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:

GREAT BASIN AND SOUTHERN ROCKY MOUNTAINS

I. FACTORS INFLUENCING FIRE BEHAVIOR IN THE GREAT BASIN AND SOUTHERN ROCKY MOUNTAINS

A. Topography.

1. Elevation: Elevations of major landforms in this geographic area range from about 2,000 to 14,000 feet above sea level.

2. Landforms: Major landforms found in these areas include the full spectrum of broad valleys to mesas, and mountains, varying in elevation and steepness. Most mountain ranges are oriented north and south with the Uintah Mountains in northeastern Utah the only exception.

B. Weather.

Because this area experiences a continental climatic influence, it is subject to extended duration of hot, dry, and windy weather with frequent thunderstorm activity throughout the summer.

1. Precipitation: Precipitation varies in amounts from about 4 to 25+ inches per year. In the Great Basin area, western Colorado, and high mountainous areas of Colorado, the majority of precipitation is received in winter in the form of snow and rain, depending on the elevation. March is quite often the heaviest precipitation month. But, along the Front Range foothills of Colorado, east of the Continental Divide, at lower elevations, the majority of precipitation comes in form of rain during the late spring/early summer months. In this area, May is usually the heaviest month of precipitation. This condition sometimes, although not always, results in lower elevations experiencing a facsimile of a split fire season. When early springtime conditions remain dry, fast spreading fires can be supported by dry vegetation in late March and early April. The occurrence of this situation diminishes with late spring plant growth but returns in July and persists throughout the fall or until the first snowfall.

2. Relative Humidity: Relative humidities can drop to minimums in the single digits with nighttime recovery ranging to 25 – 30 percent. Fire behavior is generally greatest at lowest levels but can occur up to 30 - 35 percent. Above this level, spread, and intensity are markedly reduced, although strong winds can

sometimes overpower the dampening effects of humidity. An example is the fact that sagebrush stands can be consumed with significantly intense headfires at relative humidity levels in excess of 30 percent in the presence of winds in excess of 20 mph.

3. Temperatures: During July and August, maximum temperatures can reach 80 - 100 degrees with minimums 30 - 50 degrees lower. (Minimum temperatures can drop below freezing and even into the teens. Snow can occur at higher elevations during any month of the year.)

4. Winds: Upper air flow generally originates from the west to southwest and moves to the east to northeast. Surface winds vary greatly, are affected by local terrain, and afternoon surface winds of 10 - 20 mph are common. Winds associated with the passage of thunderstorms can reach higher levels for short durations and often have significant effects on fires. Dust devils are common, and dry cold fronts frequently affect active fires.

5. Storm Tracks: Storms track into the Great Basin from the southwest and affect southern and western Nevada, from the northwest into southern and central Idaho, and from the south and west into Utah. The southern Rocky Mountain area is predominantly affected by storms tracking from the west and southwest into Colorado traveling to the northeast. The extreme southern portion of the state will receive an influx of monsoonal moisture from Arizona and New Mexico during July and August. Occasionally, a low pressure in northeastern New Mexico or the panhandle of Oklahoma will cause an "upslope" condition along the Front Range. This is where the counterclockwise flow of air brings moisture from the south into eastern Colorado directly into the Rocky Mountains from the east. This situation, however, is usually associated with high amounts of precipitation.

6. Storm Frequency: Thunderstorm frequency increases as the summer progresses. Moisture associated with thunderstorms A - varies but is greatest at higher elevations. In the Great Basin or western portion of this geographic area, thunderstorms will persist into August and early September while in the Southern Rocky Mountain portion, thunderstorms begin in late May and persist until mid-August, then drop dramatically in occurrence.

7. Day lengths: Generally, daytime hours are fairly long but traveling from south to north in the area will increase the daylength about one and one-half hours. This impacts suppression operations in that the peak burning activity occurs at different times and can affect operational period crew changes, etc.

C. Fuel Types and Fire Behavior.

Vegetative structure and composition in the Great Basin and southern Rocky Mountains are closely related to elevation and precipitation variances. Temperatures increase, precipitation decreases as elevation decreases causing less occurrence of woody tree species, and greater dominance of woody shrubs and grasses. These vegetative communities contain lower fuel quantities and tend to support fixes with rapid rates of spread but of short duration. Containment actions are less rigorous than for heavier fuel types and mopup activities are minimized.

As elevations increase, temperatures drop somewhat, precipitation amounts increase, and vegetative types show a shift to forest communities. These communities possess greater quantities of fuel, both alive and dead. Slower rates of spread are common for fires in these areas, but intensities can escalate dramatically, and burnout of residual fuels after passage of the flaming front can be of long duration necessitating extensive mopup actions. The following sections provide a description of each major vegetative type, and its influence on fire behavior. Due to marked differences between fuels in the Great Basin area and the southern Rocky Mountains, they will be discussed separately.

1. Great Basin Fuel Types.

a. Desert: True deserts are located in isolated places within the Great Basin, but present very little problem in terms of fire management.

b. Salt Desert Shrub:

(1) *Description:* These communities occupy transitional zones between sagebrush-grass and true desert communities. They are found at the lower levels of the elevational gradient, elevations 2,000 - 4,000 feet, with annual precipitation amounts of 6 inches and less, and experience maximum temperatures of 85 - 100 degrees. Fuel loadings are low, with woody shrubs comprising the dominant component, but these shrubs do not commonly achieve high crown cover levels. Understory herbaceous plants are minimal. Natural barriers are common.

(2) *Fire Behavior:* Due to the sparseness of understory fuels, surface fires seldom attain any size of consequence. The presence of wind is required to move fires between shrub crowns and sustain any major fire spread. However, fuel limitation and natural barriers commonly inhibit fires from affecting extremely large areas. Head fires are the most common type of fire and with strong winds can exhibit flame lengths approaching 20 feet with rapid rates of spread.

c. Grasses:

(1) *Description:* Small isolated pockets of native grasses with few woody shrubs occur throughout the Great Basin. These areas do not represent a fire problem. Following fires in sagebrush communities, the woody shrubs are typically removed from a site returning it to grass dominance. In some areas, perennial grasses will dominate while in others, annual grasses, principally cheatgrass, will achieve rapid dominance. During the last 20 years, many wildfires have been reseeded with crested wheatgrass and large monocultures exist. Recently, rehabilitation efforts involve the use of native species.

(2) *Fire Behavior:* In a cured stage for both annual and perennial grasses, rates of spread can be high but fires are relatively easy to control. Large areas of cheatgrass pose particular concerns because they reach a cured stage very early in the summer and remain very flammable throughout the fire season. With high temperatures, low relative humidities, and strong winds, fires in grasslands can produce flame lengths that prevent direct attack with handtools and rates of spread that are very high. Safety is a particular concern in these situations because escape routes and safety zones are few and when present must have quick accessibility. Crested wheatgrass monocultures are thought to be somewhat resistant to fire spread because of the maintenance of high fuel moisture contents but during dry summers they can support active fire spread.

d. Northern Desert Shrub:

(1) *Description:* This vegetation community represents a dry steppe community found between the desert and pinyon-juniper communities. This community occupies large areas within the Great Basin and is also where the largest number of wildfires occur. Elevations range from 2,500 - 5,000 feet, annual precipitation varies from 6 – 10 inches, and maximum summer temperatures commonly reach 80 - 95 degrees. Sagebrush is by far the dominant species with associated species including rabbit brush, bitterbrush, snowberry, other sage species, various annual and perennial grasses, and forbs. Summertime periods are generally hot and dry with very low relative humidities. Fuel volumes will vary significantly depending upon site, its moisture regime, and human influences. Under moist conditions, sagebrush can attain a height of 8 feet but 3 – 4 feet is the norm.

(2) *Fire Behavior:* In areas where livestock grazing is deferred, or where a winter allotment exists, summer conditions include high amounts of understory grasses and forbs. This fuel continuity strongly contributes to surface fire spread. In areas where this surface fuel continuity does not exist, wind is required to move fires between individual sagebrush plants. Fuels are represented by fuel models 2 and 5. Flame length usually varies from 3 - 15 feet with rate of spread being strongly affected by terrain and wind. Head fires are most common, nighttime humidity recovery is sometimes slight enough to permit continual burning activity. Thermal belts will also maintain an active fire. Spread rates are high, burned areas can reach 5 -10,000 acres in a single burning period. With critical conditions, burned areas can go much larger in a single burning period.

e. Pinyon-Juniper:

(1) *Description:* Pinyon-juniper communities cover large areas in the Great Basin, occupying a transitional zone between sagebrush communities, and higher elevation montane conifer forests. Pinyon is the dominant species as elevations increase, and juniper assumes the dominant role at lower elevations. Western juniper is the only species occupying this zone in southeastern Oregon, and southwestern Idaho as the pinyon component drops out this far north. Associated species found in this zone include sagebrush, other woody shrubs, grasses, and forbs. Generally understories are sparse with this condition escalating the older the stand is. Young stands commonly have a large understory component, usually dominated by sagebrush and other shrubs. Environmental conditions common to this zone include: elevations 4,000 - 75500 feet, annual precipitation 10 - 16 inches, maximum summer temperatures 70 - 85 degrees.

(2) *Fire Behavior:* Fire behavior fuel models 2 and 6 best represent this community. The sparse understory strongly controls the ability of these communities to support surface fires. Fire burning out of another fuel type into this one can travel into it in surface fuels, but seldom can sustain this for very long. The arid nature of the environment combined with the small stature of these trees makes total crown closure a rarity, thus when crown fires do occur, they are totally dependent upon strong winds to sustain their existence. High quantities of dead and downed fuels in old stands, high quantities of resin, pitch in pinyon trees, and low moisture contents of juniper trees as well as their shreddy bark make this woodland zone a very flammable situation. In the presence of strong winds, 25 - 50+ mph, independent crown fires occur that can cover large areas, 1,000t acres, but natural barriers and fuel changes are common and limit spread. Spotting can be a problem but without wind can be easily dealt with. Wind is the key element in these communities, fires are either a single tree, low intensity event, or a wind-driven, high intensity event covering large areas.

f. Ponderosa Pine/Douglas-fir:

(1) *Description:* These montane communities comprise a significantly important portion of the Great Basin area. These communities are found between the pinyon-juniper woodlands and the subalpine zone. Within this area, 75 - 80 percent of all extended attack and/or team-action wildfires occur in the Great Basin. These communities occur between 5,500 and 8,000 feet, are comprised of ponderosa pine, Douglas-fir, occasional lodgepole pine, and isolated aspen trees. Understories vary significantly with drier sites having grass-needle understories to those having dense tall shrub understories in heavily shaded conditions. Slopes range from very steep to gentle. Activity fuels and plantations can be present but do not pose any

particular problems in this geographic area. Annual precipitation ranges from 12 - 20 inches and maximum summer temperatures are found in the range of 70 - 85 degrees. Fuel complexes in these communities have been markedly altered in some areas through fire suppression, grazing, timber harvesting, insect, and disease occurrence. Open stands having low accumulations of down and dead woody materials have been changed to areas characterized by numerous dead overstory trees, shade tolerant regeneration abundant in the understory, heavy accumulations of surface fuels, high vertical, and horizontal fuel continuity.

(2) *Fire Behavior:* Fire behavior in these communities ranges from low intensity surface fires in needlegrass fuels to all types of crown fires. The specific fire type that will occur is dependent on the fuel availability, fuel quantities, environmental conditions, topographical conditions, weather conditions, and present stand structure. All types of fires, (heading, backing, flanking, and crown) can occur with active burning possible throughout nighttime periods and sustained by thermal belts. Nighttime inversions develop frequently in valleys but fires can sustain activity above the inversion on slopes. Of special concern is the speed with which a fire can change from a benign surface fire to a fast-moving, high intensity, crown fire. Safety considerations regarding this potential are paramount, fire behavior predictions are an extremely valuable part of incident action plan development, and implementation.

g. Subalpine Communities:

(1) *Description:* This fuel type covers a relatively small area at higher elevations within the Great Basin, but fires that do occur here are often difficult, and expensive to suppress.

High elevation communities are comprised of Englemann spruce and subalpine fir, with some lodgepole pine present. Surface fuels can be minimal in open grown stands or very heavy, predominantly large down tree stems, in closed canopy stands. Tree limbs of both species of trees usually are present all the way to the ground, posing good vertical fuel continuity.

Fire Behavior: These stands often bum in patchy, spotty patterns best described as hundreds of spot fires. Regular line construction and burnout efforts are ineffective on fires in this type. Spread is by torching of individual trees or groups of trees with spotting into more individual trees downwind. Retardant is seldom effective. These fires have the potential to wear crews out especially in low relative humidity situations with the constant torching and spotting into new fuels. Heavy down fuels, deep duff layers, and dense stands can make fire suppression a very laborious process. The key to suppression in this type is having crews limb up all trees with fire under them, to remove the ladder fuels, stop the torching, and spotting into new fuels. Once spread is stopped, water from pumps, engines, foldatanks, and bladder bags can be used to speed up the mopup in deep duff and heavy downed materials under the trees.

2. Southern Rocky Mountains Fuel Types.

   a. Salt Desert Shrub:

      (1) *Description:* These communities occupy arid locations within the sagebrush-grass and grassland communities. They are found at the lower levels of the elevational gradient, elevations 4,000 - 5,000 feet, with annual precipitation amounts of 7 inches and less, and experience maximum temperatures of 85 -100 degrees. Fuel loadings are low, with woody shrubs comprising the dominant component, but these shrubs do not commonly achieve high crown cover levels.

Understory herbaceous plants are sparse or nonexistent. Natural barriers are common.

(2) *Fire Behavior:* Due to the sparseness of understory fuels, surface fires seldom attain any size. The presence of winds is required to move fires between shrub crowns sustaining any major fire spread. However, fuel limitations and natural barriers commonly inhibit Fires from affecting extremely large areas. Head fires are the most common type of fire and with strong winds can exhibit flame lengths approaching 20 feet with rapid rates of spread. Fires usually are confined to drainage bottoms, but may spread onto sagebrush flats, or pinyon-juniper mesas.

b. Grasslands:

(1) *Description:* Both perennial and annual grasslands are present in the southern Rocky Mountains. Perennial grasslands are found along the full elevational gradient in the form of extensive grasslands at lower elevations to mountain meadows at higher elevations. Annual grass lands are comprised of cheatgrass and are smaller pockets in the western portions of the area. Perennial grasslands in the western portion are comprised of bunchgrasses and forbs, but do not form continuous fuel beds. Perennial grasses in the eastern portion are represented by sod grasses of the short grass prairie although these areas do not pose a widespread fire problem. In all areas, cured grasses can present highly flammable fuels, particularly in areas not grazed, or subject to winter livestock use.

(2) *Fire Behavior:* In a cured stage for both annual and perennial grasses, rates of spread can be high, but fires are relatively easy to control. Cheatgrass stands pose particular concerns because they reach a cured stage very early in the summer remaining very flammable throughout the fire season.

With high temperatures, low relative humidities, and strong winds, fires in grasslands can produce flame lengths far in excess of what can be directly attacked with handtools and rates of spread that are very high. Safety is a particular concern in these situations, and escape routes and safety zones are few, and when present must have quick accessibility. Shortgrass prairie areas become flammable early in the year (as early as March), and remain in that state throughout the summer. In the absence of thunderstorm rainfall, these areas can sustain significant fire activity although the duration is very brief.

c. Sagebrush-Grass:

(1) *Description:* This vegetative community represents a dry steppe community found between the salt desert shrub and alkali flats and pinyon juniper communities. This community occupies large areas within the Southern Rocky Mountains and can be found as a component of other vegetative communities including the pinyon-juniper, montane conifers, aspen, and subalpine lodgepole pine communities. Elevations range from 4,000 - 6,000 feet as a dominant community and up to 10,000 feet as a minor component of other communities. Annual precipitation varies from 6 - 10 inches, maximum summer temperatures can reach 80 -100 degrees. Sagebrush is by far the dominant species with associated species including rabbit brush, bitterbrush, snowberry, other sage species, various annual and perennial grasses, and forbs. Species composition increases with elevation and precipitation. Summertime is generally hot and dry with very low relative humidities. Fuel volumes will vary significantly depending upon the site, its moisture regime, and human influences. Under moist conditions, sagebrush can attain a height of 8 feet but 3 - 4 feet is the norm.

(2) *Fire Behavior:* In areas where livestock grazing is deferred, or where a winter allotment exists, or at higher elevational zones, summer conditions include high amounts of understory grasses and forbs. This fuel continuity strongly contributes to surface fire spread. In areas where this surface fuel continuity does not exist, wind is required to move fires between individual sagebrush plants. Fuels are represented by fuel models 2 and 5 name lengths usually vary from 3 - 20 feet with rate of spread being strongly affected by terrain and wind. Heading fires are most common and nighttime humidity recovery usually reduces burning activity. Thermal belts will maintain an active fire. Spread rates are high and burned areas can reach 1 - 5,000 acres in a single burning period. With critical conditions, burned areas can go much larger in a single burning period. Seldom are wind events sustained for more than two consecutive burning periods, so the size, and duration of fires in these communities is limited.

d. Pinyon-Juniper:

(1) *Description:* Pinyon-juniper communities cover large areas in the Southern Rocky Mountains but do not extend north of Colorado. These woodland communities occupy a transitional zone between sagebrush and oakbrush communities, or higher elevation montane conifer forests. Pinyon is the dominant species as elevations increase and juniper assumes the dominate role at lower elevations. Associated species found in this zone include sagebrush, other woody shrubs, grasses, and forbs. Generally understories are sparse with this condition escalating the older the stand is. Young stands commonly have a large understory component, usually dominated by sagebrush, and other shrubs. Distinct differences occur east and west of the continental divide.

On the west slope, pinyon-juniper stands are very dense old growth having large quantities of down and dead material. Many stands have established on mesa tops and achieved near optimal growth. In other areas, these species are encroaching into shrub grasslands in the absence of recurring fire. Understories are comprised of a dominant shrub component. On the eastern slope, pinyon-juniper stands are only found in the southern half of this area experiencing substantial thunderstorm precipitation during the summer. This situation, in combination with the understory composition of short grass prairie sod grasses and no shrub component, causes low intensity, small wildfires with only an occasional problem fire occurring.

Environmental conditions common to this zone include: elevations 5,500 - 8,500 feet, annual precipitation 10 - 14 inches, maximum summer temperatures 75 - 95 degrees.

(2) *Fire Behavior:* Fire behavior fuel models 2 and 6 best represent this community. The sparse understory strongly controls the ability of these communities to support surface Fires. Fire burning out of another fuel type into this one can travel into it in surface fuels but seldom can sustain this for very long. The arid nature of the environment combined with the small stature of these trees makes total crown closure a rarity, thus when crown fires do occur, they are totally dependent upon strong winds to sustain their existence. High quantities of dead and downed fuels in old stands, high quantities of resin and pitch in pinyon trees, and low moisture contents of juniper trees as well as their shreddy bark make this woodland zone a very flammable situation. In the presence of strong winds, 25 - 50+ mph, independent crown fires occur that can cover large areas, 1,000 - 3,000 acres, but natural barriers and fuel changes are common and limit spread.

Even though over 50 percent of all wildfires occur in this vegetative type, few reach sizes, and durations to warrant incident management team actions. Spotting can be a problem but without wind can be easily dealt with. Seldom do more than three consecutive burning periods occur with high wind conditions, thus wildfires in these communities are relatively short-lived. Wind is the key element in these communities, fires are either a single tree, low intensity event, or a wind-driven, high intensity event covering large areas. Many national parks and monuments are located within this vegetation type. Fast moving, high intensity fires are difficult to suppress posing serious threats to communities, and other developments. Some particularly troublesome examples include the Battlement Mesa fire, and Long Mesa fire in Mesa Verde National Park.

e. Oakbrush:

(1) Description: This vegetative type is fairly unique to this geographic area. Approximately 10 percent of all extended attack and/or team-action wildfires occur within this zone in the Southern Rocky Mountains. It is found in warm, moist environments mostly west of the continental divide. In its northern limits, it can be found as pure stands, or mixed with other tall shrubs as a mountain shrub zone. In its southern limits, it can be present in a pure community, or as a dominant understory component of aspen, or ponderosa pine stands. Oakbrush can tolerate fire extremely well and can respond with 18 - 24 inch sprouts during the same season it was burned, depending upon moisture conditions, etc. As an overstory dominant or in pure stands, it can reach heights of 10 - 12 feet but is usually in the 3 - 6 foot range. As an understory dominant, it ranges in height from 2 - 4 feet. It grows as a dense clump with an understory of total ground cover in the form of grasses, sedges, and forbs.

Other shrubs can be present and include chokecherry, serviceberry, mountain mahogany, snowberry, gooseberry, rose, greenleaf manzanita, and others. Elevation ranges from 6,500 - 8,000 feet, annual precipitation varies from 12 - 18 inches, and maximum summer temperatures can reach 75 - 90 degrees.

Fire Behavior: Fire behavior in oakbrush stands can be variable, depending upon many factors. Fire behavior fuel models for this type can include 2, 4, and 6. Live fuel moisture levels reach their lowest about the end of July. The trend in oakbrush live moisture content will follow that of cheatgrass: The lowest point will occur when, or within a few weeks of when, the cheatgrass reaches the cured stage. Fires commonly occur during July and August with intensities varying. Flame lengths frequently exceed the limits for direct attack with ground forces. Special conditions occur in this fuel type that warrant close attention. When late season frosts occur after leaves have developed, frost-killed leaves can remain on the shrub throughout the remainder of fire season. Following new leaf growth, flammability can be greatly increased, to the level of California chaparral. Fires occurring during these situations can exhibit high intensity, rapid rates of spread, and can develop into crown fires very quickly. Steep drainages where preheating can occur during the morning and early afternoon are particularly dangerous places. In 1976, within a two hour period, a benign appearing fire (Battlement Creek) quickly grew into a rapidly moving crown fire that traveled from the bottom of a drainage to the top on 50 - 70 percent slopes, and over the ridge point at nearly 100 chains/hour. Flame lengths were 20 - 40 feet, this fire resulted in three fatalities. In 1994, another benign appearing fire (South Canyon), grew from 100 to 2000 acres in a few hours, and was responsible for 14 fatalities.

Fires in these communities can be affected by winds, slopes, or by either one in absence of the other. Crowning runs can develop during consecutive burning periods and prolong suppression actions. Of particular importance is the fact that a fire can remain active in the leaf litter understory during the night, back down slopes, and then travel through the overstory back upslope during the day, in a reburn scenario. Also important is the fact that a fire may show no appearance of activity, quickly come to life during the peak of the burning period, making a significant, and threatening run. Mopup to reduce the potential of this occurring is extremely important.

f. Ponderosa Pine/Douglas-fir:

(1) *Description:* These montane communities comprise a significantly important portion of the Southern Rocky Mountain area. These communities are found between the pinyon-juniper woodlands, the subalpine zone west of the continental divide, between the short grass prairie, and the subalpine zone east of the continental divide. Within this zone approximately 60 percent of all extended attack and/or team-action wildfires occur in the Southern Rocky Mountains. These communities occur between 6,000 - 8,500 feet and are comprised of ponderosa pine, and Douglas-fir trees. Understories vary significantly with drier sites having grass-needle understories to those having dense shrub understories in heavily shaded conditions. Slopes range from very steep to gentle. Annual precipitation ranges from 12 - 20 inches, and maximum summer temperatures are found in the range of 70 – 90 degrees. Fuel complexes in. these communities have been markedly altered in some areas through fire suppression, grazing, timber harvesting, insect, and disease occurrence.

Open stands having low accumulations of down and dead woody materials have been changed to areas characterized by numerous dead overstory trees, shade tolerant regeneration abundant in the understory, heavy accumulations of surface fuels, high vertical, and horizontal fuel continuity. Mountain pine beetle, and spruce bud worm infestations on the east slope have left entire hillsides with standing dead trees representing significant snag hazards.

(2) *Fire Behavior:* Fire behavior in these communities ranges from low intensity surface fires in needle-grass fuels to all types of crown fires. The specific fire type that will occur is dependent on the fuel availability, fuel quantities, environmental conditions, topographical conditions, weather conditions, and present stand structure. All types of fires, (heading, backing, flanking, and crown) can occur with active burning possible throughout nighttime periods, and sustained by thermal belts. Nighttime inversions develop frequently in valleys but fires can sustain activity above the inversion on slopes. Of special concern is the speed with which a fire can change from a benign surface fire to a fastmoving, high intensity crown fire. Safety considerations regarding this potential are paramount. Fire behavior predictions are an extremely valuable part of incident action plan development, and implementation.

g. Lodgepole Pine:

(1) *Description:* Lodgepole pine forests comprise the second largest forest type in the Southern Rocky Mountain area. Team-action wildfires in this vegetative type represent about 25 percent of the total. Elevation of this community ranges from 8,000 and 12,000 feet. Annual precipitation is primarily received in the form of snow and amounts to 12 - 18 inches. Maximum summer temperatures range from 65 - 80 degrees.

Understory fuels are sparse or nearly absent in this vegetative type. Stands are even-aged unless infected by disease which has caused early overstory mortality opening canopies for regeneration. Fuel complexes have been affected by insect and disease infestations. Mountain pine beetles have infested widespread areas, especially in northeastern Utah. Dwarf mistletoe infection represents the most significant disease in lodgepole pine and infects over 50 percent of all stands. This disease has caused enough mortality in some stands that predictive fuel models have changed from 8 to model 10 and downed fuel loadings have increased from 5 - 10 tons/acre to as high as 75 - 100 tons/acre. Large amounts of standing dead trees are present posing significant snag hazards to firefighters.

(2) *Fire Behavior:* Wildfires can be very intense and fast moving in these communities. Some important points to be aware of are that the lowest live fuel moisture contents of the year occur immediately prior to bud break, some of the largest fires have occurred at this time (early June). In stands unaffected by insects, or diseases, surface fuels seldom support much fire activity. Overall stand flammability varies with age as young and very old stand; are the most flammable, and immature to mature stands are much less flammable. Stands affected by insects, diseases, and fire suppression can have greatly increased fuel loads, and exhibit all types of crown fires, especially supported by the surface fires. Reburning over previously burned surface areas is a possibility and residue burnout of downed fuels prolongs suppression activities. Under conditions of high winds, fires can cover large areas in short time periods. Since lodgepole pine is a fire dependent species, its presence and appearance is an indication of past fire activity and fire behavior.

h. Spruce-Fir Forests:

(1) *Description:* This fuel type occupies a relatively large area at higher elevations within the Southern Rocky Mountains. Team action fires occur here about 5 percent of the total time and are difficult and expensive to suppress. These high elevation communities are comprised of Engelmann spruce and subalpine fir, with some lodgepole pine present. Surface fuels can be minimal in open grown stands, or very heavy, predominantly large down tree stems, in closed canopy stands. Tree limbs of both species of trees usually are present all the way to the ground, posing good vertical fuel continuity. Elevations of these communities are 9,000 - 12,500 feet, annual precipitation is 15 - 25 inches, and maximum temperatures range from 60 - 70 degrees.

The Flattops Wilderness Area is unique in that it suffered a spruce beetle epidemic about 40 years ago resulting in extremely high tree mortality. The relatively high elevation of this area (10,000+ feet) has inhibited tree decomposition, the present forest is one of regeneration coupled with large quantities of standing dead trees in the form of large snags, and heavy surface fuel loadings. Fires in this area are extremely difficult to control, pose logistical problems, necessitate wilderness camps, and pose extreme safety hazards to firefighters who are on the line and in camps.

(2) *Fire Behavior:* These stands often burn in patchy, spotty patterns best described as hundreds of spot fires. Regular line construction and burnout efforts are ineffective on fires in this type. Spread is by torching of individual trees or groups of trees with spotting into more individual trees downwind. Retardant is seldom effective. These fires have the potential to wear crews out especially in low relative humidity situations with the constant torching and spotting into new fuels.

Heavy down fuels, deep duff layers, and dense stands can make fire suppression a very laborious process. The key to suppression in this type is having crews limb up all trees with fire under them, to remove the ladder fuels, stop the torching, and spotting into new fuels. Once spread is stopped, water from pumps, engines, foldatanks, and bladder bags can be used to speed up the mopup in deep duff and heavy downed materials under the trees. In heavy bug-killed areas, slash fuel models (12 - 13) are appropriate for fire behavior predictions.

II. SUPPRESSION STRATEGIES AND TACTICS

A. Strategy.

Since both the Great Basin and Southern Mountain areas contain a full spectrum of resource values at risk, fuel types, and terrain features, appropriate strategies utilized during suppression activities will vary depending upon the specific set of conditions for a particular incident. Control-contain-confine strategies will be common between all agencies with objectives defining greater effort in minimizing burned areas as values at risk increase. Strategy will be set by the Escaped Fire Situation Analysis (EFSA), Delegation of Authority, or other direction from the agency administrator. Costs and environmental concerns will have the major effect on strategy in the Great Basin and Southern Rocky Mountains.

1. Direct Attack.

Generally speaking, on most fires within the Great Basin and Southern Rocky Mountains lower elevation fire communities (pinyon-juniper and northern desert shrub-sagebrush), direct attack with handtools and engines can be effective. Direct attack is also effective for higher elevational fuel types depending on the fire intensity. Normally the flame length and spread rates will allow close-in work with equipment. Water and retardant can effectively stop the fire spread. If rekindling occurs, it will happen over a short period of time due to the light fuels. Most failures come from running out of water prior to completing control line. Aerial retardant is

effective in direct attack for establishing line and also for tying engine lines together. Foam units and single engine airtankers dropping foam are becoming more common and are very effective in these light fuels.

The direct attack method is limited by the following:

- Ability to work close-in to the fire (fire intensity), size of perimeter, and number of engines available.
- Availability of water.
- Terrain (maneuverability).

2. Indirect Attack.

In lighter fuels, indirect attack and burning out are a good approach in areas where resource values are low, and fire size isn't a major concern. Indirect attack also becomes an option when direct attack is limited as mentioned earlier.

Indirect attack is also used in higher elevation fuel types to stop the spread of crown fires.

When using an indirect attack, several factors must be considered:

- Natural barriers.
- Roads.
- Burned acreage.
- Timing - Can burnout be completed prior to fire spread reaching predetermined line?
- Availability of resources for firing and holding.
- Methods available to prepare burnout line. Methods of preparing burnout line that have proven effective include:
    - -- Wet line with immediate burnout.
    - -- Engine applied retardant or foam line.
    - -- Airtanker applied retardant line.

NOTE: Indirect lines have to be fired out immediately. CARRY YOUR FIRE WITH YOU! Time and availability determines ignition device used.

Time is critical. Ground and aerial based ignition devices can be highly effective. Terratorches mounted on four wheel drive vehicles offer high utility while aerial devices including the helitorch and plastic sphere dispenser both provide a rapid firing method.

Ground firing by hand is much slower but also effective.

3. Parallel Attack.

This type of attack is used on medium to large sized fires at higher elevations. Intensity of these fires frequently precludes direct attack so establishment of sound anchor points and well timed burnouts makes this method successful.

Again, the full spectrum of tactics is available and will be called into play in this geographic area. As resource values at risk increase, tactics will implement a more aggressive and productive capability of suppression resources.

Common tactical considerations include:

- Night operations - can be highly effective.
- Helicopter rappelling becoming increasingly important.
- Use of natural barriers/fireline location.
- Chemical retardant use and limitations on use.
- Burnout, aerial and ground ignition.
- Coyote tactics.
- Minimum Impact Suppression Tactics (MIST) - should be standard procedure on all wildfires but will be mandatory in all wilderness areas.
- Minimum impact rehabilitation techniques.
- Mopup standards.
- Helispot location and rehabilitation.
- Safety concerns/snag problem areas/evacuation needs.

B. Suppression Resources.

Engines and hand crews are the primary tools in the Great Basin and Southern Rocky Mountains. Most engines are four wheel drive and range in size from 100 to 1,000 gallons in capacity. Foam and retardant capability is becoming common on most engines.

Hand crews are the most common resource utilized on extended attack and team-action wildfires. Use may be limited in some areas due to terrain but hand crews can be extremely effective where terrain limits other techniques. Hand crews require substantial logistical support.

Bulldozer use has decreased in recent years due to environmental considerations but still remains a viable tool when warranted. Shallow soils and arid environments are difficult to rehabilitate.

Helicopters are effective for reconnaissance, personnel movement, initial attack support, supply transport, water, or chemical delivery. Airtanker use in the Great Basin is moderate, airtanker use in the Southern Rocky Mountains is greater although the primary use in both areas is for initial attack. There are numerous airtanker bases throughout this area with the capability for operation of portable refill bases to support large fire suppression activities as needed. In wilderness areas, helicopters will be critically important and large air operations will be common.

III. SPECIAL CONSIDERATIONS OF THE GREAT BASIN AND SOUTHERN ROCKY MOUNTAINS

A. Snakes, Scorpions, and Insects. Rattlesnakes and scorpions can be quite common throughout this area. Special safety instructions should be provided to ensure personnel safety. Yellowjackets, hornets, wasps, ticks, and spiders (tarantulas and black widows) can be encountered also.

B. Access. Generally, four wheel drive vehicles can move over terrain. Some rock outcroppings, steep sided gullies, cliffs, and underground arroyos pose special hazards at night. Loose soil types and rocks can high center vehicles quickly.

Foot travel is difficult. Sprained and broken ankles are possible. Tall sage is difficult to move through. Rapid rates of spread and sudden wind changes create needs for crew awareness, safety zones, and escape routes.

C. Fuel Models. As typical of fuel models described in "History of Fatalities and Near Misses," light flashy fuels have caused more fatalities than any other fuel models. Avoid complacency, all fuel models support fire, and fire is dangerous.

D. Aviation. High elevations and hot temperatures produce high density altitudes. Most fire activity is at, or above a density altitude of 9,000 feet. Helicopter and fixed-wing performance is reduced. Military training routes and special use airspace (especially west desert Utah, southern Idaho, and all of Nevada). Lack of water sources requires heavy water tender support if any major tactical water show using aircraft is planned. Retardant is ineffective in wind-driven fires.

E. Water. Due to high temperatures and direct exposure to sun, water consumption will be abnormally high. Up to two gallons of water per person, per operational period, is often necessary. This requires special efforts to get crews to carry enough water, it is a good idea to also make extra water available on the line. Dehydration is a serious problem if adequate water is not provided. Potable water must be obtained from a safe source due to giardia in many streams.

F. Vehicles. Because of the access and the fuel type, build-up of vegetation on the undercarriage of vehicles often occurs. Undercarriage fires are not uncommon, with fire being spread over a considerable distance before the driver is aware of a problem. Catalytic converters also present a potential ignition device whenever the vehicle is traveling across country.

G. Volunteers. Due to the remoteness of areas within the Great Basin and Southern Rocky Mountains, local ranchers and other parties are often on the fire when fire suppression personnel arrive. This can present a serious safety concern. Volunteers should be released from the fire or provided the necessary personal protective equipment and close supervision, as quickly as possible.

H. Adverse Weather. Rapid changes of temperature from hot to very cold, often with moisture (sometimes snow) can pose a serious hypothermia threat to personnel. Planning should include plastic sheeting to keep crews and equipment dry in the case of rain or snow, fuel for warming fires, and a place where wet, cold firefighters can be taken to dry out and warm up.

When utilizing camps, they should be equipped early on with plenty of plastic sheeting and rations in case bad weather should prevent resupply by air, which happens frequently.

Of particular importance are chinook winds. These winds occur when high pressure systems set up west of the continental divide in the Southern Rocky Mountains. In this situation, winds push up against the mountain range, crest it, and then travel eastward downslope. As they travel downslope, they pick up speed, frequently achieve speeds of 80 -100 mph at the base of the foothills. These winds can drive any fire downslope regardless of the diurnal, upslope wind patterns, and slope interactions (Ouzel Fire, Old Stage Road Fire).

I. Medical Facilities. Medical facilities are few and far between, evacuations for serious injuries will generally be by air.

J. Snags. Insect and disease caused tree mortality has created significant snag areas throughout the timbered areas of this geographic area. Fire suppression personnel should be aware of snag areas and take appropriate actions to minimize exposure to firefighters. Snag-related injuries have been increasing during recent years.

K. Terrain Features. Unique terrain features such as the major river breaks (Salmon, and Snake) can pose specific problems. In these areas, steep slopes and dry fine fuels produce very fast moving fires. Special safety considerations are necessary here in that tactics may have to be modified in regard to crew placement, camp location, and crew movement. Use of coyote tactics can be common also. Numerous instances of shelter deployment have occurred in these river break areas (Ship Island, Butte, and Eagle Bar Fires).