

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
NATIONAL PARK SERVICE  
HORACE M. ALBRIGHT TRAINING CENTER  
Grand Canyon, Arizona

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FOREST FIRE CONTROL

I. INTRODUCTION

A. What is Fire Control

1. Fire Control is defined as all activities concerned with protection of the vegetative cover and structures from destruction by fire. These two fields of fire control operations are vital protection functions and one of considerable concern to area administrators. In this discussion we are primarily concerned with forest fire control, but the two cannot be separated for there are many structures scattered throughout Service areas.

B. History of Fire Control

1. There is no honor attached to the detection and suppression of a fire, if you could have prevented it. A fire prevented is a fire that does not have to be suppressed. Fire has always been considered a menace to Service areas. In reading fire records from the early days of the Service one will find prevention and suppression duties were given considerable attention. The Army and other personnel assigned protection duties were constantly on the watch for fires. It was an integral part of their responsibilities. Fire is a dangerous threat to the primeval values we are relied upon to protect for the enjoyment of this and future generations. When an area with a high fire potential is subjected to the ever increasing visitor travel now in evidence, added prevention programs and staffing are required to provide the protection necessary to hold man-caused fires within allowable standards.

Fire prevention and suppression in many ways adds to protection and workload problems. By preventing and suppressing fires, flammable material such as dead trees and brush are allowed to accumulate on the forest floor.

This creates a reservoir of highly flammable fuels and when the right combination of conditions exist, a damaging fire can occur. We must recognize these conditions and then take steps to make certain all precautions possible are exerted to prevent fires from occurring.

Let's do our part to see that the areas we are responsible to protect will always provide the visiting public with the enjoyments and inspirational values for which they were established and not a blackened and ghostly landscape.

## II. FOREST FIRE CONTROL GENERAL POLICY STATEMENTS

Fires, whether originating from human carelessness or from natural causes, constitute the greatest menace to the enjoyment of national parks and monuments since they not only cause serious injury to the natural beauty of the areas, but may destroy valuable property, including historic objects of priceless value, wildlife, and may even endanger human lives. Therefore, fire suppression takes precedence over all other park activities, except the safeguard and saving of human life.

Policy guidelines authorizes use of heavy equipment for fire-line construction when the fire boss considers it to be the most effective and efficient way to control the fire. Good judgment must be exercised to prevent excessive marring of the landscape.

The use of fire retardants is also authorized. Their use is at the discretion of the fire boss. However, some retardants are soil sterilents and should be used with discretion, especially in high use areas where their application will detract from the esthetic values of the area.

(NPS Administrative Manual, Organization Volume, Part 5)

## III. OBJECTIVES OF FOREST FIRE CONTROL

No matter how insignificant a forest fire may appear at its inception, humidity and wind conditions may combine to develop a small spark into a catastrophic blaze, sweeping over miles of forest and creating utter desolation. This is just as true of fires originating in wilderness areas as those which occur in the more developed areas.

The objectives of fire control are as follows:

- A. Control time in Fire Suppression. To attain fast, energetic and thorough suppression of all fires in all locations, during possibly dangerous fire weather. When first attack forces fail to do this, the policy then calls for prompt calculating of the problems of the existing situation and probabilities of spread, and organizing to control every such fire within the first work period. Failing in this effort, the attack each succeeding day will be planned and executed with the aim of obtaining control before ten o'clock of the next morning.
- B. Man-caused Fires. To reduce the number of man-caused fires to the smallest attainable minimum.
- C. Fire Hazard Reduction. To locate, analyze, and reduce such fire hazards as adequate protection of park areas makes necessary, bearing in mind at all times the maintenance of natural appearance and wildlife habitats.
- D. Fire Control Organization. To make the park fire control organization the best trained, best equipped, and most efficient forest fire control organization in the nation because of the superlative or unique scenic, historic, or recreational values at stake.

#### IV. PREPAREDNESS

##### A. Fire Prevention

Fire prevention is the work done to reduce fire occurrence. Its objective is to eliminate all preventable fires, especially those caused by people who are inexperienced, misinformed, negligent, or incendiary.

Fire prevention is a continuing job. For success, it must first gain full public support by informing people of the reasons and need for fire prevention. Then, with public support, there must be continuous prevention work with people (1) to change human habits and reduce negligence and (2) to discourage and eliminate incendiary whenever and wherever it occurs.

Analyses of past fires give valuable guidance in causes needing prevention treatment, and how and when to do it.

Individual fire causes should be analyzed to determine reasons for the cause, class, and source of persons responsible.

Every effort should be made towards the elimination of man-caused fires inasmuch as a fire prevented from starting is better than a fire suppressed, both in the prevention of damaging fire scars and in the saving of fire suppression and rehabilitation expenditures.

There are a number of ways in which we can promote our prevention program, such as:

1. Contacts with visitors and neighbors adjacent to park.
2. Oral appeals.
3. Salesmanship.
4. Signs.
5. Posters.
6. Motion pictures and slides.
7. Radio and TV.
8. Smoking restrictions.
9. Reduction of fire hazards.
10. Law enforcement closures.

#### B. PRESUPPRESSION

Is that which can be done to prepare for, eliminate or reduce the chances of a fire occurring. Some activities would be:

1. Instructions and fixing responsibility for fire control training.
2. The operation of weather stations, the forecasting system, application of the fire danger rating system including cooperation with the weather bureau.
3. Outline special measures or precautions to be taken during critical fire danger periods or in preparation for extra period fires.
4. Maintenance of structures, facilities and equipment.
5. Construct and maintain fire breaks.
6. Cooperation with other agencies, including mutual-aid dispatching and initial attack zones.
7. Recruiting.
8. Planning and organizing.
9. Procuring equipment, supplies.

## V. TRAINING

Frequent and adequate forest and structural fire control training for field personnel is necessary to develop and maintain the essential skills and organizational efficiency required to prevent major losses from fires. Local area training of three to five days duration is required annually for all physically qualified permanent rangers, fire control aids. All other personnel should be given training in fields of fire control in which they will be expected to participate. Training conducted at regional or sectional levels is also desirable to develop special skills. As a general guide, all training below the level of sector boss should be at the area level.

## VI. PARK FIRE CONTROL PLAN

The superintendent of an area administered by the National Park Service is responsible for the protection of that area. If the area is sufficiently subject to forest, brush, or grass fires to warrant it, the superintendent shall see that a written fire control plan is prepared to help him fulfill his responsibility effectively with respect to control of fires that occur within, or threaten the area.

A fire control plan is a written statement setting forth (1) information needed for a proper understanding of the fire control problems of an area, its available personnel and physical resources for fire control and (2) instructions to personnel as to how manpower resources shall be organized, trained, and directed, and how all resources shall be prepared, used and maintained for effective protection of the area against fire. It prescribes the action to be taken, and by whom, in each phase of fire control -- prevention, presuppression and suppression.

## VII. THE FIRE ATLAS

The Fire Atlas contains maps and statistical data basic to or directly concerned with forest fire control. It is a valuable reference source for information required for all phases of fire control. Fundamental data may be secured for use in developing fire prevention programs. It contains essential information for presuppression plans and activities, particularly forest fire control training. The atlas furnishes background material and specific information needed to develop an organization, to set up operating procedures, to determine equipment and personnel placement, and to plan improvement and facilities required for

adequate protection of the area from fire. Areas should encourage all protection personnel to make full and free use of the atlas as a valuable tool in forest fire control.

#### VIII. COOPERATIVE AGREEMENTS

The fire control plan of a park should be coordinated with those of adjacent protection agencies, and a cooperative agreement entered into, either formally or in memorandum form, which outlines the specific fields in which coordination or cooperation are required. Some of the items which might be desirable for inclusion are:

1. Area to be included and distance to which aid can be sent.
2. Provisions for reporting fires to cooperating agencies.
3. Initial attack - who will make it.
4. Coordination of fire suppression work by the cooperating agencies.
5. Supervision - provision for designation of the fire boss for the areas included under agreement during various stages of fire suppression operations.
6. Furnishing of fire tools and equipment, food supplies, and transportation.
7. Release of fire fighters furnished by cooperators after fire is controlled.
8. Distribution of costs on a prorated basis.
9. List of personnel available for dispatch under the cooperative agreement.
10. Map outlining mutual aid zones, facilities, location of equipment, etc.
11. Provision for cooperative review of large fires on which two or more cooperating agencies participate.

#### IX. COOPERATION WITH OTHER AGENCIES

Cooperation is one of the most important elements in forest fire control. It is essential that we work harmoniously in all of our fire control activities. There will be many occasions when the fire fighting resources of the area are not sufficient to do the job. Then we must look to other fire control organizations for assistance.

Cooperation and good working relations must be carried on at all levels of the organization. By getting acquainted with employees of neighboring agencies, you will be in a better position to know what help can be expected and when. It is also essential

that we make our services and fire fighting resources available to the cooperators. Let's take the initiative and make the contacts now and not wait until emergencies arise.

X. FINANCING

The cost of financing fire control activities is charged to various fire accounts depending on the project and prevailing conditions. A forest fire emergency will not be accepted as an excuse for haphazard or negligent accounting for wages, stores, equipment and other items. While the emergency of a forest fire is fully recognized, it does not waive the requirements for adequate accounting. There are four fire accounts, all are generally used during a fire season:

Account 122 (Fire Presuppression)

This account is chargeable with all the normal costs (not emergency) incident to fire presuppression activities. This includes the pay of all fire lookouts, fire control aids, and other personnel engaged therefor, the maintenance and operation of fire control equipment (except when combating fires), the maintenance of fire breaks, fire tool caches and lookout stations. When engaged in fire suppression work, overtime for the above personnel will be charged to the 3127 account.

Account 3127 (Forest Fire Suppression)

This account is chargeable with all costs incident to suppressing forest fires. Allotments of funds for fire fighting purposes can only be made after the obligations have been incurred. The account is chargeable with all expenses relative to the suppression of forest fires. A separate subsidiary account will be maintained for each fire beginning at the first of each fiscal year with 3127.1, and then 3127.2, 3127.3, etc.

Account 124 (Emergency Fire Presuppression)

This account is chargeable with all costs of emergency (not normal) forest fire presuppression activities. The use of this account is generally based on the Fire Danger Index. Allotment of funds will be made after the obligations have been incurred.

### Account 129 (Fire Equipment)

This account will be charged with the purchase price, including transportation and freight, of all fire control equipment for both forest and building fire control work, except fire extinguishers which are a permanent part of a building and are chargeable to the account benefiting. In new construction they are charged to the construction account.

If purchases are made with operating funds they will be posted as 122 (129). If purchased on a going fire, use the individual fire account number (i.e., 3127.1) followed by (129).

Equipment is Capitalized Major Personal Property and is property which is assigned a property number and generally has a value of \$100 or more. Shovels, pulaskes, back pack pumps, etc., should be reported under other costs on Form 10-400.

## XI. FIRE BEHAVIOR

Every forest fire fighter appreciates weather as one of the most important factors governing the start and spread of fires. When fuels are soaking wet they won't burn. When they are "bone dry" and a strong wind is blowing, the result may be a forest fire of exceptional violent behavior. In between these extremes are a wide variety of weather conditions which need recognition and understanding if meaningful evaluations are to be made of fire behavior and in turn the fire control job.

The location and reaction of a fire dictates the spread, strength, and type of attack necessary to combat the fire. A proper evaluation of the behavior of a fire reduces the possibility of unexpected "blowups and runs." Why does a fire burn fast? Why does it burn slow? Why does it burn so intensely at times? Why does it burn in one direction and not another? Just what is the cause of this varying behavior?

There are many causes and reasons for fires acting as they do, but the primary factors that influence the spread of fire are weather, slope and fuel:

### A. Weather

#### 1. Moisture

- a. Precipitation
  - b. Fuel moisture
  - c. Relative humidity
2. Temperature
- a. Air temperature
  - b. Ground temperature
  - c. Effect on fire fighters
3. Winds
- a. Supplies oxygen
  - b. Aids in radiation and convection heat transfer
  - c. Causes spot fires
  - d. Winds generally greater at tree tops than ground level
  - e. Winds gentler between 0400 and 0700
  - f. Winds blow upslope during day, downslope at night
- B. Topography
1. Exposure
- a. South and southwest slopes have higher temperatures; fuels are sparser, but are drier than north slopes
2. Elevation
- a. More moisture at higher elevations
  - b. Flashier fuels at low elevations
  - c. Warmer at lower elevations
  - d. Thermal belts
3. Steepness of Slope
- a. Fires burn faster on steep slopes
  - b. Fires burn faster upslope than downslope
4. Shape of Country
- a. Narrow canyons are likely to have independent wind currents. Fires are apt to spot across.
  - b. Wide canyons - prevailing winds will not be deflected
- C. Fuels

1. Fuel type
  - a. Flash fuels - fast burning
    - (1) Grass
    - (2) Leaves
    - (3) Pine needles
    - (4) Fern
    - (5) Tree moss
  - b. Heavy fuels - slow burning
    - (1) Snags
    - (2) Logs
    - (3) Large limbwood
2. Fuel Components
  - a. Aerial fuels
    - (1) Tree branches
    - (2) Moss
    - (3) Snags
  - b. Ground fuels
    - (1) Low vegetations
    - (2) Large logs
    - (3) Leaves, grass and limbwood
    - (4) Duff
    - (5) Roots
3. Fuel Continuity
  - a. Uniform fuels
  - b. Patch fuels
4. Fuel compactness
  - a. Loosely packed fuels burn more rapidly

There are five steps in judging Fire Behavior:

- A. Basic knowledge
  1. Principles of combustion

B. Forest knowledge

1. Weather
2. Topography
3. Fuels

C. Aids and Guides

D. Estimate of situation

E. Decision

1. How, when, and where to control

Before ignition or combustion can occur we must have three essentials or elements in proper combination. These three elements are heat, oxygen, and fuel. They make up the fire triangle. If any one of these elements or the leg of the triangle is removed there can be no fire.

A. To remove heat

1. Apply water or dirt to the fuel

B. To remove oxygen

1. Smother with dirt
2. Fire swatters, fir boughs and gunny sacks can be used in fine fuels

C. To remove fuel

1. Separate
2. Cut fireline

In order for combustion to continue, heat must be transferred to other fuels. This can be accomplished in three ways:

A. Radiation

1. Heat from heating stove (example)
2. Travels in straight line
3. Radiant heat transfer decreases inversely with the square of the distance from the fire
4. Slope and wind influence the amount of heat transmitted

B. Convection

1. Example - hot air furnace
2. Hot air rises
3. Tree crowns receive heat through convection

C. Conduction

1. Not very important in forest fires
2. Wood is a poor conductor of heat

The firefighter that understands fire behavior is a safe firefighter. The most dangerous man on a fire line is one that has fear of a fire. If a firefighter has a basic knowledge and the leaders a high degree of knowledge of fire behavior there is no need for fear. A good understanding of fire behavior will prevent many fires from developing into project size.

XII. PRINCIPLES OF FOREST FIRE CONTROL

Forest fire is one of the greatest enemies to the vegetative cover of National Park Service areas. The type of suppression actions taken on the initial attack will generally determine the final size of the fire. If we are to protect and maintain these areas in the condition stated in the Act of 1916 creating the National Park Service we must apply all the best strategic and tactical fire control methods known. It behooves all employees involved in fire suppression to have a good understanding of the principles of fire control so that sound and timely decisions can be made. The fire boss, on arrival of a fire, must decide what to do, where to start control action and how to control a fire. Before any action is taken the fire boss or first man on the scene should sizeup the fire. This can be made while walking or flying to a fire and/or going around it upon arrival. Factors to be considered are:

- A. What fuel is burning
- B. What fuel is in the path of fire
- C. Are there natural barriers
- D. Topography
- E. What are the primary values endangered
- F. Spot fires
- G. Weather conditions
- H. Time of day
- I. Danger spots
- J. Safety of men

## K. Cause of fire

After the sizeup the method of attack must be considered. It is to be a Direct or Indirect attack or a combination of both.

Direct Attack is a method of suppression that treats the fire as a whole, or all its burning edge, by wetting, cooling, smothering, or chemically quenching the fire or by mechanically separating the fire from the unburned fuel. Under this method a line should be constructed from finger to finger of the fire, thus keeping the line as short as possible and reducing the chance of losing fire line.

Indirect Attack is a method of suppression in which the control line is located by using natural firebreaks, favorable breaks in topography, or at a considerable distance from the fire and the intervening fuel is backfired or burned out.

Once a decision has been made on the method of attack to be used we must determine the location of the fire line. The method of line construction is dependent on topography, vegetative cover, weather, etc.

### A. PRINCIPLES OF LINE LOCATION

1. Locate near fire edge
2. Make line short as possible
3. Locate line so rolling material cannot cross
4. Locate line to give time for line construction and backfiring
5. Locate lines to give uphill start to backfiring
6. Leave hazard types outside of line if possible
7. Enclose burning snags
8. Locate line so as not to trap men
9. Use existing barriers
10. Avoid sharp angles in line
11. Select most open area for line location
12. Use oblique lines for frontal attack to pinch in the head of the fire, rather than a line squarely in front of fire
13. Take advantage of normal daily shift between up-canyon and down-canyon drafts
14. Encircle area where spot fires are so numerous as to make impractical to handle as individual

### B. PRINCIPLES OF LINE CONSTRUCTION

1. Make line no wider than necessary
2. Clean all lines to mineral soil
3. Scatter burned material inside fire line
4. Scatter unburned materials either inside or outside, depending on the condition
5. Protect undercut lines against rolling material
6. Use dirt or water to cool down fire along fire line
7. Cover rotten logs or stumps that are just outside of fire line

C. SPECIAL LINE CONSTRUCTION METHODS

1. Cold trailing - "A method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand to detect any fire; digging out every live spot, and trenching any line edge."
2. Feeling out - "Examining burned material after fire is apparently out and feeling with bare hands to find any live coals."
3. Hot spotting - "Checking the spread of fire at points of more rapid spread or special threat."
4. Backfiring - "Fire set along the inner edge of a fire control line to stop a spreading wildfire by reducing the fuel or changing the direction of force of the fire's convection column."
5. Burning out - "Setting fire inside a control line to consume fuel between the edge of the fire and the control line."

D. MOFUP

"The act of making a fire safe after it is controlled, such as extinguishing or removing burning material along or near the control line, felling snags, trenching logs to prevent rolling, etc."

E. PRINCIPLES OF MOFUP

1. Start work as soon as possible
2. If it will do it safely and promptly, let fuel burn up
3. All fire should be extinguished on small fires
4. On large fires, extinguish all fire adjacent to line to

be certain that no fire can blow, spot, or roll over the fire line.

5. Search for smoldering spot fires
6. Spread all smoldering material that is not put out with water or dirt
7. Eliminate or make safe rotten logs or snags
8. Dig out burning roots along line
9. Separate masses of large fuels
10. Fall snags that are on fire
11. Place rolling material so it cannot roll downhill
12. Dig trenches below heavy materials to keep from rolling
13. Feel for smoldering spots (with bare hands)
14. Whenever available, use water
15. Cut out partially burned clumps of brush or reproduction close to fire line

#### F. PATROL

1. Patrol is part of the mopup action
2. Each man should have a definite area to work, and some type of communication
3. Patrolmen should work on dangerous spots as well as watch them

### XIII. ORGANIZATION AND MANAGEMENT OF FIRE SUPPRESSION OPERATIONS

Organization, as used here, is the arrangement of personnel and equipment into a fire suppression team. Management is the art of controlling and directing this team to suppress fires. It includes (1) getting the facts, (2) deciding on a plan of action, (3) obtaining necessary men and equipment, and (4) suppressing the fire.

Organization, balanced in all phases is essential and vitally important to successful fire control operations. Organization of men and equipment by sectors, and the fire as a whole, is a specific and important function on all large fires. Detailed written instructions must be prepared for all key personnel in the fire control organization. It is generally necessary to organize quickly, using personnel unaccustomed to working with each other in a fire situation. Under these conditions delegated responsibility and close supervision is required to assure success.

The size of the fire measured in terms of its perimeter is not the controlling factor when determining the organization needed

for control. Nor is the area of the fire the primary factor to consider when organizing for control. Some fires, 1,000 to 5,000 acres in size, have been controlled by 25 to 50 men while others from 500 to 1,000 acres in size have required from 200 to 400 firefighters for control. Obviously, the organization for the 5,000-acre fire would be simple compared to the organization for the fire having a job load requiring 200 to 400 men. It is the responsibility of the fire boss to determine the size and complement of his organization.

The fire job load for each segment of the perimeter requiring control, measured in terms of what is needed to quickly and efficiently control the fire, correlated with fire behavior and terrain features, is the determining factor when estimating the organizational requirements for control. The fire control organizations vary for each fire and can generally be broken down into the following categories:

- A. Small crew fire (six line workers/shift)
- B. Medium crew fire (14 line workers/shift)
- C. Large crew fire (21 line workers)
- D. Multiple crew fire (63 line workers)
- E. Two sector fire (126 line workers)
- F. Three sector fire (189 line workers)
- G. Two division fire (370 line workers)
- H. Multiple division fire (945 line workers)
- I. Zone fire (at least two divisions)
- J. Coordinator fire situation

Fundamentally, controlling a large fire is the same as controlling a small one. One man, the fire boss, is in charge of the whole job, but it takes many men and more machines to do the job.

Firefighting is based on these fundamental principles:

- A. Organize within the basic functions of command, line, plans, service and finance. Fill positions only as needed.
- B. Organize to give proper control and direction to both personnel and equipment.
- C. Every fire will have only one fire boss at a time.
- D. The main functional heads, that is, fire boss, line boss, service chief, plans chief, and finance chief, may have assistants but the heads will retain their responsibility unless specifically delegated to others during rest periods. Duties of vacant positions will be absorbed by the functional

heads or assigned to others in the organization.

Fire job titles have been assigned with a view to uniformity while preserving traditional and commonly used titles. Nationwide use of these job titles is necessary to insure Servicewide understanding.

Firefighters having line or tactical authority are called bosses. The heads of the plans, service, and finance sections are called chiefs. Personnel reporting directly to chiefs are called officers. Personnel reporting to officers are called managers, with some exceptions as timekeepers, cooks, photography interpreters, line scouts, line locators, and line inspectors.

#### XIV. REPORTS, REPORTING, AND TIMEKEEPING

The value of good reports cannot be overemphasized. They are an essential document in analyzing and evaluating fire history occurrence, fire seasons, initial attack time, suppression cost data, etc. Correct detailed recordings in fire reports is the factual information needed to maintain the fire atlas as a ready reference source.

The timekeeper functions in a position where discretion must be exercised on all time determinations and postings. Many firefighters consider fires as a way to supplement their income, and it is often abused. An efficient timekeeping operation, with the controls applied that are delegated to the position, can make an economical fire operation that otherwise would be costly and questioned.

On large fires, commissaries are generally established and the posting of purchases to the firefighters' timeslips is the responsibility of the timekeeper.

#### XV. TRAVEL - PER DIEM - OVERTIME

Travel and per diem are authorized when traveling to and from a fire outside of your home area. The per diem rate while on the fire is reduced by 15% for each meal and 30% per day for lodging. A sleeping bag constitutes lodging. Overtime will only be paid while in travel status, if you are driving heavy equipment or are en route as a liaison officer in charge of organized crews.

While on fires, overtime is paid at the same rate as it would

be if you were on overtime in your home area.

#### XVI. CLASSIFICATION OF FIRES BY SIZE

All reportable fires fall into various categories according to the total burned area. This information becomes valuable when plans are formulated for manpower and equipment requirements for prevention, presuppression and suppression action.

In determining the area of a Class A fire (up to 1/4 acre) it is important that we be exact in our measurements and final determination, especially when it approximates the Class B fire. The acreage of small fires can be obtained by pacing and visual blocking of the burn. By doing this and forming a triangle, rectangle or circle one can get the square footage burned with a relatively small percentage of error. If the fire area is less than .01 acre (435 square feet) it should be expressed in square feet.

##### Size Class Fires

Class A (0.25 acre or less)

Class B (0.26 acre to 10 acres)

Class C (10.1 acres to 100 acres)

Class D (100.1 acres to 300 acres)

Class E (300.1 acres to 1,000 acres)

Class F (1,000.1 acres to 5,000 acres)

Class G (Over 5,000 acres)

#### XVII. FIREFIGHTING EQUIPMENT

##### A. Helicopter in Forest Fire Control

The helicopter has proven to be a very versatile tool in fire control operations. It has cut down initial attack time to where it is now possible to suppress many fires with little or no acreage burned. It provides ready access to most sections of the fire, it provides close observations of fire behavior, terrain, vegetative cover and possible control lines. Men and equipment can be moved to almost

any part of the fire. Fire retardants can be dropped where conditions prevent fixed wing aircraft operations. We could go on listing the uses of the helicopter. However, there are also some limitations. They can only operate during daylight hours. Fog and cloudy conditions will ground them. Turbulent and/or strong winds will force shutdowns. The pros and cons must be weighed whenever we consider this tool. It has its place in fire control and can be used to good advantage.

B. Cargo and Fire Retardant Aircraft

This type of aircraft requires an airport to operate from and the operations are generally handled by cooperating agencies. Firefighting personnel must be aware of safety guides when this type of aircraft is being used.

When fire retardants are being dropped all other aircraft must clear the air in the vicinity of the drop zone. Personnel on the ground should be clear of the drop zone and away from snags or loose rocks. If caught in the drop zone, toss fire tools away or downhill side, lie down, bury face in arms, hard hat on and face direction from which the plane is coming. Cargo drop areas should also be cleared when drops are being made.

C. Power equipment

All power equipment must be maintained in top condition at all times. Operational instructions should be given whenever there is doubt of the operator's capabilities.

D. Small tools

Maintain in top condition at all times and see that maintenance equipment and tools are available in fire camps and on the fireline.

XVIII. FIRE RETARDANTS

It must be remembered that this is just another tool in forest fire control. It is also a very costly tool and must be backed up by firefighters on the ground, ready to complete the control operation. It is generally considered a means of "buying time," that is, giving firefighters a chance to get to the fire, or knocking the fire down so that control action can be taken along

a predetermined route.

When considering the use of retardants the resultant effect must be realized. Will the scar be greater from the application of the retardants than from the fire if controlled by ground efforts. This is very important when fire occurs near roads and are readily noticeable by the visitor in high use areas.

XIX. THE WILDLAND FIRE DANGER RATING SYSTEM

This system is designed to estimate the relative effects of weather on the several aspects of fire behavior -- fire spread, fire intensity, and fire ignition. The effect on spread and intensity is combined to form the Burning Index on a scale of 0 to 100, which is then a relative measure of the job load per fire. The Ignition Index, also a scale of 0 to 100, indicates the effects of weather on fuel ignitability and is a relative measure of fire probability. Combining the Burning Index and the Ignition Index into a Fire Load Index, again on a 0 to 100 scale, produces a relative measure of the potential job load per day.

This system was developed in California but will probably be adopted by many other Forest Service and Park Service regions during the coming years.

Fire weather is taken in all Service areas that have a forest fire problem. It provides the area with local weather data and also provides the Weather Bureau with data for area and/or district rating which will give a general fire danger index.

The obtaining of fire weather data requires little time and effort. The data you obtain is essential to planning fire control operations. When forest fires are burning it is best to obtain fire weather as near the fire as possible. This will give you information directly related to the conditions in which you will be working. The timing of fire weather data collections should be scheduled to provide a sample representative of the general prevailing conditions during periods of high fire potential. Weather taken at 0800 and 1600 do not give the maximum temperature nor do they necessarily give the strongest winds encountered during the day.

XX. LAW ENFORCEMENT

On man-caused fire every effort possible should be made to

determine the cause and apprehend the violator. This can be accomplished in a number of ways, but should not be to the detriment of fire suppression activities. It may consist only of preserving the scene for investigation at a later time. It can also result in vital clues being obtained on the way to a fire; i.e., car leaving scene, hikers in area, fishermen, etc. Law enforcement should always be considered on all man-caused fires.

## XXI. SAFETY

Safety will receive top priority in all phases of the firefighting operation. Safety of the men will be considered and discussed with firefighters at the start of each shift.

There is no place for showoffs or haphazard performances when working with fire tools. Be on the alert. Watch out for others and promote safety at all times. Safety will be covered in the discussion of each subject as it applies to the operation.

The most dangerous individual in a suppression organization is usually the man who is afraid of fire. Fear is largely a result of ignorance. Many risks can be eliminated from firefighting if each man knows what to expect the fire to do. The average firefighter need not be an expert on all phases of fire behavior, but he should have a working knowledge of ignition, combustion, and rate of spread of fires burning in forest fuels. Equipped with such basic fire behavior "know-how" the individual firefighter can approach his job without fear and with confidence that he can perform required duties in a safe and efficient manner.