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Common Denominators of Fire Behavior on Tragedy and Near-miss Wildland Fires

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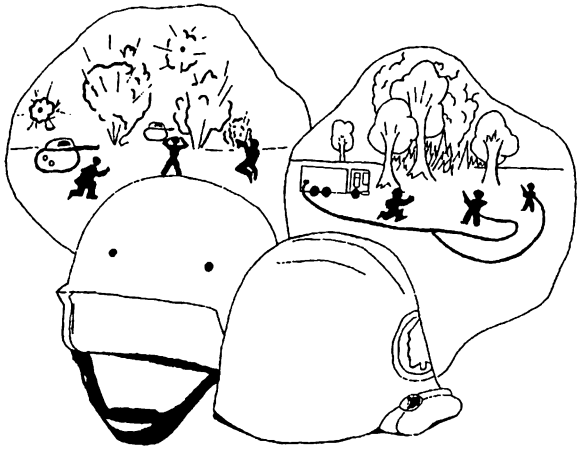


INTRODUCTION

Fighting large wildland fires is often compared to a military operation. Each involves such things as: an organization with a general at the head, massive movements of personnel and equipment; tactical aerial support, and long periods of combat and stress until the enemy is finally conquered. Yet, there is one major difference between a military operation and firefighting strategy: in fighting fires we always figure that no firefighters will die, whereas in a military operation there is a calculated risk of death of soldiers. In spite of this philosophy, many people have lost their lives on wildland fires in the United States.

The similarities and differences between fatal fires and those where a firefighter had a narrow escape can be survival lessons for other firefighters. A review of recorded firefighter entrapments on wildland fires between 1926 and 1990 shows that over 400 firefighters died of fire-induced injuries on 100 fires. Among the largest losses on single fires occurred on the Blackwater fire in Wyoming in 1937 and on the Rattlesnake fire in California in 1953. In each case, 15 people died. The fire responsible for the largest number of deaths, the 1933 Griffith Park fire in southern California, accounted for 25 fatalities and 128 injured people. A recent multiple fatality incident occurred on the 1990 Dude fire in Arizona. Eleven members of a crew were entrapped: the fire claimed the lives of six firefighters, five members survived, four with minor to critical burns.

It is possible to identify some **common denominators** of fire behavior both in the fatal fires and in the near-miss fires.

The Four Major Common Denominators of Fire Behavior on Tragedy Fires

1. Most incidents happen on *small* fires *or* on *isolated sections* of large *fires*.

2. *Flare-ups* generally occur in deceptively *light fuels*, such as grass and light brush.

3. Most fires are innocent in appearance before unexpected *shifts in wind direction and/or speed* result in "flare-ups." Sometimes, tragedies occur in the mop-up stage.

4. Fires respond to large- and small-scale *topographic conditions*, running uphill surprisingly fast in chimneys, gullies, and on steep slopes.

Be Alert
Watch Out For:
LIGHT FUELS
WIND SHIFTS
STEEP SLOPES AND CHIMNEYS

Many firefighters are surprised to learn that tragedy and near-miss incidents occur in light fuels, on small fires or on isolated sections of large fires, and that fire behavior is relatively quiet just before the incident. A common assumption is the high-intensity crown fire in timber or heavy brush traps and kills firefighters. Yet, with rare exceptions such as the disastrous Sundance fire (north Idaho, 1967), the Blackwater fire (Wyoming, 1937) and the King's Canyon fire (western Nevada, 1926), most fires are innocent-appearing, burning in light fuels, just before the flare-ups.

The difference between near-miss or tragedy fires and a safe fire is decided by a person's reaction to a sudden crisis. Recognizing conditions under which narrow escapes and fatalities occurred on past fires help firefighters increase survival skills.

WHY DO TRAGEDY AND NEAR-MISS FIRES OCCUR UNDER APPARENTLY INNOCUOUS CONDITIONS?

Hot weather dries out the lighter fuels quickly, causing any change in wind, slope, or other environmental factor to result in a drastic change in fire behavior. There are *few visual clues* to warn of fire behavior changes: dry fuels burn with little or no smoke. The obvious signs of change, such as smoke and the crackle of flames are noticeable only after the situation has become critical.

Remember that *all fires differ* and that the change of one factor can result in an entirely different picture from another similar fire. It is important that the firefighter be *alert and sensitive* to the *environmental conditions* in which a sudden change in fire behavior may occur. **Size-up** considerations allow firefighters to assess each incident. **Size-up considerations** are:

Fuel Characteristics
Weather Conditions
Topographical Characteristics
Fire Behavior
Operational Period
Area of Responsibility
LCES

ENVIRONMENTAL FACTORS

•FUEL

Fire intensity changes much more quickly in light fuels than in heavy fuels. The light fuels are more responsive to changes in atmospheric conditions.

• WEATHER

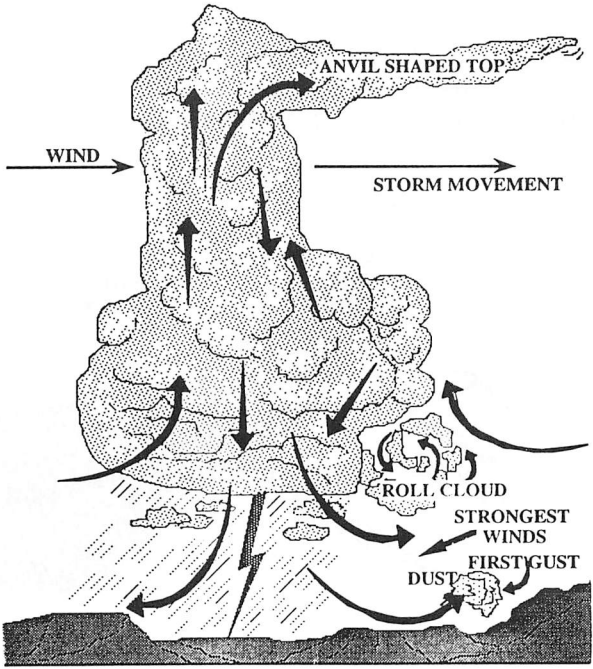
Wind is the single most significant weather factor contributing to erratic fire behavior or "flare-ups." Three kinds of wind to keep in mind are **cold fronts, foehn (fān) winds, and thunderstorms**. Remember, *wind direction is the direction the wind is blowing from*.

A **cold front** is the boundary line between a cooler air mass that is replacing a warmer air mass. The winds associated with a typical cold front are: southeasterly to southwesterly winds *ahead* of the front; westerly to northwesterly winds *behind* the front. *Indicators* of a cold front are:

- ✔A line of cumulus clouds approaching from the west or northwest
- ✔Large dust clouds can precede a cold front
- ✔Winds normally shift clockwise, from the southeast to the south, to southwest, and increase in velocity before the front's arrival
- ✔Winds will be strongest, most erratic and gusty as the front arrives
- ✔Winds will continue to shift as the front passes, generally resulting in strong, gusty, cool winds out of the west and northwest.

Foehn winds (Santa Ana, Chinook, Mono, or East winds) cause dry, downslope winds, usually on the downwind (lee) side of mountainous regions. They frequently reach speeds of 40-60 miles per hour (mi/h) but can be as high as 90 mi/h. The winds are usually strong and steady. Relative humidity and fuel moisture will decrease.

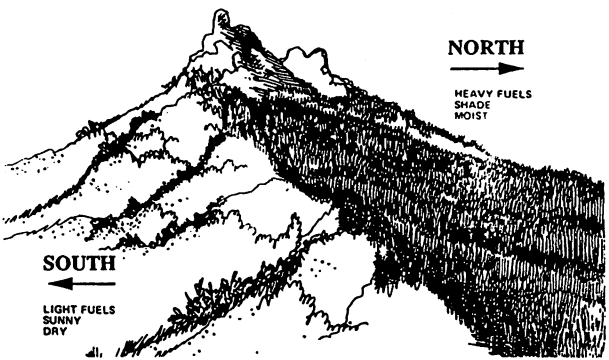
A **thunderstorm** is a violent local storm produced by a cumulonimbus cloud that is accompanied by thunder, lightning and strong, gusty winds. Thunderstorm movement is in the direction the anvil-shaped cloud top is pointing. *Downdraft winds* from thunderstorms that reach the ground usually *spread radially in all directions*. These wind velocities will often be 25 to 35 mi/h and can reach as high as 60 mi/h.



•TOPOGRAPHY

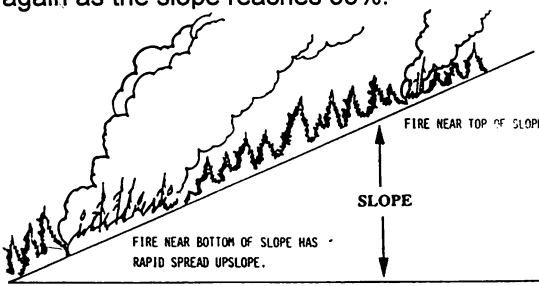
Topography, or the lay of the land, is a major influence on fire behavior. There are three main considerations regarding topography: *aspect, slope and terrain.*

Aspect, the direction a slope faces, determines the amount of heating it gets from the sun and the amount, condition and type of fuels present. South and southwest slopes are normally more directly exposed to sunlight, generally have sparser, *lighter fuels*, higher temperatures, lower humidity, lower fuel moisture, and are the most critical in terms for the start and spread of wildland fire.

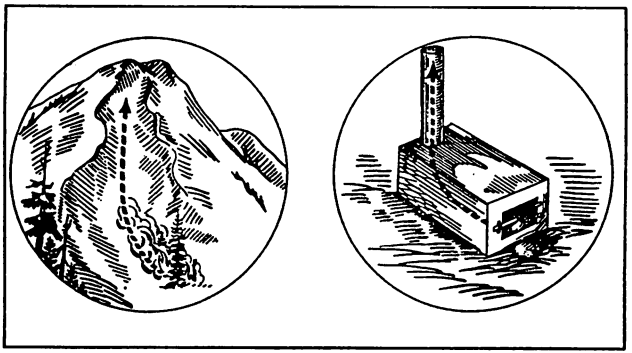


Slope, the degree of incline of a hillside, determines the rate of which a fire burns. Fires burn more rapidly uphill than downhill. The steeper the slope, the faster the fire burns. A fire spreading *uphill* resembles a fire spreading before a strong wind. The rate of fire spread will usually increase as the degree of slope increases. Not only are the flames closer to the fuels (radiant heat), but the movement of heated air (convection) is more likely to carry firebrands that may start spot fires. The fire's position on the slope influences the fire behavior. A fire starting near the bottom of a slope will normally spread faster and burn more area than a fire that starts near the top of the slope because it has a longer uphill run. However, another concern about steep slopes is the possibility of burning material rolling downhill which can ignite the fuel below the main fire.

Compared to a fire burning on level ground (up to 5%), a fire will spread twice as fast when it reaches a 30% slope. The spread rate will double again as the slope reaches 55%.



Terrain, the shape of the land, has a major affect on fire behavior. *Box canyons*, narrow canyons, and gulches act like a chimney of a stove. Radiation, convection, and spot fires speed up as when a damper was opened in a chimney. This effect can result in *extreme fire behavior* and can be very *dangerous* to firefighters.



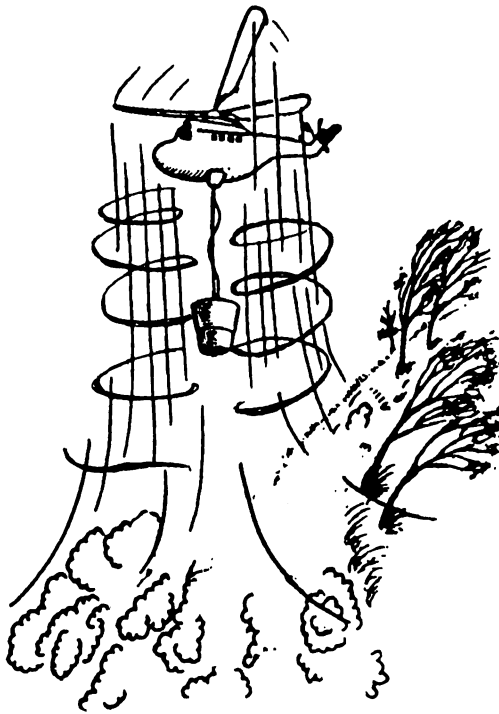
Fire burning on one side of a steep, *narrow canyon* can easily spread to fuels on the opposite side by radiation and spotting.

Fire burning along lateral ridges may change direction at the point when the ridge drops off into a canyon. This direction change is cause by the flow of air in the canyon. In some case whirling (eddying) motion by the fire may result from a strong air flow around the point of a ridge.

A mountain pass or saddle will cause the windspeed to increase as it passes through the constricted area and spread out on the lee (downwind) side with probable eddy action.

•AIRCRAFT

Helicopters or air tankers can adversely affect fire behavior in certain situations. The blasts of air from low-flying aircraft have been known to cause flare-ups.



•CARBON MONOXIDE

Topography features that encourage the buildup of carbon monoxide include saddles, deep canyons and depressions, because carbon monoxide is heavier than air. Although it takes high concentrations (800+ppm) of carbon monoxide in the environment to cause unconsciousness and death (within several hours), research and experience show that the low-level carbon monoxide poisoning can impair alertness, judgment, vision and the ability to move quickly. The effect of carbon monoxide is cumulative.

This deadly gas is both colorless and odorless!

•WILDLAND/URBAN INTERFACE FACTORS

The wildland/urban interface is where people, structures, and wildland fuels meet. Fires that occur in this intermix of wildland fuels and structures complicate the firefighting job when protecting life and property. Firefighter safety must not be compromised when fighting wildland or wildland/urban interface fires.

WILDLAND/URBAN WATCHOUT SITUATIONS

- ☐ 1. Wooden construction and wood shake roofs.
- ☐ 2. Poor access and narrow one way roads.
- ☐ 3. Inadequate water supply.
- ☐ 4. Natural fuels 30 feet or closer to structures.
- ☐ 5. Extreme fire behavior.
- ☐ 6. Strong winds.
- ☐ 7. Evacuation of public (panic).
- ☐ 8. Structures located in box canyons, chimneys, steep slopes in flashy fuels.
- ☐ 9. Bridge load limits.

•HAZARDOUS MATERIALS

Hazardous materials disposal has been detected in wildland areas. Hazardous materials are an environmental factor that can cause danger to the firefighter.

☐ Detect hazardous material presence.
- use caution
- avoid a false sense of security
- don't touch, breath or swallow HM
- don't move containers
- don't drive through spills or clouds
- contact dispatch or supervisor

☐ Visualize likely harm *without* intervention.
- recognize your limitations in training and safety equipment

☐ Choose response objectives

☐ Identify action options

☐ Act on best option

☐ Evaluate progress

INTERNAL FACTORS

Keep CALM, THINK clearly, ACT decisively
The internal state of the firefighter is also important in staying safe and making the correct decisions under pressure. Even well-trained firefighters may ignore environmental signals of a dangerous situation, then react fatally once they do become aware of the danger.

Visualization is a valuable training aid that allows a firefighter to prepare for events before they occur. Visualization ensures making the correct response in the fastest time. Learn the safety factors, practice safety measures, then use visualization techniques to mentally prepare yourself to react without panic in a stressful situation. Visualize a stressful situation, such as erratic fire behavior, and decide the steps to be employed. Learning to relax while under pressure can improve visualization techniques.

A firefighter's physical condition affects awareness of the environmental factors. A firefighter may be tired, with senses dulled by a long, fatiguing shift or an extended fireline assignment. Or the firefighter may be "fresh" to the assignment, but not tuned into subtle signals that precede changes in environmental factors.

CONCLUSION

There are four common denominators of fire behavior on tragedy and near-miss fires.

1. Most incidents happen on *small* fires *or* on *isolated sections* of large *fires*.

2. *Flare-ups* generally occur in deceptively *light fuels*, such as grass and light brush.

3. Most fires are innocent in appearance before unexpected *shifts in wind direction and/or speed* result in "flare-ups." Sometimes, tragedies occur in the mop-up stage.

4. Fires respond to large- and small-scale *topographic conditions*, running uphill surprisingly fast in chimneys, gullies, and on steep slopes.

Recognizing these conditions, using safety checklists, and staying alert will assist the firefighter to avoid tragic results.

Each circumstance has the potential for creating a tragedy. Often, human behavior is the determining factor. The firefighter who remains calm when the wind direction changes and moves into the safety zone will survive. Trying to outrun a fire or other panic reactions may cause tragic results. It pays to be alert and aware of any signal to a sudden change in fire behavior. The firefighter who is on the lookout for possible trouble can change a potentially tragedy or near-miss situation to a safe firefighting experience.

Be Alert
Watch Out For:
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WIND SHIFTS
STEEP SLOPES AND CHIMNEYS

FIRE ORDERS

Fight fire aggressively but provide for safety first.
Initiate all action based on current and expected fire behavior.
Recognize current weather conditions and obtain forecasts.
Ensure instructions are given and understood.

Obtain current information on fire status.
Remain in communication with crew members, your supervisor, and adjoining forces.
Determine safety zones and escape routes.
Establish lookouts in potentially hazardous situations.
Retain control at all times.
Stay alert, keep calm, think clearly, act decisively.

- ✔ **L**OOKOUTS
- ✔ **C**OMMUNICATION
- ✔ **E**SCAPE ROUTES
- ✔ **S**AFETY ZONES

WATCHOUT SITUATIONS (SURVIVAL CHECKLIST)

- ☐ 1. Fire not scouted and sized up.
- ☐ 2. In country not seen in daylight.
- ☐ 3. Safety zones and escape routes not identified.
- ☐ 4. Unfamiliar with weather and local factors influencing fire behavior.
- ☐ 5. Uninformed on strategy, tactics and hazards.
- ☐ 6. Instructions and assignments not clear.
- ☐ 7. No communication link with crew members/supervisor.
- ☐ 8. Constructing fireline without safe anchor point.
- ☐ 9. Building fireline downhill with fire below.
- ☐ 10. Attempting frontal assault on fire.
- ☐ 11. Unburned fuel between you and the fire.
- ☐ 12. Cannot see main fire, not in contact with anyone who can.
- ☐ 13. On a hillside where rolling material can ignite fuel below.
- ☐ 14. Weather is getting hotter and frier.
- ☐ 15. Wind increases and/or changes direction.
- ☐ 16. Getting frequent spot fires across line.
- ☐ 17. Terrain and fuels make escape to safety zones difficult.
- ☐ 18. Taking a nap near the fireline.

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