Supervision of Fire Suppression

by

Glenn Thompson

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INTRODUCTION

The primary objective of this report is to outline the proceedings necessary for the most efficient and economic suppression of all large forest fires from the standpoint of the fire chief after he has arrived on the fire line.

The past history of the suppression of large forest fires discloses the need for a complete and condensed work on the subject of fire suppression. The record of every fire since suppression of forest fires has been undertaken in the United States is marred by gross mistakes in suppression tactics, and as the requirements become more exacting there is greater possibility for mistakes. In the majority of these cases the error can be traced directly or indirectly to the man in charge of the fire. This fact should not be to the discredit of any man as the duties of the fire chief are many and varied and founded on variable factors, the failure to consider any one of which may result in serious difficulty.

The efficient suppression of fires requires organization of high order, and the man responsible for such organization must have either wide experience or detailed and comprehensive training. As funds are now available for forest fire protection agencies to develop and maintain a suppression organization similar to the army and navy the next best method is to develop instructions for each man to be used in such a capacity and furnish him with these instructions. Better instructions are further needed by the many men who, because of the position they fill and because of administrative regulations, are automatically placed in charge of project fires regardless of previous experience and it is for these that this report is designed.

The written material available, which deals with this subject, is incorporated in fire plans and diffused throughout the work in such a manner as to confuse the individual who would seek the proper procedure for carrying out a fire chief's assignment for large fires. The few instructions for overhead positions are usually in the form of general expressions or presented under the headings of good and bad practices of suppression.

The manner of execution of a majority of fire suppression factors is determined to a large extent by policies which are based upon the net social and economic results of fire suppression activities. For a proper understanding of these policies one must approach the subject from the philosophical viewpoint. Such a viewpoint also affords a readable picture of the whole and allows one to more readily grasp the how and why of the many complex and unrelated parts of the job, which in the whole are intricately sunchronized to form a smooth workable plan. As the principles of operations of an army in war are familiar to most of us it is but a short step to make an analogy of war and fire suppression. The tactics and maneuvers of a fire fighting force are not unlike those of any army in battle, and shows closely related functions throughout the analogy.

In the beginning we have a very active and destructive enemy invading our valuable natural resources that may spread rapidly with each hour of unrestricted freedom. This enemy is capable of taxing the ingenuity and resources of man with numerous complex problems as broad as the universe itself. Fortunately for the fire chief the field of science has been able to devise ways and means of measuring some of these problems and bringing them into the realm of exact science.

It is, therefore, necessary for the fire chief to understand the principles of science that apply to fire control and to have a workable knowledge of the essential instrumental equipment employed in determining meteorological data, and of the correlation of this data with the inflammable condition of forest fuels. He must also be familiar with the use of all tools, equipment, and devices at his command in suppressing fire.

The procedure followed in developing this report is, as far as practical, in the same order and arrangement as they should be acted upon in the field under actual conditions. The general items covered are: size up the situation, calculation of probabilities, planning of attack, organization of suppression forces, the establishment and maintenance of liason. Each of the above factors is broken down into its component parts with sufficient treatment to identify its place in fire suppression and to present the manner in which each can be determined by the fire chief.

The suppression standards as set up by the United States Forest Service form the basis for this report, but it is general enough to be applicable to the suppression activities of any other forest fire control agency which is sufficiently organized to carry out the necessary operations.

In conformity with the requirements of the course under which this report is submitted, the author has resorted to other work on the subject in but a few instances and this largely to refresh his memory on technical points and for a few of the tables which are included in the appendix. All sources from which material is drawn is acknowledged in the bibliography. The body of the material contains the knowledge of the author on the subject as gained from seven years of fire suppression while in the employe of the United States Forest Service, and from experience on fifty five fires in the capacity of fire chief. Many of the ideas presented have not been employed in suppression work to the knowledge of the author, but are believed to be essential.

Grateful acknowledgment is made to the many veteran fire fighters for guidance, encouragement, and helpful advice given during suppression work in the past.

Section I

The Fire Chief and His Duties

Qualifications. The fire chief is the man in complete charge of a forest fire, and his job is to actively direct operations on the fire line. Ordinarily, he will, on smaller fires, combine in himself many of the overhead duties. On larger fires he will appoint assistants to whom he will delegate most of the duties such as scouting, communication, transportation, fire line construction, and service of supply.

He is in reality the general of the suppression forces and is solely responsible for the success or failure of their actions. His training should be intensive, his experience broad, and his knowledge of the efficient use of men and materials comprehensive. The qualities of leadership are essential and he must be a man of action. He must exercise the power of rapid mental concentration as accurate, and final decisions need to be made on widely varying matters in a minimum of time. The ability to get along with men, though desirable, is not as important under the present day policy of large scale operation in controlling the fire during the first burning period as it was in the old days when fire crews were on the job for weeks at a time. The above does not infer that the fire chief should disregard the feelings and safety of men under his control, but on the contrary should so plan and organize his operations that the maximum comfort and safety of the men be provided for consistent with the demands of the work.

A prime necessity is that the fire chief should in all cases be well acquainted with the existing fire plans and the standard of operation which are maintained by the fire control organization for which he is working.

Duties. Any part of the duties of the fire chief as here outlined is subject to modification by an individual when it is evident that it does not apply to the particular case in question. They constitute the major matters which the chief must consider in the fulfilment of his duties.

1. Obtain all information pertinent to the job at the earliest possible time. Determine the location. length, character, and priority of construction of fire line and any other control measures. Calculate the size of the job, consider the forces at hand and en route. If this set up is believed to be inadequate to complete the calculated amount of line to be built within the specified burning period, get out an immediate order for the extra needs to meet the situation that will exist at the time of their arrival. The general policy, related to this paragraph, which is followed by successful fire control agencies is to supply the fire chief with all the men and materials that he might call for, so it naturally follows that he is responsible for the fact that all such needs are immediately made known to the proper authorities at the earliest possible moment consistent with good management.

2. Formulate an initial plan of attack; utilizing available help to the fullest extent. This plan should be perfected

as added knowledge is received.

3. Organize all available man power and formulate plans for the organization of those yet to arrive. See that all overhead men assigned to the fire are properly and definitely instructed in regard to their responsibilities and duties. Make certain that men understand their instructions. Written instructions should be supplied all men whose training and experience is dubious. Special written instructions should be given overhead men carrying out special important assignments.

4. Establish headquarters at a strategic location and establish means of contact with all camps or other important stations on the fire line. For large fires (over 2,000 acres) the fire chief should remain at this station constantly or be relieved part time by his qualified assistant until the fire is controlled.

5. See that all assignments are carried out per schedule. See that all incoming men and equipment get into action on the fire promptly after arrival. Check the methods and performances of each subordinate on the fire and take immediate personnel action where it is warranted.

6. See that plans and records are kept up to date and in proper form.

7. Keep in close touch with the progress of the fire and the progress of held line ahead and, if necessary, revise the plan of action promptly.

8. See that proper men and facilities are at hand to care

for injured workers. Make certain that the Compensation for Injury Reports are made promptly and completely.

9. Foresee all needs sufficiently in advance to secure their consummation without disrupting existing plans.

10. Refer all questions in regard to policy, procedure, methods, and personnel on the fire to the fire dispatcher or other central office when such matters are of concern to them.

11. See that plans for the succeeding day are worked out at night and orders given to scouts, foremen, timekeepers, cooks, and any other overhead men assigned to the fire in sufficient time to allow them to prepare to carry out the work without disrupting the regular routine of the camp.

12. Maintain or cause to be maintained a daily record showing perimeter, area, held line, number of men in crew, etc., and a progress map as described in section III.

13. Foresee the release of men from the fire and provide for removal from the fire line in accordance with good management. The orderly and timely release of men can do much to lower suppression cost.

The later sections of this report are concerned with ways and means of executing the above duties of the fire chief. Where applicable important details are given.

Section II

Size up of the Situation

The policy applicable to the size up of the situation is that it should be made at the earliest possible moment by the most competent man available as soon as he arrives on the fire. This action should supersede all others, even the initial attack, and it is mandatory that it be executed currently ever 2 hours for the first 8 hours the fire is spreading and once daily thereafter until the fire is controlled.

A written record should be made of the findings of the initial reconnassiance especially of any unusual facts which would influence control action contrary to the regular procedure.

INFORMATION

If time permits, the fire chief should make the initial reconnassiance of the fire preferably from the air if flying facilities are available. In this initial inspection he can obtain vital data that is impossible for him to secure through the reports of others regardless of their ability. The major purpose of his reconnassiance should be to secure a bird's-eye view of the whole, and the trained fireman may be able to formulate the plans for his entire campaign from those few moments observation, even though the fire is progressing rapidly. Particular attention should be given to the factors of topography, cover type, and weather, especially the wind.

Other duties will necessarily detract from the fire chief's undivided attention from the matter of securing information of the fire and he should immediately detail the best man available to carry on this work in a more detailed and scientific manner.

Scouting unit. The scouting unit should secure and transmit to the fire chief all information desired on the fire. This unit should be organized, if not already so, and put on the job at the earliest possible moment. Their equipment will consist of adequate maps of the area, drafting instruments, compass, radio, or telephone, and transportation means where such can be used advantageously.

They will develop and maintain a progress map of the fire and act in any other capacity that the fire chief sees fit. Their organization is developed in section IV.

CALCULATION OF PROBABILITIES

The calculation of probabilities is the mathematical determination of the size of the job as it will be at the end of the first burning period, which is 10:00 a.m. when? as selected by the Forest Service, and of the men and equipment needed to control the fire at the end of that time.

The procedure employed in the determination of these needs is divided into the five following steps.

1. Estimate the number of chains in the perimeter of the fire at the end of the first work period.

2. Estimate the length of held line which can be constructed per man hour.

3. Divide the number of chains of held line to be constructed by the length that can be constructed in one hour by one man. This will give the number of man hours of work needed to corral the fire

in the first work period. Allowance being made for the use of motorized and horse-drawn equipment.

4. Estimate the number of hours the crew or crews will have to work in the first period. Reduction of travel time from the start of the men.

5. Divide the number of man hours needed by the estimated number of hours available. This will give the number of men needed, provided they all start work at the same time.

The judgment determination of the above steps can be made more scientific if each is broken down and the separate items considered in detail.

For the determination of the probable rate of spread one should consider the following factors and the facts which tend to make them important considerations.

1. The continuity, volume, arrangement, kind, and size of fuels. These have a decided influence upon the type of fire and it in turn determines the rate of spread. A combination of the above sufficiently dense and of the right kind will support a fire of the crown type which is the most rapidly spreading and most difficult to control of all fires. Dense coniferous stands of the pole age are most susceptible to this type of fire, other things being equal. A mature open stand of timber with a ground cover of herbaceous plants, small sized litter, and broken natural barriers of water or rocks will support only a surface fire, the spread of which will depend largely upon the velocity of the wind.

2. Elevation, degree of slope and the character and exposure of topography. These factors are chiefly important from the standpoint of the origin of the fire. Fires originating at high elevations on south slopes will experience the fastest rate of spread, other things being similar. This is largely due to the fact that the mean deviation of temperature and of relative humidity at these elevations is lower than at the lower altitudes. In contrast to the above, the areas experiencing the least danger, due to fuel moisture and wind, are the north facing aspects at low elevations.

Normal differences in fire danger and in individual danger factors at different hours of the day or night must be known by altitudes and aspect if the fire chief is to "calculate the probabilities" most dependably. Figure I of the appendix presents a picture of what these differences are on south slopes at various elevations and may be referred to in obtaining a size up of the character of these differences. It is also shown on these charts that there is little difference between north and south aspect at night.

The character and exposure of topography is important in that fires behave entirely differently in different situations. On a flat even surface with uniformly distributed fuels a fire will spread evenly in all directions or with the wind if one be present, but in a deeply cut topography, even the best firemen are often puzzled as to just what action a fire will take, so complicated becomes the problem. During average bad burning conditions it is reasonable to assume that a fire will spread to the highest elevation above it, and will go to the bottom of the slope if it is over 100 per cent and the fuel type is such as to allow it to roll. The steepness also has a direct bearing on the amount and distance to which spot fires may be set ahead of the main fire. The vertical acceleration given spark carrying particles by the fire draft coupled with cross country wind, form an ideal condition for distributing spot fires long distances. Under extreme conditions of slope, fuel, and inflammability large fires have been known to throw spot fires in excess of 2 miles [1].

3. The present and predicted wind velocity, direction, and duration is a major factor to consider in the calculation of probabilities on any fire regardless of time or place.

In general the rate of spread of a fire during high hazard weather is directly proportional to the velocity of the wind. With average conditions of fuel density, topography, and fuel inflammability, a ten mile per hour wind will cause a fire to spread at the rate of 2 miles per hour; a 20 mile wind double this amount and so on up.

In rugged mountainous country there are usually two types of wind to be considered in any determination of fire behavior or planning of attack. These are the prevailing winds which are usually general over the entire area and the local air currents which are confined to main canyons at low elevations and are independent of the prevailing wind. The latter are troublesome and are the most difficult of the two to predict with any degree of accuracy. Data on the prevailing winds as to their present and future direction and velocity may be obtained from the nearest United States Weather Bureau Station, but local winds present a local problem for fire administrators. Local air currents

1. Salmon River Fire in Idaho 1931.

generally blow up a canyon during the daytime and down during the night. The direction depending upon local temperatures at high and low elevations, the time of day these temperatures reach minimum and maximum degrees, which is in turn influenced by the season of the year and the exposure and direction of the canyon. A local wind, which has been blowing, say, down a canyon, for any definite period in the past under stable conditions of the above factors may be safely considered as unchangeable if these controlling factors remain constant. They may be subject to reversal if the maximum temperatures are reversed between high and low elevations. This reversal has been known to occur at midday or at any other time, but usually occurs at night. The occurance of a large fire at low elevation in such a canyon may influence local winds, especially if the fire is spreading up a major side branch of the main canyon. In which case the draft produced may create an up and down canyon wind to the mouth of this side canyon.

A form of wind characteristic of fires in rugged country is the draft created by large fires themselves. This draft is due largely to the fact that the air currents are formed by cold air replacing the rising warm air which is heated by the fire. This replacement may reach such proportions as to exceed any normal wind velocity and create a blow-up fire spreading over several hundreds of acres per hour independently of local or prevailing winds. These drafts cannot be measured nor predicted directly, but blow-up conditions as created by these drafts cannot occur when the relative humidity is in excess of 20 per cent and the maximum temperature remains below 80 degrees or the fuel moisture content is above 5 per cent as measured with the 2 inch wood cylinder.

Air movements of the above type are the most dangerous of those with which the fire fighter must deal, both from the standpoint of the safety to life and adversity to previous plans. Such a condition has proven to be the weak spot in many otherwise well executed calculation of probabilities.

The duration of the wind should in all cases be considered and determined if possible. As an average, during the fire season, winds may be expected to begin from 9:00 to 11:00 a.m. and continue until 6:00 to 10:00 p.m. with the maximum velocity occurring between noon and 4:00 p.m. While the minimum usually occurs between midnight and 3:00 a.m. regardless of altitude. Special care should be taken in all cases to predict the exact duration of the wind as it may continue unabated thru 24 hours or longer and thus necessitate considerable revision of the regular procedure of calculating the rate of spread. Ordinarily the length of time a wind will endure as discussed above is determined by the prevailing temperature and elevation, and exposure. If a high temperature is predicted for the following day, with the present high temperature at a similar figure and the temperature does not fall during the evening it is safe to assume that the present wind velocity will prevail through the night. This condition is especially likely to occur at high elevations where the deviation from the mean temperature is at a minimum.

4. The highest art in the calculation of probabilities is contained in the determination of fuel inflammability as effecting the

rate of spread of any fire. This determination embodies several factors mainly, previous precipitation, evaporation, relative humidity, temperature, wind velocity, fuel moisture content, and exposure.

In making this determination it is desirable to have instrumental equipment on the site affected for measuring all the elements of weather possible. If the scouting unit has not arrived with such equipment the best judgment determination of each should be made promptly and the procedure repeated as soon as readings can be secured from the instruments.

Precipitation. This is the only weather element that insures noninflammability. As a general rule it is safe to assume that any rain of .02 inches or more in 24 hours will be sufficient to eliminate fire danger temporarily. Rain is capable of raising the fuel moisture content to over 300 per cent. The amount, date, and hour of falling are data to be considered in connection with previous precipitation. The records of the nearest weather station should be secured for this information or from conversation with local men.

Evaporation. The speed of evaporation, as measured by wood cylinders or evaporimeter, since the latest rainfall must be known in connection with precipitation. Maximum evaporation occurs when a combination of high temperatures, low relative humidity, and high wind velocities endures for a considerable length of time. The advantages gained in lowered fuel inflammability by one-fourth of an inch of rain during midseason may be lost in from 2 to 3 days time by an extreme combination of the above factors. Other things being equal the rate of evaporation is directly proportional to the difference in temperature as indicated by the wet and dry bulb thermometers of a whirled psychrometer.

Relative Humidity. Relative humidity has a close correlation with fire behavior, but unless accompanied by corresponding conditions of other weather factors it may prove misleading, as an undiscovered fire may remain quiet through a day with relative humidity of 7 per cent or less and then blow-up the following day when the minimum reading is above 17 per cent. Such situations emphasize the need for weighing all factors and the degree of art applicable to the task. It is essential that the variations of relative humidity, as effected by elevation and exposure, be recognized. These fluctuations are presented in chart form in Figure I - B of the appendix. An outstanding feature of this chart is that during fifteen hours out of every 24, relative humidity at the 2300 feet elevation is greater, hence more favorable to fire control, than it is at any hour at 4400 feet. It also shows that the diurnal fluctuations in relative humidity corresponds closely to that of temperature for similar elevations, and brings out the fact that there is an intermediate zone which remains dangerously dry at night. In this zone for almost 20 hours out of every 24, conditions are more favorable to rapid drying of fuels than at higher or lower zones. In some localities the altitude of least humidity at night is higher than the altitude of nightly maximum temperature.

Atmospheric humidity can raise the fuel moisture content up to 50 per cent over a period of 3 to 4 days. Duff responds most nearly to the effect of humidity, but with too great a lag to permit the use of humidity by itself as an index of fuel inflammability.

Temperature. For areas of low rainfall, temperature is a controlling factor in influencing fuel inflammability. This fact is largely because temperature partially controls the other drying elements of wind and humidity. Aside from solar radiation, which influences the moisture content of the surface vegetation, temperature has both a direct and an indirect effect on the fuel moisture content of all fuels above the surface of the ground. Temperature influences relative humidity by increasing the water holding capacity of the air when warm. A rise of 20 degrees in temperature will double the water holding capacity of the air and thus lower the relative humidity. Local winds are largely a result of differences of temperature between two areas or between differences in elevation.

Winds. Exact determination of the effect of winds upon fuel inflammability. It is certain, however, that the drying effect of wind is very greatly increased when the daily departure from normal amounts to plus 20 per cent or more, and especially if such departures are accompanied by high temperatures or low humidity.

Fuel moisture. Data for half-inch wood cylinder and for duff moisture shows practically the same zones and trends as that of temperature and relative humidity. The duff is further affected by the heat generated by direct sunlight at the surface of the duff layer. The character of exposure is important in this latter case as south facing slopes are subject to more direct rays of the sun than the north facing ones, where the effect is in most cases negligible.

Fuel moisture is the limiting factor as to whether a fire will spread. It has been proven that fuels with a moisture content of 10 per cent or below can be readily ignited and will support a running fire while fuels with a moisture content of over 18 or 25 per cent are very difficult to ignite by any ordinary method.

As the determination of fuel moisture requires more time to measure than can be taken in the calculation of probabilities on the fire line, such data can be secured from surrounding stations and a visual inspection of the action of the fire itself. Fuel moisture may be considered very low when large fuels as logs and stumps, which are remote from large volumes of heat, will ignite and become entirely consumed, also when live vegetation as herbs and shrubs are consumed. Needles and small particles of limbs and branches free from pitch, will emit less and a lighter colored smoke when dry then when they contain considerable moisture.

Duration of weather period. Fuel inflammability and its effect on the rate of and duration of spread of a fire is effected by the length of time which the elements governing fuel inflammability have remained constant. A fire will spread more rapidly and for a longer period throughout the 24 hours when extreme weather conditions have persisted for a month than if they have been changeable over the period previous to the fire. Thus a fire occurring late in the season of a bad fire year will spread for a longer period of time during 24 hours than one originating early in the season although fuel moisture content and other factors controlling fuel inflammability have similar values. The difference in exposure, slope, and ground cover as discussed above are minimized as the season progresses and may reach a condition where the heavier and more dense fuels on north exposures are as inflammable as those on south slopes.

The above fact is offset to a certain extent by the length of daylight hours which gradually become less as the season progresses. Longer nights, though they may not reduce the moisture content of the forest fuels will lessen the period of time during which temperature, humidity, and wind will endure. Long cold nights are characteristic of late summer and fall in mountainous areas especially at lower elevations.

5. The effect of corral action on the rate of spread. The initial reconnaissance will in most cases disclose just what can be expected of corral action. This is partially influenced by whether the attack can be made directly in front of the fire or whether a flanking attack is necessary. Also whether the fire is at the top or bottom of the slope or drainage and what the possibilities are of cutting off leads which are threatening major drainages and heavy stands of timber. In rough topography a fire may be held to a minimum if corral action confines it to one slope.

Where, for any reason, a fire cannot be corralled during the first burning period, the influence of corral action becomes a very important consideration in connection with the probable extent of the spread. In any case it is much more desirable to have a safe continuance trench against the fire as far as faculties will permit than to have a remote disconnected line subject to being flanked by the fire and allow renewed spread in every direction during the following burning period.

In determining the effect of corral action on the ultimate perimeter of the fire it is essential that a map of the fire be prepared with boundaries located as indicated by the summation of all the previous factors and from this map reduce the perimeter by the amount of those sections which it is evident the initial attack and immediate follow-up suppression forces will eliminate by their efforts. In making such allowances it is necessary to take into account the future action of the fire as influenced by wind, temperature, and humidity changes and the line located so that no losses will be experienced. The physical condition and experience of the men constituting the initial attack should be considered.

The fire chief on the average job will spend not more than 15 minutes considering all the above factors which influence the rate of spread of a fire and will immediately proceed to determine the average length of held line a man can construct per hour. Much data needed in this respect will have been noted or determined in the calculation of the rate of spread. The determination of the amount of line that can be built per man per hour is most efficiently done when tables, which have been developed from the recorded experiences of fire crews in the past, are used as an aid to judgment. Such tables and charts have been provided in connection with each of the major factors effecting rate of fire line construction, and it is but a matter of determining from the field the character of the job and applying this to the tables for the desired results subject to immediate correction where the circumstances clearly indicate such action to be feasible.

Factors to be considered in speed of line construction are given below with corresponding tables.

1. The type of cover, topography, and soil have the greatest influence on line construction, and are closely related to each other in innumerable combinations. The output of held line per man hour may

range from 3 chains on level grassland on sandy soil to .01 chains on steep ground with deep duff, and large timber. The following specifications have been set-up for Pacific Coast Regions as representing resistance to control for 4 cover classes as recognized by the United States Forest Service.

Low

1.0 chains of held line per man hour.

General specifications: work mostly digging or scraping to remove thin layer of fuel down to mineral soil. Very few logs or snags and, therefore, a very small amount of ax or saw work to be done. Brush absent or very minor item. Soil, cover, and slopes favorable to work.

Moderate

0.50 chains of held line per man hour.

General specifications: work may be mostly digging or scraping, but with deeper duff and more roots than in "low" resistance types with more time spent cutting brush, logs, or an occasional snag.

High

0.25 chains of held line per man hour.

General specifications: digging a minor part of the total job unless it is extremely time-consuming, for example, in deep duff and roots. Ax and saw work usually a major item because of snags, logs, or dense brush that must be cut. Cover, soil, or slopes unfavorable to production of held line.

Extreme

0.10 or less chains of held line per man hour.

General specifications: ax or saw work a major item because of the snags, logs, or brush that must be cut to corral the fire. Digging a very minor part of the total job. Cover, soil, or slopes extremely unfavorable to production of held line. Danger from falling snags or rolling rocks and logs may be an important factor in reducing output. Only the very worst conditions in the region requires the man power indicated for the "extreme" condition.

Table I of the appendix may be referred to in respect to cover, topography, and soil as well as for other factors.

2. The speed of line construction depends a great deal upon the number of experienced and trained overhead available to direct the work. The fire chief should have obtained, or secure at the earliest possible time, the names and qualifications of the overhead to be supplied him for the most important positions. Trained and experienced assistants as well as foremen, strawbosses, and others are on the average 50 per cent more efficient than those without knowledge of the job regardless of what other qualities they might posses. This factor is especially important because of the character of the work and organization. There is much possibility of confusion unless the leaders know definitely what they are doing. Confused leaders produce disorganization and misdirected effort, which results in a low held line output per man hour.

3. Effectiveness of the organization, though difficult to

evalulate, should be considered in determining held line output. Advance knowledge of the fire control agencies' personnel, equipment, and methods of operation is necessary in this respect. The fire chief must use his best judgment as to what to expect of his men as based upon information of their previous fire fighting experience, their place of hire and the kind and condition of tools with which they are equipped. The morale of the organization is an important item in relation to its effectiveness. Local men or those familiar with outdoor life have a much better morale on the average than do men secured from large employment centers. The effectiveness of different crews may vary from 15 to 75 per cent due to extremes in the above factors.

4. The character, experience, and training of the crew is one of the most important inhibiting factors governing the output of fire fighters with which the fire chief must consider. A crew composed of young local men experienced in forest work and trained in the up-to-date methods of controlling fire may be considered as 100 per cent efficient. Good physical conditions and proper clothing, shoes especially, are essential items making up the character of the crew.

A crew's experience may be a factor for or against its effectiveness. Men experienced in the older methods of controlling fires frequently produce less footage of held line under present standards than do the beginners. They are usually less responsive to training on the job and to instructions given by the overhead. Also in a number of conditions the application of old methods is fatal to the success of new procedures. Therefore, experience may be evaluated as negative or positive, but in no case should it effect the total output with a divergence of more than 25 per cent.

From 10 to 50 per cent more line can be expected from a capable trained crew than the untrained, other things being equal.

5. Decrease in efficiency per man as the size of the crew is increased and fatigue develops. The United States Forest Service has set up the following tables as average allowances to compensate for these factors.

Table III

FATIGUE FACTORS FOR HOURS AND FOR NUMBER OF MEN

1	hrs.	work	------	100% Efficient.	1	man	------	100%	Efficient
2	"	"	------	99% "	5	"	------	98.5%	"
3	"	"	------	96% "	10	"	------	95%	"
4	"	"	------	85% "	15	"	------	85%	"
5	"	"	------	70% "	20	"	------	70%	"
6	"	"	------	55% "	25	"	------	60%	"
7	"	"	------	45% "	30	"	------	54%	"
8	"	"	------	39% "	35	"	------	50%	"
9	"	"	------	35% "	40	"	------	48%	"
10	"	"	------	32% "	50	"	------	45%	"
11	"	"	------	31% "	75	"	------	40%	"
12	"	"	------	30% "	100	"	------	35%	"
13	"	"	------	29% "	150	"	------	30%	"
14	"	"	------	28% "					
20	"	"	------	22% "					

6. Methods of attack: the choice or choices of the methods of attack or location of the fire line govern to a certain extent the output per man hour of held line. The indirect methods produce a greater amount of line than do the more direct methods largely because of the greater freedom the men have from smoke, heat, and confinement in area. Less attention is made to the disposal of material removed from the trench and the direction in which snags and trees are thrown, short cuts may be made to take advantage of natural breaks and sites requiring a minimum of labor.

7. Special equipment; plow and tractor chance. Sections of the fire line upon which tractors or horse-drawn equipment may be used to advantage should be determined after the total for hand control has been established and such figures reduced by the following amounts to compensate for the special equipment.

For horse-drawn plow reduce hand work figures by:

Easy construction, reduce 50%

Average construction, reduce 35%

Difficult construction, reduce 15%

For tractors equipped with bull-dozer, plow, scraper, etc., reduce hand work figures by:

Easy construction, reduce 75%

Average construction, reduce 60%

Difficult construction, reduce 45%

Many variables, such as topography soil, cover, size of equipment, etc., enter into these determinations so they should be used only to supplement judgment.

The fact should not be overlooked here that, for the maximum results from power equipment, varying amounts of hand labor must supplement all equipment. Both from a safety standpoint and efficiency in cleaning up light jobs.

8. Danger of injury; may influence output per man hour in two ways.

First, by limiting the time which a crew may actually be working as in very steep country where crews cannot be worked one above the other and, therefore, must work in relays, also by increasing the time which must be spent keeping on guard and taking cover from falling snags and rolling material.

Second, indirectly by limiting the methods of attack as influenced by time of day to which work must be confined and the distance to which men must stay from the edge of the fire to avoid injury.

After determining the net values of the perimeter of the fire and the number of chains of held line per man hour it is then necessary to determine the number of hours of work needed to corral the fire in the first work period. This procedure is merely a matter of dividing the net number of chains of held line to be constructed by the length that can be constructed in one hour by one man.

Step four is to estimate the number of hours the crew will have to work in the first work period. This period will be, with the exception of the occurrence of unusual circumstances, the full time, from the hour the calculations are being made, until the next 10 a.m. For fire discovered before 10 a.m., and not too soon before this hour to allow at least 2 hours of actual work on the line, the phrase, the next 10 a.m., will necessarily mean 10 a.m. of the following day. For example: the end of the work period would be 10 a.m. of August 16 for a fire occurring at 7 a.m. August 15, 2 hours <u>average</u> travel distance from the average source of suppression forces. Unusual circumstances, such as dangerous conditions may prohibit night work to a certain extent and must be allowed for in determining the number of hours in the work period.

The final step in the calculation of probabilities is the calculation, which gives the actual number of men needed for fire line construction. This calculation is but a matter of dividing the number of man-hours needed by the estimated number of hours available, provided they all start to work at one time. If they are not likely to begin work at the time calculated in the above probabilities then the final figures must be increased by the amount necessary to meet the deficiency, making due allowances for the effect of this belated corral action upon the spread of the fire.

Table II supplies average figures for determining the number of average fire fighters required to complete one mile of fire line for various lengths of work time, for different cover types and for the major classifications of resistance to suppression.

In general the results of the calculation of probabilities should be adequate in the judgment of the fire chief to insure the fast and thorough suppression of the fire, regardless of how severe the burning conditions may become. He should check each detail in review to insure against the omission or improper consideration of factors which may, in his judgment, become important.

It is assumed that the initial attack has been dispatched by the fire dispatcher, and he has calculated the probabilities from available information. The fire chief's calculation and determination of needs are to supersede that of the dispatcher. The results of the fire chief's calculation should be made known to the agency responsible for their fulfilment, and the chief should ascertain if all the needs can be filled before he and his staff plan their attack.

Table II

NUMBER OF AVERAGE FIRE FIGHTERS REQUIRED
TO COMPLETE ONE MILE OF HELD FIRE LINE

Available work time on fire	Easy construction					Average construction				
	Type					Type				
Hours	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.
2	31	91	67	60	54	35	121	91	84	74
4	16	46	34	30	27	18	60	46	42	37
6	10	30	22	20	18	12	40	30	28	25
8	8	23	17	15	13	9	30	23	21	18
10	6	18	13	12	11	7	24	18	17	15
12	5	15	11	10	9	6	20	15	14	12

	Heavy construction					Extra heavy construction				
	Type					Type				
Hours	Br.Gr.	P.P.	L.P.	D.F.	S.Alp	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.
2	39	182	133	130	110	43	364	266	266	231
4	20	91	66	60	56	22	181	133	133	116
6	13	61	44	43	37	14	121	88	88	77
8	10	45	33	32	28	11	91	66	66	58
10	8	36	27	26	22	9	73	53	53	46
12	7	30	22	22	18	8	61	44	44	38

No travel time included.
Number of men include fire fighters only.
Based on hand work. If plow is used, reduce above figures by:

Easy construction, reduce 50%
Average construction, reduce 35%
Difficult construction, reduce 15%

If tractor with plow or bull-dozer is used, reduce figures by:

Easy construction, reduce 75%
Average construction, reduce 60%
Difficult construction, reduce 45%

Section III

Suppression Plan

In no other similar type of undertaking is a plan more essential than in fire suppression. It is a vital necessity in securing the most prompt, energetic, and thorough suppression of that particular fire. The attack plan is second to the calculation of probabilities only because it is dependent on the information in those probabilities for its basic data. A fact which the fire chief and his subordinates must keep in mind at all times and never be confused by seemingly physical limitations which can be controlled. It further stresses the care with which the data for the calculations must be determined. If the needs have been properly determined the basis of the plan will be more reliable and the facilities needed will be on hand in sufficient quantities to carry out the suppression plan.

This plan must be dynamic in nature; one that forces the issue at every point and allows no quarter. It must be offensive and not defensive. A hit and miss half-hearted attack has no place in fire suppression and is bound to fail against average or above average fire conditions. A dynamic attack plan is necessarily progressive in nature and must be promptly amended when added knowledge of the fire clearly indicates that the basic data is faulty.

In developing his plan of attack it is good policy for the fire chief to enlist the aid of his subordinates. Such action not only produces a more sound plan, but is of great value in helping those entrusted with its execution to understand the plan as a whole and their part in it. This is best done by using the conference method with the fire chief acting as leader. All members of the overhead present at the time may sit in even though their qualifications and the efficiency limitation on number of participants in conference may prevent their taking an active part. The above policy is likewise desirable when supervising members of the overhead are confronted with important decisions on the ground throughout the suppression period. Besides improving the efficiency of the suppression forces it does wonders to their morale.

The procedure of formulating the plans begins by assembling all data pertinent to the field conditions. Ordinarily this information will be furnished by the scouts in the form of charts and maps with supporting figures. From this information the points of attack may be determined and plotted on the plan maps with priority numbers. Next, is blocked off the sections of line which are suitable to each method of attack, considering topography, soil, and cover type in this respect. Also plot those locations which will allow the use of each kind of special equipment. From this map it is now possible to determine the dispersion of men, materials, and supplies, and to definitely determine the needs for communication and transportation. The entire fire line can now be set off in divisions and sectors, according to the dispersion of man power. Camp sites are also located. If the desired overhead are present they should be definitely assigned to their position and location at this time and supplied copies of any part of the plan which it is essential that they should have.

Members of the headquarter's staff should immediately prepare sufficient copies of the plan to supply all members of the overhead who have positions higher than that of foreman.

It is evident that such a procedure will require some time, but should never consume more than one hours time for both calculations of probabilities and determination of needs and preparation of the suppression plan. This should in no way hinder the initial attack or keep the early arriving suppression forces waiting when conditions are suitable for attack. There are always obviously important points on the fire line which these first crews may be put to work on with a scout or foreman to place them and direct their work temporarily.

The above procedure will be open to criticism with those protection men who believe that speed in initial attack is paramount, but the writer firmly believes that intelligent planning and the proper coordination of effort cannot be secured otherwise. The situation is a desperate one when a suppression job is undertaken without first definitely determining what the job to be done consists of and preparing a clear-cut plan of attack with all responsible members of the overhead furnished with written instructions setting forth their specific duties, supplemented with an outline of the complete plan. The task of properly suppressing a project fire is a colossal one at the best, and only an intelligent plan and its energetic execution can prevent the forces from taking on the characteristics of a mob as so often has been the case in the past. Loose methods are not only economically wasteful, but highly dangerous to human life.

The major items of the suppression plan with their subheadings are covered in the succeeding paragraphs of this section.

INFORMATION

The accumulation of all factual data concerning the job at hand is imperative to the success of the plan. Such information must be verified by signature and presented to the fire chief in writing or other referable form in a minimum of time. The problem of information consists of three major division: (1) what information is needed and how it is to be obtained, (2) how is it to be transmitted, and (3) who is responsible for it.

INFORMATION NEEDED AND HOW OBTAINED.

Information is needed on all matters connected with the suppression job. The most important being data on weather, fire behavior, corral progress, fire costs and damage, and law enforcement. With further divisions we obtain the following classifications.

Fire Weather. Essential data for determining fire weather is best obtained by securing actual measurements of temperature, wind, relative humidity, and fuel moisture content. On the site supplemental data may be secured from local weather observation stations and weather forecasts from the nearest United States Weather Bureau Station. The instruments used on the fire line should be of a mobile type such as is available in the new fire weather trucks. Special mountings permit the delicate instruments to be transported quickly and safely to central locations representative of average conditions of weather on the fire. Referring to 1 - A and 1 - B of the appendix it becomes evident that, where large differences in elevation are encountered on any one fire, there must be two or more weather recording stations in order to obtain the true fire weather conditions.

A competent man, preferably a technically trained meteorologist, should accompany the instruments and be supplied any help he might need to facilitate the proper functioning of this unit.

Fire Behavior. What the fire is doing and what it shows indications of doing are vital data for the information of the fire chief and those who might be endangered by unforeseen blow-up conditions. Of special value is any information regarding a diversion of fire behavior from that upon which the plan is based. A member or members of the scouting force will maintain a close watch for indicators of a changed condition. A continuous airplane patrol is desirable on large fires when visibility conditions permit, and especially is this type of patrol desirable when line construction and mop-up work are in progress during that period of the day when bad fire behavior may be expected. Fire behavior indicators, other than those obtained from weather measurements, for conditions changing to the worse or bordering on blow-up are:

1. Action of the fire - surface fire's velocity accelerating. Time required for surface fires to reach and crown out trees shortened. Ground fire beginning to blaze and cease throwing smoke. Large materials igniting much more readily.

2. Smoke - increased rising speed and changing in form from a thin drift to billowing black clouds. A change in color and volume as turning dark and increasing in volume. It may be safely assumed that a fire will not spread rapidly as long as the smoke lays dense and low over the fire as the condition ordinarily is during the early morning hours.

3. Action of wild life - as a rule game animals and birds sense

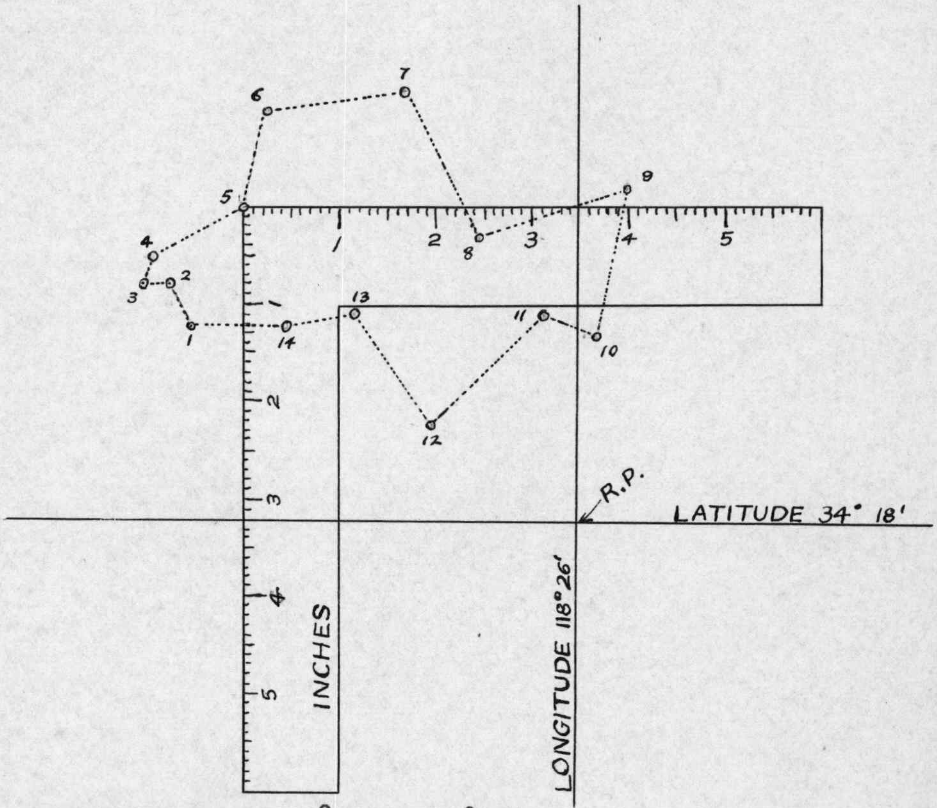
unusual danger in sufficient time to allow crews to take the departure to more safe location, but not in time to allow a change of plans at headquarters.

Suppression Progress. Data is vital to the success of the suppression plan. It is to be expected that each crew will not encounter the exact conditions as indicated in the plan, so revision must be made as corral action progresses and a balance or shifting of crews provided for. The scouting and mapping unit will obtain this data and forward it to the fire chief in similar form as that shown in figure 6. Progress mapping is as important in this respect as when used to map the progress of the spread of the fire. The maps for line construction and for fire spread may be made and submitted to fire headquarters at the same time. Figure 6 suggests a practical method of recording and sending progress data.

Fire Cost Data. This data is desirable not for the present job, but for future reference and the records. It is mentioned here as it is part of the information to be obtained and is best handled by a member of the scouting unit or a special man assigned to each sector. It has been largely the practice to neglect the accumulation of such data because it did not pertain to the fire job. Figure 9 illustrates the data which should be included and the form on which it may be recorded.

Law Enforcement data, pertain to man caused fires or where a law enforcement officer is needed in the camps. Such an officer is especially effective in lowering the costs from lost or stolen supplies and equipment. This officer should be put on the job as soon as possible, before valuable clues are destroyed. He should be supplied with any help needed. It is practical to enlist this officer in the scouting unit and allow them to help in the matters of law.

Fig. 6 METHOD OF PLOTTING FIRE
LINE WITH COORDINATED SQUARE SCALE



Note:-R.P. = 118°26' - 34°18'
Point #5 North 3.2" - 3.5"

Example of message from scout to the fire chief's headquarters would be as follows for the diagram given above: 6p.m. Partial fire line report from John Doe. August 14. Call from Camp 5. Base map 1" scale. R.P. 118°26' and 34°18'

1	North 2.0	West 4.0	Cold trailed Fire burning northerly
2	North 2.4	West 4.2	Hot line
3	North 2.4	West 4.5	
4	North 2.7	West 4.4	
5	North 3.2	West 3.5	Cold line
6	North 4.2	West 3.3	Hot line
7	North 4.4	West 1.8	
8	North 2.9	West 1.0	Burning slowly
9	North 3.4	East 0.5	
10	North 1.9	East 0.2	
11	North 2.1	West 0.3	One lick line, few hot spots
12	North 1.0	West 1.5	
13	North 2.1	West 2.3	Cold Trailed
14	North 2.2	West 3.0	

Closure to Point 1

Forest .... Date .... Fire ....

(1) Line construction									
(2) Mop-up									
(3) Hand work									
(4) Plow									
(5) Tractor									
(6) Pump									
(7) Timber type									
(8) Ground cover									
(9) Slope									
(10) Soil condition									
(11) No. of days since crew came on fire									
(12) No. of hours since crew began work on day involved									
(13) No. of men began work									
(15) Hour finished work									
(16) Elapsed time									
(17) Line built (Chs.)									
(18) Chs. per man hour									
REMARKS									

Fig. 9 Record of Fire Line Constructed

COMMUNICATION

Communication is the limiting factor in fire suppression. Without it the modern methods of fire fighting, based as they are on speed and coordination, would be impossible. For fire purposes there are three types of practical communication. These are telephone, radio, and messenger, by foot, animal, or machine. The scouting service should have charge of the installation and control of the communication system; cooperating with other organizations of the suppression forces in the use and maintenance of the system where their needs for communication overlap.

The establishment of the communication system should have equal priority with the line construction and possibly higher priority when crews have been dispatched to a remote and dangerous sector of a fire. As upon arrival at the sector the crew may find conditions changed so that it is impossible to commence line construction until the fire has quieted down and unless this fact can immediately be made known to the fire chief, serious consequences may result. At any event the communication system must keep pace with the actual operation. The development of portable radios has made this possible.

Figure 5 illustrates a typical communication net as used by the United States Forest Service. Telephone and radio may be used interchangeably in any phase of the net.

Telephone. The use of telephone in fire line communication is largely restricted to locations where standard lines are already in existence. The installation of emergency lines is not practical since the advent of the new improved high frequency radio. Telephone constitutes the major means of communication with other agencies or with the forest headquarters. It will always remain the principle means of communication where it is already established because of its numerous advantages over radio, especially so on small fires where men trained in the use of radio are usually at a minimum.

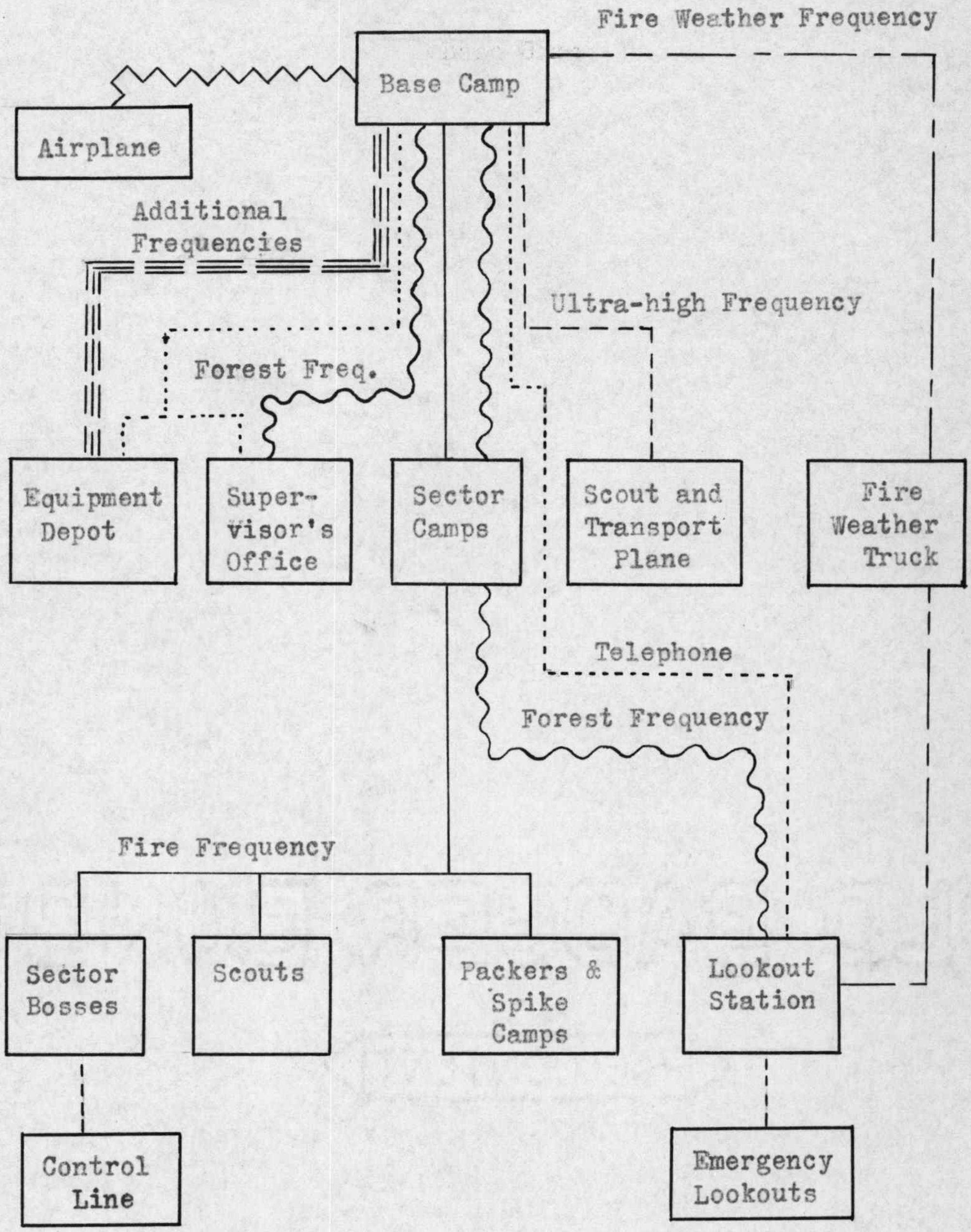
Radio - the plan for the use of radio on a fire must not exceed the possibilities of radio's use, or in other words, do not use too much radio in the wrong places. Where radio must be depended upon entirely for all communication needs in connection with the fire, a number of different frequencies should be used as is illustrated in figure 5. Equipment is now available for this kind of setup which greatly advances the uses to which radio may be put.

A specially trained radio engineer, preferably one who has had fire experience, should be in charge of the installation and operation of the radio system. He will operate as a part of the scouting service and will be directly responsible to the chief scout.

There are 3 essential uses of radio on project fires. For airplane to ground communication, fire scout to headquarters, using light portable sets, and for headquarter's communication with remote sectors and spike camps to which telephone systems are not available.

In the operation of radios only experienced operators should be allowed to transmit messages. A uniform method of transmitting and receiving messages, as well as a definite schedule for each station, should be established and strictly adhered to.

Fig. 5 COMMUNICATION NET FOR USE ON LARGE FIRES WITH TELEPHONE AND RADIO



Messenger. The policy of sending information by messenger either by foot, or horse, or auto should be encouraged where other means of communication are not available or have not as yet been established. This is particularly true during the initial attack. In the past, overhead have hesitated to spare men from their crews for use as messengers when difficulties were encountered. This practice has often resulted in great losses which could have been avoided had help been sent for.

A distinct advantage of messenger service is that it can be available at all times and for use by any member of the suppression force. This fact should be stressed in instructions to overhead members of the organization.

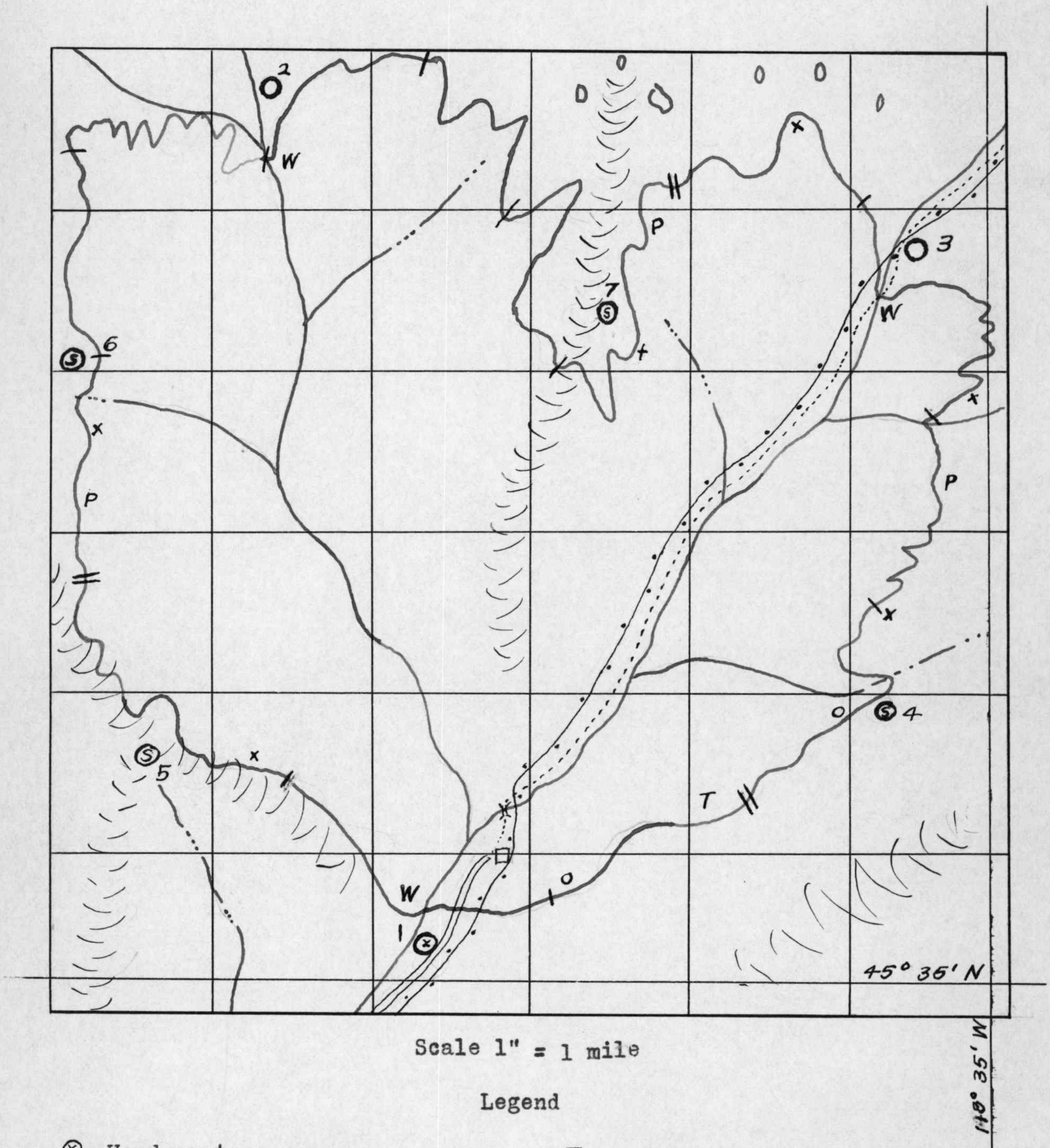
SCOUTING SERVICE

The scouting service supplies all the information concerning the fire to the fire chief. The chief scout is in charge of the scouting unit or units, and is directly responsible to the fire chief. He should not remain at any one station except on projects requiring more than 2000 men. The suppression plan should outline the functions of the scouting service, without supplying too much detail. The organization and duties of the scouting service is considered under section IV of this report.

FIRE FIGHTING

Fire fighting constitutes that part of the suppression plan directly connected with actual suppression of the fire. The six major considerations of fire fighting are time of attack, point of attack, method of attack, use of special equipment, mop-up, and dispersion of forces.

Fig. 8 ATTACK PLAN AND ORGANIZATION MAP FOR A PROJECT FIRE



Scale 1" = 1 mile

Legend

⊗ Headquarters camp
○ Division camps
Ⓢ Sector camps
— Fire line

o T o - Tractor chance
x P x - Plow chance
W Pump chance
╫ Division boundaries
┼ Sector boundaries

The attack plan map or written sheets should show in general each of the above with appropriate symbols for identification. It is especially important that boundaries be plainly marked for each, otherwise a hand trenching crew might consume valuable time constructing a trench on ground constituting your only tractor chance. It is also essential from the standpoint of safety and coordination of effort. As for example, the attack would necessarily begin at the bottom of a slope on a spreading fire rather than at the top and the crew responsible for the top sector would need to know the when, where, and how of the crews below them; a properly constructed map of an efficient suppression plan would supply all such information.

Each of the six items of fire fighting are treated under separate headings as they would be considered in the suppression plan.

TIME OF ATTACK

It is as important to time the attack in fire suppression work as it is to time the attack in battle. The rule of success dictates that every advantage possible be taken of the enemy. The calculation of probabilities will diagnose the actual conditions and the plan of suppression will give the treatment. With each sector mapped out and its character determined the order of attack will be plotted with numbers, and action taken upon each in turn in numerical order as the suppression crews arrive on the fire line.

In accordance with the best policy of fire suppression, the time to attack a fire is now. Any fire can be successfully combated at one or more points at any time of the day or night regardless of burning conditions and cover type. Such action may force the use of the indirect method which is perfectly legitimate if its use is such as to hold a strategic point. The most formidable appearing fire has its weak points, as a crown fire of the worst type may be attacked at the time of its largest run. In making the attack always remember that there is a reason for everything that a fire does. Determine these reasons to the fullest extent and your time for attack can more accurately be determined.

As previously discussed in the calculation of spread, a fire is the least active, other things being equal, between the hours from 3 p.m. to 7 a.m. This then is the logical period in which to concentrate line construction activity. It is a matter of hitting the enemy while he is down and dying.

The policy of holding crews back to wait for the fire to recede is definitely out, under the new principles. Start men constructing line immediately upon arrival and continue work through the first burning period. Order replacements if it becomes evident that the initial crews are not sufficient to corral the fire and continue on immediately with the mop-up work. Keep in mind that one chain of trench constructed and held at the beginning may save 500 chains at the end of the burning period.

On the average backfiring should be done in the evening or at night, burning conditions permitting.

POINTS OF ATTACK

The points of attack are vital considerations in fire fighting, especially so with the initial attack. The determination of the points of attack shall be based upon the data collected in the calculations of probabilities and from progressive facts as furnished by the scout and others. It is in fact the secondary purpose of the scouting unit to keep the fire chief informed of the progress of the fire so that alterations in plans for the points of attack may be made. There will obviously be some sections on a fire which are more important to attack than others. In general they are of 3 class of points of attack:

1. Parts of the fire where a small amount of work will produce maximum results in preventing spread. In general, this class constitutes spot fires, small leads which are nearing more dense fuels, and bottoms of a fire which are likely to back down and spread across a drainage.

2. Sections which threaten the safety of men and equipment or existing lines. This occasion arises when first action has been taken on the lead of the fire during poor burning conditions.

3. Sections where the spread may be the most rapid during the next burning period. This problem arises when the initial attack is being made at night or early morning or before the wind arises.

In general, the time of day or night the attack is being made is the major factor influencing the section of the fire to attack first; whether the flanks, lead, or spot fires. During average bad fire weather the point of attack will be the flank during that part of the day most favorable for fire spread. Spot fires should be attacked in the evening for maximum results, both because they are less difficult to locate at that time and because their spread is confined to a minimum. The lead of the fire will, under nearly all conditions, necessarily be attacked only during the late evening or early morning hours and only then when it is evident that the fire can be prevented from out-flanking the lines constructed.

Topography and cover type are essential factors to consider when they are present in certain combinations. As a rule, in a rough topography a forest fire may be expected to spread up hill more rapidly than down and to follow out a certain drainage rather than across.

In the Rocky Mountain and similar regions, where large differences in elevation are encountered in small horizontal distances with many distinct cover types represented, the character of spread of a fire is extremely variable. During the highest inflammable periods the Ponderosa pine-grass-brush types may support a surface fire 24 hours of the day, while the lodgepole pine-alpine fir types of the higher elevations will carry a fire only during the afternoon and early evening hours, other things being equal. For a fire spreading into both of these types in such a country, the point of attack is necessarily at the lower elevations.

A characteristic fire of the above conditions may be said to progress by spurts with the low elevation fire slowly spreading horizontally from the mouth of one canyon to the next, and at each making a rapid run to the higher elevations in the form of a crown fire. The fire dies down on the summits surrounding the canyon; possibly lapping over and backing down into the next canyon, fuel conditions permitting. The initial attack should be made on the lower points and the follow-up attack on the spurs resulting from the lapping over on ridge tops.

Other important factors to consider in determining the points of attack are wind movements and safety to men. Either or both of the above may prevent an attack on an otherwise ideal point of the fire line. A general rule to always keep in mind is to never place a crew on a dangerous sector of the fire without first knowing the present and future direction and velocity of the wind and unless there is ample time for the crew to corral the fire before the next known burning period. It is an inhuman action and unworthy of the risk to send men to a dangerous sector of the fire line with the thought that they can seek known available protection, in the event the gamble fails.

The determination of points of attack are not restricted to the suppression plan concerning the fire in general, but should be followed up by the sector boss, and foreman. It is always good policy to have a hot-spotting crew working in advance of the swamping and trenching crews for the purpose of cooling down or cutting off small leads which if left unattended would greatly lengthen the corral line. The purpose of such a crew is not to build held line, but to temporarily extinguish or control threatening points. Ordinarily they will be equipped with dirt throwing tools with which to smother the fire.

Care should be exercised in determining points of attack to make available competent guides to place the men on the desired site.

METHOD OF ATTACK

The suppression plan should not restrict the use of methods of locating the fire line too closely, as actual field conditions are subject to change, and there is much irregularity in topography, cover type, soil, and fire behavior. Thus a crew of 10 men may find it necessary to use two or three different methods of attack in the space of one or two chains distance. The plan, should, however, definitely limit the attack to either the direct or indirect method for each sector.

(Direct, in this case, being used loosely to cover the three more close methods of fire line location).

The four general methods of attacking a fire are: (1) direct method, (2) two-foot method, (3) parallel method, and (4) indirect method. In order that all overhead may interpret these terms similarly, they are briefly discussed in the following paragraphs:

Direct Method. This term is loosely used by many writers, but should be confined to cases where the fire line is located directly against the fire's edge. The clearing and trenching is contiguous to the fire. The burning material is dug up and thrown into the burned area and the trench is narrow and down to mineral soil. The method also applies to sections of fire line which have gone out naturally.

This method is best adapted to ground and slow moving surface fires which are not too hot to prevent direct contact with suppression tools. The shovel is the tool best suited to this method. Grass fires can be successfully attacked by smothering with dirt or water and then applying the direct method of trenching where necessary.

Two-foot Method is nearly synonymous with the direct method, except that it is away from the burning edge of the fire and is adaptable to the use of such tools as hoes, mattocks, and scrapers. It is employed on fire sectors similar to those on which the direct method is used. The material removed in constructing the trench is thrown away from the fire. It depends upon the fire to burn out the intervening strip between the fire and the trench, and when this does not happen on all parts it becomes part of the method to shovel this strip into the burned over area. The line should not be over two feet from the burning edge to be classed as this method.

<u>Parallel</u> <u>Method</u>. This is the method of building a continuous fire line from a few feet to a few rods back from the edge of the fire. It relies, for a safe line, upon the immediate burning out of the intervening strip, and should never be used unless this is done as a narrow trench is valueless in stopping the spread of a fire such as this method would be used against. The parallel method may be advisable on; fast-running surface fires, numerous spot fires, the flanks of crown fires, and fires when using plow and tractors.

The use of the parallel method produces the greatest held line production per man hour of any of the three close methods of locating the fire line. It is most applicable during the heat of the day when the fire is most likely to be too hot and smoky to allow men to use either of the above methods. The fire fighter who masters the use of this method has gained a great deal in mastering the art of fire fighting and will experience little difficulty in getting men to work against a hot fire.

<u>Indirect</u> <u>Method</u> consists of completing a continuous fire line a considerable distance ahead of the fire, and backfiring as soon as it is relatively safe to do so, all things considered. Advantage should be taken of natural or other barriers, such as streams, open ridge tops, roads, trails, bluffs, and lakes. The gamble taken in using this method seldom justifies the expense of building machine or hand trench in other than the lightest construction types. For any sector on the fire for which it is determined in the plan to employ the indirect method a capable and experienced man in backfiring should be put in charge.

The method is seldom advisable and should be used mainly as a last resort when; fires are burning on precipitous slopes, crown fires are to be stopped in the lead, fuel is exceedingly dry and highly combustible, humidity is very low, fast running fires are burning in slashing as windfalls where the resistance to control is extreme and must be stopped to prevent the destruction of valuable property. A special case, which can be combated by no other method, is a fire which angles out of a canyon with unburned material below the burned area with large amounts of material subject to roll.

It is the best policy, when instructing overhead, and in developing the suppression plan, to employ the more direct methods and have it well understood that the indirect method should not be resorted to, except where planned, without first consulting the fire chief.

BACKFIRING

Backfiring should be considered as a separate function of the attack. It constitutes one of the highest arts of fire fighting and is probably the least understood of any item of fire suppression as evidenced by the large percentage of failures connected with its use. The terms "backfiring" and "burning out" are generally used synonymously, but for clarity in adopting them to a plan of attack they should not be confused. Burning out properly means the ignition of unburned material for the purpose of making the fire safe from future spreading. It applies to the parallel method and for unburned areas between the fire and some barrier such as a stream, or road, which does not result in a continuous line. Backfiring refers to the use of fire to widen or extend the fire trail over a continuous line.

DISPERSION OF SUPPRESSION FORCES

Every precaution should be taken to secure the proper disposition of men on the divisions and sectors as located on the plan map. The two factors considered here are: (1) getting the crews to the proper location on the fire, and (2) disposing of them on the fire line.

Distribution is effected by dispatching as many men to each division and sector as the determination of needs dictates for those places. Generally, crews do not arrive at the same time so must be distributed as they arrive to the points of attack in order of priority.

Other factors to consider in planning the distribution of crews is methods and routes of travel, transportation of equipment, and guides.

Disposing Men on the Fire Line. For the direct, two-foot, and parallel methods of attack there are three methods of disposing men on the fire line. These are: (1) the hand over hand method, (2) the sector method, and (3) the one lick method. The choice of these will depend upon the topography, cover type, kind and amount of equipment, experience and training of the overhead and crews. The advantages and disadvantages of each are given below:

1. The hand over hand method is advantageous where it is necessary to complete the trench as the crew progresses around the fire. It may be used in a flanking attack on a crown or fast running surface fire. The method is especially adapted to trained men, but tends to scramble the crews and break down the organization when employed with untrained men who are not acquainted with their straw bosses or with each other.

2. The sector method makes it possible to assign each foreman, straw boss, and fire fighter a definite sector of the fire and to hold

him strictly accountable. The overhead can function more efficiently as authority is more easily recognized by the workers. This method is difficult to apply to sectors in rough topography, at night, and in heavy timber where there is a large amount of falling and bucking to be done.

3. The one lick method is the most progressive of the three, but is restricted to brush and light timber types, and where men trained to its use are available.

The attack plan may make use of all three of the above methods if conditions suitable to each are present on the fire edge. It necessarily puts an added responsibility upon the planner and tends to make the plan cumbersome, unless trained men are available.

In general the two-foot and parallel methods with the sector method of disposing men will be used for 90 per cent of the line construction if the plan is properly prepared.

USE OF SPECIAL EQUIPMENT

The largest possible gains to be made in the efficiency of fire suppression are to be had through the development and proper use of power equipment. Large fires constitute the ideal physical and economic conditions under which special equipment may be used, and every effort should be made to obtain it on such fires. The major objective in suppression planning is to so outline the job that all possible use will be made of such equipment. In the past the overhead have been too much concerned with other duties to make proper use of such equipment supplied them.

The plan of attack as planned and recorded will show what and where each kind of equipment can be used. There are at present three types of special equipment which have proven practical in fire work. Mainly the plow (horse and motor drawn), tractor, and pump.

Plow is a line constructing instrument of the most convenient and practical kind. Every effort must be made to get it on the fire immediately and put into use.

Tractor is limited by transporation and topography, but is worth any effort it might cost when once it is put into operation on topography which is suitable for its use. It is not practical to operate a tractor on slopes over 20 degrees or on rocky ground.

The maximum efficiency of tractor units is obtained on fire line construction when a crew of men accompany the tractor at all times for the purpose of protecting it from fire and to clean up the light work. Adequate lights and a lookout man should be supplied each tractor during night work. The parallel and indirect methods are used mostly when constructing line with plows and tractors.

Pumps - water is the most effective and convenient fire extinguishing and retarding agent at the fire fighter's command. The forest fire pumps supplied the suppression crews are practical and adequate for any need and the suppression plan should consider their use wherever possible. Their major use in line construction is in knocking down flames and cooling off hot spots to allow the trenching crews to put through their trench by a more direct method. The greatest use of pumps is largely confined to mop-up work in snags and windfalls where water is available.

MOPPING-UP

Mopping-up is the last phase of fire fighting, and plans for its accomplishment should be incorporated in the suppression plan as soon as possible after other prior factors have been considered. Mop-up work is closely related to methods of attack and in most cases it will be started before the fire line is completed. Experiments have demonstrated the advisability of commencing mop-up work while the line construction is still in progress. The chief advantages are that it; requires less work on the line itself, makes the job more complete and safe by forcing the issue, and eliminates the tendency for fire fighters to slack up immediately after the trench is completed.

The latter case of men slowing up after corralling the fire is a carry over from the old days when fires were patrolled rather than mopped-up. It is particularly advisable to avoid the word patrol in connection with fire fighting as it carries a connotation which is particularly difficult to overcome. In the fair sense of the word men cannot be expected to continue work on the fire when they are instructed to patrol it. To the average individual it is synonymous with policeman's beat and it is much easier to replace the word than to attempt to convince a crew of men that the word does not mean what it does mean. There is no place for a patrol in fire suppression. If a fire is too dangerous to leave unattended, it should be extinguished and any member of the overhead who permits his men to watch a fire inside the fire line rather than put it out should be replaced.

Mop-up work constitutes all action taken by suppression forces to extinguish the fire. The majority of the work will be done after the fire is corralled, but may be undertaken on untrenched sectors under certain circumstances created by topography, cover, or soil.

The chief means by which fire is extinguished or mopped-up are water, dirt, and chemicals. Pumps, both power and hand, are essential where water is available, but effort should be balanced and not permit waste of time and effort making water available for remote dry areas where dirt is an equally effective extinguishing agent. Chemicals, especially fire foams should be used, when available, for purposes of fire retarding and fire extinguishing.

Special circumstances may justify the use of explosives in either corral action or mop-up work.

The mop-up work must be pressed aggressively until the last spark is out over a distance of at least 100 feet inside the fire edge. Where possible, without too great an expense, relief crews should be made available to carry on the mop-up work without pause until a satisfactory safety margin has been secured.

The task of efficiently administering mop-up work is one to test the leadership qualities of any fire chief. It constitutes one of the major factors which tend to make fire costs so excessive, and is probably the most susceptible to reduction in time and money spent upon it. The intensity of the mop-up work has a direct bearing upon the release of men from the suppression job.

RELEASE OF SUPPRESSION CREWS

The plans for releasing men and materials from the project should be developed immediately after the fire is corralled. Present methods of fire suppression will produce an excess number of men as soon as the trench is completed unless an above average amount of mop-up work is to be done.

It is a good policy to retain those men who have performed most creditably in the line construction work for the remaining mop-up job. Also crews should not be transferred from a sector on which they have worked to a strange location.

Before any men are removed from the fire line, however, the fire chief or his competent aids should carefully inspect every line of the fire. This inspection will supply reliable information upon which to base the release plan. Few men are qualified to say when a fire is safe or out and in no case should the fire chief accept the word of a man of known qualities.

EQUIPMENT AND SUPPLIES

Supplemental equipment and subsistence supplies are secondary to the actual work on the fire line, but every effort should be made to provide all such items in the proper quantities at the proper time.

The functions related to this phase of the suppression job are: transportation, line camp organization and establishment, equipment and supplies, and timekeeping.

Transportation faculties best adapted to fire suppression work are truck, airplane, and horse. The choice of any of these methods is determined to a large degree by accessibility, distance from the central warehouse, allowable time, and the availability of each. Truck should be relied upon where the distance is not in excess of 100 miles over good roads. Airplanes are the most practical in inaccessible areas where speed is essential and the other means are not available in sufficient quantities. Preparation must be made to facilitate dropping materials from airplanes to camps and other locations on the ground. Horse and mule transportation are last resort means and plans for their use is justified only in very rugged country or for short distances from roads.

Line Camp Organization and establishment. This function should be coordinated dispersion of suppression forces, but must be under separate supervision on large fires. The object in so doing is to increase the efficiency in carrying out this function and to allow the attacking overhead to devote their full time to the duties of fire fighting. The man in charge of camp organization will work with the fire scouts in locating camps and determing routes of travel to them. Camps will be established as soon as the chosen sites are safe from fire spread and materials become available to do so.

Equipment and Supplies. All orders for materials will be centralized and issued from the headquarters camp when possible. One man from each unit will be responsible for the supply and maintenance of adequate materials for each camp.

Timekeeping is a function of trained men and should be planned and organized in advance of the suppression job.

ORGANIZATION

The first essential on a fire-control job is, that each overhead engaged in the operation understand, definitely, just what his functions are. This should be settled upon, positively, at the outset of the job.

It is mandatory, that on fires of over 2,000 acres the fire chief should remain at the central headquarters camp during the time of corral action. He is the man responsible, and must be where he can keep his fingers on the pulse of the operations. Centralization is highly necessary and as all communication, transportation, and organization activities are built up around the one point it is obvious that one man must be there constantly to keep the organization working smoothly. This central station will be the clearing house for all information, requisitions, and commands.

The following charts have been worked out with the centralization system as the key note. The major functions have been developed along 3 lines with the many duties segregated and placed under the heading which will most efficiently control them. There will necessarily be some functions which will overlap to a certain degree, but as this overlapping will be separated on the job it is not believed to be a serious factor. Organization charts in their best form are only suggestive and should be used as such. These have been developed for different sized organizations from 40 men to that which should cover the largest possible suppression job.

Fig. 2 ORGANIZATION OF SUPPRESSION
CREWS OF 40 - 130 MEN

No.	41 to 60 Men	No.	61 to 90 Men	No.	91 to 130 Men
1	Fire Boss	1	Fire Boss	1	Fire Boss
2	Foremen	1	Scout	2	Scout
1	Camp Boss (he	3-4	Foremen	4-5	Foremen
	will act as time	1	Camp Boss	1	Camp Boss
	keeper also	1	Timekeeper	1	Timekeeper
1	Cook	1	Cook	1	Cook
2-3	Flunkies	4	Flunkies	1	Asst. Cook
5-8	Straw Bosses	8-11	Straw Bosses	4	Flunkies
1-2	Plow Units	2	Plow Units	12-20	Straw Bosses
				2-3	Plow Units
1	To gather fire cost data	1	To gather fire cost data	1	To gather fire cost data

Fig. 3 ORGANIZATION SET UP FOR
FIRES REQUIRING 150 TO 800 MEN

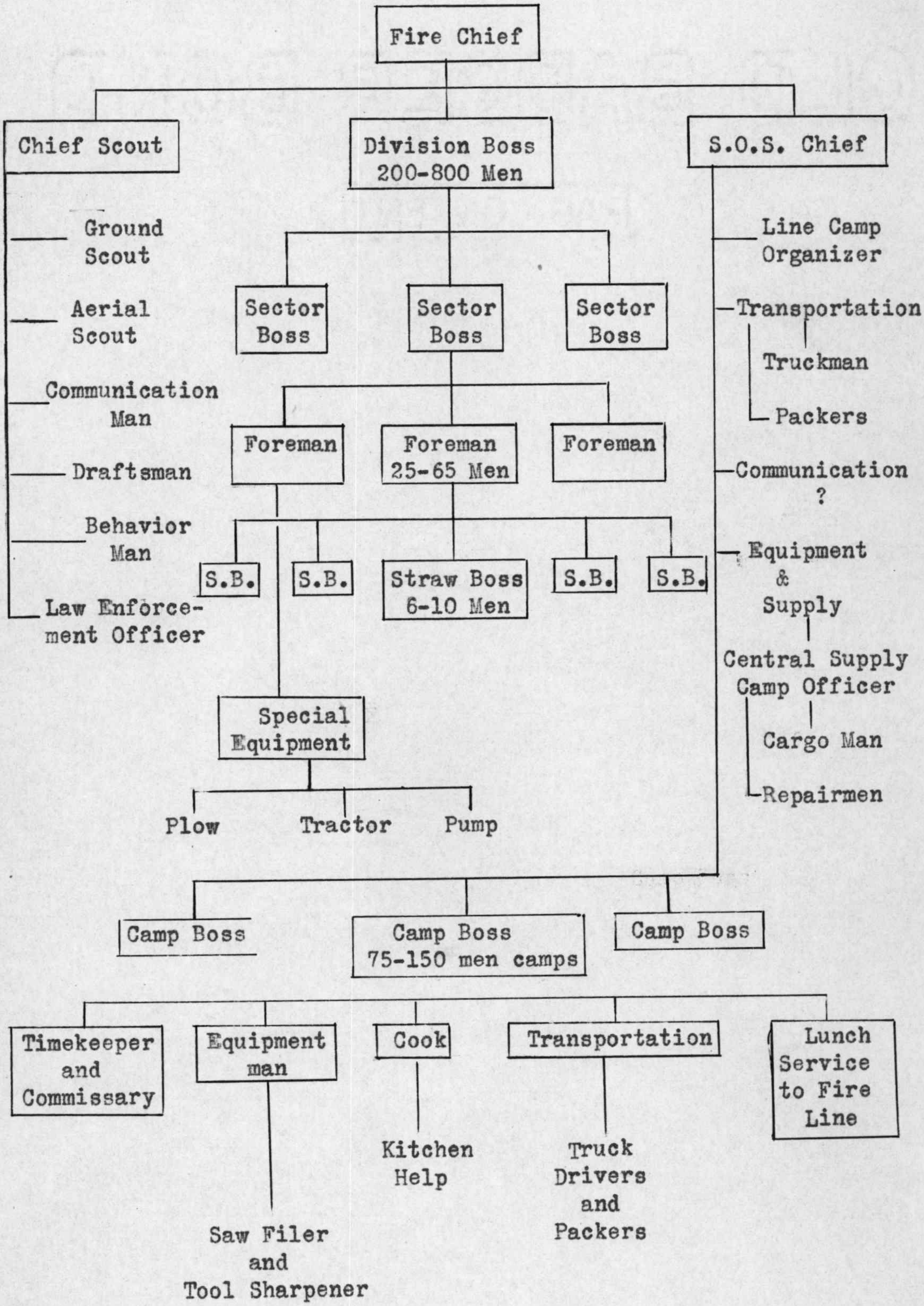


Fig. 4 - A ORGANIZATION OF SCOUTING SERVICE
FOR FIRES REQUIRING OVER 800 MEN

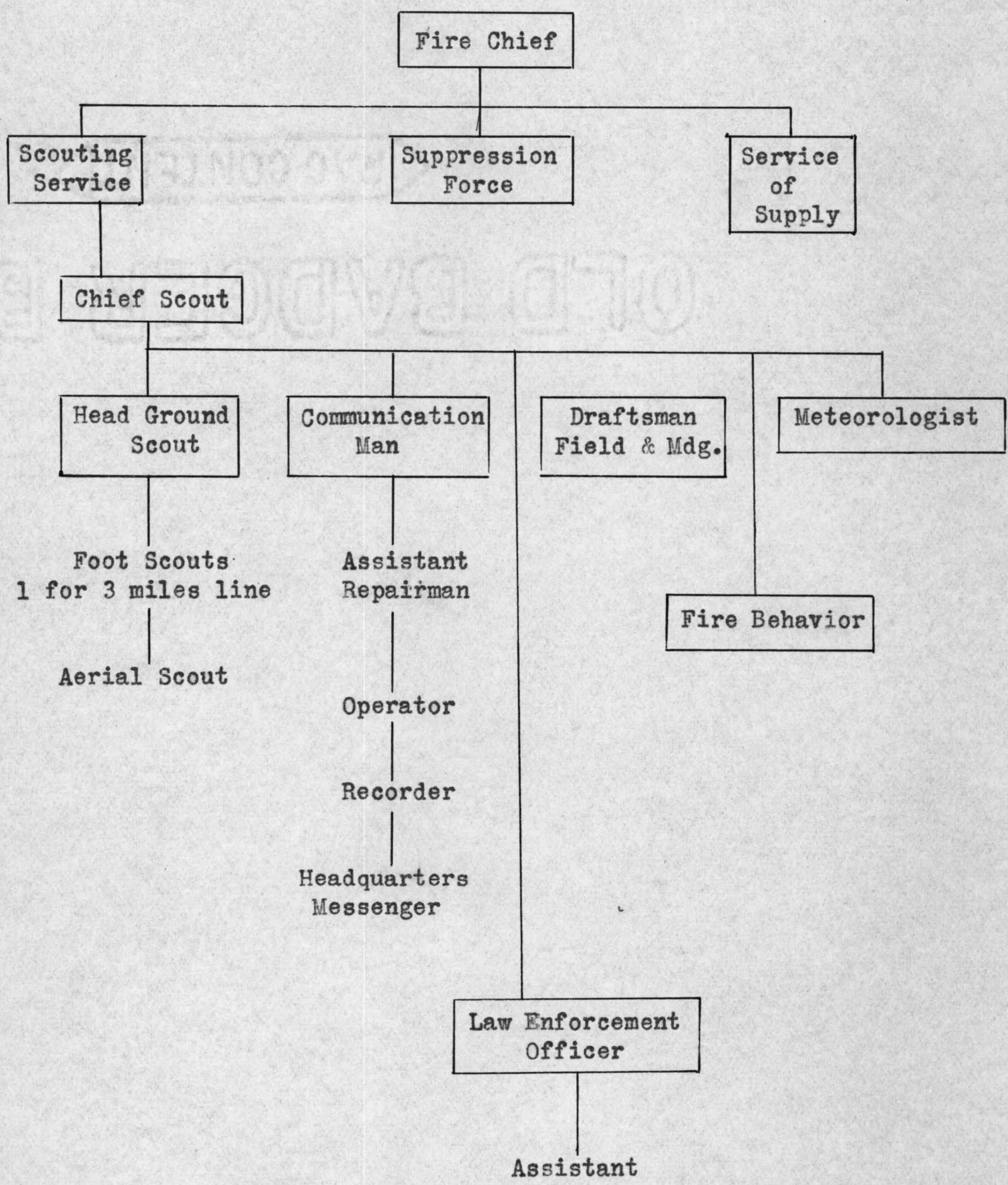


Fig. 4 - B ORGANIZATION OF SUPPRESSION FORCES FOR FIRES REQUIRING OVER 800 MEN

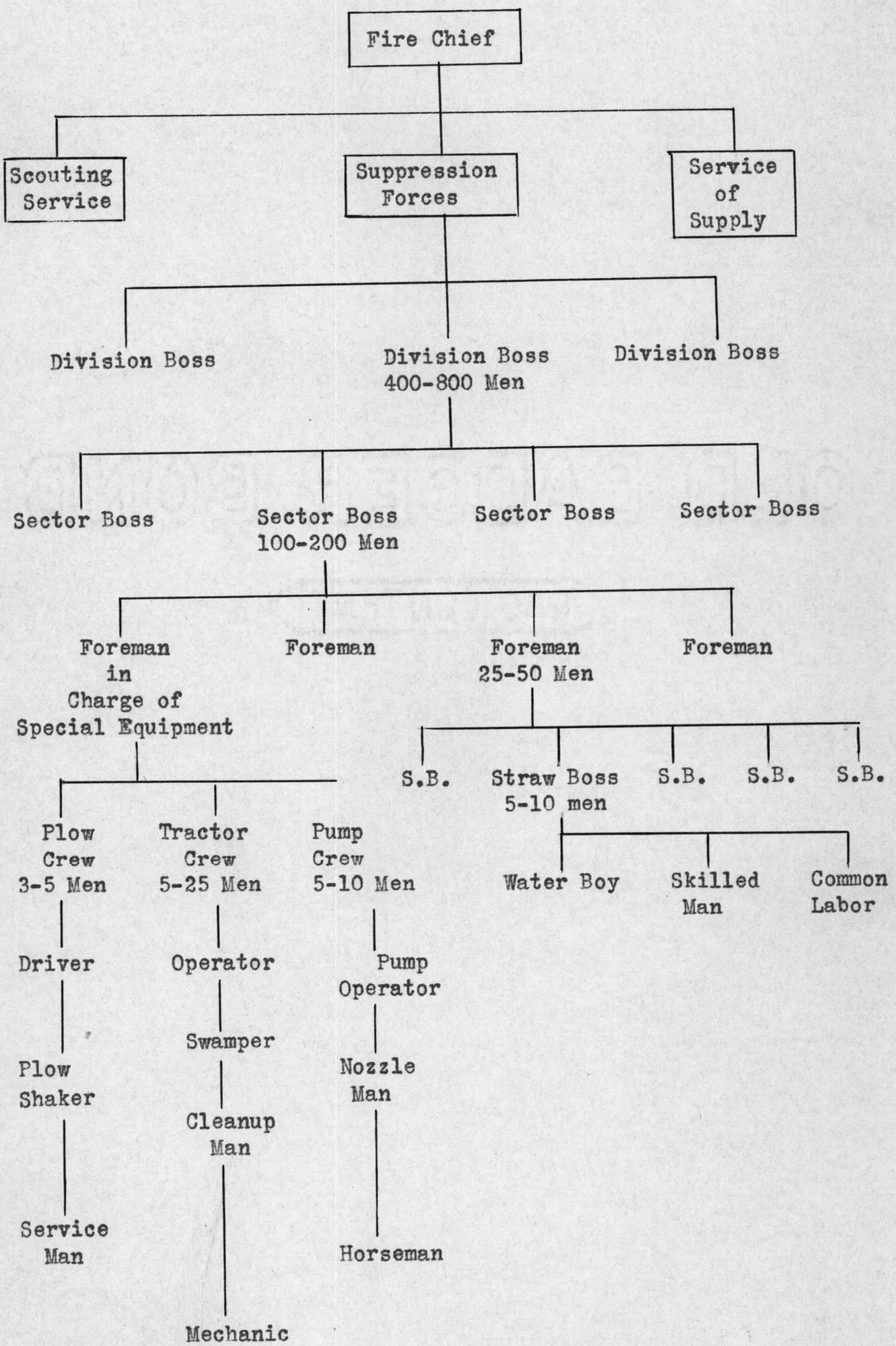
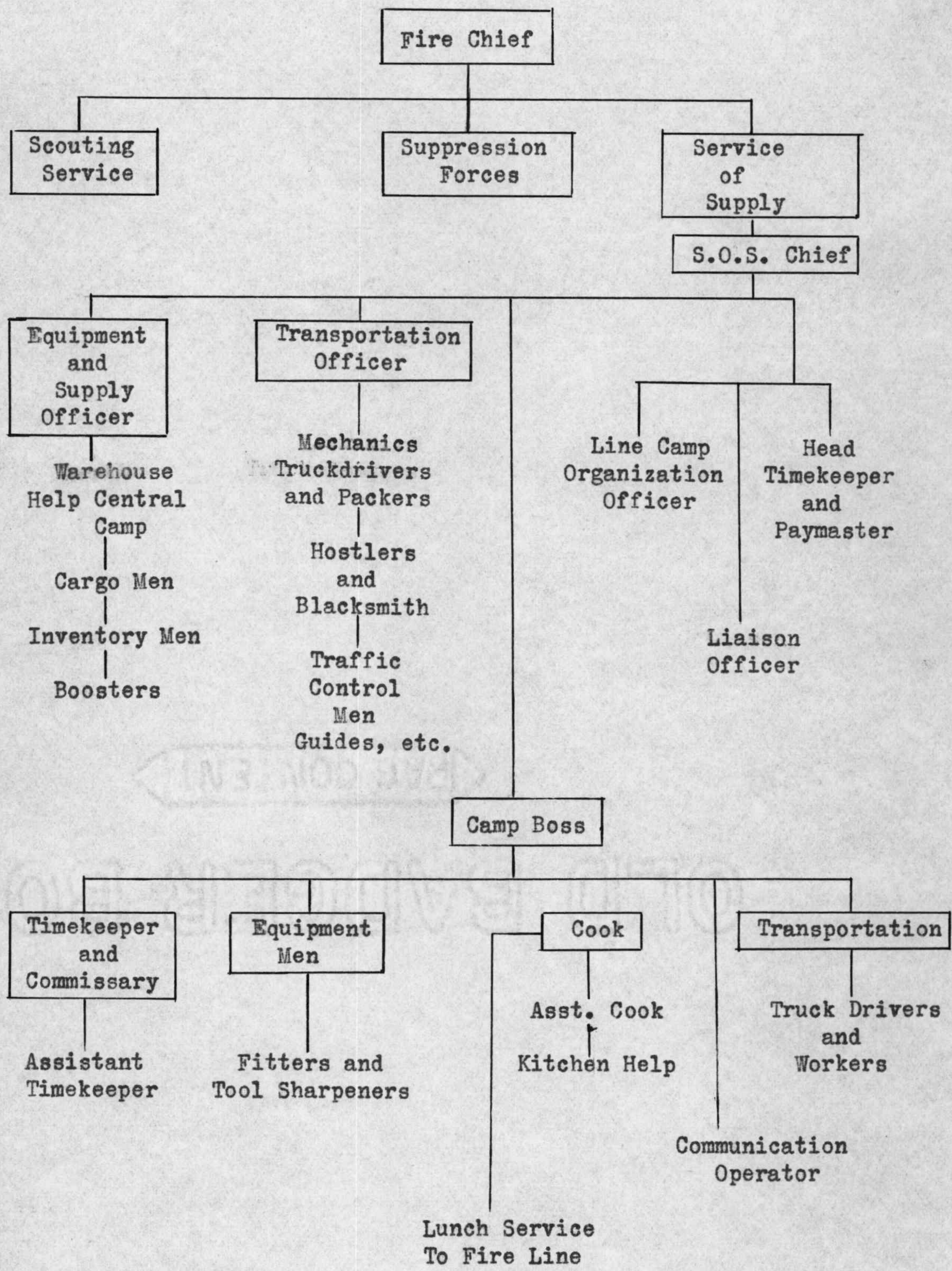


Fig. 4 - C ORGANIZATION OF SERVICE OF SUPPLY FOR FIRES REQUIRING OVER 800 MEN



SUMMARY

The supervision of modern methods of forest fire suppression on large fires is a scientific procedure requiring leadership of a high degree. The man responsible for the fast, energetic, and thorough suppression of large forest fires must understand management principles and their application to fire suppression.

In order to intelligently develop a sound management plan for the suppression of a fire the man responsible for the plan must secure all pertinent data. The more reliable the data the better will be the plan and the more closely can it be followed. He should use every resource at hand to secure this data, even at the cost of making the initial attack less effective.

It is good policy for the fire chief to encourage suggestions from his subordinates in developing his plan of attack and to give added responsibility to thos capable of receiving it. Keep every agency alive to the work at hand and revise the plan whenever field conditions warrant any change. The management must be progressive and action taken at the earliest possible moment on all phases of the job.

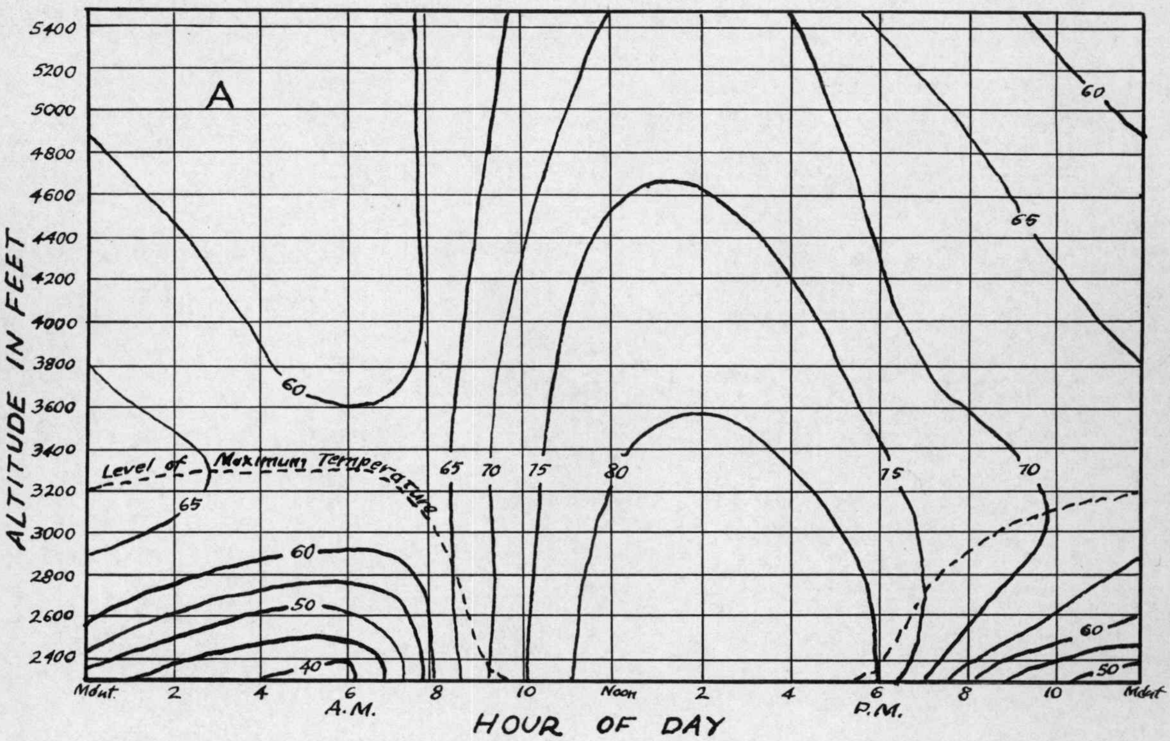
Centralize the operation as much as practical, but do not penalize individual initiative and judgment.

Organization of the suppression forces and materials must be developed along definite lines with the functions of each clearly set forth. See that each man engaged as overhead in the operation understands, definitely, just what his functions are.

Let the cost of operation be a guide to the efficiency of suppressing the fire within standard limits of time, but do not sacrifice human energy to save a few dollars. Have plenty of men, especially overhead.

Lastly keep in mind at all times the comfort and safety of the men engaged in the operation. Upon such consideration largely depends the morale of the men and, in the last analysis, a suppression plan is abortive without the united support of all members affected by it.

A P P E N D I X



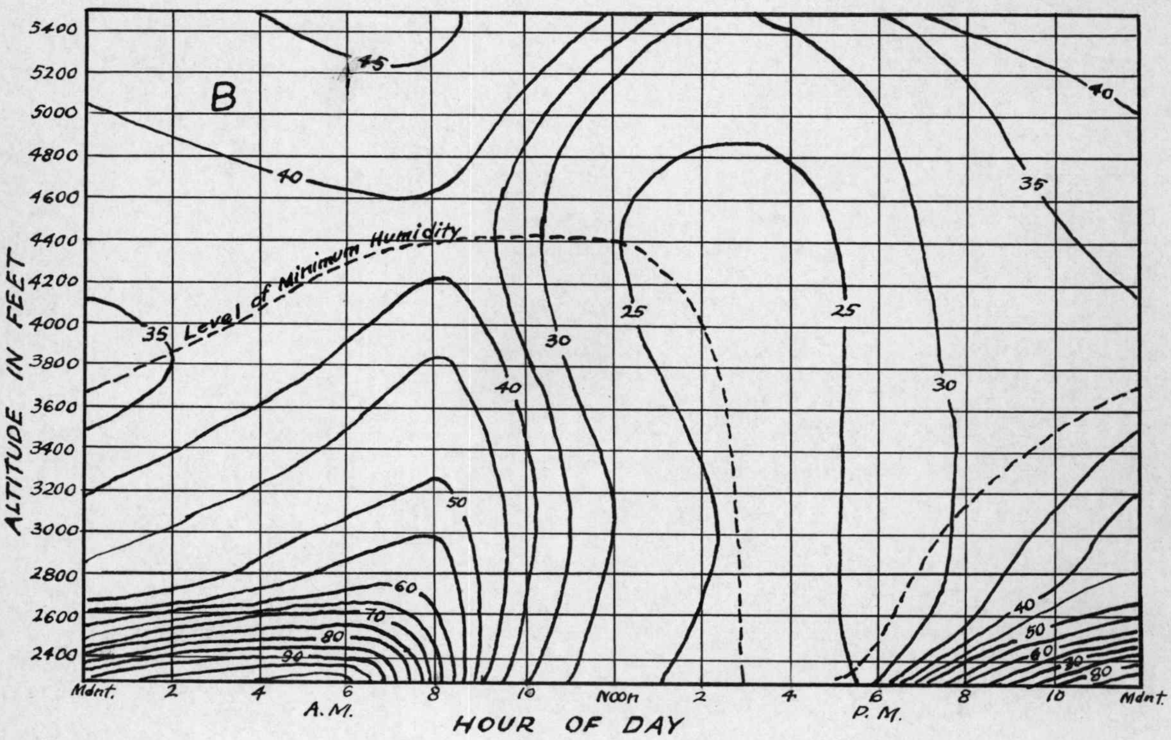


FIG. 1-A-ISOGRAMS OF TEMPERATURE ALONG SOUTH SLOPES
B-ISOGRAMS OF RELATIVE HUMIDITY ALONG SOUTH SLOPES

MEDIAN DAY OF AUGUST, 1936, ON PRIEST RIVER EXPERIMENTAL FOREST

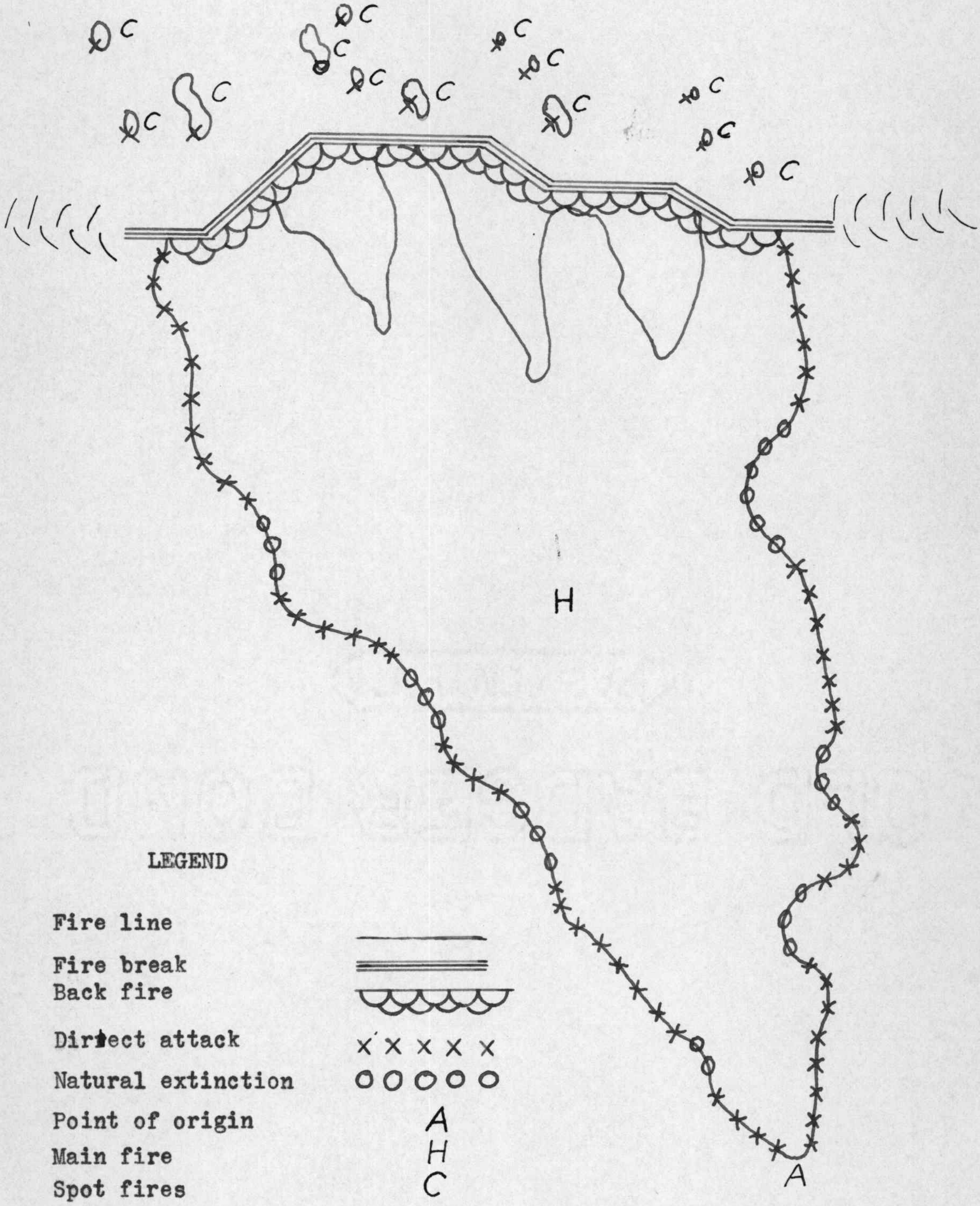
Table I

NUMBER OF CHAINS OF HELD
LINE CONSTRUCTED PER MAN

Available work time on fire	Low					Moderate				
	Type					Type				
Hours	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.
2	2.6	.9	1.2	1.3	1.4	2.5	.66	.88	.95	1.08
4	5.	1.7	2.4	2.6	2.9	4.4	1.3	1.7	1.8	2.1
6	8.	2.7	3.6	4.	4.4	6.6	2.	2.6	2.8	3.2
8	1.	3.5	4.7	5.3	6.1	8.8	2.6	3.5	3.8	4.4
10	13.3	4.4	6.1	6.6	7.2	11.4	3.3	4.4	4.7	5.3
12	16.	5.3	7.2	8.	8.8	13.3	4.	5.3	5.7	6.6

	High					Extreme				
	Type					Type				
Hours	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.	Br.Gr.	P.P.	L.P.	D.F.	S.Alp.
2	2.05	.44	.60	.61	.72	1.8	.30	.30	.30	.30
4	4.	.88	1.2	1.3	1.4	3.6	.44	.60	.60	.60
6	6.1	1.3	1.8	1.8	2.1	5.7	.66	.90	.90	1.0
8	8.	1.7	2.4	2.5	2.8	7.2	.88	1.2	1.2	1.3
10	10.	2.2	2.9	3.0	3.6	8.8	1.09	1.5	1.5	1.7
12	11.4	2.6	3.6	3.6	4.4	10.	1.3	1.8	1.8	2.1

Fig. 7 CONTROL MAP OF A FOREST FIRE



ANALYSIS OF WARREN CREEK FIRE

Sept. 17, 1937.

Results - gross area burned, 2176 acres in a 46-hour burning period.

Number of Extra Periods which fire burned through uncontroled - one.

Topography - rolling to steep - glacial moraine. Difference in elevation between the lowest and highest points on fire, 1000 feet.

Forest type - L P; + L P - D F; & L P - Sp.

Fuels - rate of spread, low to high. Resistance to control low to extreme.

Cause - Hunter's temporary camp fire.

Time of inception - Sept. 17, 1937, about 9:00 a.m.

Time of discovery - 11:40 a.m., Sept. 17, 1937.

Fire behavior - 87% of the area which burned occurred between noon and 8:00 p.m. of the first day. Extra period burn totaled approximately 210 acres. A 20 to 35 mile an hour wind, which changed directions 3 times during the afternoon, started the fire crowning 1 hour from time of discovery.

Lead of fire had advanced about 5 miles by 5:00 p.m. of the 17th. largely due to the numerous and distant spot fires.

A large number of spots were $1\frac{1}{4}$ miles in front of main fire.

Analysis of action:

A. Elapsed time periods:

1.	Discovery	2:40	min.	(9 - 11:40 a.m.)
2.	Reporting	05	min.	(11:40 - 11:45 a.m.)
3.	Get-a-way	13	min.	(11:45 - 11:58 a.m.)
4.	Travel	80	min.	(11:58 - 1:18 p.m.)
5.	Corralled	46	hours	(1:18 p.m., Sept. 17 - 11:30 a.m., Sept. 19)

Remarks - No. 3 - time of day necessitated depriving men of meals which they were prepared to eat. Most of the 10 men were employees of the mine and dredging companies. No. 4 - Travel - 40% of the road required low gear to travel by car with load of men. No. 5 - Corral time - largely due to the numerous spot fires which could not be reached in time after they became visible during the late forenoon of Sept. 18. One spot ran to 180 acres and developed into a project fire of itself, 100 men corralled this on the morning of the 19th.

Lack of proper distribution of man power resulted in 1 mile of untrenched line on the West side of the main fire. The guide detailed to take 50 men to this sector became confused in the darkness and heavy smoke and began work in the wrong direction. This error was not discovered by the overhead until it was too late to connect the trench before the end of the first burning period, this was not a dangerous sector.

The only other line not corralled resulted from loss of 3/8 of a mile of line on the Northeast sector. High winds and uncrowned trees within the fire line made this section difficult to hold.

B. Man Power Deployment.

TABLE I

Time of Arrival and Placement of Men on Fire Line

Foreman	Time	Number of men	Cumulative No. of men	Location
		September 17		
Jacking	1:18 p.m.	5	5	Point of Origin
Locals	1:25 p.m.	5	10	Same
	2:30 p.m.	25	35	West Center
Johnson	3:10 p.m.	20	55	West Center
Kerby	3:10 p.m.	35	90	Same
Sandy	4:30 p.m.	25	115	S. W.
Foust	6:45 p.m.	35	150	W. Center
Bross	7:30 p.m.	25	175	N. W.
White	7:45 p.m.	40	215	N. W.
Nassi	8:10 p.m.	25	240	N. Spot
Axe	8:25 p.m.	25	265	N. W.
Benson	9:10 p.m.	32	297	North
Printz	11:30 p.m.	25	322	N. of main fire
Ford	11:45 p.m.	25	347	Center
		September 18		
Bower	12:30 a.m.	25	372	N. E.
Hoff	1:20 a.m.	30	402	N. W.
Hammond	2:10 a.m.	27	429	N. E. Main Fire
Robinson	4:15 a.m.	25	454	East Main Fire
Potter	4:25 a.m.	32	486	N. Spot main fire
Marquis	4:55 a.m.	25	511	Spots on main fire
White	6:10 a.m.	25	536	S. E. of North fire
Blake	6:35 a.m.	25	561	N.E. Spot Main fire
Hawks	6:45 p.m.	25	586	S. W. Main fire

The above chart does not include camp personnel and scouts.

September 17, 1937

11:45 - Fire Dispatcher referred lookout reporting this fire to myself for action as he was receiving a report on another fire at that moment. I took the report, checked their readings, made a calculation of probabilities which called for 10 men, and immediately left the phone to gather them in Warren. One trip through town by car and I had 10 men and a pickup to take them.

11:58 - 9 men with foreman Jacklin left Warren by car, all men good fire fighters and knew the country well in the vicinity of the fire. They should arrive about 1:00 p.m.

12:00 - Checked with lookouts on action of fire. Intermittant spurts of smoke were showing at intervals of 5 min. Steamboat L. O. and Cottontail L. O. each estimated fire to have an area of 100 sq. ft.

12:10 - 12:30 Gathering men and making arrangements for following of supplies and equipment. The wind was increasing to a velocity of about 15 miles per hour. Although the fire was in an open lodgepole type with bear grass ground cover, and a relative humidity of 32 at South Fork Station, 14 miles distant, I deemed it advisable to send a follow up because of the high wind. The Fire Dispatcher confirmed this decision.

12:35 p.m. - Lookouts reported fire crowning and about $\frac{1}{4}$ acre in size. Wind velocity increasing.

1:00 - 5 men left Warren by car for fire with extra equipment.

1:10 - I calculated the probabilities of spread and determined that 200 men would be needed to construct 2 miles of line in this timber type. Notified Fire Dispatcher of this need. It did not seem likely that the fire could spread to more than 160 acres because of its topographic location on top of an intermediate ridge which terminated 3/4 miles from point of origin of fire on leeward side from wind.

1:18 - Foreman Jacklin arrived on fire, which was crowning and spotting ahead. He and 5 men began work immediately flanking the fire on each side using the parallel method. It was impossible to work in the lead of the fire because of the rate of spread.

1:25 - Remainder of crew arrived and began work.

1:50 - 4 miners and sheepmen from nearby arrived and joined crews on the fire.

1:50 - Due to smoke being held to the ground by the wind and screening the lead, the lookouts could not observe the action of the fire. I left the station by car to determine character of fire.

2:10 - Arrived at observation point $1\frac{1}{2}$ miles from lead of fire. It was crowning downhill and throwing hundreds of spot fires in advance.

2:30 - Returned to Warren Station. Fire spotted $1\frac{1}{4}$ miles across Warren Creek to S. W. of Forks of stream.

2:30 to 2:40 - Arranged with Idaho Gold Dredging Company to have 2 tractors, R. D. 7 and R. D. 8., with bulldozers for fire duty as soon as possible. Organized pump crews to set up and operate Edwards Fire Pump on east side of town, which the fire had a good possibility of reaching.

2:45 - Supervisor Shank arrived and further plans were made. Additional overhead were requested and 600 men.

3:10 3:20 - 55 C.C.C. enrollees arrived at Warren, started them trenching on West side of fire, indirect method.

4:20 - Completed $\frac{1}{4}$ mile of held line, but change in wind, which threw spot fires far back of trench, forced the withdrawal of these men. Supervisor Shank directed these men with an additional 25 and one caterpillar to the southwest corner of the main spot which was threatening the town and spreading to the northwest on top of that ridge.

4:30 to 5:30 - At Warren - planning organization and placement of men and camps on fire line. Making these plans known to Fire Dispatcher and ascertaining that overhead, special equipment and transportation would be received.

As Forest overhead would not arrive until after the majority of the men I organized and instructed all available local men so as to carry out the placement of camps and to assist in guiding crews to their sectors on the fire line.

Supervisor Shank, Asst. Supervisor Kooch, and myself instructed crews and placed them on fire line during the night. Each crew was given a warm lunch and a few minutes to warm themselves before going out on the line.

9:20 p.m. - Mr. Kooch, George Mosher, and myself started out to scout the fire as it had died down sufficiently to permit accurate mapping. Mosher scouted the north end or lead; Kooch the south end to the point of inception and I scouted the central spot fires. From the information obtained from the scouting trip the plan was developed to make the heaviest concentration of men on the central portion of the fire where the spot fires were of major concern and the resistance to suppression was the greatest.

September 18, 1937

2:00 a.m. - Complete organizatio plans were developed for each sector camp and crew. We were notified of the overhead we could expect and the time of their arrival.

Forest Officers on the Fire

Sept. 17	H. M. Shank	Supervisor Idaho National Forest
	J. G. Kooch	Asst. Supervisor Idaho National Forest
	Kenneth Wilde	Asst. Supervisor Idaho National Forest
	C. E. Favre	Asst. Regional Forester R - 4
Sept. 18	J. W. Kinney	Asst. Regional Forester R - 4
	J. W. Farrell	Asst. Regional Forester R - 4
	I. M. Varner	Asst. Supervisor Boise National Forest
	A. L. Bunch	Asst. Supervisor Payette National Forest
	G. E. Kreizenbeck	Asst. Supervisor Payette National Forest
	K. Daniels	Ranger Payette National Forest
	H. C. Hoffman	Asst. Supervisor Weiser National Forest
	D. Russel	Ranger Weiser National Forest
Sept. 19	C. J. Olsen	Asst. Regional Forester R - 4

Report submitted by:

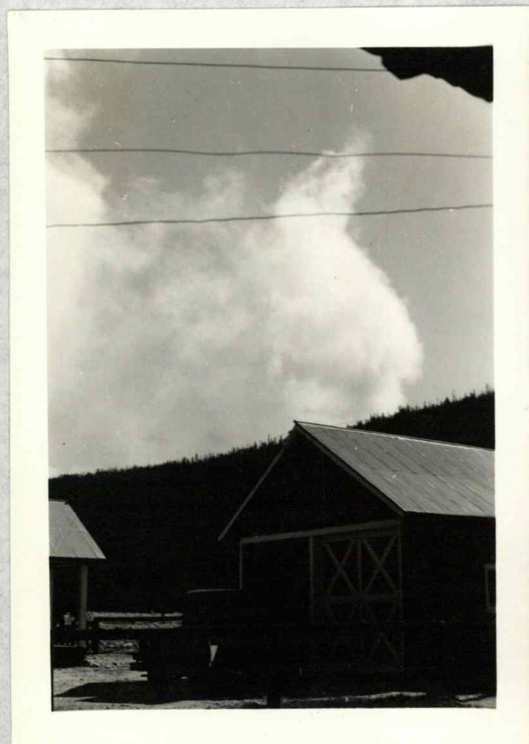
Glenn Thompson
Fire Chief

TABLE II

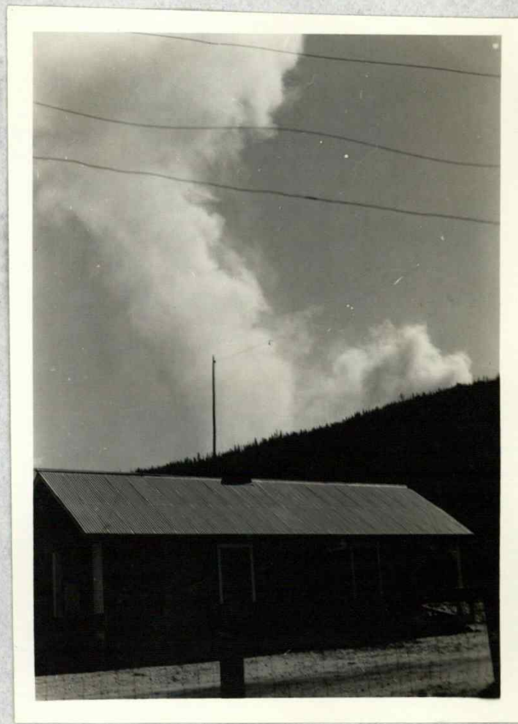
Release of Men from the Fire Line

Date	Foreman	Number of men	Number of men left on fire
Sept. 19	Reed	35	
	White	20	540
Sept. 20	Foust C.C.C.	35	
	Printz	25	
	Ford	25	
	Hoff	30	
	Hawks	25	
	Benson	32	
	Axe	25	343
Sept. 21	Bower	25	
	Robinson	25	
	White	25	268
Sept. 22	Potter	32	
	Hammond	26	210
Sept. 23	Kerby	35	
	Johnson	20	
	Blake	25	130
Sept. 24	Nassi	25	
	Marquis	25	80
Sept. 25	Bross	30	50
Sept. 29	Jacking	20	30
Oct. 2	Mosher	25	5

PICTURE PROGRESS OF WARREN CREEK FIRE
District 4, Idaho National Forest



1. Fire at 1:30 p.m.
5 miles distant



2. Fire at 2:00 p.m.
4½ miles distant

3. Fire at 3:30 p.m.
1 mile distant

4. Fire at 4 p.m.
$\frac{1}{2}$ mile distant

5. Fire at 5 p.m.
15 miles distant

O
Fire

Warren, Idaho
Sept. 12, 1935

Porphyry Creek Fire

Memo for Ranger Briggs

In regard to action on West Sector of Porphyry Cr. Fire. The following report is compiled from the best available information and from my own experience on the fire line. Some diarys, including my own, may not check with this report on time of discovery and other details, but this has been taken from notes made at the telephone desk at the exact minute while diarys were written in fire camps without reference.

July 28

5:25 A.M. Smith Knob L.O. reported fire in Porphyry Creek. Reading 135, R-8, E. T-22, N S-23. Estimated size 1/10 acre. Tried to call Fire Dispatcher.

5:30 A.M. 5 men (Flying Squadron) left South Fork by way of So. Fork Trail. Dispatched 3 men from Carry Ranch, 1 man from Thompson Ranch. George Mosher in charge; men carrying tools, waterbags, and lunches. I arranged for another man to take government pack stock from So. Fork station and pack more equipment and supplies to mouth of Porphyry Creek.

6:15 A.M. After repeated attempts,,during the dispatchery of men as stated above, I got connection with Don Parks at McCall Office by telephone. Gave report of fire and asked for 50 men with back ~~packs~~ pack outfits, to go in by way of Smoke House on Elk Creek. With full consideration to the 1935 fire policy I estimated 50 men to be plenty to handle this fire in case the 9 already sent could not.

The topography is exceedingly rough with slide rock bordering the West, North and East sides of Porphyry Cr. at point of origin of fire. Above the slide rock, on these sides, to the top of breaks the ground covering is grass with very little brush in draws. Some mature Yellow Pine and Douglass Fir. The South side was an old burn with very little second growth, short brush and scattering down timber. In all there was no chance for a crown fire, unless the fire spread to larger proportions then it seem possible, considering the amount of rainfall over that section on July 24 and 25 and the cumulative relative humidity deficiency of about 60.

10:00 A.M. Gave full instruction, by telephone, to foreman Bowman, at Smokehouse, as to route of travel, ~~and~~ camp location, and objective ridge from which the fire could best be approached. Crab Springs was the point I had in mind, located on top of first ridge due West of starting point of fire. How far from crab sps. to Fire

July of 28+29 + about 100 yds from actual fire line

It was very probable that the fire would run 1/2 mile, to top of break on South side, if first 9 men could not stop it before noon of 28th. Assuming this happened, with fair margin for lateral spread 50 men could have easily trenched that erea in that type of open country before the next burning period.

11:00 A.M. First 9 men reached fire. Foreman Mosher stated that fire was approximately 100 acres and spreading fast in all directions. 3 men were cut off and remained in the slide rock during afternoon and night, others out ran fire back down Porphyry Creek.

Due to smoke lying in canyon all observers, with comunication, were unable to determine action of fire until about 1:30 P.M., when large column of smoke indicated a blow up.

5:00 P.M. I asked for 50 more men and permission to take them to mouth of Porphyry Creek. My object: to cut off lower end of fire and hold it to higher elevation, where objective ridges formed natural breaks. It was unsafe to send initial attack from top as long as fire spread down into mouths of side canyons and into worse hazards.

6:00 P.M. Had 15 men organized and equipped at Warren.

from McCall to fire. at Mouth of Porphyry Cr.

9:00 P.M. Received orders to take 50 men // ~~Ranger Briggs leaving French Creek to come on fire at mouth of Porphyry Cr., with 50 men.~~

10:00 P.M. Started Warren crew to fire. Le Marinal in charge.

9 P.M. to 12 Mt. Waiting for 50 men from McCall.

July 29

12 Mt. Left Warren for South Fork by car.

1:00 A.M. Left South Fork for fire by foot.

3:00 A.M. Overtook 15 men from Warren.

7:00 A.M. On fire line on Porphyry Cr. 3 other men already on line. Started 3 men working from Creek up north side by direct method. 12 men, LeMarinal in charge, from Cr. up south side. Edge of fire was practically all dead. Trenching few smoldering fires and mop up on numerous logs and stumps was main job. Heavy smoke hanging in canyon was almost sufficating. Natural breaks of slide rock were a great aid for distances of 1/4 mile on either side of Porphyry Creek.

9:00 A.M. to 12 N

Myself with 1 man made trip through fire to point of origin to check on 3 men who were cut off the day before. Found their tracks in ashes where they had climbed out on top. Fire had destroyed any trace of cause of fire.

12 N to 12 N P.M. to 4:00 P.M.

Climbed out on top of North side. Smoke had cleared out, giving a good view of all the West edge. Fire was idle except for short points which were burning down on West side of ridge. The furthest lead was not more than 100 yards from top of divide. On the North of Porphyry creek fire had burned out against slide rock draw nearly to top of divide - or about a mile.

4:00 P.M. to 4:00 P.M. to 6:00 P.M.

4 men and myself mopped up the most dangerous burning logs down to creek on North side. LeMarinal had fire controlled 3/4 miles up South side.

From top on North to top on South of Porphyry, about 4 miles distance, the fire had not spread over more than 10 acres during the burning period of the 29th. This entire sector was on a minimum slope of 75 percent and a great deal of it over 90%. The amount of roll made it too hazardous to work men after night.

8:00 P.M.

Arrived at camp. Ranger Briggs and 50 men were there. Reported to Briggs and helped make plans for the morrow.

July 30

5:00 A.M. to 8:00 A. M.

Walking to point on fire where men had turned back on 29th.

Ranger Briggs took 25 men up North side. Myself and 40 men went to South.

8:00 A.M.

Sent messenger with note to man in charge on South side of fire on top. what Message?

8:00 A.M. to 2:00 P.M.

Flanked fire out to point of ridge, the highest elevation to which we could work from our camp, nearly 4 miles and a difference ~~of~~ in elevation of over 3000 feet.

2:00 P.M. to 7:00 P.M.

Mop up work. Held all line constructed.

July 31

Ranger Briggs Left Fire.

5 to 8 A.M.

Men walking to positions on fire line. 20 to North. 30 to South.

1:00 P. M.

Constructed 1/4 mile more line to tie in with crew from top on South side. Did not tie in as crew on top did not get far enough down.

Glenn:

J. B. Bruce will
release you from your
detail at Porphyry Cr.
Give him any instructions
you think necessary
and get back to Warren
If your line is in good
shape it probably will
not be necessary to
go over it with Bruce

[redacted]

F. R. V. S.

7:00 P.M. 90% of mop up completed. All line held and I consider West Side well under control with present crews patroling. North side not losing any ground beyond their limit to trench

August 1

4:30 A.M. Advised, by phone, that I would be relieved from my sector of fire by Ranger J. B. Bruce.

5:00 A.M. Sent men out on fire line with full instructions to foreman in charge.

9:00 A.M. Ranger Bruce arrived at Porphyry Creek camp. Gave him notes on organization, map of fire line, location of camps joining his sector and all other details concerning fire in general.

10:00 A.M. to 1:00 P.M. Walking with Bruce to fire line and point from which we could see entire sector from top to top. We could see not more than a dozen smokes along entire line at 1:00 P.M. Pointed out to Bruce what I considered to be most dangerous sections. No. of men on this sector?

25 men were distributed over the South sector

1 to 7 P.M. Returned to Warren Ranger Station.

8:00 P.M. Bruce reported all well.

August 2

7:00 A.M. Bruce reported everything to be in fine shape. His plans for the day were to make personal contact with camp joining his on North.

8:00 P.M. Foreman Francis reported lines in fine shape. No. of men on this sector?

Bruce had reduced patrol to 11 men on South side & had shifted these men to north section Total of 40 men in Porphyr camp

August 3

8:00 A.M. Stopped arrangements Bruce had made to transfer 25 men from Porphyry Creek camp to camp on top of North side. Bruce had remained in upper camp on night of August 2 and was not in communication until about 5:00 P.M. August 3, when he arrived at So. Fork Ranger Station. Ellis had been sent down to relieve him.

5:00 P.M. Foreman Francis reported that fire had broken over line on South side about 3/4 mile from Porphyry Cr. He ordered 25 men and left the phone, which was 1/4 mile from camp. We could not get in contact with them again that evening.

Supervisor Scribner advised that I should make trip to Porphyry Camp, get the facts, straighten out the organization, and return to Warren as soon as possible.

Facts, gathered later from foreman and straw-bosses on that section, indicate poor distribution of men and neglect in enforcing complete mop up as cause of break. Men were watching stumps burn in-

Facts, gathered later from foreman and strawbosses on that section, indicate poor distribution of men and neglect in enforcing complete mop up as the cause of break. Men were watching stumps burn instead of putting them out.

August 4

2 to 7 A.M. Travelled to Porphyry camp with 25 men from McCall. Ellis had arranged to have these men back pack to fire line and work them at night and early mornings.

9:00 A.M. Contacted Ellis on fire line. He had nearly all of the lost line, 1/4 mile, trenched tying in at the head of a wide slide rock draw. The line lost on Aug. 3 was nothing vital, in fact the new line would be much easier to hold with practically no mop up to be done. The most serious problem was the jog in fire line along Porphyry Creek caused by loss of ground on South side. I suggested to Ellis that he get some men to work along creek with water buckets and pumps.

There was now a total of 65 men on this sector. A ten man patrol was sufficient for North section, leaving at least 50 men for a section that 40 men had controlled in a more difficult location and a mile longer line on July 29 and 30. It was understood with Ellis that he was in charge of that sector and would be required to make a full report at least once a day.

12:30 P.M. Reported situation to McCall office and was ordered by Asst. Supervisor Price to return to Warren Ranger Station.

August 5

8:00 P.M. Ellis reported everything O.K. Fire had broken over in one place but had plenty of men to hold it. Ellis Asked for 25 more men.

August 6

2:00 P.M. Messenger from Ellis reported fire had crossed Porphyry and had burned out 1 mile of trench on North side. Ellis had neglected to place any men on creek and fire had burned across on a log drift.

8:00 P.M. Ellis reported fire line had been lost on South side, had crossed the West fork of Porphyry and run to top of divide.

8:15 P.M. Smith Knob L. O. reported fire burning down numerous draws from crown of ridge toward So. Fork of Salmon and mouth of Porphyry on the South.

8:30 P.M. I reported the situation to Fire Chief Shank at Big Creek.

10: P.M. to 12 Mt. The Edwards Fire Pump was loaded into the Pick up and I drove to So. Fork Ranger station. Shank ordered me to go to Porphyry Cr. camp and take charge of that sector.

August 7

1 to 4 A.M. Walked to Porphyry camp.

4:00 A.M. Learned that all lines had been lost on that sector. Sent Ellis with 60 men to North side. Took 50 men to South 1 mile up So. Fork from mouth of Porphyry. Tied in with Mosher on top and trenched first ridge south of fire from top of main divide to So. Fork. Back fired only when necessary and as fire came up to line.

7:00 P.M. Had dead line 1/4 mile down from top. It was impossible to work men below fire at any point from mouth of West Fork to South edge 1 mile up So. Fork. We were forced to let fire burn down and to hold it as best we could on South trench. Burning out from bottom would be fatal in such narrow canyons and with changeable winds. Made arrangements to work 2 Fire Pumps up Porphyry on 2 mile front. Mopping up fire as it burned down to creek. Ellis had not held any line. Fire not serious on North. Nearly all bunch grass, slide rock and Yellow Pine.

5:00 P.M. 25 men had arrived in Porphyry Creek camp. Total 130.

August 8

Divided men as of yesterday.

10:00 A.M. North wind came up, had to start backfiring early. Everything fine until 5:00 P.M. The main fire crowning out threw spot~~s~~ fires over line. Lost upper end of line, nothing serious. Fire Chief Shank contacted us and formed plans for the morning. North side still loose and threatning North Fork of Porphyry Cr. Ellis and foreman Boron had gone against orders, not to back fire, and had lost about 1 1/2 miles of their line in grass type by doing so.

August 9

Ellis and 20, culled, men went out. to Mccall

4:00 A.M. Sent best crews up river to help Shank and took remainder to North side, fire serious in that section. Had 1 1/2 miles trenched and held from Porphyry Cr. north by 2 P.M.

25 men and 2 pump crews doing good wok along south side of Porphyry creek fighting many very hot fires in wind falls and brush.

3:00 P.M. Everything trenched and holding. Very few places that fire had not burned down to creek and river.

4:00 P.M. to 5:00 P.M. Worst fire hour in my experience. Held line from Porphyry North but lost all others. Fire jumped creek between So. Fork and North Fork of Porphyry, and ran 2 miles up Chicken Creek ridge. South side went wild at 5:00 P.M. The boys had this all backfired to river and well burned out by 4:00 P.M.

50 men were cut off in Porphyry Creek until 10:00 P.M. They sank pumps in creek in order to save them.

8:00 P.M. Notified Shank that we could not help him on South section until we caught the North side.

At time of blow up there was very little unburned area inside trenches and with an average bad day we would have had fire controlled by 7 P.M.

Our deci~~s~~sion, on August 7, to let this section burn down to Porphyry Creek and So. Fork of Salmon River was not a matter of choice. The only men who tried to pass below this fire, against orders, resulted in one man receiving a crushed foot and two broken arms, caused by rolling rocks.

August 10

4:00 A.M. Had every available man on North side from mouth of North Fork up No. Fork 1 mile and along fire edge to So. Fork of Salmon.

12 Noon Fire corralled. Started mop up work.

3:00 P.M. Unburned patches within fire crowned out, spotting across line in numerous places on West side of Chicken Creek ridge. Lost 1/4 mile of ground along 1 mile section.

5:00 P.M. Sent men to camp. Arranged for 10 to patrol on West side up So. Fork opposite fire.

5:00 P.M. to 11:00 P.M. Scouted fire myself until it died ~~out~~ down at 11 P.M. It had burned over ridge and backed down to stream of North Fork Porphyry Creek. Line had been held along North Fork 1 mile, up Porphyry Cr. 1 mile, and 2 miles north toward Mosquito Springs.

10:00 P.M. Ten man patrol crew, from our camp, had put out 1/2 acre spot fire on West side of So. Fork opposite Howard's Bar.

August 11

August 11

5:00 A.M. Men on fire line

11:00 A.M. Fire corralled. Kept men at mop up work until 7:00 P.M.

7:00 P.M. Fire controlled ~~corralled~~. Had every smoke out within 100 yards of trench and not an inch of unburned area inside the line.

8:00 P.M. 25 relief men in camp. 25 more at So. Fork Station. Arranged to move them to mouth of Rattlesnake Creek.

Held full crew of 100 men to patrol and mop up our sector of over 6 miles of line. All this work from July 29 had to be done from our 1 camp at mouth of Porphyry Creek.

August 12

Mop up work all day for crew.

5:A.M. to 6:00 P.M. Made personal inspection of all our line and consider it safe

8:00 P.M. Arranged for Foreman Kesler and 30 men to go, early in morning, to Grouse Creek Camp.

August 13

5 A.M. to 5 P.M. Made inspection of most dangerous parts of line. All in safe condition.

5:00 P.M. Supervisor Scribner phoned that fire had jumped river at the Thompson ranch and for me to bring all available men and come to that section. Arranged for 35 men to work on North side of new fire early in the morning.

August 14

6:00 A.M. Took charge of 200 men on Warren summit.

6 A. M. to 10:00 A.M. Organized force and walked men 6 miles to fire line on Big Buck Creek.

1:00 P.M. Contacted Ranger Williams, who was in charge of crews from Grouse Creek camp on that section. Made arrangments with him to work 90 of my men down to river and feed them at ~~Grouse Cr. Camp~~ his camp. Edge of fire was dead, mop up the only job.

4:00 P. M. to 6:00 P.M. Took remainder of crew of 100 men back to camp at Head of Big Flat Creek, to hold in case something broke in another sector.

August 17

Relieved Shank of his detail on Porphyry Creek Fire.

15 men are patrolling the West side of fire to date.

Very truly yours,

Glenn Thompson, Key Guard

Memo. to Accompany Claim.

In Regard to loss of Three horses owned & operated by E H Hopper. while packing on Porphyry Fire
Aug 12 I had instructed him to move a 25 man camp & supplies from Base camp to Top of Chicken Cr ridge by way of Chicken Peak trail. Hopper departed from base camp at 9:30 AM with 11 head of stock packed. He had reached a point 1 mile from camp & about 200 yds up Chicken Peak Trail from So. Fork Salmon River when the accident occurred. The three rear horses Lost Their balance & rolled over a cliff Perpendicular cliff nearly 150 feet to Rivers edge, Killing Two instantly & seriously injuring the Third. There were no eye witnesses to the first actions of horses when leaving the Trail, but careful examination of the ground immediately afterward by myself & D. W. Kerr indicated That the rear horse had ~~~~ steped over The edge of the Trail into soft earth with the right hind foot. This misstep would cause a slackening of pace & This in turn bring about the taught lead rope which was the first Action noticed by witnesses to the accident.

I was about 400 yds distant & in full view of all that happened. The first indication of Trouble that I noticed was the Four rear horses with very tight lead ropes. The rearmost horse was partially off the Trail.

At this stage the lead rope of the Third horse from rear broke with such suddeness That it seemed to throw The rear Three from the Trail + over The cliff.

The accident ~~in its entirety~~ happened so quickly That Hopper did not have time to dismount.

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