b. A slope reversal.

2. Intersecting drainages are another concern when working in narrow canyons.

III. Scenario Four

What is similar about the fire behavior in all three situations shown in the scenario?

UNIT 5 WIND

I. Wind Introduction

A. Wind is the primary factor that influences fire spread. This includes both the rate and direction of spread.

B. Winds change frequently. The change can be diurnal, caused by the movement of fronts, or the result of gradients between pressure systems.

II. Wind Indicators

A. Strong Surface Winds

Strong surface winds provide a means for wind driven fire runs and the transport of firebrands.

B. Lenticular Clouds

Lenticular clouds indicate high winds aloft with potential to surface and produce strong downslope winds.

C. High Fast Moving Clouds

High fast moving clouds indicate potential wind shifts, particularly if the clouds are moving in a direction different from the surface winds.

D. Approaching Cold Front

Winds will shift and increase in speed as a cold front approaches. Look for a squall line of thunderstorms as a visual indicator.

E. Cumulonimbus Development

Thunderstorms present the potential for strong, erratic downdraft winds. If you see cumulus clouds building into a thunderstorm, anticipate possible downdraft winds.

F. Battling Winds or Sudden Calm

1. When a gravity or foehn wind interacts with a local wind significant wind reversals are likely. Indicators would be a sudden calm or winds battling back and forth causing a wavering smoke column.

2. A decreasing foehn wind that allows a local wind to regain influence can be as dangerous as the foehn wind that overpowers a local wind.

3. A sudden calm can be an important indicator for other situations such as prior to thunderstorm downdrafts.

III. Scenario Five

Why does the fire in the scenario burn downhill at such a rapid rate of spread? What indicators might you have looked for that day to warn you such a situation was developing?

WINDSPEED RANGES

Frontal winds.....Too broad a range to be specific.
Foehn.....40 to 60 mi/hr common; up to 90 mi/hr reported at 20 ft.
Land breeze.....2 to 3 hours after sunset, 3 to 5 mi/hr at 20 ft.
Pacific sea breeze.....10 to 15 mi/hr at 20 ft.
Up-valley winds.....10 to 15 mi/hr, early afternoon and evening at 20 ft.
Upslope winds.....As high as 4 to 8 mi/hr at midflame height
Downslope winds.....3 to 6 mi/hr at midflame height

BEAUFORT SCALE FOR ESTIMATING 20-FT WINDSPEED

Wind Class	Wind Speeds(mph)	Nomenclature
1	<3	Very light - smoke rises nearly vertically. Leaves of quaking aspen in constant motion; small branches of bushes sway; slender branchlets and twigs of trees move gently; tall grasses and weeds sway and bend with wind; wind vane barely moves.
2	4-7	Light - trees of pole size in the open sway gently; wind felt distinctly on face; loose scraps of paper move; wind flutters small flag.
3	8-12	Gentle breeze - trees of pole size in the open sway very noticeably; large branches of pole-size trees in the open toss; tops of trees in dense stands sway; wind extends small flag; a few crested waves form on lakes.
4	13-18	Moderate breeze - trees of pole size in the open sway violently; whole trees in dense stands sway noticeably; dust is raised on the road.
5	19-24	Fresh - branchlets are broken from trees; inconvenience is felt in walking against wind.
6	25-31	Strong - tree damage increases with occasional breaking of exposed tops and branches; progress impeded when walking against wind; light structural damage to buildings.
7	32-38	Moderate gale - severe damage to tree tops; very difficult to walk into wind; significant structural damage occurs.
8	>39	Fresh gale - surfaced strong Santa Ana; intense stress on all exposed objects, vegetation, buildings; canopy offers virtually no protection; wind flow is systematic in disturbing everything in its path.

Source: Fire Behavior Field Reference

UNIT 6 ATMOSPHERIC STABILITY

I. Atmospheric Stability Introduction

A. What we are most concerned with is an unstable air mass that provides potential for vertical fire development and rapid growth.

B. Stability can change frequently. The change can be diurnal or caused by the movement of the air mass.

C. It is important to recognize both an unstable air mass or an air mass that is in transition from stable to unstable.

II. Stable / Unstable Air Mass Indicators

A. Good Visibility

B. Gusty Winds and Dust Devils

C. Cumulus Clouds

D. Castellatus Clouds

E. Smoke Rising Straight Up

* The indicators A through E tell you that an air mass is unstable.

F. Thermal Belt

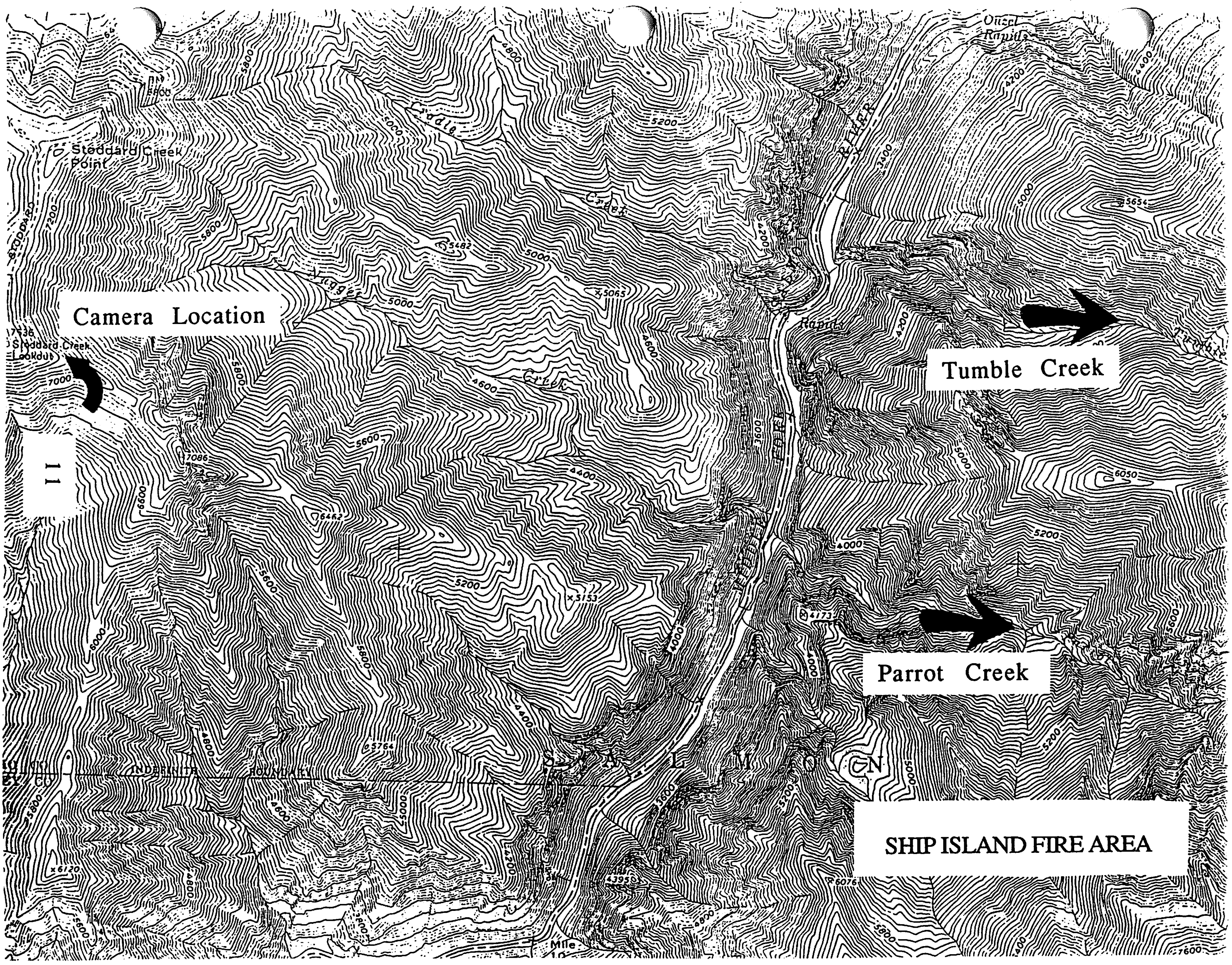
The thermal belt is a zone of warm night time temperatures and lower night time RHs.

G. Inversion Lifting or Breaking

When an inversion begins to lift or break, the air mass is in transition from stable to unstable.

III. Scenario Six

What occurs during each of the three days shown in the scenario that indicates that fire will be influenced by an unstable air mass?



Camera Location
Tumble Creek
Parrot Creek
SHIP ISLAND FIRE AREA
Stoddard Creek Point
Stoddard Creek Lookout
Ouzel Rapids
Rapids
RIVER
FORK
MIDDLE
SALMON
Creek
Nugget
Creek
Cradle

UNIT 7 FIRE BEHAVIOR

I. Fire Behavior Introduction

A. A fire builds toward problem fire behavior in observable stages. We want to use these stages as indicators to anticipate problem fire behavior.

II. Fire Behavior Indicators

A. Leaning Column

Rapid rates of spread and short-range spotting are associated with this type of column.

B. Sheared Column

Winds aloft may cause long-range spotting.

C. Well Developed Column

1. Intense burning and unpredictable fire spread in any direction can occur with this type of column.

2. When the power of the fire becomes stronger than the power of the local winds it is called a plume dominated fire.

3. The danger of a plume dominated fire is the potential for downbursts that are similar to, but stronger than, downdrafts from a thunderstorm.

D. Changing Column

A column that is changing to a darker color; beginning to rotate faster; or splits, can indicate fire behavior is increasing.

E. Trees Torching

Torching trees are an indicator that a fire is starting to transition from a surface fire to a crown fire.

F. Smoldering Fire Picking-Up

Observe fire activity by monitoring flame length and rate of spread.

G. Firewhirls Beginning

Firewhirls are another indicator that a fire has the potential to move from a surface fire to a crown fire.

H. Frequent Spot Fires

Spot fires increase fire spread and complexity.

FIRE SUPPRESSION INTERPRETATIONS from FLAME LENGTH

Flame Length (feet)	Interpretations
<4	Fires can generally be attacked at the head or flanks by firefighters using handtools. Handline should hold the fire.
4-8	Fires are too intense for direct attack on the head by persons using handtools. Handline cannot be relied upon to hold the fire. Equipment such as dozers, pumpers and retardant aircraft can be effective.
8-11	Fires may present serious control problems - torching, crowning, and spotting. Control efforts at the head will probably be ineffective.
>11	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Source: Fire Behavior Field Reference

UNIT 8 USE OF INDICATORS

I. Using Indicators

A. Several adverse conditions are usually present for extreme fire behavior to occur. As a result, you should be able to observe several indicators to help you predict or anticipate problem fire behavior. These indicators are "accumulating".

B. Remember, the observation of one indicator at a critical level does not always mean you will experience problem fire behavior. But it should key you to be "heads up" and looking for other indicators.

II. Fireline Safety

A. Provide for your safety and those you supervise.

1. Monitor the fire environment FACTORS and their INDICATORS in order to predict or anticipate fire behavior.

2. Adhere to the fire safety guidelines.

3. Select effective tactics considering observed and expected fire behavior.

B. LCES Safety System

1. Focus on the essential elements of the Fire Orders.

Lookout(s), Communication(s), Escape Route(s), Safety Zone(s)

2. Brief all personnel on escape and safety plans well in advance. As conditions change, there may be a need to change your escape routes and safety zones ... if this occurs notify others. LCES must be established before it is needed.

3. If escape plans include use of vehicles, have the vehicles prepositioned with drivers.

4. Indirect line construction needs to have well scouted safety zones.

5. Select an experienced, trusted firefighter as a lookout and insure dependable communication systems are in place.

6. If you must activate escape routes and safety zones ... think clearly and act decisively. Panic leads to trouble.

LCES Checklist

1. All personnel need to be informed.

2. Update throughout the shift.

3. Lookouts / Communications
   *Competent and trusted individual(s)?
   *Radio and frequencies?
   *Watch or time piece?
   *Map and communication plan?
   *Knowledge of crew(s) location on division?
   *Good vantage and safe location?

4. Escape Routes
   *Scouted?
   *Walkable?
   *Timed?
   *Marked?
   *Away from fire head?

5. Safety Zones (no shelters needed)
   *Clean Burn / Natural / Man-Made / Vehicles.
   *Scouted?
   *Close enough? Anticipated ROS.
   *Large enough? Consider number of people.
   Consider fuels / flame length.
   *Terrain? Avoid saddles; chutes; box canyons.
   *Snags or rolling rocks?

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