FOREST FIRE SUPPRESSION

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INTRODUCTION

Prompt, efficient forest fire suppression is a huge problem confronted by the foresters today. The damages caused by forest fires each year is tremendous. This problem is one that should be the concern of each and every citizen and one not solely the interest of foresters.

Fire control is a job requiring accurate selection of the practices shown by experience to be most effective in meeting particular problems. It is in every sense a professional job, in which thorough knowledge of methods and practices is essential.

This report is intended to be a review of the important items involved in actual fire suppression. It is by no means complete in every respect, but an endeavour has been made to cover the subject in a brief, concise manner.
FOREST FIRE SUPPRESSION

OUTLINE
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OUTLINE

INTRODUCTION

I. Fire discovery, locating, and reporting.
   A. By lookouts
   B. By patrolmen
   C. By other protective personnel
   D. By cooperators

II. Fire dispatching
   A. Securing and recording essential fire information
   B. Checking and platting information
   C. Formulating plan of initial action
   D. Contact, instruct, and dispatch initial force.
   E. Contact and instruct follow-up crew
   F. Contact and inform proper superior officer of fire and action taken
   G. Check on condition of fire
   H. Re-man positions vacated for initial action
   I. Plan follow-up action if necessary
      1. Men
      2. Supplies
      3. Equipment
   J. Contact, instruct, and dispatch follow-up as needed
   K. Cooperate with the fire chief as needed
   L. Keep accurate records and accounts of all essential fire information
   M. Notify cooperating agencies of the time of return of their men and supplies.
III Getting to the fire.

A. Record necessary information
B. Check force, supplies, and equipment
C. Leave for the fire
D. Travel to vicinity of the fire
E. Finding the fire
   1. Getting on the Lookout's line of sight
   2. Gridironing
   3. Locate oneself in the field in reference to landmarks and then compute compass reading to the fire
   4. Tangent offset method

IV Planning and organizing attack

A. Sizing up fire behavior
   1. Fuels
      a. Moisture content
      b. Quantity
      c. Quality
   2. Weather conditions
      a. Wind
      b. Relative humidity
   3. Topography
   4. Time of day
   5. Influences of the season of the year
      a. Soil moisture
      b. Length of the day
      c. Length of the night
      d. Nearness of storms, amount of dew

N. Submit final fire report.
B. Planning attack

1. Note critical points
   a. Fire approaching more dangerous fuels
      1. Smgs
      2. Blowdowns
      3. Mossy areas
      4. Slashing areas
      5. Fern patches
      6. Steep grassy areas
      7. Brush areas
      8. Sawdust piles
      9. Peat bogs
     10. Old burns
   b. Fire approaching more dangerous topography
      1. Steeper, rougher, more hazardous areas
   c. Fire approaching areas of greater resistance to control
      1. Rocky country
      2. Lava beds
   d. Fire approaching more valuable areas
      1. Home sites, improvements
      2. Valuable timber or cover types, watersheds
   e. Fire approaching areas susceptible to more hazardous weather conditions
      1. Getting out of fog belts, etc.
   f. Spot fires

2. Nature of ground and cover

3. Natural aids
4. Length of line to be build and line location
5. Resistance to control
6. Methods to be used in attack
7. Man power and equipment on job
8. Need for additional men and equipment
9. Look for camp-sites, sources of water, and traces
   of evidence for law enforcement
10. Decide which is the most vital point and begin
    attack

V Executing plan of attack

A. FIRE FIGHTING

1. Hot spotting salient points
2. Line location
   a. Resistance to control
      (1) Topography
      (2) Soil
      (3) Cover type
      (4) Barriers
   b. Rate of spread
      (1) Barriers
      (2) Fuel
      (3) Topography
      (4) Weather
   c. Values
      (1) Timber
      (2) Improvements
      (3) Watershed
d. Safety of men
   (1) Pick safe places (watch cliffs, etc)
e. Forces available
   (1) Condition of men
   (2) Equipment
   (3) Number of men
   (4) Efficiency of men

3. Line construction
   a. Methods
      (1) Progressive
      (2) Assignment
      (3) Passing
      (4) Motorized
      (5) Cold trailing
      (6) Horsedrawn
      (7) Water
   b. Standards
      (1) Width of line
         (a) Snag line
         (b) Tree line
         (c) Brush line
         (d) Duff line
         (e) Mineral soil line
      (2) Cross-sectional appearance
         (a) Conventional
         (b) Cupped
4. Back firing

a. Purpose of backfiring
   (1) To rob the fire of fuel
   (2) To save time
   (3) To save labor

b. Safety of men
   (1) Adequate supervision
   (2) Always know route of retreat
   (3) Minor safety precautions

c. Setting the backfire
   (1) Place
      (a) Highest points usually set first.
      (b) Set so as to burn toward the fire
         ((1)) On hill
         ((2)) More than one setting
         ((3)) Utilize drafts
         ((4)) Adapt backfire to special topographic conditions
      (c) Utilize control line and natural barriers to utmost
   (2) Time
      (a) Set fire when burning conditions are favorable
         ((1)) Humidity
         ((2)) Wind
         ((3)) Etc.
      (b) Set fires so as to utilize drafts
      (c) Set backfires as soon as practical
         (after line if you construct one--might use fire breaks)
(3) Method

(a) Torches
(b) Bombs
(c) Fuses
(d) Matches
(e) Burning material

d. Control of backfiring

(1) Technique

(a) Set only amount you can hold
   (1)) Small amount of fire
   (2)) Large amount of men
(b) Under adverse conditions use dirt or water as aids in holding backfire
(c) Adapt backfire practices to special topog. conditions
(d) Chances must frequently be taken in backfiring under adverse conditions (safety of men considered)
(e) The best special tools available should be supplied and used

(2) Equipment

(a) Shovels
(b) Pumps
   (1)) Hand
   (2)) Machine--gravity, marine, etc.
(c) Torches
5. Mop up

a. Objectives
   (1) To put out all fire on small fires
   (2) To make fire safe on very large fires

b. Methods of making the fire safe
   (1) Burning fuels
       (a) Those subject to reburn
       (b) Those dangerous but not yet burned
   (2) Putting out fires with dirt
   (3) Putting out fires with water
   (4) Falling snags
   (5) Scattering fuels
   (6) Rechecking fires
       (a) Roots under lines
       (b) Look for spot fires

c. Technique of mop up
   (1) Technique used on burning fuels
       (a) re-arrange and trench logs and other
           large materials so they will not roll
           or scatter embers across the fire line
       (b) Chunking up, if feasible, so material
           will burn faster
       (c) Digging fuels out so as to speed up
           burning.
       (d) Allow fuel to burn up if it will do
           so promptly and safely
       (e) Do not leave partially burned clumps
           of brush or reproduction close to
           fire lines
(f) Burn only amounts that can be held safely with facilities available

(2) Technique in the use of dirt in mop up
   (a) Dirt may be used to cool down hot spots so they can be worked on easier
   (b) Dirt may be used to prevent ignition of stumps, logs or other heavier material outside but adjacent to the line
   (c) May be used to put out fires by smothering it—later dig out material
   (d) Be sure dirt is clean, mineral soil

(3) Technique in the use of water in mop up
   (a) May be used to cool down hot spots
   (b) Used with back pumps for putting out fire out of ordinary reach
   (c) Burning material should be mixed or stirred up when using water
   (d) Use water carefully in places where it will do the most good
   (e) Water should be used whenever possible
   (f) Use springboards or spurs to use water in putting out short snags

(4) Technique in falling snags in mop up
   (a) All dangerous snags either inside or adjacent to fire must be felled
   (b) If it is impossible to fall a burning snag in a safe place, prepare a place for it to fall that is safe
(c) Throw snags so as to remove them as far as possible from a hazardous location
(d) Use a three man falling crew for safety

(5) Technique in scattering fuels in mop up
(a) Spread, rather than bury, smoldering fuels that cannot be put out
(b) Separate masses of large fuel to reduce heat and danger of spotting
(c) Spread concentrations of hazardous fuels adjacent to fire line if deemed feasible

(6) Technique in re-checking fires
(a) Search for smoldering spot fires ahead of the main head of the fire
(b) Search for burning roots that may carry fire under the control lines
(c) Feel with hands for possible smoldering spots

(7) Miscellaneous techniques in mop up
(a) Start work on each portion of line just as soon as possible
(b) Eliminate promptly, both inside and outside of lines, all special threats, such as snags, rotten logs, stumps, and singed brush
(c) On small fires, all fire should be extinguished in the mop up, where quantities of burning material are not so large as to make this obviously impracticable.

(d) On large fires, mop up completely enough of the area adjacent to the line to be certain that no fire can blow, spot, or roll over the fire line under the worst possible conditions.

(e) Systematic work plan

(f) Adequate supervision

d. Equipment used in mop up

   (1) Back pumps, pumps, tankers, etc.
   (2) Shovels, saws, pulaskies, etc.
   (3) Torches, flares, etc.

6. Patrol

a. Objectives of patrol

   (1) To keep watch on the fire lines and danger points to see that no fire escapes
   (2) To do actual mop up work when feasible

b. Establish patrol as soon as needed

c. Techniques of patrol

   (1) Designate definite beats for each member of the crew
   (2) Designate special danger points
   (3) Work on hazards as well as watch them.
(4) Search systematically for fire outside of the line
(5) Arrange system of communication to call for help
(6) Place lookouts for definite areas when needed to watch for flare-ups and spot fires
(7) Be on the alert and change the patrol beats as may be frequently necessary or feasible.
(8) Keep in constant touch with mop up crews
  d. Equipment used in patrol:
    (1) Axe, shovel or pulaski
    (2) Lights

7. Releasing forces from the fire (Objectives)
   a. To keep costs to a minimum
   b. To allow for re-manning of protective positions
   c. To permit forces to go to other more serious fires
   d. To increase efficiency of organization
     (1) To relieve exhausted forces with fresh men
     (2) To give other men experience
     (3) To eliminate undesirable men
   e. To fulfill contracts with cooperative organizations

8. Abandoning the fire
   a. Definition: Release of all residual forces
   b. Procedure in determining time of abandonment
     (1) Check inside of the fire within threatening distance
        (a) All snags and spike tops felled
(b) Logs and chunks
(c) All stumps
(d) All unburned patches
(e) All brush and reproduction with scorched dry crown
(f) All smouldering litter, duff, rotten wood, etc.
(g) All craters left by burned-out stumps filled with dirt and tamped down

(2) Check the fire line
(a) Continuous, clean line is built to mineral soil
(b) No burning or smouldering material left along fire edge
(c) No unburned patches against line
(d) Trench constructed on undercut lines on steep slopes

(3) Check outside of the fire line
(a) Ground has been covered systematically in zone surrounding fire.
(b) Zone near line has been checked for surface roots which may come from stumps burned just inside the fire
(c) Spot fires have been completely extinguished
(d) Lava cracks or rock fissures have been followed up and checked

c. Release all men and arrange for periodic checks if conditions warrant it.
B. SCOUTING

1. Definition
2. Importance of scouting
3. Line of authority
   a. Chief of scouts
      (1) Air scouts
      (2) Ground scouts
      (3) Draftsmen
4. Organization of scouting system
   a. Gathering information
   b. Assembling information
   c. Checking information
   d. Using information

C. SERVICE OF SUPPLY (S O S)

1. Definition
2. Line of authority
   (See next page)
3. Functional organization of SOS
   a. Furnish and maintain suppression force strength
      (1) employ, release, and fire the fire fighters
      (2) Obtain best available forces
   b. Furnish and maintain transportation
      (1) Arrange for all transportation to and from fire of both men and equip
2. Line of authority (See page 14)

- Fire Chief
  - Asst. Fire Chief
  - Camp Boss
    - Time Keeper
    - Chief Cook
    - Equipment Mgr.
    - Doctor
    - Communication Man
    - Transportation Agent
    - Misc. Helpers
  - Canteen Man
    - Asst. Cook
    - Filer, Helper
    - Sanitation Asst.
  - Funkies
    - Administrative Asst.
    - Warehouse Chief
    - Transportation Agent
    - Communication Chief
    - Employment Agent
  - Protective
    - Asst.
  - Purchasing Agent
  - Paymaster
  - Steward
    - Cargo Chief
    - Head Warehousemen at Ranger Station
    - Packer Boss
    - Helpers
    - Packers
(2) Types used
   (a) Motor
   (b) Animal
   (c) Air
   (d) Other

c. Furnish and maintain subsistence of men
   (1) Food
   (2) Mess gear
   (3) Canteen equipment

d. Furnish and maintain food and equip. to animals used
   (1) Hay, oats, etc.
   (2) Saddles, bridles, alforjas, etc.

e. Furnish and maintain communication facilities
   (1) Radios and supplies
   (2) Telephone and supplies
   (3) All other types used.

f. Furnish and maintain all necessary property needed
   (1) Camp equipment
   (2) Fire fighting tools and equipment
   (3) Bedding
   (4) All repairs and incidentals

g. Furnish and maintain necessary maps and record equipment.
   (1) Maps of the area
   (2) Bookkeeping supplies and others.
FOREST FIRE SUPPRESSION

FIRE DISCOVERY, LOCATING, AND REPORTING

BY LOOKOUTS

Lookouts usually are the most integral part of any detection system. It is their most important duty to detect fires as soon as it is humanely possible. The entire phase of fire suppression hinges around prompt, efficient detection. Lookouts are always situated on vantage points where the most efficient detection is possible. These men must be on duty all day and even at night if necessary.

The lookout must be intimately acquainted with the area he covers. As soon as he detects a fire, he must swing into action. Minutes count, so he must be trained to a high peak of efficiency. His actions must be rapid, yet very accurate. Experience and practice, therefore, are essential. He must be very careful in taking his azimuth and vernier readings and in locating the fire in its proper place on the map. While speed is essential, he should not hurry so as to report inaccurate information. All lookouts have a detection form to fill out when reporting a fire, and these reports should be filled-in with all the required information before reporting the fire to the dispatcher.

One of the lookout's duties is the maintenance of his communication system. The system should be in proper working
order at all times. When he has the fire located, and all other essential information noted, the lookout must immediately report the information to his headquarters. He must give the information in a clear and concise manner. After he has transmitted all essential information, he should stay near his phone or "stand by" on the air in case he is called back. He should, at this time, check over his report to see that the information is correct. He also should keep careful note of the fire and study its progress. The lookout must be dependable and must act many times on his own initiative.

BY PATROLMEN

Patrolmen are very effectively used on many areas under bad weather conditions to aid in detection. On some areas patrolmen are regularly employed during the entire fire season. Patrolmen are a mobile form of detection and usually have definite areas to patrol. Patrolmen must be alert at all times. They usually carry their communication system with them; either as short wave radios or emergency buzzer phones. When a fire is sighted, a patrolman many times can tell its exact location by direct observation. However, the majority of times this is not possible. If this is the case, the patrolman must first make sure of his exact location on the ground. When he knows his location, he can take a compass reading on the fire. When carefully done, these readings are almost as accurate as azimuth readings from a lookout and for all practical purposes can be accurately platted in the office. A patrolman must possess good judgement and should know as
much essential information as possible when reporting the fire. Patrolmen are usually sent to the fires they discover, so it is likewise important that they stand by for dispatching instructions.

BY OTHER PROTECTIVE PERSONNEL

Sometimes fires are picked-up by other protective personnel such as rangers on inspection trips, etc. Many times it is the case that these men are not equipped with compasses and the accurate location of the fire depends upon their good judgement. These men usually are well acquainted with the country and can furnish accurate information to the dispatcher.

BY COOPERATORS

It is heartening at times to have the cooperation of the public, sawmills, logging companies and other agencies aid in the reporting of fires. While the information furnished is at times general and incoherent, it is certainly valuable. Upon the receipt of such information, the dispatcher should express his gratitude in a tactful manner. Cooperation of this type certainly is to be encouraged.

FIRE DISPATCHING

The key-man in the suppression organization is the dispatcher. He must be a man of keen judgement and be able to stand up under a heavy load. He should have a good background of fire experience and understand the principals of fire behavior.

The dispatcher has many duties and a great amount of responsibility. He is the coordinator of detection and
suppression activities. He must secure and record all essential fire information as he receives it. After receiving the initial fire information, he should check with other men on the protection force whom he thinks may be able to see the fire. Panoramic photos greatly aid the dispatcher in this work and they should be used. This must be rapidly done, as no time can be lost. After receiving sufficient information, he should plot the fire on his plating board to obtain its correct location.

The dispatcher must be very resourceful and immediately formulate his initial action. He must send the man or crew that can get to the fire in the shortest length of time, and not necessarily the force that is closest to the fire. Upon the formulation of his initial action, he must contact and instruct the initial fire force. He must give clear and concise instructions and make sure he is understood. Any information that will aid the initial force in prompt, efficient suppression should be given. After receiving all essential instructions and help, the initial force must leave at once for the fire.

After the initial force has been sent to the fire, the dispatcher must formulate his follow-up plan of action. His follow-up forces should be contacted and informed of the fire and given instructions. The dispatcher probably will want them to "stand by".

The dispatcher must inform his superior of the fire and also tell him the size, location, and what action has been
taken as soon as he can after his initial action has been taken. His superior will be able to advise and help him. It is usually the case that the superior will want to go to the fire and will then leave the dispatcher in charge of the office.

The dispatcher should keep in close touch of the conditions on the fire by frequent contacts with lookouts or other personnel who can see the fire. He must find out immediately if follow up action will be necessary. The dispatcher is usually dependent upon the advise of lookouts or others who can see the fire as to whether or not additional forces will be necessary. The necessity of follow up depends upon many factors. If the dispatcher is at all doubtful about sending a follow up force, he should by all means send it. Follow up forces means supplies and equipment as well as man power.

If follow up is necessary, the men or crews must again be contacted and given as much information as is necessary. As soon as the follow up has been instructed, they should be dispatched to the fire.

If any of the regular protective force has been sent to the fire, the dispatcher must plan to re-man their positions as soon as he can. His pre-suppression plan will indicate to him the men that are available in such emergencies.

On any going fire the dispatcher must cooperate as much as possible with the fire chief or man who is in charge of the fire. He must send the supplies, equipment, and man power requested. The dispatcher should keep in constant touch with
the suppression forces in order to keep abreast of the conditions on the fire.

One of the important duties of the dispatcher is to keep accurate, "up-to-the-minute" records of the fire—action taken, progress, statistics, conversations, etc. A dairy should be kept so that a story of action—taken on the fire will be known.

After the fire has been controlled and mop up is progressing, the dispatcher should inform any cooperating agencies the time of return of their men and equipment. It may be that they are needed on another fire and they should be made available as soon as practical.

After the fire is out, the dispatcher has to make a final report of the fire. He has to give all essential information such as the area of the fire, values destroyed, number of chains of fire line built or lost and much other information. If the dispatcher has kept good accounts of the fire, this will greatly aid him.

GETTING TO THE FIRE

In going to any fire it is of the utmost importance that all necessary information be written down. In any emergency such as this, it is too easy to forget important details if not recorded. The fireman or crew leader should make it his business to know the country; i.e., routes of travel, topography, local landmarks, etc. Often times, however, the dispatcher will be able to give valuable and helpful information. Arrangements for communication of some sort from the fire must be made so that an accurate picture of the fire, conditions, and behavior will be known to the dispatching force.
At all times during the fire season, fire fighting equipment should be kept in excellent condition. Outfits should be assembled so that they can be easily obtained in any emergency. Before leaving for any fire, the equipment must be carefully, yet quickly checked. Fires on some locations may require additional equipment to supplement the standard fire fighting outfits. It must be remembered, however, that the time to "hit" a fire is when it is small and a single wasted minute in get-away time is inexcusable. Dispatching and especially get-away action must be the result of a well planned study. The carrying out of this plan must be a simple routine in which all men participating are thoroughly familiar.

Travelly to a fire is an action that receives very little consideration; it is taken too much for granted. The crew or fireman will be of inefficient use unless they reach the fire in a conditions which will enable quick, efficient, common sense action on the fire. Foot travel to a fire should not be so rapid that the crew upon reaching the fire is "all worn out." Often fires are in back country where vehicles cannot be used and many miles on foot must be covered to reach the scene. A good steady pace should be enforced as much as possible. Night travel should always be done with lights and lead by a man familiar with the country.

In country where roads and trucks can be used, the driver should drive at a safe speed, because your crew will be of little use if they have an accident and never reach the fire. On many fires chances must be taken, but safety must
always have a consideration.

When travelling to the fire, the fireman or crew leader should be "taking stock" of the situation. In a few cases the plan of attack can be formulated before the crew reaches the exact scene of the fire. The leader must be alert and notice any conditions or situations that may aid him in the suppression of the fire. Water and camping places should be noted, and any law enforcement information or evidence should be obtained and preserved. This, however, should not interfere with rapid, steady progress to the fire.

Many times the fire, upon reaching its given vicinity, can readily be seen and the fireman can go right to it. However, more often this is not the case. The fireman, then, must use his initiative and good judgement in using one of the many ways to find the fire. He may go to a vantage point, climb a tree, gridiron the area, use the tangent offset method, locate himself in the field in reference to landmarks and then compute compass reading and distance to the fire, or various other possible methods. In any event, this must be done in a prompt, efficient manner.

PLANNING & ORGANIZING ATTACK

SIZING-UP FIRE BEHAVIOR

Upon arriving at the fire and putting his unused equipment in a safe place, the fireman must quickly formulate his plan of attack. He must rapidly size up the fire behavior. To do this he should scout the fire, that is he should go around the fire in order to take note of the entire situation.
Particular attention must be given to the fuels on the area; its quality and quantity. A very low moisture content will greatly add to the burning rate of the fuels. Weather conditions such as wind and relative humidity must be noted. Topography has to be observed as it influences the rate of spread and also the resistance to control. The topography also may aid the fireman in controlling the fire.

The time of day may be a considerable handicap to the fireman for prompt suppression or it may prove to be a considerable help. If the fireman arrives at the fire during the late morning or in the heat of early afternoon, he knows that the fire will probably have five or six hours of rapid burning conditions. If, however, he arrives in the late afternoon, he knows that usually in a few hours, with the coming of evening, the temperature will decrease and the relative humidity will increase. If the fireman arrives at the fire at night and conditions make it possible that work can be done at that time, he will be able to accomplish quite a lot in the control of the fire during this period of normally slow rate of spread and decreased burning intensity.

Similar to the time of day is the season of the year. Fires occurring very late in the season are accompanied by longer nights and shorter days which are quite helpful in fire control. Fires at this time of the year also are near to the Fall rainy season, which may occur at any time, but
this, of course, cannot be depended upon too much. At this late season, the increased amount of dew also helps considerably. The above aids to fire control, of course, are usually not found in the middle of fire season. The control of early season fires are aided by relatively high soil moisture conditions, which diminishes as the fire season progresses.

**PLANNING ATTACK**

One of the major items to consider in planning the attack is to note the critical points of the fire. One type of critical point would be a point where the fire is approaching more dangerous fuels. The following are some of the types that are usually considered as being very dangerous; snag patches, blowdowns, mossy areas, slashing areas, fern patches, steep grassy areas, brush areas, sawdust piles, peat bogs, and old burns. Anyone familiar with fire suppression will realize the immense possibilities if a fire reached one of these above areas. Naturally, great effort must be made to keep a fire out of any of the above fuels due to their high hazard, rapid rates of spread or great resistance to control.

Another critical point would be an area of more dangerous topography. A steeper, rougher, or more hazardous area makes the control much more difficult, and concentrated effort should be made to keep the fire out of such places.

Areas offering greater resistance to control are likewise critical points and must be watched for. Rocky country and lava beds are good examples of this.
Another critical point would be an area where the fire is approaching more valuable acreage, such as a home site area, an improved area, a valuable timber or cover type, a large important watershed and the like.

Often a spot fire may be a critical point because its possibilities may be greater than the original fire itself. Action may have to be taken on the spot fire before action is taken on the original fire.

There are isolated cases where an area susceptible to more hazardous weather conditions may be a point to consider carefully in planning the attack. A good example of this would be along the coast in the fog belt. The fog in such an area offers considerable aid in combating forest fires. Effort should be made to keep fires originating in this belt within its area. If the fire breaks out of the fog belt area, it will undoubtedly be more difficult to bring it under control.

The nature of the ground and cover must be carefully considered when planning the attack. This point closely ties in with resistance to control. Often in selecting the line location, it is advisable to fall back just alittle to a point where conditions of ground and cover are more favorable to rapid and safe line construction rather than to try to make slow, difficult progress where the cover is very dense and the ground very rough or rocky. Usually in these later cases, the line, due to the necessity of rapid construction, is not made
safe or secure enough and will not hold. In falling back to a more favorable place, the line can be built safely to mineral soil and backfired with a greater security of holding the oncoming fire.

The fireman should make use of all natural aids available. Many times it is advisable to fall back to a natural fire barrier and concentrate most of the activities at such a place. Valuable time and energy can thus be saved. Slides, bluffs, openings, roads, trails, streams, rivers, agricultural lands, breaks in cover types such as alder patches, and many other natural aids are usually helpful. There is a strategic advantage in trying to catch the fire on a ridge-top instead of on the slope. There is a tendency, due to shifting in drafts, for the fire to slow down as it reaches a ridge top and often a well constructed, backfired line on the ridge top will hold a fire that a line on the slope could never hope to hold.

The length of line to be built and the line location naturally are important in planning the attack. In carrying out the policy of controlling the fire to obtain the smallest acreage possible, it goes without saying that the line should be located just as close to the fire as feasible. The amount of line construction should be held at a minimum and every endeavour should be made to accomplish this. However, this cannot be made a hard and fast rule. There are times when the crews will have to fall back to gain a strategic advantage
and greater security, and it may be necessary to construct a few more chains of line.

In planning the attack, the method or methods of attack is a vital consideration. The method of attack will be influenced not only by the nature of the fire but also upon the man power and equipment available. The direct attack is usually used on small fires or by the initial crew but conditions may warrant the use of the two-foot method, parallel or even the indirect attack. If there is a decided need for more men and equipment, the fireman must use his present facilities the best he can under the circumstances.

After weighing all of the factors and considerations that the fire presents, the fireman must decide which is the most vital point and immediately begin the execution of his attack plan.

EXECUTING THE PLAN OF ATTACK

Hot spotting of salient points should be done at once. The fireman should go around the fire and try to stop quickly the fingers or points that are spreading rapidly to dangerous areas. This hot spotting is usually a temporary step to slow down the rate of spread until a good line can be put in.

LINE LOCATION

One of the most important things in the control of any forest fire is the proper location of the fire line. The proper location of the line depends upon the very best of good judgement. The line locator must be very familiar with fire
behavior and have the keen judgement that comes from experience.

There are many factors to consider when locating the fire line. As has been said before, the fire line should be kept just as close to the fire as possible. This reduces the amount of fuel for consumption by the fire. It also reduces to a minimum the amount of line to be built. As far as possible, all dangerous snags, trees, windfalls, and any concentration of fuels should be cut out from the fire. Lines should be run into natural barriers if feasible. Resistance to control is an important factor. The line should be put in a location that offers the easiest amount of work with, of course, due regard to existing conditions. To put a line through an area heavy with down logs is a tedious, time-consuming operation and one that should be avoided if feasible to cut the area out of the fire.

Naturally, some areas have a faster rate of spread than other areas and allowances often have to be made in line location to give adequate time for the backfiring operation. Fuels, topography, and weather conditions are the important factors influencing the rate of spread.

In locating the line, thought must be given to values on the area. Lines should be located to protect existing high value areas when practicable.

One very important consideration in line location is that of safety of the crew. Chances, of course, will have to be
made on most any fire from time to time, but they must be within reason. A route of retreat or escape must be kept in mind at all times. Cliffs and dangerous slides must be watched and care should be made to pick safe places.

The forces available, naturally, influences the line location. The amount, condition, and efficiency of the men and equipment determines as well as the nature of ground and cover, the progress that can be made. The crew must be kept at the highest peak possible. As the crew becomes tired and less efficient, the line may have to be swung a little farther from the oncoming fire. This is necessary to be sure the line is properly made and backfired clean before the fire reaches the line. A tired crew will need more time to prepare the control line.

LINE CONSTRUCTION METHODS

There are various methods of line construction and all of them have their adaptations to different conditions such as number and efficiency of men, topography, equipment and resources available. One of the more recent methods is the progressive or "one-lick" method. This is coming into more popular use, and have proved itself superior to other types used in the past. However, for real efficient use of this method, the crew should have training and instruction before actual work on a going fire.

The assignment and passing methods have long been the regular standard methods. They are somewhat inefficient,
however, due to the lost time in passing and going from one assignment to the next.

Motorized line construction, when it can be used, is a great advantage due to the speed and efficiency of the line construction. Bulldozers and tractor drawn plows are often pressed into use in some regions, where the topography is such that their use is possible.

On many areas horses can be used to plow furrows where larger motorized units could not be used. Due to the flexibility of this unit, it is quite efficient where the topography and cover permits its use.

On some locations water can be used as a direct attack on the fire and no line construction is necessary in the initial attack. Tankers, pump trucks, and even back pack pumps can be used if the water and equipment facilities are readily available. Water should be effectively used and not wasted; it should be directed at the base of the flame where it will do the greatest good. Care must be stressed in the use of large pump equipment and men familiar with the outfits should be in charge.

On many fires there are points where the fire has gone out and these areas can be cold trailed to advantage during the initial work on the fire. The practice of cold trailing, however, is a dangerous one due to possible latent sparks or embers. Cold trailing often results in the escape of the fire. Before the fire can be considered safe, the cold
trailed areas should be checked and rechecked. Usually lines are build along the cold trailed areas before the area is accepted as being safe.

LINE CONSTRUCTION STANDARDS

Due to various changing conditions, the width of the fire line is quite flexible. A fire line that is too wide shows lack of efficiency, and a line too narrow is inefficient as well as dangerous and hazardous. To be effective, the fire line must be constructed down to mineral soil even if this means digging through a foot or more of duff. The mineral soil line must be clean and contain no leaves, needles, twigs, etc. All roots must be chopped out of the line. Usually a safe width for the mineral soil line is 16 inches, but this depends upon varying conditions. All duff must be cleared away from the mineral soil line so that there is no danger of duff falling onto the line.

The width of the brush line depends upon the height, kind, and amount of brush. A width of five or six feet is usually sufficient. The brush should not be left as concentrations of fuel along the fire line but should be scattered outside of the line.

The width of the snag line is quite variable. No fire line is safe until all of the dangerous snags are felled. This may mean going back 300 to 1,000 feet or more from the line. Sparks blown from snags or spike tops and setting fires across the line are the single greatest cause of fires getting away.
Snag falling is a hazardous job due to the danger of the tops or large limbs breaking and falling on the crew below. Snag falling crews should be composed of three men if it is at all possible. One man should act as a lookout and warn the others if a limb or the top breaks.

As would appear in a cross-section, the fire line has two types of construction; the conventional and the cupped. The tread of the conventional type is a level, smooth surface and is constructed on level terrain. On a slope the cupped type is used. This type is a sort of trench dug into the slope of the hill with high outer walls. The tread of this type is semi-circular so that material rolling down the slope will be caught in this cupped area and will not roll across the fire line. This latter type of fire line must be carefully constructed or it will defeat its purpose.

Care should be taken at all times to build a good clean line down to mineral soil. The progress of the line constructing crew should not be too rapid so that an insecure line is built. Frequent inspection and rechecking of the fire line should be made by the foreman. It should be remembered that a fair amount of line built and held is much more worthwhile than a lot of line built and not held.

BACKFIRING

The main purpose of backfiring is to rob the fire of fuel. In order to accomplish this purpose it is essential that the backfired area is burned clean. In this way the
oncoming fire must stop when it reaches the backfired area because there is no fuel to burn. Naturally, if the backfiring operation is not properly done and the area contains fuels which will be ignited by the going fire, the backfiring operation has not accomplished its major purpose.

Backfiring also saves valuable time and labor. A fire line properly backfired has a much greater chance of holding than a good fire line that has not been backfired. Usually if time is taken to backfire, it will save the crew from rebuilding a line which did not hold because it wasn't backfired.

Backfiring is a hazardous job and every safety precaution possible should be taken. There is always the danger of the fire getting away and trapping the men. The operation should always be in charge of a skilled foreman. The crew itself should be composed of selected men who have had experience and posses good judgement. It is absolutely essential in backfiring that the foreman know a safe route of retreat at all times. The backfiring crew should have contact with the line construction crew so that they may be called upon for help in emergencies.

Various oils are often used in starting the backfires and there is constant danger of the men getting these oils on them and their clothes becoming ignited. Therefore great care must be exercised in the use of these fuels and the equipment. The equipment must be kept in good condition at all times.
SETTING THE BACKFIRE

Good judgment must always be used in selecting the place to set the backfire. The highest points are usually set first. Drafts should always be utilized so that the backfire will burn toward the main fire. Many times it is necessary to make more than one setting to secure a good clean burn and to enlarge the backfired area as much as possible. The backfiring will have to be adapted to the topography as different topography presents different conditions. Control lines and natural fire barriers should be utilized to the utmost.

The backfire should always be set when burning conditions are favorable. The humidity and wind must be watched at all times, and their changing or shifting will have to be adapted to the operation. Drafts play an important part and they should be utilized to the very best advantage. There are times when it is too risky to set backfires due to serious weather conditions and the operation must be postponed to a more favorable time or not done at all.

Backfires must always be set just as soon as practical; right after the line construction, if a line is built, or from the fire breaks that are used. This tends to insure a maximum amount of backfired area before the main fire reaches the control area.

There are various ways of setting the backfires and the crew will have to make the best use of the facilities that are available. Torches, bombs, fuses, matches, and burning material are used.
CONTROL OF BACKFIRE

There is always the danger that the backfire will get away and may become more serious than the main fire itself. The foreman, of course, should be well aware of this fact and adapt his operations to insure the security of the fire line.

Only the amount of backfire that can be held should be set at one time. The amount that can be held varies under different conditions. Fuels, their quality and density, topography, weather conditions, type and efficiency of control line, intensity of going fire, amount and efficiency of men and equipment, and other factors all influence the amount that can be held.

Under adverse conditions, dirt and water will have to be used to hold the backfire. It may be even necessary to go outside of the control line and fireproof dangerous fuels such as punky stumps, logs, etc. Sometimes dirt can be piled up against these fuels to keep them from becoming ignited. Spotters should be sent out to look for spot fires that may start from the backfire. Chances will have to be taken many times, but the safety of the men should be considered. Many fires have been held because a few men had the courage to stay and fight it out. Courage should not overshadow reason, however.

Due to the importance and hazard involved in backfiring, the very best of men and equipment should be made available and used in the backfiring operation. Pumps, both hand and machine, may be necessary. Torches are a necessary and must
be supplied. Shovels are the standard hand tool and some cutting tools should also be available.

MOP UP

To insure the safety of the fire, mop up should begin just as soon as practical. The objective of mop up on a small fire, usually considered less than ten acres in size, is to put out all of the fire. The objective on a large fire is to make the fire absolutely safe. The question naturally rises to what extent must the mop up operations be carried to make the fire "absolutely safe." This is a problem that varies on every fire and one that is up to the judgement of the man in charge of the fire. Minimum requirements can usually be set up however.

METHODS OF MAKING THE FIRE SAFE

There are many and various ways of making the fire safe. Any fuel that is subject to a reburn or any dangerous fuels which have not yet burned should be eliminated. These fuels usually are taken care of in the backfiring operations. However if these fuels were not taken care of they usually should be set again, provided, of course, that they are hazardous and in dangerous locations. Fuels that have been singed but not completely burned are relatively easy to ignite and must be destroyed. Fuels of this nature which are quite a distance within the fire usually are considered as being safe.
Water is an important instrument in mop up and can be used to a considerable advantage. On most fires, water in sufficient quantities is difficult to obtain. Therefore it should be used sparingly and only where it will do the greatest amount of fireproofing. Probably the quickest and most effective way to mop up a fire is to completely drown out a strip forty or fifty feet wide along the entire fire frontage and then go back into the fire and take a similar strip until a safe width has been reached. Even to "completely drown out" the fire does not insure that it is actually out. It is rather difficult to reach every spark and ember and the area must constantly be checked and rechecked for latent burning points. The water, to be most effectively used, should be stirred and mixed with the smoldering fuels and not just merely poured onto the fuels. Burning logs and similar material should be attacked from both sides with a large quantity of water underneath where the fuel contacts the ground. To conserve water, small trenches can be dug and the burning or smoldering fuels put in, one at a time, then stirred or mixed with water and moist dirt and layed aside in a cleared place when safe.

Dirt is an important element in mop up work. It can be used to smother out flames, and it can be used to cool down areas to a point where it is possible to work on them. An area should not be covered with dirt and then forgotten about, because such an area is a hazard. A fuel covered with dirt
may not go out, but continue to smolder for days until it reaches a point of flaming-up again. Any fuel treated this way should be uncovered and worked on until out. Even then frequent checks are advisable.

All dangerous snags must be felled before the mop up work can be considered completed. Often the base of the snag and the ground around the snag will have to be cooled down with dirt or water so the fallers can get at the trunk. Back pumps are very effective in putting out fires in snags if the burning area is not too high. It should be remembered, that when putting out snags with back pumps, to work from the top down. In this way all the water running down the trunk will be used. The surest and most effective way to put out a fire in a snag, however, is to fall the snag and work at it on the ground. If it is impossible to fall a burning snag in a safe place, prepare a safe place for it to fall. In falling, the snags should be thrown as far as possible from a hazardous location.

If it can be done safely, it is advisable at times to let the fuels consume themselves instead of trying to put them out. If this can not be done safely, concentrations of fuels should be scattered.

One important part of mopping up, is constantly checking and rechecking the entire area for burning fuels that may have been overlooked. The fire line must always be checked for roots or other fuels that may cause the fire to cross the control line. The crews must always be watching and checking for spot fires.
Large burning fuels should be re-arranged and trenches on the lower side so that there will be no danger of ignited particles rolling across the fire line. If the operation can be carried on with safety, it may be advisable to "chunk up" some fuels so that they will be consumed quickly. Sometimes fuels should be dug up to make them burn-up more rapidly. It is almost always advisable to allow the fuels to burn up if they will do so promptly and safely. Partially burned clumps of brush or reproduction should not be left near the control line. One should always burn only the amounts of fuel that can be controlled with ease. It will be repeated that mop up work on each portion of line should be begun just as soon as practical. All special threats, such as snags, rotten logs, stumps, and singed brush, both inside and outside of the control lines, should be eliminated promptly.

It is very important that the mop up work be under adequate supervision. It is absolutely essential that the work be carried out under a systematic work plan. As a final check to see if all fire is out, one should use his hands and search for smoldering embers.

Quite a variety of tools and equipment is usually necessary in the mop up work. Torches or flares may be needed to reburn singed fuels that are hazardous. Back pumps, mechanical pumps and tankers should be used, if possible, for prompt, efficient work. Shovels, saws, axes, pulaskies, and hoes constitute the main hand tools used.
PATROL

The main objectives of patrol is to keep watch on the fire lines and danger points to see that no fire escapes and insure quick detection of any spot fires. Patrolmen also should do actual mop up work when feasible. Patrol should be established just as soon as needed.

It is absolutely essential that definite beats be assigned to each member of the crew. These patrol beats should frequently be changed. One man may discover a smoke that another man has constantly overlooked. Beats should be lengthened or shortened if conditions warrent. The limits of each beat should be plainly marked on the ground. This will help to insure the entire area being patrolled and guard against unpatroilled areas. Adjacent patrolmen should contact one another and exchange notes at the ends of each beat.

Patrolmen should keep in constant touch with the mop up crews and a system of communication should be arranged for in case an emergency arises. Special danger points should be designated and lookouts should be placed on specific areas when needed to watch for flare-ups and spot fires. The patrolmen should work on hazards as well as watch them. The men should make a systematic search for fire outside of the control line.

Patrolmen must be alert at all times and should be frequently contacted by the foreman. Any changes of conditions should be reported to the foreman.
Night patrol should be done in groups of two and they should have adequate light facilities. When shifts are being changed, the men coming off should inform their relief of the conditions, hazardous areas, and any other facts that will aid the relief crew in efficient patrol work.

**RELEASING FORCES FROM THE FIRE**

There are many objectives involved in releasing forces from the fire. On any fire it is essential to keep the cost to a minimum; therefore the men should be released as soon as they are no longer needed. The regular protection force working on the fire should be released just as soon as feasible so they can return to their regular protective stations. In case of a more serious fire, as many men as are no longer needed should be released to go to the more serious fire. In order to fulfill contract agreements with cooperative organizations, it is usually required to release their men and equipment just as soon as they can be spared. It is often necessary to release forces from a fire to increase the efficiency of the fire organization. Exhausted men who have fought fire for many days should be replaced by fresh men. Undesirable men should be released just as soon as possible. Sometimes men are released in order to give other men experience in fire suppression. Equipment likewise should be released just as soon as it is no longer needed so it can be repaired and made available for use on other fires.
ABANDONING THE FIRE

Abandoning the fire means the release of all residual forces. Before the final abandonment of the fire, the entire fire must be checked over again. The fire line must be checked, and the area outside of the fire line must be checked as well as the area inside of the line.

The fire line must be checked to see that there is a continuous, clean line to mineral soil. No burning or smoldering material should be left along the fire edge. There should be no unburned patches against the line, and trenches should be constructed on undercut lines on steep slopes.

The ground outside of the conventional line should be covered systematically in the zone surrounding the fire. Make sure the zone near the line has been checked for surface roots which may come from stumps burned just inside the fire. All spot fires must be completely extinguished and lava cracks or rock fissures must be followed up and checked.

Inside the line, within threatening distance, all snags and spike tops must be felled. All logs, chunks, stumps, unburned patches, brush and reproduction with scorched dry crowns, smoldering litter, duff, rotten wood, etc. must be rechecked and made certain they are completely safe. Craters left by burned-out stumps must be positively out then filled with dirt and tamped down.

After the entire fire zone has been given a thorough examination and is considered safe beyond any doubt, all remaining forces should be released. If conditions warrent,
arrangements for periodic checks of the fire may be advisable. After many large fires have been abandoned, a patrolman is employed for the duration of fire season to make certain the area is safe, and any change in conditions is immediately reported. Standards usually call for a complete check of the fire within 24 hours after the abandonment.

SCOUTING

Scouting consists of those activities necessary to keep the men in charge of the fire informed as to the conditions and progress of the fire and topography of the surrounding country.

Efficient and adequate scouting is extremely necessary on any fire, and without it the control of the fire will be greatly handicapped. The men in charge of the fire must be informed about all conditions on the fire to the very nth degree if proper supervision and planning is to be done.

On large fires a chief of scouts is employed, who is in charge of all scouting activities. It is his duty to assemble and correlate all information from the scouts, to supervise the drafting and then to present all information obtained to the fire chief in a usable form. His responsibility is very great, and he must be a man who has had considerable fire fighting experience. He must know what information is essential and must see that he secures this information. The fire chief depends upon him for expert counsel and advise, so the chief of scouts must be dependable.
The chief of scouts has many scouts working under him and he must correlate their activities so as to make the scouting operation just as efficient as is possible. Scouts fall into two classifications; ground scouts, and air scouts. The ground scouts are assigned specific sectors of the fire and are responsible for the adequate scouting of their assignment. The ground scouts actually cover or patrol the area assigned to them and must use every available means of obtaining or observing the conditions of the fire. The air scouts have a rather unique job. They observe the conditions of the fire from airplanes and it can be said that they receive a comprehensive birds-eye-view of the fire. The air scout must be very experienced with fire fighting and have a good knowledge of fire behavior. He should be very familiar with the country and be able to recognize the exact location of the fire. Similar to the ground scouts, he is responsible to the chief of scouts and transmits all information to him.

Draftsmen are usually necessary on large fires and are under the direction of the chief of scouts. They must carefully draw-in the fire so that the fire's exact location and size will be known. Progress of the fire and progress of the line construction can be shown.

THE ORGANIZATION OF THE SCOUTING SYSTEM

Ground scouting is the backbone of the scouting system. Ground scouts must thoroughly understand the importance of their job and must be very resourceful and possess much
initiative. It is very essential that the scouts have a very good knowledge of fire fighting and fire behavior. In this way they will be able to understand and know what information is essential and must be obtained. These scouts must go along the fire line and study the conditions. It is essential that he keep accurate account of the time. The scout must note the fuels, their quality and density, snags, weather conditions, wind direction, progress being made by the crews, rates of spread, resistance to control, type and efficiency of control line, natural aids, water supplies, lack of man power, too much concentration of man power or equipment, efficiency of man power, spot fires, changes in cover type or fuels, hazardous or dangerous areas, exact location of the fire and control lines, amount of lost line, and a host of other facts. The scout may find it feasible at times to go to a vantage point to correlate his facts and get a better idea of the fire location. The scout must carry a map and draw-in all pertinent data.

At times it will be feasible to send out scouts in pairs. The two then can coadunate their observations and reach sound conclusions. Scouting is rather hazardous and it may be a worthwhile safety precaution to travel in pairs. Also in case of sudden changes in conditions of the fire or emergencies, one man could be sent back to camp and report to the chief of scouts these changes.
If the equipment is available, scouts usually carry short wave sets with them and can keep the chief of scouts informed of the fire conditions at frequent intervals. The scout must always make certain of any information received and must be sure that all information he gives is correct. Dates and times are important and should be carefully kept.

When the scouts arrive back in camp, they should immediately go to the chief of scouts or get in touch with him and give a concise report of their findings and observations. The chief of scouts must gather all of the information possible and check all reports to make certain of their exactness. Air scouts and ground scouts both must report their findings to him. Valuable information can be obtained from the various foremen also. The chief then must weigh the various reports and formulate his report for the fire chief.

It is customary to hold a "board of strategy" in the evening to plan the work for the following day. The fire chief must use all information obtained and personal observations to decide his plan of attack. The information and report of the chief of scouts is of the utmost importance. Various foremen will be able to offer valuable advice. The fire chief, upon completing his plans for the next day, must forward his instructions to the various foremen. The
entire suppression organization must be correlated and
the following of instructions down to the very last man is
of the greatest importance for efficient fire control.

SERVICE OF SUPPLY

Service of supply is the furnishment and maintenance
of the suppression force strength, personnel welfare, com-
munication, transportation, equipment, supplies, records
and accounts.

The chief of the service of supply has a huge and
important job. All supplies and necessities that are need-
ed to make the suppression organization function smoothly
must be furnished and maintained at the proper time and in
sufficient quantities. This chief has many men and many
functions to direct and correlate; therefore he must be
an efficient, experienced man. His inefficiency will break
down the efficiency of the entire suppression organization.

FUNCTIONAL ORGANIZATION OF THE SERVICE OF SUPPLY

This organization must employ, release and fire the
men employed on the fire. Under the strain of a bad fire
season, it is rather difficult at times to secure man
power in sufficient quantities. The men employed must be
the very best available and if experienced men can be
employed, they will increase the efficiency of the organi-
zation.
Transportation of all kinds must be furnished and maintained. Trucks, busses, airplanes, and pack stock may all be necessary. The pre-suppression plan will have to be consulted and all available sources of transportation should be known at all times.

One of the greatest items in the service of supply is that of furnishing and maintaining the subsistence of the fire fighters. Food, mess gear, canteen equipment, etc. must be available quickly and in sufficient quantities.

Likewise, pack stock and other animals used on the fire must be furnished with food and also the necessary gear for their use.

Adequate communication facilities are of the utmost importance on a fire and it is one of the functions of the service of supply to furnish and maintain the best possible facilities for communication. Short wave radio sets of many types are now in common use. The telephones used are primarily the portable, emergency type.

All camp equipment, fire fighting tools, and equipment, bedding, repairs, maps, bookkeeping and office supplies, and other incidentals must be furnished and maintained.

This organization on a fire is of the greatest importance. It is the "back of the line" outfit and the fire fighting and scouting organizations would be helpless if it did not function properly.
CONCLUSION

Some of the many considerations involved in forest fire control have been pointed out. It has been shown that actual forest fire suppression involves three main organizations; the fire fighting force, scouting, and the service of supply. All three of these organizations must be developed to a high degree of efficiency within themselves. Then these three forces have to be correlated and united for a common cause; that of the prompt, efficient suppression of the fire. Each of these three organizations is an important gear in the fire suppression machine, and to try to determine the most important one would be as useless as trying to determine the most important leg of a three legged stool.