Some common denominators of fire behavior

on tragedy and near-miss forest fires

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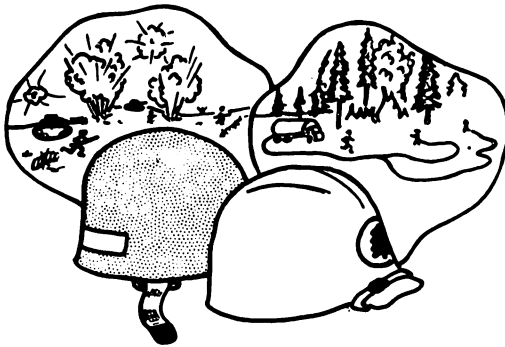


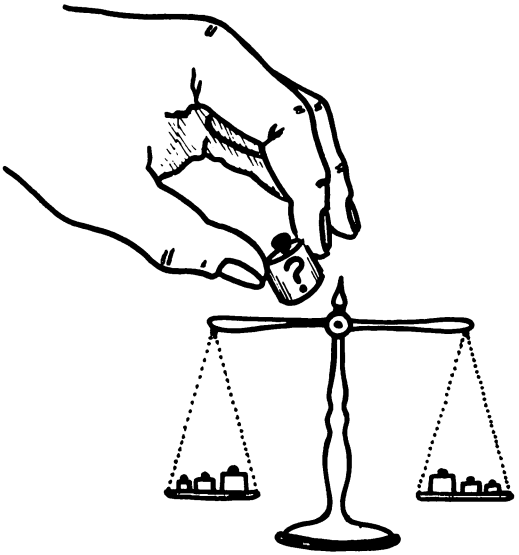
Introduction

Fighting large forest fires is often compared to a military operation. Each involves such things as: an organization with a "general" at the head; massive movements of men 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 military 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 sol-

diers. In spite of this policy, many people have lost their lives on forest fires in the United States.

We are concerned both with the differences between fatal fires and those in which someone has a narrow escape and the similarities between these two kinds of fires.

A review of the U.S. Forest Service's records between 1926 and 1976 shows that 143 men died (from fire-induced injuries) on 41 fires. 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. A similar analysis for areas protected by other federal agencies and by state, county, and private agencies reveals 77 fire-induced fatalities between 1933 and 1976, on 26 fires. One fire was responsible for the largest number of deaths; the 1933 Griffith Park fire in southern California, which accounted for 25 fatalities and 128 injured people.



It is possible to identify some common denominators of fire behavior both in the fatal fires and in the near-miss fires. But remember that all fires differ and that the change of one small factor can result in an entirely different picture. Tragedy and near-miss fires often involve so-called "erratic fire behavior" and occur under seemingly innocuous conditions.

Identification of common denominators of fire behavior on tragedy fires

1. Most incidents happen on the smaller fires or on isolated sectors of larger fires.

2. Most fires are innocent in appearance before the "flare-ups" or "blow-ups." In some cases, tragedies occur in the mop-up stage.

3. Flare-ups generally occur in deceptively light fuels.

4. Fires run uphill surprisingly fast in chimneys, gullies, and on steep slopes.

5. Some suppression tools, such as helicopters or air tankers, can adversely affect fire behavior. The blasts of air from low flying helicopters and air tankers have been known to cause flare-ups.

Most of the generalizations made concerning fire behavior apply to near-miss fires as well as to the fatal or tragedy fires. The hairline difference between the two groups of fires is determined by a person's reaction to a sudden crisis. Escapes may be due to luck, circumstances, advance planning, a person's ability to stay calm and not panic, or to a combination of these factors. Whatever the reasons, individual behavior and circumstances make the difference between life and death. For the individual firefighter and crew boss, it becomes more and more important to be able to quickly recognize conditions under which so many close calls and fatalities occur.

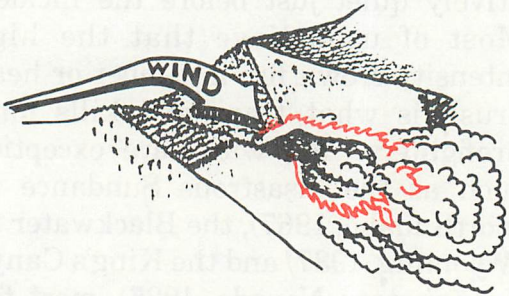
Be Alert. Watch Out For:

LIGHT FUELS
WIND SHIFTS
STEEP SLOPES AND CHIMNEYS

Why do tragedy and near miss fires occur under apparently innocuous conditions?

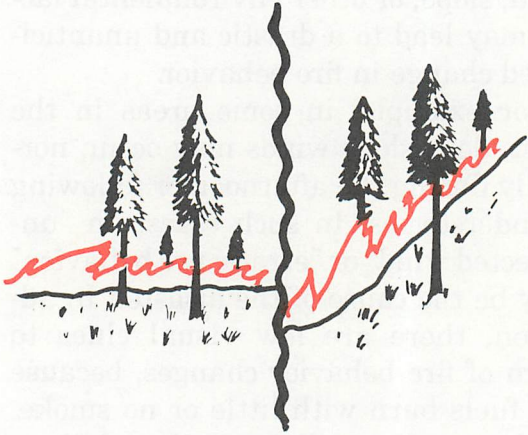
Many firefighters are surprised to learn that tragedy and near-miss incidents occur in fairly light fuels, on small fires, or on isolated sectors of large fires, and that fire behavior is relatively quiet just before the incident. Most of us believe that the high-intensity crown fire in timber or heavy brush is what traps and kills forest 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 just before the accidents.

Why then, do tragedies and near-misses occur under so-called "easy" fire behavior conditions? The first reason is that fire intensity can change much more quickly in light fuels than in heavy fuels. The light fuels tend to be more responsive to changes in atmospheric conditions than heavy fuels.

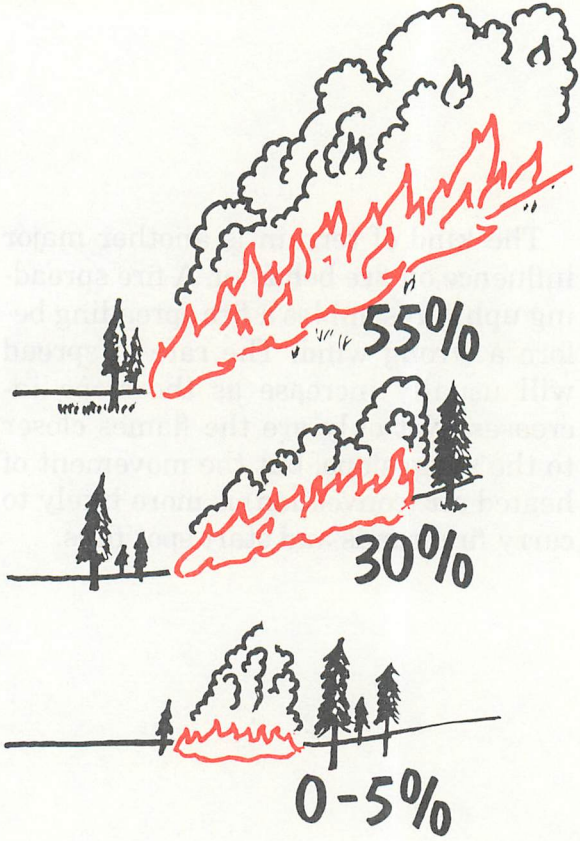

WIND

The second reason is that hot, dry weather or the action of foehn-type (Santa Ana) winds dry out the lighter fuels, with the result that any change in wind, slope, or other environmental factor may lead to a drastic and unanticipated change in fire behavior.

For example, in some areas in the West, downslope winds may occur, normally during the afternoon or following thunderstorms. In such cases, an "unexpected wind" or "erratic fire behavior" may be the cause of the disaster. In addition, there are few visual clues to warn of fire behavior changes, because dry fuels burn with little or no smoke. Under such conditions, the obvious signs of a change, such as smoke and the crackle of flames are noticeable only after the situation has become critical. It is, therefore, important that the firefighter be alert and sensitive to the fire's behavior, particularly under those weather conditions in which a sudden change in fire behavior may occur.



The kind of terrain is another major influence on fire behavior. A fire spreading uphill resembles a fire spreading before a strong wind. The rate of spread will usually increase as the slope increases. Not only are the flames closer to the steep slope, but the movement of heated air (convection) is more likely to carry firebrands and start spot fires.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For example, with other factors staying the same, a fire burning on level ground (up to 5 percent slope) will spread twice as fast when it reaches 30 percent slope. The rate of spread will double again as the slope reaches 55 percent.

The shape of the land's surface also has a major effect on fire behavior. Box canyons, narrow canyons, and gulches tend to act like the chimney of a stove. Radiation, convection, and spot fires speed up, as if a damper were opened in a chimney.

THIRTEEN SITUATIONS

1. You are building a line downhill toward a fire.
2. You are fighting a fire on a hillside where rolling material can ignite a fire below you.
3. The wind begins to blow, increase, or change direction.
4. The weather turns hotter or drier.
5. You are on a line in heavy fuel with unburned fuel between the firefighter and the fire.
6. You are in an area where the topography and/or cover makes travel difficult and slow.
7. You are in unfamiliar country.

8. You are in an area where firefighters are not familiar with local factors influencing fire behavior.
9. You are attempting a frontal assault on a fire with pumpers.
10. Frequent spot fires are crossing the line.
11. You cannot see the main fire, and you are out of communication with anyone who can see it.
12. You do not clearly understand your assignment or instructions.
13. You are drowsy and feel like taking a nap near the fire line.

The external signs and warnings are important, but the internal state of the firefighter is also important in tragedy and near-miss fires. Even well-trained firefighters are often unaware of a dangerous situation until it is too late, which is the reason why they often act foolishly and fatally once they do become aware of the danger.

Also, the firefighter's physical condition may be the reason why he is not aware of a potentially dangerous situation. The crew may be tired and their senses dulled by a long, fatiguing shift on the fire line. Or, they may be fresh but with their "sensing system" not yet tuned to the early-warning signals that precede change in wind direction, velocity, or both. Another physical factor is the adverse effect of carbon monoxide on wildland firefighting personnel. Although it takes relatively high concentrations (800+ppm) of carbon monoxide in the environment to cause unconsciousness and death (within several hours), research and experience show that low-level carbon monoxide poisoning can impair alertness, judgment, vision, and the ability to move quickly. The firefighter or crew boss is less likely to detect the warning signals associated with drastic changes in fire behavior when affected by carbon monoxide. Carbon monoxide readings of 55 ppm

have been recorded on a grass fire in the type of location where a tanker or initial attack crew would usually be operating.

Carbon monoxide studies on one fire showed that most of the firefighters were exposed to levels of carbon monoxide higher than those permitted by the standard proposed by the National Institute of Occupational Safety and Health (35 ppm during an 8-hour period).

Since the effect of carbon monoxide is cumulative, it becomes a matter of great concern to the firefighter, who should be aware of the kinds of topography which encourage the build-up of carbon monoxide. This includes areas such as saddles, deep canyons, and depressions, because carbon monoxide is heavier than air.

THIS DEADLY GAS IS BOTH COLORLESS AND ODORLESS! IT CANNOT BE DETECTED BY THE HUMAN SENSES!

Potential for loss on forest fires — Now and in the future

The potential for loss of life in forest fires, due to burns or other fire-induced causes, is higher now than ever before. Many people live in or play in the wildlands. As a result, "protection of life and property" has begun to dominate fire suppression action plans. The relative safety of "perimeter fire strategy" must often be sacrificed in favor of people and their possessions. This puts forest-fire agencies at a disadvantage, because most training in the past has concentrated on perimeter strategy. Additional hazards arise as the state, city, and county fire departments confront the extraordinarily flashy grass, brush, and timber fuels in the urban-wildland border.

Summary and conclusions

There are four major common denominators of fire behavior on tragedy and near-miss fires. Such fires often occur:

1. On relatively small fires or deceptively quiet sectors of large fires.
2. In relatively light fuels, such as grass, herbs, and light brush.
3. When there is an unexpected shift in wind direction or in wind speed.
4. When fire responds to topographic conditions and runs uphill.

Yet, these factors should not be considered all-inclusive. A sudden change of wind, and the fire may change direction, regardless of the topography.

Each set of circumstances has the potential for creating a tragedy or near-miss fire. Often, human behavior is the determining factor. The firefighters who

"keep their cool" when the wind direction changes and move back into a burned area will survive. The people who panic and try to outrun a fire under similar conditions may die. The difference between a tragedy fire and a near-miss fire may be due to luck, skill, or advance planning. But, in all cases, it pays to be alert and aware of certain conditions that may signal a sudden change in fire behavior.

In a few words:

Be Alert. Watch Out For:

LIGHT FUELS
WIND SHIFTS
STEEP SLOPES AND CHIMNEYS

The person who is always alert and on the lookout for possible trouble has the best chance of surviving.

TEN FIRE FIGHTING RULES

1. Keep informed on FIRE WEATHER conditions and forecasts.

2. Know what your FIRE is doing at all times.

3. Base all actions on the current and expected BEHAVIOR of the FIRE.

4. Plan ESCAPE ROUTES for everyone, and make them known.

5. Post a LOOKOUT where there is possible danger.

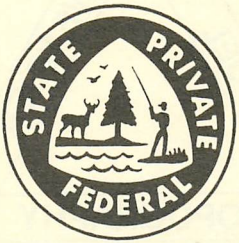
6. Be ALERT, keep CALM, THINK clearly, and ACT decisively.

7. Maintain prompt COMMUNICATIONS with your crew, your boss, and adjoining forces.

8. Give clear INSTRUCTIONS and be sure they are understood.

9. Maintain CONTROL of your crew members at all times.

10. Fight fire aggressively, but provide for SAFETY FIRST.



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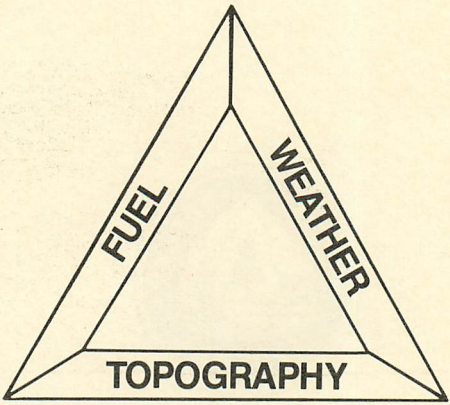
FUEL
WEATHER
TOPOGRAPHY