SECTION 7 - FUELS, FIRE BEHAVIOR, AND TACTICS BY GEOGRAPHIC AREAS OF THE UNITED STATES

The purpose of this section is to identify by geographic areas of the United States:

- important fuel, topographic, and fire weather conditions that produce critical fire behavior situations.
- appropriate safety, strategies, and tactics for fire suppression.

The following geographic areas are covered:

SOUTHERN AND CENTRAL CALIFORNIA

I. SOUTHERN CALIFORNIA

Southern California has had a long history of large and damaging fires. Some of the more notable include Laguna, 1970-182,000 acres, Marble Cone, 1977-170,000 acres, Panorama 1980-300 homes, the numerous fires in the fall of 1993 which burned over 200,000 acres. Deaths to firefighters include: Inaja, 1956-11 fatalities, Decker, 1959-7 fatalities, Loop, 1961-12 fatalities, Spanish Ranch, 1979-4 fatalities, Glen Allen, 1993-2 fatalities. Weather conditions, such as the Santa Ana winds, cause adverse fire behavior and rates of spread under severe conditions that may reach 6,000 acres per hour. These fires are further complicated by highly flammable fuel and steep topography.

Firefighters must be constantly aware of structures within the wildland. Virtually any escaped wildfire in which a Type I Team is assigned will involve a structural threat. During the fall of 1993, over 1,000 homes were destroyed between October 26, and November 4, through a series of fires in southern California. Even a relatively small fire such as the Sycamore fire, (1979-less than 1000 acres-245 homes) and the Paint fire, (1990-900 acres 641 homes) can present substantial structural protection problems. Whenever structures are threatened, numerous other agencies will most likely be involved and must be included in incident management operations.

For purposes of this information, southern California will include San Diego, Riverside, San Bernardino, Orange, Los Angeles, Ventura, Kern, Santa Barbara, San Luis Obispo, and Monterey counties. This area involves the Santa Monica Mountains National Recreation Area, Cleveland, San Bernardino, Angeles, Los Padres and Sequoia National Forests.

II. SOUTHERN CALIFORNIA FUELS

A. Chaparral.

Southern California fuel is dominated by brush but includes large areas of oak woodland and some small stands of timber. The term chaparral is often used to describe these fuels. Chaparral communities are generally bounded by timber stands above and grasslands below. Elevations where chaparral is found vary from about 500 to 5,000 feet. Chaparral is well adapted to fire and a fire every 20 to 30 years is necessary to keep it healthy.

Chaparral's relatively large amount of loosely arranged small material, much of it becoming dead as the plants mature, and its highly volatile oil content make it extremely flammable. Burnable chaparral fuel will average 15 to 20 tons per acre but can range from 2 to 40 tons per acre. After a fire, the chaparral is relatively fire-resistant for about 15 years. At about 20 years of age the proportion of dead fuels becomes great enough to support big fires under adverse conditions. As a consequence, the recurrence intervals of fires more than 5,000 acres is 20 to 40 years. Most fires in chaparral which exceed 30,000 acres occur in age classes greater than 30 years. Chaparral is Fire Behavior Fuel Model 4.

1. Chamise and Manzanita - The Primary Components.

   Chamise is the most abundant and widespread of all chaparral shrubs in southern California It usually occupies the drier, south facing slopes. Manzanita is the second most important group of shrubs and it usually occupies the more moist, north facing exposures. Chamise decreases in abundance with elevation and gives way to manzanita at higher altitudes.

2. Other Chaparral Fuel Components.

   Other specific fuels included in southern California chaparral are buckwheat, sage (several types), scrub oak, and oak woodland sumac. There are many additional fuels; however, they don't match these in consequence.

B. Fuel Characteristics.

Grass in southern California usually begins to bum in May. Normally, chaparral will start to bum and sustain fire in late June or early July. The fire season ends around the first of December. However, major fires have occurred in January, February, and March. Chaparral fuels are relatively drought resistant; live fuel moistures may drop to 60% during critical periods. Dead fuel ratios will range from 15 to SO%, depending on the age of the fuel.

C. Chaparral Communities in Other Regions.

Chaparral is also found abundantly in Arizona. Arizona chaparral and California chaparral have common origins-on the North American Continent. Arizona chaparral differs from California chaparral as follows:

1. Arizona chaparral has a higher portion of sprouting shrubs.

2. Most of Arizona chaparral is on rough broken terrain at elevations that range from 3,000 to 6,000 foot elevations.

3. The upper elevations border ponderosa pine or pinyon juniper and the lower elevations border desert grassland or southern desert shrubs.

4. Arizona chaparral grows primarily during the summer whereas California chaparral grows primarily in the winter.

5. The fire frequency in Arizona chaparral is somewhat less than California chaparral. Although, we have identified some differences in California and Arizona chaparral, they are both dependent upon fire to remain healthy and behave very similarly under extreme fire conditions.

III. SOUTHERN CALIFORNIA FIRE TOPOGRAPHY

The topography in southern California is unique. It consists of coastal and inland valleys which lead to mountain ranges with elevations from sea level to 11,000 feet. The change in elevation from the base of the mountain slopes is very rapid; slopes in excess of 40% are common. This rapid change in elevation can result in fuel type changes over a relatively short horizontal distance. Most fires occur in the 1,000 to 5,000 foot elevations. East and north of the mountain ranges are primarily desert plateaus.

A. Topographical Features.

The topography consists of broken canyons with many steep side drainages. Such topography causes uneven surface heating, radical changes with fuel conditions, opposing wind directions and resulting erratic fire behavior. Other unique features include:

1. Chimney and chute canyons - Chimneys and chutes are common and vary in depth from a few feet up to 1,000 feet. Many firefighters have been killed in or above these topographical features, such as during the Loop Fire on the Angeles in 1966, when 12 firefighters died.

2. Steep rock areas - Steep rocky areas can make firefighter access difficult and provide additional safety hazards to personnel.

B. Access.

A good road system of major freeways, county roads and forest roads provide rapid access to many areas and also provides natural fuel barriers. Major roads are quite often used as control lines and anchor points. This is why engines are a primary suppression resource.

IV. SOUTHERN CALIFORNIA FIRE WEATHER

Annual rainfall in southern California varies depending on elevation, from 10 to 40 inches a year. From May until December little or no rain falls. Fuels at the lower elevations such as grass, light brush and desert fuels will bum early in the season. As the heavier brush dries out, depending on rainfall and weather, it will start to bum in June. A dry winter will cause an early season in heavy fuels but will reduce starts, spotting, and rates of spread due to less flashy fuel. The worst type of fire season for southern California is a wet spring, a hot dry summer, and Santa Ana winds. Such was the case during the bad fire years of 1967, 1970, and 1980. In 1993, southern California experienced a wet spring, a dry summer and Santa Ana Winds - over 200,000 acres were burned during the Santa Ana Wind events.

A. Temperatures.

An onshore weather pattern is standard through much of the early and mid-fire season. Temperatures vary, but as a general rule will follow this daytime pattern: 70 to 80 degrees in the immediate coastal areas (1-5 miles inland), 80-90 degrees in the coastal plains and valley areas, (5-20 miles inland), 80+ degrees in the mountain areas (20-50) miles inland and 100+ degrees in the desert areas (about 50+ miles inland). Night temperatures depend on the time of season but generally cool rapidly in the coastal and mountain areas, but remain warm in the desert during the summer months.

B. Humidities.

Humidities will range from 20-40 percent, depending on distance from the ocean. In coastal and inland areas humidity recovery is fast and can cause major problems with back fire and burnout operations. Use your slug psychrometer! Coastal fog will keep morning and mid-afternoon humidities up and temperatures down. Coastal fog usually occurs in May and June. Conditions at higher elevations maybe much hotter and drier than in coastal valleys.

Coastal fog may require the movement of aircraft from one location to another on the fire, and from one air base to another.

C. Wind.

Because of the relationship of the desert plateaus and the Pacific Ocean, the normal wind pattern is west or southwest. Winds will vary during the daytime from 5-15 mph. Due to surface heating in the inland valleys and desert, the onshore flow will increase during the afternoon hours. Downslope winds will start at dusk and be in the 5 to 10 mph range. They normally stop by dawn. This wind cycle is known as a diurnal variation. The downslope winds are strongest at the base of mountains and in river drainages.

D. Special Weather Conditions;

There are special weather conditions which are important to be able to predict and recognize. These conditions are as follows:

1. Santa Ana Conditions.

Santa Ana wind conditions occur when a high pressure system develops over the Great Basin area. Air will move from the high pressure system to the low pressure system over the Pacific Ocean. All aspects of the weather change as follows:

a. Wind - The normal pattern of onshore flow reverses dramatically to a high velocity offshore flow. Santa Anas are a gradient foehn type wind which cause extreme fire conditions. The wind will blow from 30 to 50 mph, and has been known to gust to 90-100 mph. During the 182,000 acre Laguna Fire (1970), wind conditions were reported to be 80-90 mph and the fire spread at an average rate of 6,000 acres an hour (between 450 and 500 chains per hour) for 19 hours straight. The winds often blow strongest at night and during the early morning hours. During light Santa Anas, you may get a light westerly flow in coastal areas. These winds normally last for about three days. The last day of a Santa Ana will change to the regular onshore flow but will return the dry air that was pushed out to sea. This is sometimes called an ebbing Santa Ana.

This wind change will cause the fire to change direction and can pose a hazard to firefighters. You should closely monitor the predicted wind changes.

b. Temperature - Temperature will gain about five degrees per 1,000 foot drop in elevation and will be in the 80's in the mountains and 90-100 degree range in the lower elevations.

c. Humidity - Humidity will drop rapidly with the onset of the Santa Ana. It may decrease to between 5 and 10 percent and has been recorded as low as 1 to 2 percent. Fuel moisture will also drop rapidly, especially in the 1 and 10 hour fuels and go down to the 2-5 percent range.

2. Sundowner Winds - The Sundowner is also a gradient downslope type wind. This special condition takes place in the Ojai and Santa Barbara front country some 90 miles northwest of Los Angeles. The difference with the Sundowner is the speed in which it develops and diminishes. The area in which Sundowners occur involve the steep slopes which rise immediately adjacent to the Pacific Ocean and the desert plateau immediately behind the mountain range. These two vastly different areas in close proximity cause a micro-climate to rapidly develop when there are temperature differences between the desert and the ocean front. The air in the micro high pressure flows to the micro low pressure area of the ocean front. This air flow is enhanced by the normal down canyon wind starting around sundown. The air compresses and heats as it flows down the mountain slopes toward the ocean. Sundowners have all of the same characteristics as Santa h a s (temperature increases, humidity drops, etc.) but these events happen much more rapidly. Due to the rapid onset, Sundowner winds have caused fire deaths such as the Romero Fire in 1971, on the Los Padres Forest where four fatalities occurred.

V. SOUTHERN CALIFORNIA FIRE BEHAVIOR

Many firefighters have been killed in southern California. Fires run hot and fast. A typical fire from July through August with a normal onshore flow (10 to 15 mph) will burn 175 to 200 chains per hour with flame heights of 20 to 25 feet on moderate slopes. Spotting can be expected.

In September, October, and November, fires will bum 250 to 275 chains per hour with flame lengths greater than 30 feet. Moderate intermediate and long range spotting is common.

Wildfires in chaparral will slow and rapidly lose intensity as they reach the 5,000 foot elevation range. Normally, evenings will cool and fire intensities will subside substantially. Canyon bottom and mid-slope runs will still occur, however sustained runs with high intensities are the exception under normal conditions at night.

Unless the area is under extreme drought conditions, fires under normal onshore wind conditions will not continue to run or carry through the mixed conifer stands at higher elevations.

Under Santa Ana conditions, fires will bum with extreme intensity. These can occur at anytime of the year, but are most dangerous in the fall when fuel moistures are at their lowest. Rates of spread can exceed 1,000 acres per hour and flame lengths of 75 feet or greater are not unusual. Santa Ana conditions cause extreme burning at all hours of the night and day. Long range spotting up to a half mile or greater can occur.

Santa Ana fires are influenced by the wind with virtually no influence from topography. Once the Santa Ana Winds start to subside, there will be various wind changes from opposite directions as the onshore flow tries to overcome the high pressure air movement from the east. Fire behavior during this transition can be confusing and dangerous.

VI. SOUTHERN CALIFORNIA STRATEGY AND TACTICS

Strategy is the broad plan, tactics is what you do to carry out the plan. There is often much confusion concerning what are tactics and what is strategy. Strategy is usually the overall general plan. Tactics are the specific actions and methods to accomplish the plan.

A. Strategy.

Initial attack strategies in southern California include fast aggressive initial attack. Due to land ownership patterns and rapid rates of spread, fires usually involve several jurisdictions and threaten structures and other improvements.

Extended attack strategies include the 3 C's which are Confine, Contain and Control. Most fire situations in southern California will result in a control strategy. Because of the multijurisdictional involvement, and structures and improvements at risk, controlling the fire at its smallest practical size will usually be the general strategy.

B. Tactics.

Tactics are those specific actions taken to accomplish the overall goal (strategy). Your tactics will be based upon using the right equipment (both in quantity and type) to suppress the fire safely, and meet all of the incident objectives. Your tactics will be developed based on current and expected fire behavior.

1. Direct Attack.

In southern California it is always safest to employ direct attack. Because of the steep terrain, it is not always possible to see the entire fire. Because of the numerous canyons and broken topography, the wind can be erratic. Add to these factors the flashy, fast burning fuels and direct attack is obviously the safest tactic. In chaparral fuels it is always best to have "one foot in the black whenever possible. During Santa Ana Winds, it is best to flank the fire, as it is virtually impossible to stop the head of the fire during these conditions.

If the fire is too intense for direct attack, parallel tactics can be used. Parallel tactics involves getting far enough away from the fire to avoid the heat and still see it. Line is fired out as it is constructed.

2. Indirect Attack.

Indirect attack is usually employed when the fire is already large and other tactics are not safe or appropriate. It is risky and must be well planned with all of the necessary safety precautions including Lookouts, Communications, Escape Routes, and Safety zones (LCES) strictly adhered to. Burnout or back fire will normally be used in conjunction with indirect tactics. Burning must be well planned and executed. Burning must always be accomplished with favorable wind conditions, adequate resources and when the exposure of the fuels is appropriate.

Southern California fuels will often be difficult to ignite if they are shaded (cold) and will suddenly takeoff with greater intensity than anticipated once exposed to the sun (hot). Most of the firefighters killed in southern California have died during indirect attack operations. These include the Inaja 1956 - 11 fatalities, Decker 1959 - 7 fatalities, Loop 1966 – 12 fatalities, Libre 1968 - 1 fatality, Bell Valley 1972 - 1 fatality, the Spanish Ranch 1979 - 4 fatalities, and the Glen Allen 1993 - 2 fatalities.

When fire intensity is extreme, such as in Santa Ana conditions, the tactical posture may be primarily defensive rather than offensive, since the conditions make offensive tactics futile and dangerous. Protection of structures, critical watersheds or other values may be the only tactic that is attainable. As offensive opportunities present themselves, it will be important to be prepared with resources to take advantage of them. This posture may continue until the conditions change and the fire's intensity reduces.

3. Structure Protection.

Structure protection will quite often take away many of the wildland firefighting resources. You will have to make tough judgments on resource allocation. When possible, allocate structural protection to the local structural protection agency and when applicable involve them in a unified command structure. One of the biggest challenges an incident commander will encounter is attaining perimeter control when structures are involved. The best overall structure protection strategy is to control the wildfire.

Type 1 and Type 2 engine strike teams are often ordered for structural protection assignments. This type of equipment is usually readily available. However there may be times when a mixture of Type 2 and Type 3 engines may be more appropriate. When making tactical decisions consider:

a. Firefighter Safety. (**ALWAYS OUR FIRST PRIORITY**)

b. Rescue-Evacuation.

c. Available Engines.

d. Location of Homes.

e. Roof Coverings.

f. Rate of Spread.

g. Direction of Spread.

h. Engine Access.

i. Water Supplies.

j. Defensible Space.

4. Tactical Resources.

a. Engines:

The primary attack tool in southern California is the engine. There are literally hundreds available with quick attack times due to a good urban and mal highway system.

Wildland engines normally carry 500 to 1,000 gallons of water, a 250 to 500 gpm pump, and about 2,000 feet of hose plus handtools. Hose lays and mobile pumping is done on most fires. A number of wildland engines in southern California are equipped with Class A foam. Class A foam proved to be invaluable during the 1993 Santa Ana fires. The Los Angeles County Fire Department is currently equipping many of their engines with this capability.

b. Hand Crews.

Abundant in southern California.

(1) USFS - 9 Hot Shot Crews.

(2) CDF - 65 Hand Crews.

(3) LA COUNTY - 30 Hand Crews.

All are fully trained and equipped, they have radios and are mobile.

c. Dozers.

Plentiful, several available from fire agencies for initial attack. Many rentals available; however, training may be limited. Size D-6 to D-7 is best for the fuel and terrain. Federal agencies have land management limitations on the use of dozers & almost all areas of southern California.

d. Aircraft.

Five air attack bases serve the area with 15 minute attack times. A number of these bases are jointly operated and staffed by CDF and the U.S. Forest Service. Aircraft types include C-130's, Orions, DC-6's, DC-4's and CDF S-2's. Terrain favors coordinated attack with aircraft and helitack crews. Approximately 15 initial attack helitack crews are available with both medium and light helicopters.

Normally, tactics will use a combination of all of these resources; engines, dozers, aircraft, and hand crews. At higher remote elevations, operations are usually limited to hand crews and aircraft.

5. Tactical Planning.

California fires move fast and constantly threaten improvements on multiple jurisdictions. It is important to have a person with local fire expertise for input to the planning process. Because of the frequency of fires in southern California it is also helpful to have bum history maps of the area. Fires in southern California often repeat themselves and reviewing previous bums in the same area may prove to be invaluable. Long range contingency planning is a necessity. You must have an idea of what your next move will be if current tactics fail. Including the other jurisdictional fire agencies into this process is also important. It is important to start your demobilization plan as early as possible. With vast amounts of resources that can be mobilized in a short period of time, it is key to start thinking about demobilization and priority releases as early on into the incident as possible.

VII. SAFETY CONSIDERATIONS

Firefighter safety will always be the primary incident objective. Some of the historical southern California safety problems include:

A. Fireline safety - It is important to stress LCES (Lookouts, Communications, Escape Routes and Safety Zones). This is particularly important when any tactic other than direct attack is being employed. Numerous fatalities have occurred in grass and light flashy fuels with flame lengths of 4 feet. An area may look relatively calm and innocent prior to a change in factors which cause light fuels to make an explosive run. Light fuels react very quickly to changes.

As previously stated, during Santa Ana Wind conditions, you will often be in a defensive posture, flanking the fire as it heads in a very predictable direction. Problems can occur when a Santa Ana starts to dissipate and the onshore flow starts to return. This ebbing Santa Ana can result in wind changes which will turn a fire from a wind driven fire often burning down- or cross-slope back to a fire which is influenced by wind and topography. This can cause the fire to start burning back up the slope flanking itself. When Santa Ana's and onshore winds battle for control, a fire will run downslope with the Santa Ana influence and then run upslope as the onshore takes over. This can occur several times as the wind influence makes its transition.

The sundowner winds in the Santa Barbara area must always be considered. They will occur at dusk with little warning and cause strong winds from the north and east to run from the desert plateau to the ocean. Extreme fire behavior will occur.

B. Air operations in southern California are complicated. Smog and smoke will often cause poor visibility. There are numerous private, commercial, and military aircraft in the area, along with dense populations and all of the associated hazards (powerlines, antennas, etc.). It is always important to have the Federal Aviation Administration declare temporary flight restrictions over and around the fire. Because of the numerous low level military training routes in southern California, it is important to double check with the military to assure they are aware of the restricted air space.

C. General kinds of fireline safety issues include;

1. Heat Exhaustion - Make sure firefighters drink and carry sufficient fluids. Heat exhaustion is a common problem.

2. Critters - Southern California has poisonous rattlesnakes, scorpions, ticks and bees. Persons who are allergic to insect bites should carry medication for anaphylactic reactions. The Pajahuello tick can cause severe damage to surface skin and underlying tissues; Lyme disease can be a serious long tern health hazard. Proper clothing and sleeping arrangements will help prevent bites. Stay away from rodents and rodent burrows, hantivirus is beginning to be a serious problem throughout California

3. General Hazards - Uneven terrain and rolling material often result in ankle injuries, blisters and cuts from handtools.

4. Poison Oak - Southern California has poison oak. It is usually found in or near shaded areas where fuels are more moist.

VIII. CENTRAL CALIFORNIA

Central California also has a history of large, damaging fires. For purposes of this information, central California will include the Sequoia, Inyo, Sierra, Stanislaus, Eldorado, Tahoe, and Lassen National Forests, Yosemite and Sequoia/Kings National Parks (Central Nevada Range). Low frequency, high intensity large fires are the historic pattern. This pattern can often be associated with drought conditions and lightning storms; however, human caused ignitions have resulted in large damaging fires. Structural threats can be a protection problem, but somewhat different than southern California. Southern California structures are often found densely packed at the base of foothills. Central California has some areas like this however, much of the problem consists of small communities tucked in the woods. Numerous houses and cabins can also be found isolated throughout the area. Commercial timber, spotted owl habitat, archeological sites, wilderness area and other natural resources are often the protection priorities. Central California wildfires are often characterized by heavy fuels, burning intensely in remote areas. Logistical support problems can be a difficult challenge.

IX. CENTRAL CALIFORNIA FUELS

The Central Sierra Range consists primarily of grass and oak at the lower elevations, mixed brush at the intermediate levels and coniferous stands at the higher elevations. The eastern side of the Sierras is dryer and consists of sage transitioning into ponderosa and Jeffrey pine at higher elevations. Mixed conifer fuels present the primary fire problem in the Central Sierra Range.

A. Oak woodland.

Oak and grass lands will be found at the lower elevations up to 2,500 feet. These fuels occur primarily on the west side of the central Sierras. Oak grass lands are Fire Behavior Fuel Model 1 with fuel loading less than one ton per acre. Wildfire is carried through the fine grass fuels. Fire spreads rapidly and responds well to direct control efforts.

B. Mixed brush.

Mixed brush (chaparral, deer brush, ceanothus and manzanita) can be found at the intermediate elevations on the west side of the Central Sierras. Mixed brush in the Central Sierras can often be accompanied by a timber overstory.

Mixed brush exists between 2,500 and 4,000 feet, it is a combination of Fire Behavior Fuel Models 2 and 4; with a fuel load that ranges from 10 to 20 tons per acre. Wildfire can spread moderately through these fuels and be very difficult to control.

C. Sage.

Sage can be found at the lower to intermediate elevations on the east side of the Central Sierras. Sage is Fire Behavior Fuel Model 2; its fuel load is less than one ton per acre. Sage can burn at a moderate rate of spread, but usually requires a moderate wind to spread. Sage has little continuity on the east side of the Sierra range.

D. Mixed Conifer.

Mixed conifer can be found from approximately 4,000 to 9,000 feet elevation. Mixed conifer is Fire Behavior Fuel Model 10, with a fuel load that can range from 10 to 50 tons per acre. Duff layers (compressed pine needles and organic matter) can range from 2 inches to 6 inches in depth. Mixed conifer in the central Sierra Range consists of Jeffrey pine, white fir, Douglas-fir, incense cedar, red fir, white pine and ponderosa pine. Mixed conifer fuels present the most difficult fire problem in the Central Sierra Nevada Range. The worst or most hazardous mixed conifer fuel is:

1. A combination of young to moderate reproduction and mature conifer. This provides ladder fuels to the crown of the mature conifer.

2. A combination of mixed conifer fuels combined with a mixed brush understory. Once again this provides a combination of ground and crown fuels.

3. Mixed conifer fuels when the 1000 hour fuel moistures dip down into the low teens. Fuels become explosive at this fuel moisture content.

X. CENTRAL CALIFORNIA TOPOGRAPHY

The topography in the Central Sierra Ranges ranges from 2,000 to 13,000 feet elevation. The east side of the range is primarily desert, the west side is primarily grassy valleys and farmlands.

A. Topographical features.

The topography consists of steep slopes, valleys, and canyons. In most of the Central Sierras, lakes, streams, and ponds are plentiful. The mountain range runs north and south with numerous canyons and valleys facing east and west.

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B. Access.

Access consists primarily of some paved roads, logging roads and hiking trails. Helicopter transportation and walking can be primary transportation modes. Fires with limited access present substantial logistical problems.

XI. CENTRAL CALIFORNIA FIRE WEATHER

The annual rainfall averages 10 to 20 inches at the lower elevations and from 30 to 40 inches at the upper elevations. From July to September, rainfall is minimal. Most large fires occur between late July and late October.

A. Temperatures.

Temperatures at the lower elevations range from the mid 70's to the mid 90's. Temperatures can exceed 100 ^{o}F under extreme conditions. At higher elevations (above 6,000 feet) temperatures range from the high 60's to the low 80's. Temperatures can drop below freezing at night at higher elevations.

B. Humidities.

Humidities can range from the mid 20's to the high 30's under normal conditions. Humidities can drop to the low teens during extreme conditions.

C. winds.

Average winds range from 7 to 10 mph out of the south, southwest under normal conditions. A frontal wind (in conjunction with the passage of a weather front) can create wind speeds in excess of 30 mph.

D. Special Weather Conditions.

1. The most common special fire weather conditions are thunderstorms. Thunderstorms are a source of fire ignition and cause erratic winds from unpredictable directions.

2. Another special weather condition is "mono" or east winds. These gravity winds are usually associated with a high pressure system moving southeast across Washington and Oregon from the Gulf of Alaska. Humidities drop, temperatures rise and winds can blow in excess of 30 mph. These conditions occur most often in spring and late fall. A wildfire under these conditions, particularly in fall, can be very intense and difficult to control.

XII. CENTRAL CALIFORNIA FIRE BEHAVIOR

Wildfires in mixed conifer fuels burn hot at moderate rates of spread. Average chains per hour range from 10 to 15. This can increase dramatically when spotting beings to occur. A typical wildfire in mixed conifer fuels will burn hot and be influenced by slope during peak burning periods. At night the fire will lay relatively dormant until mid-morning and repeat the pattern. This pattern is often complicated by thick smoke inversions in canyons and draws. During drought conditions, extremely - intense burning can occur in mixed conifer fuels. Convection columns can rise in excess of 35,000 feet. After an intense fire run, the convection column will flatten out or break up. When this occurs it can result in numerous spot fires sometimes miles in front of the fire. This will often result in a number of fires which leave difficult control and mopup problems.

Spotting is always a problem in mixed conifer fuels. Currently, as a result of many years of drought, dead fuels are abundant. There are pockets, 30 to 50 acres, of standing dead material. Fire, as it spreads into these areas burns intensely and sends bark platelets high into the convection column. This results in unusually violent fire behavior and long distance spotting. Due to heavy duff layers, mopup will be difficult and require significant time.

Mixed conifer fuels with young reproduction or with mixed brush always present a potential for re-burns. A wildfire may bum through the brush or smaller fuels and later run through the overstory. This is always a dangerous possibility for firefighters.

XIII. CENTRAL CALIFORNIA TACTICS AND STRATEGY

A. Strategy.

Strategy, as previously stated is the overall plan. Strategies in mixed conifer fuels may be somewhat different than those of chaparral. Fires in mixed conifer fuels usually require thinking bigger and looking for opportunities well out in front of the fire.

B. Tactics.

Tactics are those specific actions taken to accomplish the overall strategy.

1. Direct attack.

The best method for attacking fires in mixed conifer fuels is direct attack. This may not always be possible. If the fire demonstrates any of the characteristics listed below, direct attack may not be possible.

a. Running in the crown

b. Long distance spotting

c. Substantial convention column

d. Influenced by mono and east winds

e. Burning in heavy logging slash or windfall

2. Indirect.

If direct attack is not possible, a combination of parallel attack on the flanks and indirect on the head may be necessary. It is critically important to build long range contingencies. Look for topographic opportunities in front of the fire which allow sufficient time to execute. Backfiring operations must be well planned and carried out only under ideal weather and burning conditions. If the fire is running and spotting, backfiring operations may make the situation worse. Consideration should be given to burning at night, if practical. In many cases it will require a change in the weather conditions which are causing the extreme burning conditions before you will be successful in halting the spread of the fire. It may be important to think in terms of 72 hours rather than 12 or 24.

Mopup will be a difficult job. All fireline should be black and mopped up entirely 100 feet inside. If foam can be used, it will make the job easier. (Mopup in these fuels is very difficult.)

3. Tactical resources.

   a. Hand crews - In large fire conditions, hand crews will be one of the primary resources. It is not uncommon for fires to be in remote areas with limited road or heavy equipment access. There are numerous crews available in California.

   b. Dozers - If the topography permits, dozers will be invaluable. They will be particularly important in implementing contingency plans where firing from a wide fire break is required.

   c. Aircraft - Aircraft will be vital; both fixed and rotor wing. Airtankers will assist not only supporting crews, but in knocking down spots. Rotor wing will be necessary for tactical operations as well as logistical operations. Crew transportation will most likely be accomplished with helicopters. Remote camps and coyote tactics may be necessary. Helicopters will be key to the success of these operations. Aerial ignition for firing operations may also be required. Heavy lift or Type I helicopters are very effective for water and retardant dropping in mixed conifer fuels.

   d. Engines - Fire engines will be useful if the fire is accessible or if structures are threatened. Engines are normally plentiful in California.

   e. Smokejumpers - Smokejumpers are usually used in initial attack operations. Smokejumpers may be helpful in jumping or rappelling into isolated spot fires if this can be accomplished safely.

XIV. SAFETY CONSIDERATIONS

Firefighter safety will always be a primary incident objective. Historical safety and special concerns in mixed conifer fuels include:

A. L.C.E.S. - Lookouts, Communications, Escape Routes and Safety Zones are critical considerations in mixed conifer fuels. Visibility is often very poor due to the canopy and indirect or parallel tactics are often employed.

B. Snags - Snags have caused many injuries and fatalities. Snags are one of the most important fireline safety considerations in mixed conifer fuels. This becomes increasingly more important and dangerous during night operations.

   Due to recent drought conditions, numerous pockets of snags exist. Potential problem snags should be flagged along the fireline or anywhere crews may be working or walking. Night operations may have to be reduced to monitoring if the problem is significant.

C. Mono-winds - Mono or east winds cause humidities to drop and the temperature to rise. Fires will burn intensely and spread with the wind which can exceed 30 mph. These conditions develop when a high pressure system moves from the Gulf of Alaska south and east across Washington and Oregon. It can be dangerous when this situation develops and diminishes during fire operations. Fire spread will change from slope and topography influenced to wind driven. This change can occur quickly and if not anticipated, could place firefighters in jeopardy. Reburn potential becomes greater during these conditions.

D. Dehydration - Fires in mixed conifer fuels often occur under hot dry conditions at higher elevations. Firefighters need to carry sufficient water. Keeping camps and fireline helispots supplied with water will be important.

E. Critters - Rattlesnakes, scorpions and ticks (including ticks with Lyme disease) are potential problems. Bears may be found in some locations but are not normally a problem. Hantivirus is a significant problem associated with rodents and rodent burrows. Avoid contact, be sure to have safety officers work with local health professionals to determine how to best mitigate hantivirus exposures.

F. General hazards.

   Steep terrain, heavy fuels, camp operations and long duration fires result in fatigue, cuts, bruises, muscle pulls, colds, etc. Minor burns are often experienced due to burning stump holes.