MANUAL

FOREST FIRE FIGHTERS SERVICE

Minnesota

MINNESOTA OFFICE OF CIVILIAN DEFENSE

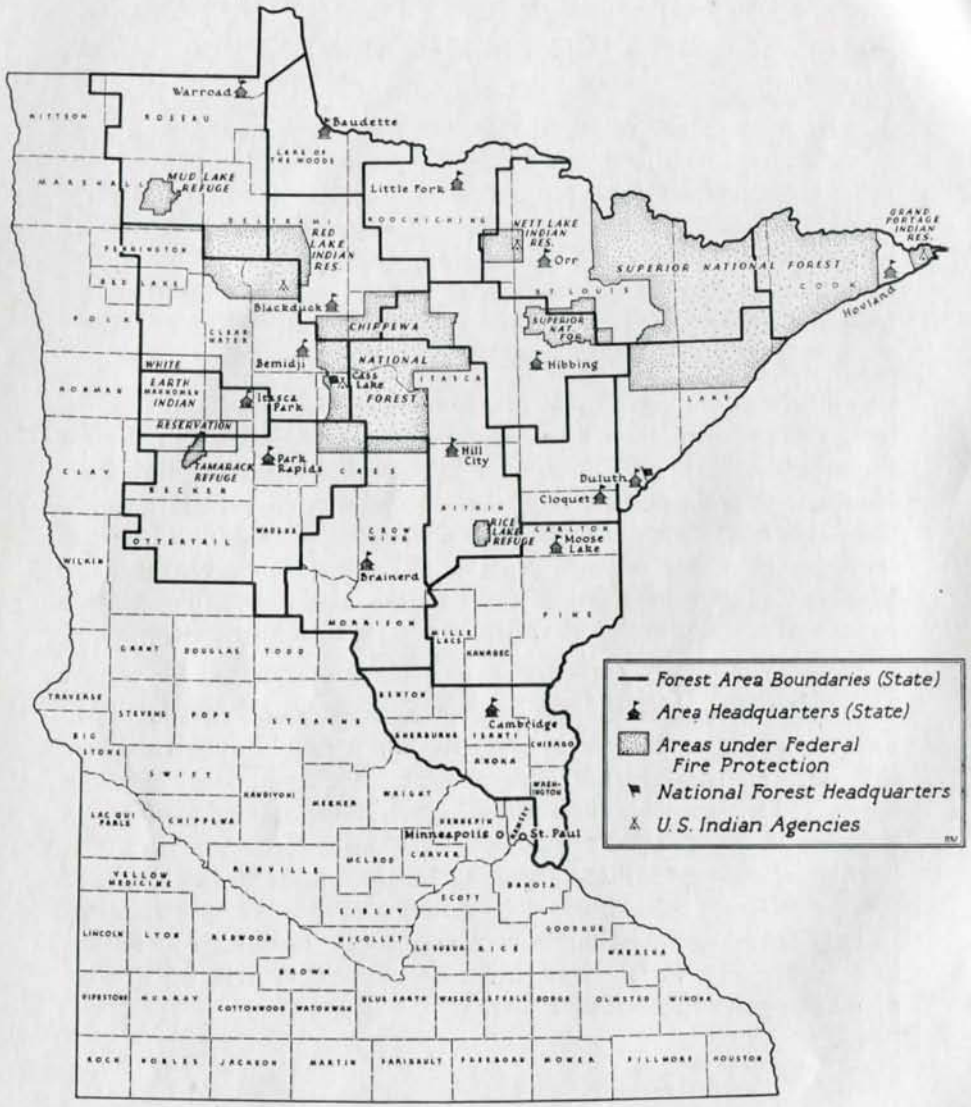
GUIDE FOR FOREST FIRE FIGHTERS SERVICE IN MINNESOTA

Because of the effect forest fires may have on the war program through the probable crippling of our defense efforts, the problem of prevention and control is of vital concern to every citizen. It is not entirely the danger of actual destruction to vital war materials, but also the danger of retarding defense activities by taking the men from their jobs to fight fire, the tying up of transportation facilities and the general disruption of all other activities which always follow devastating fires.

The fire protection organizations are intensely handicapped by the loss of so many of their trained men, and also by the alarming shortage in most localities of men available for fire fighting. Men not eligible for military service who are, during normal times, the backbone of the fire fighting forces, are steadily leaving their localities for defense centers and are no longer available. The lack of certain types of fire fighting equipment, due to the rubber and other material shortages, also increases the problem of protection.

Great fires rank floods, pestilence, famine and earthquakes, but they are soon forgotten. The fire history of Minnesota bears this out. In the Hinckley fire of 1894, burning about 160,000 acres, 418 lives were lost; in the Cloquet-Moose Lake fire of 1918, burning about 250,000 acres, 438 lives were lost; fires in 1931 burned nearly one million acres, and as late as 1936 there was a total of 276,000 acres burned over in the state. We do not seem to learn from past fires, but our awakening to the danger of forest fires, especially during war, must become general if we are to avoid a repetition of such disasters.

ISSUED BY THE FOREST FIRE FIGHTERS SERVICE
OFFICE OF CIVILIAN DEFENSE
IN COOPERATION WITH THE FEDERAL AND STATE
FIRE CONTROL ORGANIZATIONS IN MINNESOTA



The urgency of the situation is so keenly felt in Washington, that the Federal Government has established a nation-wide forest fire fighters' service to operate as an independent corps through the Office of Civilian Defense.

Establishment of FFFS

The FFFS has been established, in accordance with the policy of the Facility Security Program of the Office of Civilian Defense, to safeguard forest lands and other timber facilities and resources, to prevent and control fires which might endanger such facilities and resources, and to minimize the effects of any such fires. It shall cooperate with the forest fire protection agencies of the Department of Agriculture and Department of Interior, with State Forestry officials and private forest fire protective organizations.

It is the purpose of the organization to:

1. Provide fire fighters, equipped and trained, to augment the forest protection agencies of the locality.

2. Acquaint the people in the area with their responsibility in fire prevention and suppression.

3. Provide an opportunity for people in and near forested areas to participate in the war effort.

Regular Forest Fire Fighting Organizations

Through the Department of Agriculture and the Department of Interior the Federal Government is giving organized protection to about 4,000,000 acres, and the Minnesota Department of Conservation is similarly protecting about 20,000,000 acres. Together the State and Federal Governments are giving an intensive type of protection to about 24,000,000 acres in forested areas.

Field Organization of FFFS

The preliminary work of organizing the corps will be conducted, in about the same manner as most of the other civil defense agencies, through the State, County, and local Defense Committees, augmenting the various federal, state, and private fire control organizations.

Under the Office of Civilian Defense the auxiliary force will be enrolled, classified and certified to assist the regular forest fire fighting organizations. Members of the auxiliary force will be required to complete satisfactorily a minimum of 12 hours of training before becoming eligible for certification by the local coordinator. Experience and previous training may, in the judgment of the committee, be substituted for this training. Official certificates and arm bands will be provided to those who qualify.

In each fire protection area a Local Coordinator of the FFFS will be appointed by the State Coordinator, upon the recommendation of the state and federal supervisors. It will be the Local Coordinator's duty to coordinate the FFFS program with that of the local county and city OCD program, and to supervise the registration and cataloging of all available fire fighters and fire fighting equipment within their jurisdiction. Where practical, the regular forest officers may accept these appointments.

The local coordinator, with the approval of the local state or federal supervisor, will appoint one or more men in each city, village or township, to be known as "squad leaders."

The squad leaders are expected to assist in registering the fire fighters. They will assist the state and federal supervisors or rangers in organizing the fire fighters into squads of six or more men each, and also promote fire prevention within their territory. When necessary, they will be requested by the responsible protection officer to call out their squads for action on fires. During such periods, they will be under the general direction of the rangers, will investigate fires, and unless otherwise directed, keep the time of the fire fighters and assume leadership of their squads and also assist in the training program. While on official call, and actually engaged in fire fighting, they will receive regular foreman's pay.

Training of the auxiliary force is definitely the job of the regular fire protection agencies.

Plans for mobilizing the crews when fires occur will be a function of the rangers and the squad leaders. Quick action on fires is of the utmost importance if damage and area burned over are to be held to a minimum. Prearranged plans can be made with many of the squads and individuals, whereby initial action will be taken on fires without special instructions from the

rangers. In these cases, it is important that the state or federal supervisor or ranger be informed of the fire and of the action taken, as soon as possible after the work has been started. This will facilitate complete coordination of the activities and provide official authorization for conducting the work as prescribed by the forest officer so that each man will be placed on the payroll.

It is also important that the squad leaders be familiar with the location of all fire fighting equipment, including heavy units such as tractors, plows, bulldozers, trucks, cars, etc. This list should include all available equipment in each protection unit, whether state, federal, or privately owned. This data, together with detection and communication information, can be conveniently assembled for local use on the standard forms now used for the purpose by the federal control agencies, and the tower and township fire plan forms used by the state.

Further information affecting local conditions will be supplied the squad leaders by the local ranger.

The responsibility of fire control supervision rests with the federal and state protection organizations. This must, of necessity, be re-delegated in many cases to competent individuals during emergency periods. The squad leaders will be instructed in writing by the rangers as to the extent of their responsibility, as well as in other details concerning the work.

Most of the squad leaders will be selected from the present cooperative or auxiliary force; namely, the township wardens and key men. The status of the township wardens in the issuing of burning permits, however, is not to be changed. The splendid work accomplished in the past by these men is fully recognized, and it is of the utmost importance that nothing be done which will in any way interfere with it in the future. It is intended that this group constitute the backbone of the emergency setup and any new or additional plans should be built around it, rather than replace it.

Insignia of Forest Fire Fighters Service

Insignia shall be a pine tree in red within the customary triangle embossed upon a circular field of blue. Arm bands will be furnished by the State Coordinator.

FIRE PREVENTION

Prevention is the cheapest and best method of forest fire control. Ninety-eight per cent of Minnesota's forest fires are man-caused and preventable.

Regular agencies have stressed prevention with all the means at their disposal, but members of the Forest Fire Fighters Service can carry this program forward more quickly and efficiently than ever before. They should pass their knowledge of fire prevention on to friends and neighbors and solicit their cooperation.

Constant care in the use of fire, determining the best methods for use in necessary burning of meadows, brush, etc., and strict adherence to the rules and regulations governing the use of fire will be reflected in a decrease in the number of man-caused fires. United action is what counts, and united action is something the auxiliary force can achieve.

Fire Prevention Rules

Of all the forest fires occurring in Minnesota a large per cent fall into four cause classes. The factors contributing to this total are failure to recognize fire danger, failure to take ample precautions to prevent the spread of fire, and failure to observe the following rules designed to eliminate carelessness with fire and to provide for its safe use.

Causes	Rules
Smokers 	1. Matches — Be sure your match is out. Break it in two before you throw it away. 2. Tobacco — Be sure that pipe ashes and cigar and cigarette stubs are dead before throwing them away. Never throw smoking material out of a car or into brush, leaves, needles, or grass. 3. If you must smoke while in the woods, stop, sit down, clear a space to mineral soil on which to deposit your ashes or butts and then cover them with mineral soil before leaving, to make sure.
Clearing or debris burning 	1. Never burn brush or debris without first securing a burning permit. 2. Never burn during windy or dry weather. 3. Never burn until late afternoon or evening. 4. Never leave the fire until it is completely extinguished. 5. Always take adequate precautions while burning. 6. Pile the brush in compact piles. 7. Have plenty of help, water and tools at hand. 8. Arrange for burning bees with your neighbors.
Incendiarism 	1. Report all suspected cases of incendiarism to the forest office.
Campfires 	1. Making a campfire — Select a spot near water or where there is an abundance of loose mineral earth. Scrape away all inflammable material from a spot five feet in diameter, dig a hole in the center, and keep the fire small. Never build it against trees or logs or near brush. 2. Extinguishing a campfire — Stir the coals with a stick while soaking them with water. Turn the small sticks and drench both sides. Wet the ground around the fire and be sure the last spark is dead. If water is not available, the fire should be permitted to burn out and then thoroughly mixed and finally covered with mineral soil free from all sticks or leaves.

PRESUPPRESSION

Minnesota Department of Conservation

The north half of the state, which is the portion under intensive protection, consists of approximately twenty million acres. This area is divided into two regions, with headquarters at Bemidji and Duluth, with a Regional Coordinator in charge of each. These men work directly under the head of the Division of Forestry and the Forester in charge of State Fire Control. The two regions are divided into sixteen supervision areas with a supervisor and assistant supervisor in charge of each. The areas are again sub-divided into districts with a ranger in control. These sub-districts vary somewhat in size depending upon the fire hazard and risk, but they will average approximately five townships or about 180 square miles. Under the rangers are the fire guards, towermen, smokechasers, standby crews and the cooperative auxiliary organization.

U. S. Forest Service

The United States Forest Service confines its fire protection activities to lands within the boundaries of the Chippewa and Superior National Forests, an area of approximately four million acres.

The two national forests are each under the direct supervision of a forest supervisor, located at Cass Lake for the Chippewa and at Duluth for the Superior. The forests are in turn sub-divided into ranger districts, each in charge of a district ranger.

U. S. Indian Service

The U. S. Indian Service confines its fire protection activities at Red Lake to the Red Lake Indian Reservation, some 400,000 acres of forested lands under the supervision of a superintendent on whose staff is a resident forest supervisor. In cooperation with the State, the Red Lake Agency protects an area

at the headwaters of the West Fork Branch of the Black River, locally known as "Little Pine Island."

Reservations within the Consolidated Chippewa Agency are under the jurisdiction of a superintendent at Cass Lake on whose staff is an assistant forester. Fire protection is given to approximately 200,000 acres of forested lands, a forest officer being located on the Grand Portage and Nett Lake Reservations. The other reservations are protected through cooperative arrangements with the State Forest Service.

U. S. Fish and Wildlife Service

The Fish and Wildlife Service has refuges in northern Minnesota at Rice Lake (Aitkin county) consisting of 11,385 acres; at Tamarack Lake (Becker county) 25,573 acres; and at Mud Lake (Marshall county) 66,596 acres.

The refuges are under the supervision of refuge managers who are directly responsible for the protection of the areas.

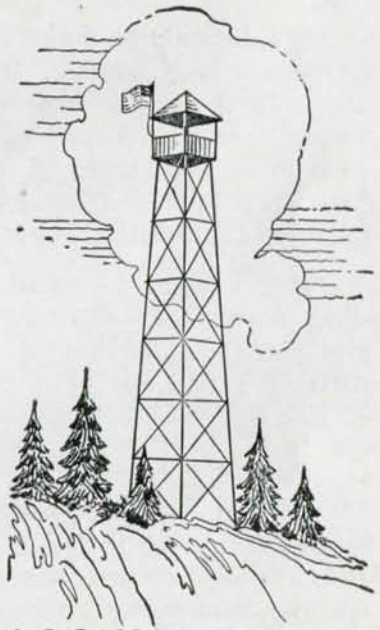
Cooperative arrangements are made with the local people for assistance in fire control activities.

Fire Detection

The key to fire suppression is the detection of fire as soon as possible. The eyes of the protection organizations are fire towers strategically located throughout the forest areas. These towers are connected by telephone and many are also equipped with radio communication.

All members of the Forest Fire Fighters Service should be constantly on the alert for forest, brush, or peat fires, and any signs of fire should be immediately investigated and reported to the proper authorities. Members should urge all other persons to do the same.

There are times when because of fog, haze, or smoke, towermen can see but a short distance, and unseen fires may be burning for a long time before they are reported. During times of extreme fire hazard and poor visibility, it may be necessary for civilians to patrol certain areas on foot or by automobile to assist the regular organization in detecting fires.



LOOKOUT TOWER

How and to Whom to Report a Forest Fire

When you discover a forest fire of any kind IMMEDIATELY check on:

1. Location of fire. If you know the exact land description, that is fine, but if you don't, locate the fire by common places, landmarks, and distances.
2. Size of fire. Estimate the size of the fire in feet, yards, rods, or acres to the best of your ability.
3. What is burning and what is in immediate danger of burning? Is it a meadow burning or is it slashings, brush or peat? Is the fire going to spread quickly into a more inflammable material or toward buildings, or is it burning toward a lake, stream, road or trail?
4. How hard the fire is burning. Is it just creeping along and spreading slowly or is it burning briskly as though it will spread quickly into a large fire?
5. How many men, if any, are fighting the fire? Is a fire suppression-crew working on the fire or is it one or two persons unable to control it and badly in need of help?

Fires should be reported to the nearest forest ranger, fire warden, or local resident. If you are a stranger in the community, go to the nearest phone, or if no phone is nearby, notify the nearest farmer, storekeeper, or tavern keeper and he will know what to do. All state and federal telephone lines connect with commercial lines, and the telephone operator will connect you with the proper authorities.

If you discover a small fire, put it out immediately if possible. A very small fire may become a large fire in the few minutes you are reporting it. IF THERE IS ANY QUESTION ABOUT YOUR ABILITY TO PUT THE FIRE OUT, HOWEVER, *REPORT IT IMMEDIATELY.*

When you have put out a fire, report it to a forest officer.

All persons living, working, traveling, or camping in areas subject to fires would do well to carry with them or have immediately available a sturdy shovel, a pail (the folding canvas variety will do), and an axe. You alone, with these simple tools, may stop the first few flames of a potentially disastrous forest fire.

Equipment and Supplies

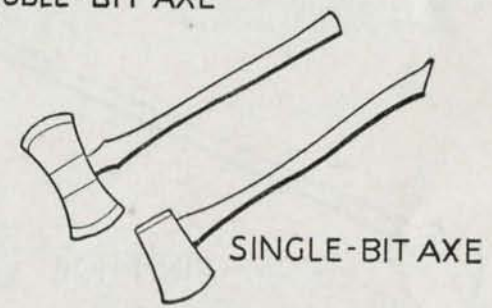
All special forest fire fighting equipment and supplies will be furnished by the state and federal agencies in charge of fire suppression.

This special equipment is stored ready for fire suppression work in two types of places:

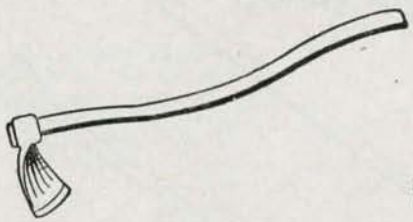
1. Ranger stations, guard stations, warehouses, and special supply depots maintained by state and federal agencies.
2. Equipment caches of basic hand fire fighting tools kept by cooperating fire wardens and keymen.

Common Fire Fighting Tools and Their Use

The common tools used in fire fighting are pictured and described below.

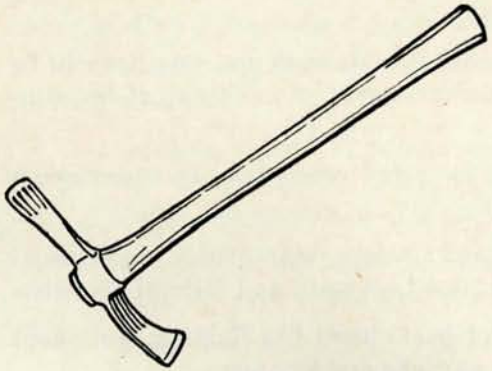


AXE — Used to cut material for fire line clearing, snag felling, etc.



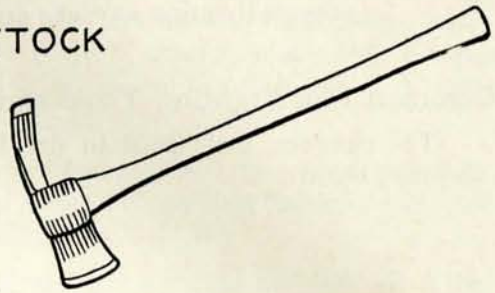
GRUB HOE — Used for digging and grubbing in soil, humus, roots, and decayed logs in constructing fire lines.

GRUB HOE



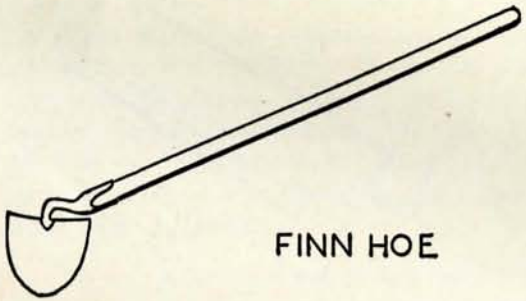
CUTTER MATTOCK

CUTTER MATTOCK — Used much as a combination axe and grub hoe. The sharp edge as an axe, the other for grubbing in fire line clearing and construction.



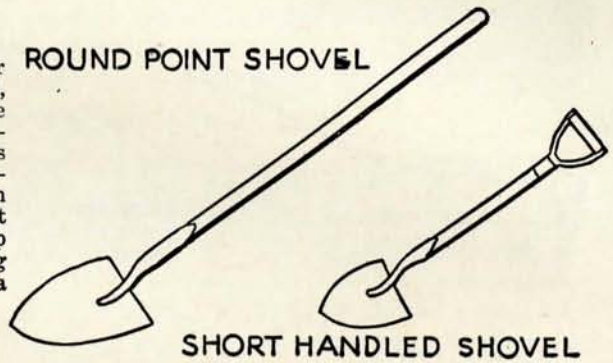
PULASKI TOOL

PULASKI TOOL — Similar to a cutter mattock except that it is somewhat lighter and sharper and used for lighter work in fire line clearing and construction.



FINN HOE

FINN HOE — Used as a grub hoe but for lighter work, mostly in duff and humus where rocks and roots are not too numerous.

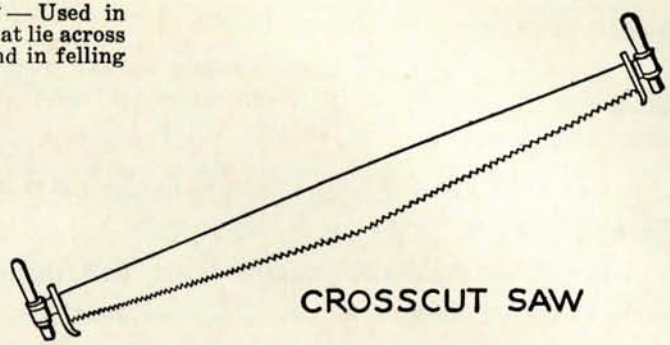


ROUND POINT SHOVEL

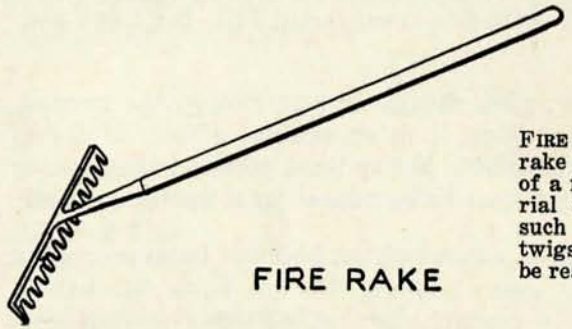
SHORT HANDLED SHOVEL

SHOVEL — Either short or long handled, are used for fire line construction by shoveling duff and humus to one side until mineral soil is reached in line construction. It is used to follow up plow or other digging in order to obtain a clean fire line.

CROSSCUT SAW — Used in bucking logs that lie across the fire line, and in felling snags.

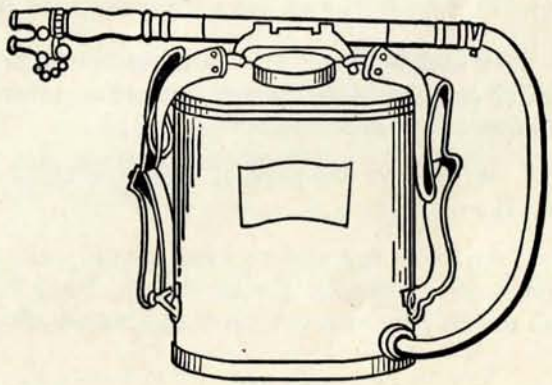


CROSSCUT SAW



FIRE RAKE

FIRE RAKE — Just a *heavy* rake used in the construction of a fire line where the material to be handled is light, such as leaves and small twigs, where mineral soil can be reached by such raking.



BACK-PACK PUMP

BACK-PACK PUMP — Carries about five gallons of water used to reduce the fire so that a line can be constructed or to put out a fire by playing water at proper places.

Safety Practices in Using Tools

Safety in regard to tools consists in (1) keeping them in good condition; (2) using them correctly, and (3) carrying them correctly.

Use tools only for their intended purpose and never as substitutes for other tools.

Do not use broken or defective tools. Turn them in or report them to the foreman.

Place tools, equipment, and materials so that there is no possibility of their falling and endangering workers.

If protective shields for sharp-edged tools are provided, always put the shield on before transporting the tools any considerable distance.

Never lay an axe, saw, shovel, or any tool on the ground. Always stick, stand or hang it in or against a tree or stump OUTSIDE THE FIRE LINE. Never leave tools where there is danger of them burning up or being broken by a tractor or truck.

Keep shovel handles as smooth as possible because even a slight roughness may cause blisters. Do not allow the handle to become roughened by contact with rolling rocks or by throwing it carelessly down on the ground. Do not use the blade or handle of the shovel as a pry.

Make sure that you are out of reach of other workers' tools and that no workmen are within range of the swing of your axe.

Watch out for overhanging limbs and brush. They may catch or deflect the tool and injure you severely. Clear them away before starting to chop.

After you are sure of your swinging space, keep your eye on the mark.

In chopping always keep a solid grip with the hand uppermost on the handle. Swing the axe away from the legs and body so that if it misses the mark or glances off, it will not strike you.

Try to keep one edge of a double-bit axe sharp, using the duller edge in all chopping where there is any chance of striking the ground or rocks. Never use a single-bit axe in place of a

sledge hammer since this results in spreading the "eye" and thus ruins the axe.

Never throw your axe.

Never carry a double-bit axe on your shoulder in rough country. Keen-edged tools such as axes and Pulaski tools should be kept sharp and carried with the head to the front, with one hand gripping the handle directly behind the head at the balance point. The blade is carried at a right angle to the ground.

Shovels, grubhoes, and similar tools should be carried in the same manner.

Carry a crosscut saw on your shoulder with the teeth away from your neck. Never carry it under your arm. Remove the handle of the end that extends back over your shoulder to keep it from catching on things.

Transportation

Regular agencies in charge of fire control will make all plans and arrangements for transportation of men and equipment to and from fires.

Food and Lodging

Arrangements for food and lodging are made by the regular fire control agencies.

Pay for Fire Fighting

Members of the Civilian Defense Forest Fire Fighters Service when actually employed in the suppression of forest fires will be paid at the regular fire fighting wage rate. In order to receive pay *you must report* to the foreman or timekeeper in charge so that your name will be on the payroll.

FOREST FIRES

Factors Affecting the Behavior of a Forest Fire

Many factors affect the severity with which a forest fire will burn, the rate at which it will spread and increase in size, or its behavior, and the problem its suppression presents. The most important of these factors are (1) Relative Humidity, (2) Winds, (3) Fuels, (4) Topography, (5) Temperature, and (6) Fuel Moisture.

The study of fire behavior under the widely varying conditions normally encountered is a very complex one and it cannot be mastered without a great deal of study of such technical subjects as weather and combustion, and a great amount of practical experience in forest fire suppression work.

Influence of Relative Humidity — The atmosphere always contains moisture, but in varying amounts, usually in the form of an invisible vapor.

The actual amount of moisture which the air contains at any given time is known as its absolute humidity and is usually measured by weight, as so many grains per cubic foot.

The capacity of the air for holding moisture, however, varies with its temperature, warm air being able to hold much more than cold air.

The term relative humidity means the percentage of the air's actual moisture content in relation to its total capacity at the prevailing temperature, or in simple terms, the air's percentage of saturation.

Extremely low relative humidities will result in high inflammability of forest fuels, the degree of inflammability becoming greater and greater as the low humidity period continues. Fire can start and spread at relatively high humidities. Normally, however, fires spread very slowly when the relative humidity is about 50%. Between 40% and 50%, fires tend to "pick up" and, with unfavorable conditions pertaining to fuels and wind, may spread rapidly. During fire seasons when the relative humidity drops below 40%, the fire danger becomes acute.

Winds—Wind is of outstanding importance in gaging the rate at which a fire will spread and the direction in which it will spread, in determining the inflammability of forest fuels. The prevailing wind in most places comes from a certain direction. Local conditions, topography, etc., tend to have considerable effect upon winds. Generally speaking the wind goes down at night and comes up again in the morning. Winds carry hot dry air (air of low relative humidity) over forest fire fuels and dry them out.

Drafts are caused by the action of the fire itself and have the same effect as wind upon the behavior of the fire. They are caused by the fact that hot air is lighter than cold air. Therefore, in any fire the natural tendency is for the column of hot burned air to rise straight up, causing an inrush of cold air at the base. Drafts carry off the burned air and cause a new supply of oxygen to be drawn toward the flames. They also tend to carry sparks and embers away from the ground.

Forest Fire Fuels—Forest fire fuels can be divided into three groups, namely (1) Flash or critical fuels, (2) Heavy or slow burning fuels, and (3) Green fuels.

1. *Flash or critical fuels* are those which, under natural conditions, are susceptible to easy ignition, and rapid combustion. They include dead vegetative materials, needles, light litter, small branches, dead leaves, ferns, grasses, and other light fuels. They are the kindling wood of a fire and make up the main fuel for all rapidly running fires. When dry, they ignite easily and burn rapidly, throwing off a large volume of heat, which accounts for the drying out and igniting of other less critical forest fuels.

2. *Heavy or slow burning fuels* include the remaining dead materials which by reason of their structure, arrangement, or covering will not burn rapidly. In many instances these fuels do

not burn at all until the overlying materials are consumed. They include the lower tier of duff, the humus, heavy limbs, logs, snags, and decaying wood. These materials usually burn out slowly long after the flash fuels have burned.

3. *Green fuels embrace* all of the growing vegetation of the forest, such as foliage of trees, brush, grasses, etc. These materials, while living have a high moisture content and do not constitute a serious hazard. However, when dried out by rising heat or flames they burn with great rapidity and intense heat.

Topography—The steepness of a slope is always a big factor in governing the spread of a fire. The steeper the slope the more rapidly the fire advances. A fire tends to run up hill much faster than it works down. The flames of a fire on a steep slope are much closer to the forest litter and thus come in contact with it more quickly; also, the draft created by a fire is always uphill.

Temperature—Air temperature has a very important effect upon the behavior of a forest fire and also upon the moisture content of the fire fuels. If the temperature rises, the relative humidity normally drops, and as a result the forest fuels are rapidly dried out. Fires burn more severely at high temperatures because warm fuels ignite and burn more quickly. If you have ever kindled a fire in a cold stove in sub-zero weather with cold kindling, you know it starts to burn very, very slowly. On the other hand, if you have ever allowed the fire in a stove to go out and kindled a fire in it with warm fuel, you know that it ignites easily and burns rapidly.

Moisture content of Forest Fuels—The inflammability of all forest materials is governed primarily by their moisture content. This is one of the most important factors in determining the speed with which a fire will burn. It is governed by the amount and frequency of precipitation, temperature, relative humidity, and the circulation of air through the fuels. If you have ever burned piles of grass, weeds and other debris when it was damp and again when it was crackling dry, you can at once recognize the importance of this factor.

Kinds of Fires

Forest fires are generally divided into three classes: Surface fires, ground fires, and crown fires.

Surface fires are those which run over the surface of the ground, feeding in the top layer of dry, loose litter, grass, needles, weeds, small bushes, and the outer surface of logs, etc. They usually are intensely hot and spread rapidly with a fairly large volume of flame. Fires in second growth aspen, grass types, old burns, fern types, etc., are typical.

Ground fires are those which consume the thick layers of decaying humus and other vegetation which are more compact and usually contain somewhat more moisture than the top layers of loose litter and duff. These fires tend to spread slowly or smolder, are most persistent and require a long time to burn out or to extinguish. Thick mats of needles and deep humus as found in old timber, peat bogs, etc., are typical.

Crown fires are those in which the foliage of trees is consumed. This is the most difficult type to control. Such a fire when started spreads through the tops of trees at a rapid rate. Dense coniferous stands of timber lend themselves readily to this type of fire.

It is necessary to recognize these three kinds of fires since the method used in suppression of each of them is different. Small fires are usually surface or ground fires.

On a large fire one sector of the fire may be crowning, and must be controlled as a crown fire. Another sector may be a surface fire; it must be controlled as a surface fire; still another sector may be a ground fire; it must be controlled as a ground fire. For example, a surface fire may run through a grass meadow and into a pine forest; there it may continue as a surface fire feeding upon grass and litter, and brush, and burn with such speed and heat that it will ignite and burn the crowns or tops of the larger coniferous trees. Such fires usually spread rapidly, throw fire brands such as burning pieces of birch bark, or sparks into the air and start new fires on ahead of the main fire. These new fires are known as *spot* fires.

Parts of a Fire

Head of the Fire—This is that part of the fire that is spreading most rapidly. With level terrain this is the lee side or the side in which direction the wind is blowing. Fires burn more

rapidly up hill than they do on the level or down hill, and thus the up hill side is frequently the head of the fire.

Rear of the Fire — On level terrain with a wind this is the windward side or the side from which the wind is blowing. Where the fire is burning on a steep slope, it is usually the side at the base of the slope.

Flanks of a Fire — The flanks of a fire are the sides connecting the rear and the head of the fire.

Fingers of a Fire — Generally the forest fire fuels are not uniform; there are patches of slash, small ribbons of meadow or grass, open ridge tops, patches of dense conifers, and other fuel types may all be intermingled. Fires spread more rapidly in some fuels than others. There are often short steep slopes and fires will run up these more rapidly than they will run on level terrain.

Whirl winds, or a shift in wind direction, may temporarily change the direction in which the fire will burn. Any or all of these factors contribute to the irregular shape or cause fingers.

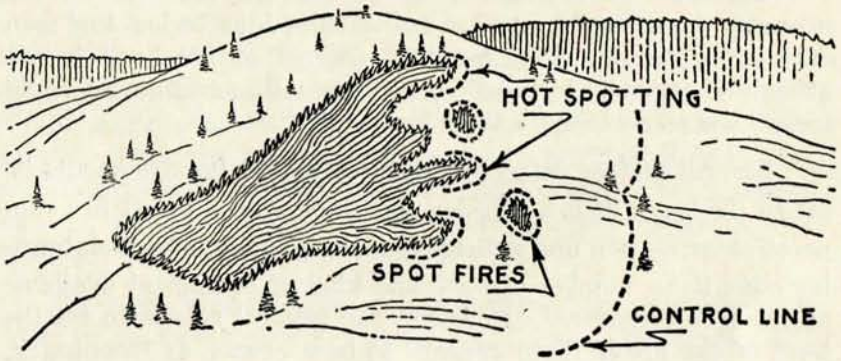
The following illustrations will assist the reader in identifying the various parts of a fire.

FOREST FIRE FIGHTING

The most important thing to remember is that a small fire is easily put out by 1 to 5 men, and that it is necessary to discover and get to the fire immediately after it starts if it is to be put out while it is small. The drier the forest fire fuels, the higher the wind, the warmer the day, and the lower the relative humidity, the more important it is to get there quickly since it is under these conditions that the fire spreads most rapidly and becomes a large fire in a short time.

Large fires may require several hundred men and take several days to control and mop up.

The suppression of a forest fire can be divided into two separate operations, namely (1) controlling or checking the spread, and (2) mopping up and patrol operations which involve the completion of the suppression job.



Controlling or Checking the Spread of a Forest Fire

The first thing to do upon reaching a fire is to carefully review the situation and determine where the initial attack should be made with the objective in mind of stopping the spread of the fire as soon as possible. There are three general ways of accomplishing this, namely hot spotting, hitting the head of the fire, or hitting it on the flanks. Each of these three ways will be discussed briefly.

Hot Spotting — This is merely concentrating the initial attack upon those sectors of the edge of the fire that are burning

the hardest and sectors where the fire, if not checked, is likely to get into heavy slash fuels, grass meadows or other fuels where it will spread rapidly or be hard to check. On a small fire, one man with a shovel, bough, wet gunny sack or other suitable tool can concentrate on the hottest spot of the fire, knock it down and temporarily check it; go on to the next one and do the same, and keep working around the fire in this manner until reinforcements arrive or until the fire has burned itself out to a point of relative safety. He can then proceed to systematically put an adequate fire control line around it and mop it up. This same procedure can often be employed quite successfully on larger fires with several men, each man working alone, or by working in small crews.

Hitting the Head of the Fire — Where there is a wind blowing and the fire is spreading rapidly in only one direction the quickest way to stop its spread is to hit the head of the fire. Making the decision of whether or not it is possible to control the head of the fire is of great importance. If it is attempted and it proves unsuccessful, a great deal of time may be lost and men exhausted; on the other hand, if control of the head is not attempted when it is possible, the fire will continue its rapid spread and soon become a large fire.

Several factors determine whether or not the fire should be hit on the head. It is a decision that experienced forest fire suppression men often find difficult to make. The type of fuel, burning conditions, number of men, and kind of equipment available all must be considered. However, the general rule is to hit the head of the fire if there appears to be a chance of stopping it, even though this means hard, fast work in the heat and smoke, since if the head can be controlled the crew can then handle the rest of the fire and mop it up.

Hitting the Flank of the Fire — If the head of the fire is too hot to work and the fire is spreading in one general direction, start control lines at the base of the fire and work up along both sides or flanks, and pinch it out at the head. Quite often one flank of the fire is parallel with a natural barrier, such as a lake, stream, road, or fuels in which the fire will not spread rapidly. In this case only one flank would need to be worked or have a control line, and the other flank, along the natural barrier, would only have to be watched so that no fire will cross.

The reader must remember that these are only general rules, that every fire is different and the primary consideration is to check the rate of spread as quickly as possible and then to methodically and systematically mop it up and patrol it.

Fire Control Lines — Control lines are natural barriers or constructed lines which are used to stop or hold a forest fire. Their purpose is to establish a break in the fire fuel and thus rob the fire of new fuel.

Roads, streams, lakes, bare rocks, wet swamps, etc., constitute natural barriers that should be used whenever possible to stop or hold a fire in check until it is completely mopped up.

Where natural barriers are not available, control lines must be constructed. Constructing a control line usually involves three things, namely, cutting a clearing through the fuel of from a few feet up to 15 or 20 feet in width; constructing a narrow fire line or trench through the duff, humus, and other vegetable matter to mineral soil, and the removal of any threats to the line constructed, such as felling snags inside the fire control line which may burn down and fall across the line, burning out any unburned inflammable material inside the control line that might result in fire crossing the line, and the removal of any other fuels or elements that would permit the fire to cross the control line.

There are four generally recognized methods of control line construction, namely the (1) direct, (2) 2-foot, (3) parallel, and (4) indirect.

These four methods are presented below in some detail to enable the reader to visualize the basic difference involved and to enable him to use the correct method when called upon to put out a forest fire.

1. *The Direct Method* — As the name implies, this involves direct action on the fire itself. It consists of digging out every spark of fire along the edge of the burn. This may be done by scraping in, shoveling in, or digging out and throwing in the burning embers along the edge. In this case the fire line becomes the edge of the fire. In doing this it is necessary to dig down to mineral soil. The result is a U-shaped trench with a clean cut

on the outside from which all embers have been removed. There should not be a single charred root or leaf on the outside of the fire line. To make sure that no sparks are left, the edge of the line should be felt with the hand. This is known as "feeling for fire."

The direct method is especially recommended:

(a) On all sectors where the fire can be caught in the smouldering stage, or in special cases, on slow fires when flames can be easily beaten out or smothered.

(b) On fires in light fuels, such as grass, leaves or duff, where the heat is not too intense for working close to the flame.

(c) Where considerable stretches of the fire edge are dead so that the digging out of a few smouldering spots will result in gaining advantage of long stretches of dead line. Often this condition prevails in the early morning.

(d) Where there is danger of fire going into the crowns later in the day.

(e) Wherever it would be particularly hard to handle back fire control on account of adverse winds, large fronts, or excessive amount of debris and snags.

(f) Where there will be difficulty or a long lapse of time in securing a clean burn up to the fire line by artificial means.

(g) Whenever standing snags inside the line will be pretty well burned out before the heat of the day, or cooled down around their bases so that they may be felled. (Backfiring from a distance would necessitate felling all intervening snags or incurring risk of their burning fiercely during the heat of the day.)

(h) On steep hillsides above the fire so as not to let the fire get a new start.

2. *The 2-Foot Method*—This is a substitute for the direct method in those situations where there is a large amount of fuel at the edge of the fire, as in case of deep duff or peat bog, and there is real danger of some unseen burning ember being left outside the fire line if the direct method were used. The 2-foot method usually involves a continuous fire line or trench from 12 to 14 inches wide dug down to mineral soil, and not more than 2 feet from the burning edge of the fire. Special care should be given to removing small roots and pockets of rotted wood, since

these are apt to carry smouldering fires across the trench. On the other hand, when rapid construction is necessary to counteract a fast spreading fire front, too much work should not be expended on cleaning up the line, as the fire in such materials spreads slowly and careful patrol can prevent its crossing.

If the fire does not burn out to the fire line, it becomes necessary either to shovel all the intervening combustible material onto the burned area, or dig out any intervening smouldering spots by the direct method. This possible additional work must always be taken into account in selecting and applying this method.

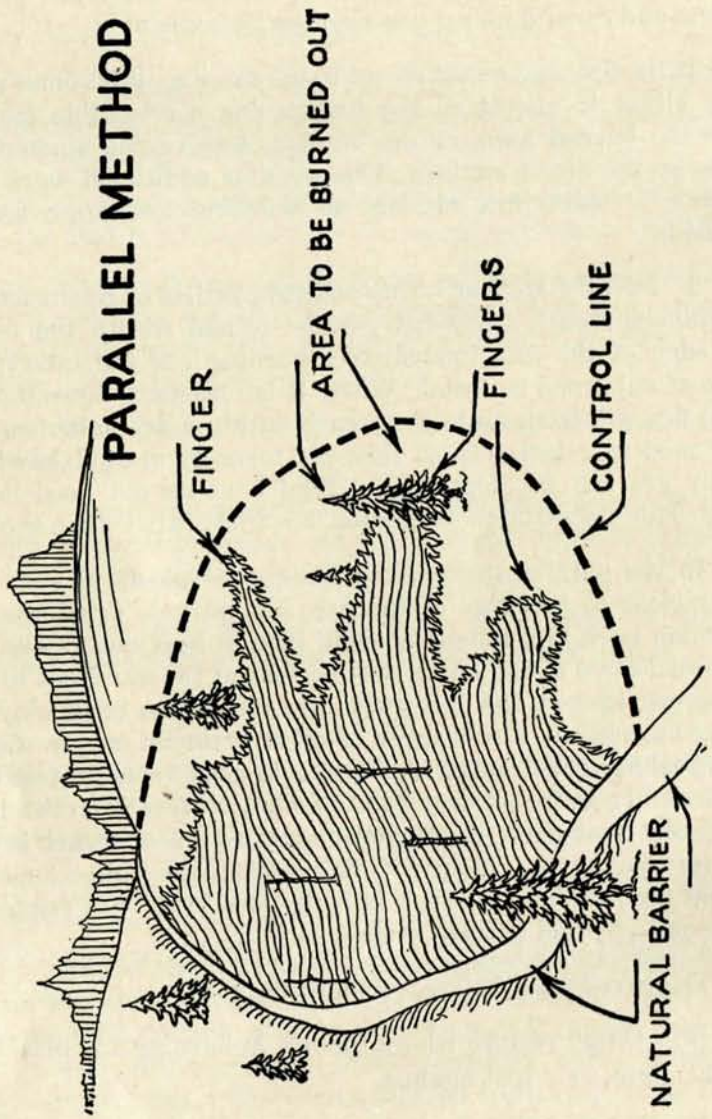
3. *Parallel Method*—This method consists of constructing a continuous trench somewhat parallel to and within 100 feet of the edge of the fire, immediately burning out the intervening strip of unburned material. Where it is reasonably sure that the main fire will burn up to the trench within a few minutes, with only moderate intensity so that the force of men at hand will surely prevent its crossing, artificial burning out need not be done. This should be the exception, however, rather than the rule.

In the parallel method the basic principle is to stay relatively close to the edge of the fire, but latitude is allowed for dropping back far enough to avoid intense heat and smoke, and in special cases to cut across deep fingers of the fire front to save labor, provided all the fuel inside the cut-off can be quickly and safely burned out with a torch or other artificial means. Generally speaking, the fire control line should not be over 50 feet from the fire and usually not over 8 to 10 feet. It differs from the direct and 2-foot methods in that a continuous fire line or trench is built and interior burning done. It differs from the indirect method in that the fire line or trench is built close to the fire regardless of topography and natural firebreaks.

The parallel method is recommended:

(a) On all sectors where the fire is burning too briskly to use the direct or 2-foot method.

(b) In special cases where fires are smouldering on a large part of the front, but conditions for burning out either now are or soon will be exceptionally good, and it is evident that use of the method will save time.



(c) Sectors where the litter can be ignited as it lies and will burn out quickly without danger of crown fires.

(d) Sectors where line can be shortened by making cut-offs.

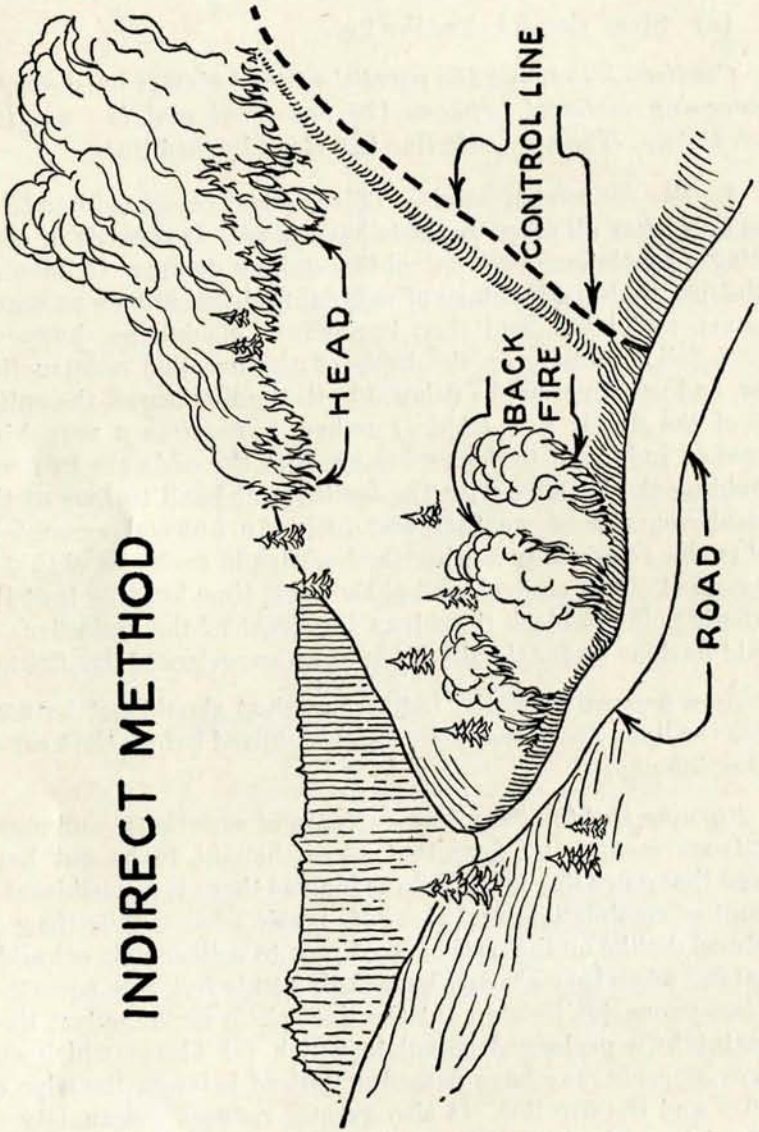
(e) Steep slopes below the fire.

Caution — In using the parallel method always burn out the intervening material between the fire front and the fire line immediately. The only safe line is a clean burned line.

4. *The Indirect Method* — This is a last resort method to be used only after all other methods have failed. It consists of completing a continuous fire control line quite a distance in advance of the fire, taking advantage of natural firebreaks, such as roads, streams, and lakes, and then backfiring. Backfiring, however, cannot follow closely on the heels of the fire line construction crew, and usually must be delayed until the line across the entire side of the fire is completed. Further, it requires a very high degree of judgment to determine whether the odds are in favor of holding the backfire with the facilities at hand in face of the critical elements of weather and fuel. An unusual amount of skill is also required in setting the backfire in such a way that it will not get out of control, and at the same time locating it at the strategic point to block the advancing front of the main fire. It should be done under the direction of an experienced fire fighter.

As a general rule, the indirect method should not be used unless the lines can be completed and backfired before the heat of the coming day.

Burning Out the Fire Line — Years of experience and many disastrous escapes by fires that were thought to be out have proven that a fire line is not safe as long as there is a considerable amount of combustible fuel along its inside edge. While there is a natural dislike on the part of most men to deliberately set additional fire when they already have their hands full, it is nevertheless less expensive to burn out the lines clean at the outset than to maintain a prolonged patrol to watch for blazes which one always suspects may have passed unnoticed between the edge of the fire and the fire line. It also greatly reduces the anxiety of the fire boss and others to know that there is nothing left to burn along the inside of the constructed fire line. This knowledge not only increases the efficiency of the overhead, but reduces the man power and time necessary for patrol, and releases a larger por-



tion of the available help for use on more critical sectors of the fire.

Burning out may be accomplished in a variety of ways. The best equipment is a pressure torch using propane gas or kerosene, which produces a hot enough flame to readily ignite all material along the fire line which is at all capable of holding or spreading fire. In light fuels, such as grass, burning may be accomplished by the use of fusees, by scattering embers with a shovel, by using torches composed of birch bark, burlap swabs on a wire, or similar homemade devices. To prevent ignition of stumps in the burning-out process, it is good practice to spread sand at their bases before starting the fire.

Peat and Bog Fires

Ground fires, as indicated in a previous paragraph, include peat fires as well as those in the humus or duff. Peat fires, however, are much more difficult to control due to the fact that they often burn several feet into the ground while those in the duff are comparatively shallow.

There is generally a dense growth of weeds and grasses found in the bogs, consequently surface fires commonly precede and also accompany those burning in the peat. This necessitates employing the practices used in both surface and ground fire fighting.

The use of water, where possible, is the most practical method of combat; heavy pumping units or trench flooding being used where an abundant supply is available and light pumpers and hand equipment where the supply is limited.

Some trenching is required in most all cases but where no water can be procured, the trenching of the entire fire is generally necessary. The trenching is accomplished in various ways depending upon location, depth of the peat, available man-power and equipment. Bulldozers, tractors, teams and plows or the use of hand equipment are the most common methods. Dynamite has also been successfully used in some cases.

After the running fire has been checked and trenching completed, it then develops into the slow, tedious and costly job of either pumping water into the fire, or by hand shovel work and patrolling, until all the combustible material has been completely

extinguished or burned out a sufficient distance back away from the edges to eliminate any danger of sparks being thrown into the unburned area.

In some instances, where water is not used, it is advisable to spread sand or mineral soil in the bottom of the trenches. This is called sanding and helps to retard the fire and keep sparks from throwing over as well as to shorten the period of patrol.

There are many details relating to combat methods which cannot be covered in this manual and which should be dealt with in the instruction classes. The most important of these affecting peat fires are the procedures followed in trench construction and in the application of water.

Mop Up and Patrol

Mop up work begins immediately after the control line is established. Its purpose is to strengthen and to hold the control line.

A fire may be under control and yet not be entirely out. On a large fire, especially, there may be stumps and smouldering duff, or peat within the fire line, which are not likely to spread and get away, if watched, but which need considerable work done on them before all fire has been extinguished. Inside the burned area, there may be patches of unburned material where smouldering embers may lurk unseen. These must either be burned out deliberately, or carefully guarded and suspicious places drenched with water to make sure that no possibility remains of reviving the fire. Mopping up is not finished until all fires on the ground, within sixty feet of the line, are extinguished and all burning snags within 150 to 300 feet or more, are felled. If a fire should get away after being pronounced under control, it does not excuse the responsible officer to say "I thought it was out." The last spark is difficult to find and dies hard.

What to Do on Mop Up on All Fires

1. Widen and strengthen fire line where necessary.

2. Start work on each portion of the line just as soon as possible after line construction and backfiring are completed.

3. Put all loose fuel into such a position it cannot blow across lines.

4. Spread, rather than bury, smouldering fuel that cannot be put out.

5. Allow fuel to burn up if it will do so promptly and safely, or use water to put out as much fire as possible.

6. Eliminate promptly, both inside and outside of lines, all special threats, such as snags, rotten logs, stumps and singed brush.

7. Search for burning roots that may carry fire under control lines.

8. Fall snags both inside and outside of line if they are threats.

9. On small fires, all fire should be extinguished, in the mop-up, where quantities of burning material are not so large as to make this obviously impracticable.

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

11. Search for smouldering spot fires ahead of the main head of the fire.

Mop-up work, as it nears completion and the fire is nearly out, becomes a patrol job. On a small fire one man may be able to handle it; on a larger fire several patrol men may be required. The big fire must be carefully patrolled and watched *from one to several days after the last smoke is seen.* The patrol man must bury burning embers in wet mineral dirt, drown with water or stir up and hasten its burning. He must strengthen the fire line where necessary, watch for snags falling across the control line, patrol the area on the outside to be sure no spot fires have been started. The finding of the *last spark* on the fire and *putting it out, dead out,* is a painstaking and important job. It is one in which we often fail, with the result that the fire *gets away* and all the previous work, money, time, and sweat, is lost and must be done over again.

The Use of Water and Dirt in Control Line Construction and Mop Up Work

Water and dirt are both very effective if properly used. The availability of water and the kind of equipment and tools available will determine which to use. Usually both can be used to good advantage.

Use of Water — The most obvious and efficient means of actually extinguishing a fire is by the use of water. In forest fire suppression, the location of the fire with respect to a water supply controls its usefulness in each individual case. Very often the expense or loss of time involved in transporting water to the fire in sufficient quantities to be effective precludes its use at all.

The use of water is valuable for:

a. Quieting down particularly hot spots so that men can work close to the fire, using the direct method or the 2-foot method, where otherwise it would be necessary to use the parallel method.

b. Extinguishing spot fires or wetting down an area where sparks are flying.

c. Holding a sector of hot line temporarily until an adequate crew can be placed on it to construct a proper control line.

d. Completely extinguishing persistent patches of fire in snags, logs, peat beds, and similar out-of-the-way places which are difficult to get at by other methods.

Caution: The use of water may often give a sense of false security in that it may reduce a live flame to an unnoticeable smouldering ember which escapes detection as long as it is moist, but will come to life later when it dries out, perhaps after the fire or a sector has been abandoned as "out." To avoid such a catastrophe it is always important to dig up and spread out smouldering material which is tightly matted to insure that the water reaches all parts.

The backpack can with pump attached is a most effective piece of water equipment. To make the best use of the 4 or 5 gallons of water in a backpack can requires considerable care on the part of the user. All pumps are fitted with a combination spray and stream nozzle or else a plain stream nozzle. A relatively fine spray of water is much more effective in knocking down a blazing fire than a solid stream of water. Therefore, either use the spray nozzle, or, by placing the thumb of one hand over the stream nozzle, break up the solid stream of water into a spray. *Always get as close to the fire as possible when applying water and direct the water at the base of the fire.* When mopping up a fire a very small amount of water will go a long way if the nozzle is placed just as close to the burning embers as possible. *Don't try to put out a six-inch spot of burning ember by directing a stream of water at it from thirty feet away. Get right on top of the spot and make every drop of water count.*

Various kinds of portable power pumper units are used by the responsible fire control agencies. These units require special skilled and experienced crews and where water is available they are extremely effective.

Use of Dirt—Clean, cool dirt, usually obtainable by throwing aside the mat of needles and digging a hole, is the common material used for quieting down blazes and literally extinguishing burning embers.

If properly used it is very effective, but if improperly used it is apt to result in serious disasters. Its beneficial effects are to smother or reduce rate of combustion by reducing supply of oxygen and to act as an absorbent for drawing the heat and so reducing the temperature of the material below the kindling point. The real art in using dirt effectively for extinguishing fire lies in making use of it as both a smothering and an absorbing agent, changing it frequently, and finally leaving the materials completely exposed so that any lurking spot of fire can be easily detected.

The danger involved is that if dirt is thrown on a fire and the fire does not go out promptly, the heat being generated by slow combustion is confined and soon makes the dirt so hot that it becomes detrimental and actually helps to maintain slow combustion in hidden fires which are apt to break out hours, days, or even possibly weeks, later.

For knocking down or temporarily checking a hot blaze a few shovels of fine cool dirt are nearly as effective as a bucket full of water. In applying dirt for such purposes, it should be thrown at the base of the fire with a swinging motion so as to scatter out the dirt in a thin layer over the burning embers and surface fuels.

Burning logs or burning spots in snags may frequently be completely extinguished by throwing dirt against them. Very hot fires in ends of logs and similar material can usually be completely extinguished by repeating the application of dirt three or four times. In doing this first slap the dirt in hard so it will penetrate the crevices or checks of the burning or charred wood and put on all the dirt that will stick. Let it stand for 10 or 15 minutes to draw the heat, then scrape off all the old dirt and as much charred wood as possible, and shovel it away. Then give it another application of dirt, and keep repeating until there is no fire left when dirt is removed.

In attempting to extinguish a fire care should be taken to secure clear, cool dirt, since a mixture of twigs, needles, or leaf mold only adds fuel. Don't use hot dirt and expect to get good results.

If possible always move heavy debris off from the hot beds on which they are lying before attempting to extinguish. In the majority of cases persistent fires in logs will go out of their own accord if the logs are rolled off from their hot beds and turned bottom side up. If logs can't be moved, shovel away all bark, embers, and hot ground from along their lower edge.

The removal of hot embers and hot ground from around the base of burning snags and hollow trees should usually be the first step toward extinguishing them.

Glowing embers, clots of smouldering duff, bark, etc., can usually be completely extinguished by spreading them out on burned-over ground that has cooled off, throwing on a thin layer of dirt and then stamping on it and working it over with feet or shovel so as to break up the embers and mix them through the dirt.

Keep stirring up and rolling the embers until every spark is out. With heavy limbs rub in the dirt or roll them in loose dirt, then scrape off charred material and repeat till all fire is out, then lay the limbs on top of ground where they can be seen. Don't leave burning material buried.

It is never safe to merely throw dirt on the edge of a fire burning in needles or duff, as fire is certain to work out through the lower layers. Such edges must be dug out or trenched.

In certain cases dirt may be used for temporarily covering certain burning materials in order to prevent the blowing of sparks. Such spots, however, should later be opened up and all remaining fire extinguished.

Use of Bough, Fire Swat, Gunnysack, or Shovel — Occasionally a grass, weed or light brush fire can be entirely extinguished by whipping it out with a bough, fire swat, wet gunnysack, or shovel. In such cases the burning material is so light that it can only hold fire for a few seconds. The results are obtained through smothering the flame and separating it from new fuel, cooling it down, breaking up embers into tiny particles, and sweeping in light litter.

Sometimes tiny spot fires established across a fire line even in needles may be entirely beaten out with a shovel. In this case the result is obtained first by smothering the flame and then by breaking up the embers into such tiny particles that they go out quickly and do not give off enough heat to ignite nearby material. In any event, fires which are "beaten out" must be carefully watched for several hours. In the "whipping out" every blow must be struck so as to sweep sparks and embers onto the burned area instead of scattering them ahead.

Care and Return of Equipment

Ineffectiveness in fire fighting can result through improper care and use of fire fighting tools and equipment on the fire line. Men must keep their tools out of danger as far as being burned is concerned and must not carelessly misplace or discard tools or equipment. Every individual is responsible for the return of tools assigned to him. All tools or equipment issued to you for use in fire fighting work *must be* checked in to your foreman or some other person in authority before you leave the fire at any time. Also, if you notice other tools or equipment left along the fire line, you should so notify your foreman or other persons in authority in order that such equipment can be collected.

SUMMARY OF FOREST FIRE FIGHTING RULES

Preparation and Initial Action

1. Be prepared. Have tools and supplies ready and arrangements made for securing foremen crews and transportation.

2. Get to every fire without delay, day or night.

3. Hit it hard on the start; that is, play safe on the size of the first attacking crew.

4. The first man at a fire should try to determine its cause.

Organization

1. Have one fire boss with full authority and responsibility.

2. Split big crews into small units under competent foreman and straw bosses, and assign definite sectors to each.

3. Avoid long work shifts. 10 or 12 hours is long enough; 6 hours of maximum effort gives greater production per man hour.

4. Provide good board if camp is established, and furnish ample lunches to men on the line at proper intervals.

5. On large fires establish small camps close to the fire. This reduces lost time and fatigue due to travel.

Plan of Attack

1. On arrival, go around fire. Then keep posted as to progress and conditions on all sides.

2. Determine most critical points, not only under present conditions but in view of what changes may be expected during day and night.

3. Have a definite reason for every act.

Time of Attack

1. Always do as much work as possible before the heat of the day.

2. On all fires night work is standard practice.

3. Take prompt advantage of all lulls in the fire due to changes in wind, moisture conditions, etc.

Point of Attack

1. Aim to cut off head of fire as soon as possible. With small or weak fires attack the head. With large fires start on the flanks and work toward the head.

2. Always guard against fire flanking rear end of line.

3. Give immediate attention to any spot fire, particularly to leeward or uphill from the main fire.

Method of Attack

1. Avoid methods which delay the issue indefinitely. Select the method best adapted to the situation found.

2. Use the direct method when fire is smouldering and backfiring difficult. Don't let it get a start.

3. Keep fires out of areas or materials which will create a large volume of heat. Always burn out a control line promptly.

4. Avoid backfiring as a habit. When found necessary by deliberate judgment, take prompt advantage of all favorable conditions.

5. Fall all snags which threaten to throw fire across the line.

6. Combat crown fires with night and early morning work.

Mop Up

1. Hold all constructed lines even if it takes the entire crew.

2. Base the intensity of mop-up crews on the condition of the main fire and the probable rate and direction of spread of any fire which might become established across the line.

3. On any fire where there has been intense volume of heat, maintain watch for spot fires up to a half mile or more beyond lines.

4. Keep at least one man on patrol for at least 2 to 10 days after the last spark of fire is discovered, depending upon the fuel type and the probability of hang-overs.

Fire Fighting Economy

1. Catch fires when they are small and send enough men to insure cleaning up job in a few hours. (The cost of a few surplus men for one day on small fires is negligible in comparison to the excessive cost of large fires which may result if too close economy is attempted at the start.)

2. Use methods which will force a quick issue and result in a clean burn to the edge of all lines by the time construction work around a fire is completed. Aim to use adequate crew for a short period.

3. Lay off majority of crew just as soon as lines are completed and properly mopped up or burned out.

4. Maintain adequate patrol.

Common Errors in Fire Fighting

1. Failure to start for a fire immediately. Man thinks more of comfort than his job — let him choose.

2. Failure to calculate probabilities. Tendency is to mobilize by guess work in general terms rather than think concretely in terms of how many and why.

3. Failure to attack promptly or to "hit it hard" at daybreak if fire is not controlled the first night.

4. Failure to have suitable equipment or to use the equipment best adapted for the job to be done.

5. Failure to have adequate overhead and facilitating personnel.

6. Failure to relieve men before they become incapacitated from fatigue.

7. Failure to keep posted in regard to all sides of a fire. Back work instead of head work.

8. Allowing fire to escape by abandoning patrol too soon. This is in the same class with the man "who didn't know it was loaded."

9. Failure to fall dangerous snags. This is like building a 3-foot fence to keep birds out of the garden.

SAFETY and WELFARE

Fire fighting is not easy work, and it can be dangerous. Safeguarding men from injuries and from fatigue due to over-exertion or over-heating is the serious responsibility of every man on a fire.

Danger to Fire Fighters From the Fire Itself

In fast-running fires, particularly in slash, heavy brush, down timber, and crowns there is always danger of crews being cut off, hemmed in, or overtaken by the fire and burned to death or asphyxiated by smoke.

Fire bosses and foremen should be aware of this danger and keep in mind a clear-cut plan of action to be followed in case a fire "goes bad." It is an important part of their responsibility to size up the possible risks and know what to do with their crews in cases of emergency.

To the boss or foreman: You must, above all things, keep cool. When a fire "goes bad," level-headedness on your part is essential. Get your men together, give them their instructions, and *keep them together.* If any break away to follow their own ideas, get them in hand, but do not risk the lives of the rest of the crew.

Have the men keep their hand tools with them, especially shovels, as these tools may be of great value in protecting themselves. Any water that can be taken along may be very useful.

The safest place is often behind the fire front on the burned-over area. Generally there are some places on the advancing front where fuel is thin and where heat and smoke are not intense enough to prevent men getting through by a quick dash. Even though it may be hot, the burned-over area is safe if it has

"crowned out," and it is often the best place even if the surface alone has burned.

If there is no chance to get behind the fire front and it is necessary to move men away from fire over unburned territory, remember that men can travel downhill faster than uphill, while fire travels uphill faster than down. Do not travel ahead of a fire in the same direction that it is spreading fastest unless it is known that there is some safe place ahead that positively can be reached by the crew.

When it is impossible to get within the burned-over area, it is better to "side step" or flank the fire and get men to one side of the advancing front by traveling parallel or obliquely to the front, rather than to try to outrun the fire.

In getting away from a fire, pick the most open ground and avoid dense tangles where travel is slow and in which men may become separated.

Remember that suffocation is a greater danger than heat, and instruct your men to keep damp cloths over their noses and to stoop low to breathe the air next to the earth.

If there is no possibility of getting away from the front of a fire, get the men to water if possible. Men have lived through bad fires by burying themselves in mud holes or lying in small streams, with only nose exposed and that covered with a wet cloth through which they breathed; by getting into tunnels and lying there flat on the ground; and, in one instance, by getting into a green circular alder patch about one acre of 240 feet across. These were last resort cases and are mentioned only as such.

If the man in charge keeps his head, is alert to what the fire is doing, keeps an up-to-the-minute plan of get-away action in mind, and then acts decisively and promptly when the crisis is imminent, last resort measures will probably never need to be used.

Keep in mind a plan for either getting into burned-over area or "side stepping."

If crews are in dangerous places on the fire line when the bad burning period of the day is beginning, plan your line of retreat, and watch the action of the fire closely. If it shows clear signs

of blowing up and there is no nearby safe place to take the men in case of a blow-up, take them back down the line at once to a place of safety and stay there until the danger period is past. It is a poor general that allows his way of retreat to be cut off. Strategic retreats are at times as necessary in fire fighting as in war. Be prepared for emergencies.

As a matter of fact, however, it is generally true that more men have been killed or seriously injured through accidents occurring in line construction and mop-up work than have been injured or killed from flames and smoke.

General Safety and Welfare of Workers

The safety and welfare of all fire fighters depend upon implicitly obeying the orders of the crew boss. Possibly the greatest danger to himself and others is a panicky fire fighter.

Be wide awake and alert and watch out for fellow workers.

Do not indulge in horseplay.

Stay with the crew. Don't wander off by yourself. You may get lost or be trapped in a fire pocket. Don't leave the crew to go off to a lake or stream to swim and cool off. There is danger of drowning, and you will be neglecting your duty.

Watch where you are walking. If you are carrying tools stay at least six feet from the next man. To trip and fall with tools may injure you or the men ahead or behind.

When working on the fire line, don't bunch up. Keep in contact with the other men but work far enough apart so as not to interfere with each other.

When on a fire at night, do not try to work or travel in the dark. A certain number of artificial lights are always available in fire equipment and you can at least be with a person who has a light.

Be careful of logs and rocks on side hills. If the fire has burned their supports, they may come crashing down on you. Always watch out for men working below you on side hills.

Keep on the alert when around burning snags or trees. A snag burned off at the ground or higher up usually makes little

or no noise until it strikes the ground. This danger is greatest during mopping up work.

You must not smoke except by the direction or with the permission of the crew foreman. A careless smoker may start another fire like the one he is trying to put out.

Transportation Safety

When riding on a truck, do not let your legs or arms hang over the sides or beds of trucks. Do not stand up in a moving truck.

If tools and men are carried in the same truck, all tools must be properly stored in tool boxes and these boxes securely fastened so that the tools cannot injure the men. This practice also prevents damaging the tools.

Do not climb over the sides to enter or leave a truck, but wait your turn and go through the rear gate in an orderly manner.

Wait your turn to get your tools from the truck. The crew foreman or truck driver will supervise this. Do not overload a truck.

Only properly authorized persons are permitted to drive trucks. If you are not one of these, LEAVE THE TRUCK ALONE.

If it is necessary to use water transportation, care should be exercised in not overloading boats or canoes, and life preservers should be provided if at all possible. IN NO EVENT SHOULD INEXPERIENCED MEN BE ALLOWED TO HANDLE LOADED BOATS OR CANOES.

Personal Health and Welfare of Workers

One of the most important things you can do is to clothe yourself properly. Your fire fighting clothing should be of the following general type:

Footwear—Sturdy, heavy-soled leather shoes or boots. Oxfords, rubber boots, and tennis shoes are not advised. Shoes or boots should be well broken in, should fit properly, and should be

capable of withstanding hard wear. Composition soles or hobnails are much superior to smooth leather soles, as the latter may become very slippery.

Socks — Heavy cotton or not too coarse socks.

Trousers — Sturdy cotton or woolen work trousers or breeches that are comfortable and easy fitting. Fire fighting is hard on clothes, so do not wear anything you value too highly.

Shirt — Cotton or woolen work shirts that are comfortable and easy fitting.

Coat — It is always best to have some sort of jacket, windbreaker, or mackinaw along. Riding to and from fires on a truck is often cold work, and many a night guard on a fire has been almost frozen because of insufficient clothes.

Hat — A hat or cap is optional, but an old hat has its advantages on a fire. It may keep sparks out of your hair, shade your eyes and head from blistering sun and hot bursts of flame, and if you are riding in a truck when you are hot and sweating, it may prevent you from catching cold.

Underwear — Underwear is optional with the wearer, but padding or insulation in the form of underwear can prevent sore spots and blisters.

It is not advisable for a fire fighter to remove all of his clothing from the waist up even in very warm weather. A jacket or shirt will prevent sunburn, fire burns, scratches, and insect bites, and will serve as padding and protection to the skin in case anything has to be carried.

Report immediately all injuries, no matter how slight, to the FOREMAN. First aid equipment is available in all standard fire fighting equipment and the proper treatment of a very small scratch, blister, or cut may prevent further severe complications. Always be especially cautious of blisters on the hands and feet.

NOTE THAT UNLESS A WORKER HAS REPORTED AN INJURY TO HIS FOREMAN IMMEDIATELY AFTER IT OCCURRED OR AS SOON AS HE COULD REPORT, NO MATTER HOW SLIGHT THE INJURY, HE HAS NO LATER RECOURSE TO CLAIM ANY SORT OF DAMAGES AS A RESULT OF THE INJURY.

Be careful of hernia. In lifting, keep the back straight. Your feet should be spread apart so that the weight of the load can be taken on the arms and legs.

If you cannot get someone to help you put a full backpack can on your back, set it down on a stump or elevation, sit down with your back to the can, and slip the strap onto your shoulders.

Severe insect stings can be fatal to a person. If you have been badly stung, report to your foreman.

Beware of over-exertion and over-heating. Signs of these are faintness, uncontrollable weakness, dizziness, nausea, or excessive sweating. Laziness, of course, is not to be confused with these.

Be careful where and how you drink water on a fire. Polluted or impure water may cause sickness or dysentery. Water out of back-pack cans can be the foulest kind of water for drinking. Check with your foreman on where to get water suitable to drink. Large quantities of water, especially cold water, should not be gulped down when you are hot and tired. Sip the water slowly, and if it is plentiful bathe your face and hands in it. Don't tank up — drink just enough to satisfy your thirst.

Be cautious of food unless you know it is all right. Old food can be especially dangerous because it may become contaminated by its container or become tainted through exposure. Sanitation plays as important a part on the fire line as it does any place. Do not eat or drink anything available out of any old container just because you are hungry and thirsty.

Be cautious of eating berries, fruits, and mushrooms that you find in the woods. They may not be poisonous, but an excessive amount may make you sick just the same.

Intoxicating liquors of all kinds and their use by workers on the job are absolutely forbidden. Any violation will call for strict disciplinary action.

Don't take unnecessary chances to show that you are a real "smoke eater." Intense smoke and heat taken into the lungs is very dangerous and should be avoided.

Don't walk through hot ashes and coals if you can stay out of them or walk around them. They burn your shoes and soften up your feet, making them more subject to blisters.

Take care that your clothing does not catch on fire.

If you have to go through much heavy smoke and fire, hold a wet cloth over your mouth and nose.

If you feel that you are being overcome by smoke, get your mouth and nose as close to the ground as possible. There will be less smoke and more air there than any place else.

If you get hurt or are overcome by smoke or exhaustion, get outside of the fire line if possible, and call for help immediately.

In short — KEEP YOUR HEAD AND USE IT.

GLOSSARY

GLOSSARY OF TERMS USED IN FOREST FIRE CONTROL

ANEMOMETER — An instrument for measuring wind velocity in miles per hour or other units.

BOSS — A man responsible for certain definite activities on a fire. The following terms should not be confused with pay roll titles:

Fire Boss — The man in charge of all operations on a fire.

Division Boss — The man who on a large fire has charge of two or more sectors. (See Sector.)

Sector Boss — The man in charge of a defined section of the perimeter of a fire and supervising two or more crews.

Crew Boss — The man in charge of a group of men composing a crew unit larger than a straw-boss unit. (Sometimes called "foreman.") When necessary, has straw bosses working under his supervision.

Straw Boss — The man directly supervising the work of a small group of men under the direction of a "crew" or other boss.

Patrol Boss — The man in charge of patrol and mop-up after control-line construction.

Camp Boss — The man in charge of camp activities in the fire camp. (Sometimes called "camp manager.")

BURNING PERIOD — That part of the day when a fire spreads more rapidly than at any other time. (Usually thought of as the "heat of the day" but may also occur during the night under adverse fire-weather conditions.)

CAUSES OF FIRES — The eight standard major causes of forest fires are:

Camp Fire — Fires resulting from fires started for the purposes of cooking, warming, or providing light by persons camping or traveling on or near wild land, except those started by railroad lumbering employees in connection with their duties.

Debris Burning — Fires resulting from any fires originally set for clearing land for any purpose, or for rubbish, garbage, range, stubble, or meadow burning without intent on the part of the burner to have such fires spread to lands not intended to be burned. (This does not include lumbering fires or hazard reduction on right-of-ways of common-carrier railroads.)

Incendiary — Fires that in the judgment of the reporting officer are deliberately set by anyone with the intention of burning over land or damaging property not owned or controlled by him.

Lightning — Fires caused directly or indirectly by lightning.

Lumbering — Fires, except those caused by smokers, resulting from lumbering operations. (Lumbering operations include all activities connected with the harvesting or processing of wood for use or sale. Lumbering fires will include those caused by logging railroads which are not common carriers.)

Railroad — Fires resulting from maintenance of right-of-ways or construction or operation of common-carrier railroads.

Smoker — Fires caused by smokers' matches, or by burning tobacco in any form.

Miscellaneous — Fires that cannot be properly classified under any of the seven standard causes just listed. (Fires of unknown causes should be classified under the most probable cause and not under "Miscellaneous.")

CHARACTER OF FIRES

Smouldering — A fire making no appreciable spread and burning without flame.

Creeping — A fire spreading slowly, usually with low flame.

Running — A fire spreading rapidly and with a well-defined head without spotting or crowning.

Spotting — A fire spreading as a result of sparks or embers falling ahead and starting new fires.

Crowning — A fire advancing primarily from crown to crown rather than from ground to crown. (See Types of Fires.)

COLD TRAILING — Very careful inspection of a partly dead fire edge, digging out any live spots or trenching short pieces of live edge, and feeling with hands where there is any doubt as to whether any fire remains.

CONTROL A FIRE — To surround a fire and any spot fires therefrom, with control lines and complete the backfiring of any unburned surface adjacent to the inner edge of the control lines.

CONTROL LINE — An inclusive term for all the constructed or natural barrier used in controlling a fire. Includes (1) clearing when that is necessary, (2) the fire line when that is needed, (3) removal of immediate threats to line constructed, (4) the edge of a grass or other fire which has been worked by direct method, and (5) roads, lakes, bare rock, or other natural barriers used in controlling a fire.

CONTROL-LINE CLASSIFICATION — The principal classes of control-line construction methods with respect to distance from the fire edge are:

Direct Method — A method of suppression that applies work immediately at the edge of the fire. (Includes building a control line there, beating out, extinguishing with water or earth, digging out and shoveling in burning material, etc.)

Indirect Method — Under this method the control line is located along favorable breaks in topography or natural firebreaks, and the intervening strips backfired. (By implication any control line more than 100 feet from the edge represents application of the indirect method, even if the line is not located along a break in the topography.)

DANGER, FIRE — A general term expressing the sum total of both the constant and the variable factors which determine whether fires will start, spread, and do damage and that determine their difficulty of control. (Constant factors include values at stake, normal occurrence, fuel type, slope, aspect, soil type, etc. Variable factors include lightning, incendiary epidemics, illegal burning, inflammability, wind velocity, etc.)

DANGER METER — A device which by integrating the combined effort of the more significant variable fire-danger elements, rates current fire danger into specific classes. (For each class, the specific fire-control measures which should be taken are indicated in some appropriate way.)

DETECTION — The act or system of discovering and locating fires.

DISCOVERY — The act of determining the existence of a fire. Differs from detection in that location is not required. (See Detection.)

DISPATCHER — A member of the fire-control organization who receives reports of discovery and status of fires, determines the locations of fires, and sends men, supplies, and equipment to suppress fires. (A central dispatcher functions over an entire forest or several ranger districts; a ranger district dispatcher, within a ranger district only.)

DIVISION — A group of two or more sectors on a large fire. (Size of division should be no larger than the division boss can supervise and inspect adequately each shift.)

DUFF — The dead organic material making up a part of the forest floor.

DUFF HYGROMETER — An instrument for measuring the moisture content of the litter or duff.

FEELING FOR FIRE — Act of following an edge of a burn after fire is apparently out, and feeling with bare hands the burned edge to determine if ground fire still exists.

FIRE BEHAVIOR — A general term used to describe the action of fire as a result of the complex of variable factors that influence it.

FIREBREAK — A partially or wholly cleaned barrier constructed before a fire occurs and designed to stop or check fires that may occur, or to be used as a line from which to work.

FIRE CONTROL — Protection of wild land and the growth thereon from fire. (Includes prevention, presuppression, and suppression.)

FIRE-CONTROL EQUIPMENT — All the tools, conveyances, machinery, and special instruments or devices purchased for or allocated to fire-control purposes, but not including structures.

FIRE-CONTROL IMPROVEMENTS — The structures used in fire control, e. g., lookout towers, guard cabins, telephone lines, roads, trails, etc.

FIRE-CONTROL PLANNING — A technological and administrative management process used in preparing for action in protecting wild land from fire.

FIRE DAMAGE — (1) The value expressed in money or otherwise, of the loss, tangible or intangible, caused by fire; (2) a general term applying to the destructive effects of forest fires either (a) direct, e. g., killing or burning of trees, forage, and crops; destruction of fish and game, scenery or facilities for recreation; destruction of improvements; and loss of human life; or (b) indirect, e. g., reduction in rate of growth resulting from site deterioration; physical injury such as wounding; subsequent attack by fungi and insects; reduction in watershed values resulting from the destruction of the infiltration capacity of the soil; destruction of favorable conditions for wildlife; and depreciation in property or social values.

FIRE EDGE — The line, usually irregular, to which a fire has burned at a given moment.

FIRE LINE — The strip which, when necessary, is scraped or dug to mineral soil in a control line; a part of a control line. (Fire line exists only when it has been necessary to remove inflammable material.)

FIRE SEASON — The period or periods of the year during which fires are likely to occur, spread, and do sufficient damage to warrant organized fire control.

FIRE TRAP — An accumulation of highly inflammable material or any situation in which it is dangerous to fight fire on a bad day.

FIRE-WEATHER FORECAST — A weather prediction specially prepared by the U. S. Weather Bureau for use by forest fire control agencies. (Three types are issued: (1) a "general outlook" for 2 to 3 days; (2) a "daily forecast" for the ensuing 36 to 48 hours; and (3) "special localized forecasts" for short periods (3 to 12 hours) when requested.)

FLANKING — A method of attacking a fire by working around either edge, usually from the point of origin, and endeavoring eventually to pinch it out by connecting the two flank lines at the head of the fire.

FOLLOW UP — The act of supporting the first man or men who go to a fire by sending additional manpower to facilitate either suppression or mop-up work.

FOREST FIRE — A fire burning on wild land in peat, duff, litter, ground cover, or crowns and not being used as a tool in forest protection or management in accordance with an authorized plan.

FOREST PROTECTION — The activities connected with the control of damage to forests from fire, insects, disease, and other harm-producing agencies.

FUELS — Critical or slash — Light fuels such as grasses, ferns, tree moss, etc., which ignite readily and are consumed very rapidly and thus contribute to very rapid rate of spread.

FUELS, SLOW BURNING OR HEAVY — Fuels such as snags, windfalls, branchwood, etc., which while they usually burn more slowly than flash fuels, liberate a greater amount of heat and burn more fiercely, thus materially increasing the difficulty of suppression.

FUELS, GREEN — Fuels such as foliage of trees, brush, and grasses which are growing and have a high moisture content.

FUEL-MOISTURE-INDICATOR STICKS — Specially prepared wooden sticks of known dry weight, which are exposed and weighed periodically to determine their change in moisture content which indicates the change in moisture content of lightweight forest fuels.

GUARD, FIRE — A general term applied to patrolmen, firemen, lookout men, and others, who, working under direct supervision of a district ranger, are employed during the fire season for the prevention, and suppression of fires, and presuppression activities.

GUTTER TRENCH — A ditch dug on a slope below a fire; designed to catch rolling cones, small chunks, and other rolling burning material. (See Control Line, Fire Line.)

HANG-OVER FIRE — A fire started by lightning which remains dormant until a later period when it becomes active. (Includes a lightning fire when the lookout man sees the strike or smoke but which subsides before ground forces are able to locate it until subsequent rediscovery. Does not include fires merely difficult to find.)

HAZARD — A term applied to materials which form a threat of special suppression difficulties if ignited, and which it is practicable to treat in ways which will remove or diminish the threat. (For example: Snags; jungles or windfalls; fuels immediately adjacent to roads or railroads; fuels around village dumps, ash dumps, or buildings; such dumps and buildings themselves as distinct from the fuels surrounding them; the burnable materials collected at small sawmills; old sawdust piles; meadows covered at certain times with inflammable grass; and man-made debris around homes.)

HAZARD REDUCTION — The removal, destruction, or treatment of inflammable physical materials, at any time other than on a going forest fire, for the purpose of diminishing the chances of fires starting or spreading. "Physical materials" may or may not include those included in the terms "flash" or "heavy" fuels.

HELD LINE — All worked line which has not been abandoned for a line on a new location when control and mop-up are completed. (Lost line, unbackfired natural barriers, and unused safety lines are excluded.)

HOT SPOTTING — Checking the spread of the fire on main leads or at salient points as an emergency measure employed in advance of control line construction.

HUMIDITY, ABSOLUTE — (1) The mass of water vapor per unit volume of space, (2) the gaseous pressure exerted by water vapor present in a space.

HUMIDITY, RELATIVE — (1) The ratio of actual mass of water vapor per unit of volume to mass of water vapor that would saturate that volume at the same temperature and pressure; (2) the ratio of actual vapor pressure to saturated vapor pressure at the same temperature.

INFLAMMABILITY — The relative ease with which fuels ignite and burn regardless of the quantity of the fuels.

KNOCK DOWN — To treat the most vigorously flaming portions of the fire edge until they are not spreading rapidly or creating any great heat. (A process used in Hot Spotting.)

LITTER — The top layer of the forest floor which consists of loose debris of dead sticks, branches, twigs, and recently fallen leaves or needles, the structures of which have been little altered by decomposition.

LOOKOUT — Term should not be used alone due to possible confusion. (See Lookout man, Lookout point, Lookout station and Lookout tower.)

LOOKOUT MAN — A guard placed at a lookout station to detect and report fires.

LOOKOUT PATROLMAN — A guard who traverses ridges and other topographic features of vantage, whose function is to discover, locate, report, and suppress fires in a locality, much of which is not visible from any lookout point.

LOOKOUT POINT — A general term for topographic vantage points systematically selected for detection purposes.

LOOKOUT STATION — A general term for the location and structures used for detecting and reporting fires. (Includes planned cooperator lookout stations.)

LOOKOUT TOWER — A structure erected to enable the lookout man to get above nearby obstructions to vision. It may be capped with a lookout house or an observatory, the latter being too small for living quarters.

MAXIMUM THERMOMETER — A special type of thermometer that registers the highest air temperature between settings of the instrument.

MINIMUM THERMOMETER — A special type of thermometer that registers the lowest air temperature between settings of the instrument.

MOPPING UP (MOP-UP) — The act of making a fire safe after it is controlled, such as extinguishing or removing burning material along or near the control line, felling snags, etc.

NORMAL SEASON — A season in which weather, rated fire danger, and number and distribution of fires are approximately average.

PARTS OF A FIRE

Fingers of a Fire — The long narrow tongues of a fire projecting from the main body.

Flanks of a Fire — The portions of the edge of a fire between the head and the rear.

Heads of a Fire — The portion of the edge of a fire on which rate of spread is most rapid.

Rear of a Fire — The portion of the edge of a fire on the windward or downhill side.

PATROL — (1) The act of moving over a given route to contact and impress people with the need for care with fire. (2) The act of moving over a given route to prevent, detect, and suppress fires. (3) The act of moving back and forth over a length of control line during or after line construction, to prevent breaks, discover spot fires, and when time permits, do mop-up work.

PATROL ROUTE — A line of travel followed by a man assigned to patrol. (May or may not be a predetermined route.)

PERIMETER OF A FIRE — (1) The entire outer edge of the fire. (2) The length of the outer line or edge of the fire.

PREPAREDNESS — (1) Condition or degree of being completely ready to prevent or suppress fires. (2) Mental readiness to recognize increases in fire danger and act promptly when action is appropriate.

PRESUPPRESSION — Those fire-control activities concerned with the organization, training, instruction, and management of the fire-control organization, and with the inspection and maintenance of fire-control improvements and equipment and supplies to insure effective fire suppression. (See Fire Control, Prevention, Suppression.)

PREVENTION — Those fire-control activities concerned with the attempt to reduce the number of fires through education, hazard reduction, law enforcement, etc., or to hold the number down after they have been reduced to a satisfactory level. (Not a part of presuppression.) (See Fire Control, Preparedness, Presuppression, Suppression.)

PSYCHROMETER — An instrument for measuring atmospheric relative humidity, and consisting usually of two thermometers, the bulb of one being covered with cloth which is moistened and thoroughly ventilated when the instrument is used.

PSYCHROMETER, FAN — A type of psychrometer in which a current of air is circulated across the wet- and dry-bulb thermometers by means of a small fan.

PSYCHROMETER, SLING — A particular type of psychrometer in which the instrument is secured to a cord, chain, or handle so that the psychrometer can be whirled rapidly in order to insure a large quantity of air coming in contact with the two bulbs thus accomplishing adequate ventilation of the wet-bulb thermometer.

RAIN GAGE — An instrument for measuring the amount of precipitation; it consists usually of a vessel to catch the rain and a measuring stock for determining its depth.

RATE OF SPREAD — The increase in size of a fire expressed in chains of perimeter per hour or some other similar units.

RESISTANCE TO LINE CONSTRUCTION — A term used to express the relative difficulty of constructing control line as determined by the character and density of fuels, soil conditions, and topography. It may be expressed in chains of held line per man hour or as extreme, high, medium, and low.

RISK — The relative chance or probability of fire starting, determined by the presence or absence of causative agencies. (A part of the fire danger on any area.)

SCALE, BEAUFORT — An empirical scale in which the strength of wind is indicated by numbers from 0 to 12. (The original Beaufort scale was designed for use at sea. A Beaufort scale with specifications for land use is used today by the Weather Bureau.)

The following terms are those used by the Weather Bureau in forecasting:

Forcast Terms	*Wind Velocity Miles Per Hour*
Calm	Less than 1
Very light	1–3
Light	4–7
Gentle	8–12
Moderate	13–18
Fresh	19–24
Strong	25–38
Gale	39–54
Whole gale	55–75
Hurricane	Over 75

SECTOR — A logical or natural length of the control line handled as a unit for suppression purposes. (Normally a sector should not exceed the amount of line the man in charge [sector boss] can supervise and inspect adequately each shift.)

SEEN AREA — An area where the ground or the vegetation growing thereon can be seen directly from any established lookout point under prescribed atmospheric conditions.

SMOKE, LEGITIMATE OR PERMANENT — Smoke resulting from locomotives, industrial operations, ranches, etc., and not from forest fires.

SNAGS — Standing dead trees or parts of dead trees. (Snags less than 6 feet high are classed as stumps.)

SPOT FIRES — Fires set in advance of or away from the main fire by flying sparks or embers.

STATION, FIRE-DANGER — A forest station specially selected, equipped, and operated to measure the daily variable factors of fire danger.

SUPPRESSION — All the work of extinguishing a fire beginning with its discovery. (See Fire Control, Prevention, Presuppression.)

SUPPRESSION SQUAD — Two or more men stationed at a strategic location, either regularly or in an emergency, for initial action on fires. Duties are essentially the same as those of individual firemen.

TRENCH — Formerly used as a synonym for "fire line" which is the preferred term because a fire line need only be scraped to mineral soil, not dug away. (See Gutter trench which is the only type of fire line which needs to take the form of a ditch in mineral soil.)

TYPES OF FIRES

Crown — A fire that burns through the tops of trees, brush, or chaparral, or which consumes all or a large part of the upper branches or foliage of trees, brush, or chaparral.

Ground — A fire confined to the materials composing the forest floor or beneath the surface as in peat beds.

(Usually combined with surface fire but not to be confused with surface fires which burn only the top of the ground cover.)

Surface — A fire that runs over the forest floor burning only the surface litter, the loose debris, and the smaller vegetation or ground cover.

See character of Fires.

VISIBILITY — The character or quality of an object or image with reference to its background and the transparency or clearness of the intervening atmosphere that permits it to be distinguished by the eye.

VISIBILITY DISTANCE — The maximum range of vision in miles at which a lookout man can distinguish a standard or specified size of smoke column under specific atmospheric conditions.

WEATHER — The state of the atmosphere at any particular time and place with respect to temperature, atmospheric pressure, wind, clouds, relative humidity, and precipitation.

WILD LAND — Protection forest and all other forest or range land used primarily for wood or forage production, recreation, or wildlife.

WIND DIRECTION — The direction, with reference to the cardinal points of the compass, from which the wind blows or is expected to blow.

BRIEF OF MINNESOTA FOREST FIRE LAWS

4031-15. *District rangers and patrolmen. — Duties. — Arrests.* — Under the direction of the forester, the district rangers are charged with preventing and extinguishing forest fires in their respective districts, and the performance of such other duties as may be required by the forester. They may arrest without warrant any person found violating any provisions of this act, take him before a magistrate and there make complaint. When the district rangers shall have information that such violation has been committed, they shall without delay make similar complaint and have the same prosecuted. The district rangers and other forest officers shall not be liable in civil action for trespass committed in the discharge of their duties.

Any district ranger or patrolman may serve any warrant for the arrest of any person violating any provision of this act; and for that purpose all district rangers and patrolmen are hereby vested with the same powers as constables or other similar officers of the courts issuing such warrants. (25C407 Sec. 15; 11C125.)

4031-16. *Fire patrolmen.—Summoning aid for extinguishment of fires. — Refusal to obey summons. — Commandeering property.* — At any time district rangers, with the approval of the forester, may employ suitable persons to be known as fire patrolmen, permanently to remain upon and patrol any territory (whether comprising public or private lands or both) as may be assigned to them as long as required to prevent and extinguish any fires. Each such patrolman so employed shall be supplied with the necessary equipment. The forester or any district ranger or fire patrolman may summon any male person of the age of eighteen years and upward to assist in stopping any fire burning in the district under the care of such state employe, and may incur any other necessary and reasonable expense for such

purpose, but shall promptly report said matter to his next superior officer or other state employe over him.

Any able-bodied person so summoned, who refuses or neglects or otherwise fails to assist in extinguishing such fire or who fails to make all reasonable efforts to that end until released by such state employe who summoned him, shall be guilty of a misdemeanor and shall be punished by a fine of not less than $10.00 and not more than $50.00 and the costs of prosecution, or by imprisonment in the county jail for not less than ten days nor more than thirty days. Such forester, ranger, or patrolman, as the case may be, shall also have power to commandeer for the time being any team, automobile, tools, appliances, or other property in the possession of any person either summoned to assist in extinguishing such fire or in the vicinity thereof, and himself to use, and to require such persons summoned to his assistance to use such commandeered property in the fighting and extinguishing of such fire. But the owner of any property so commandeered shall be promptly paid just compensation for such use thereof, and all damages done to such commandeered property while in such use by said forester, ranger or patrolman, from any money available for such expenses under this act. (25C407 Sec. 16; 11C125 Sec. 12.)

4031-17. *Compensation of persons employed to fight fires. — Emergency expenses.* — The wages and expenses of men employed to fight forest fires shall be fixed and paid by the forester and the labor reckoned and paid for at not more than 35 cents per hour. The board is authorized to draw from the state treasury, out of any money at any time appropriated for the purposes of this act, a reasonable sum, not to exceed five thousand dollars ($5,000.00) at any one time, and to place the same in the hands of the forester to be used by him in paying emergency expenses, including just compensation for services rendered by persons summoned, and for private property used, damaged, or appropriated under this act. The state auditor is authorized to draw his warrant for such sum when duly approved by the president and secretary of said board. The forester shall take proper sub-vouchers or receipts from all persons to whom such moneys are paid, and after the said sub-vouchers have been approved by the board they shall be filed with the state auditor. Said sum of $5,000.00, or such lesser amount as may be placed in the hands of the forester at any one time, shall be deposited (subject to with-

drawal by check or otherwise by said forester at any time) in some bank authorized and bonded to receive state deposits; and the bond of such bank to the state shall cover and include such deposit. Any part of said money forwarded by the forester to any ranger or other employe shall likewise be deposited in some such bonded bank, if practicable, and shall likewise be deemed covered by the bond of such bank. (25C407 Sec. 17; 11C125.)

4031-17a. *Contracts for services for forestry or fire prevention work. — Commissions to persons employed.* — The Commissioner of forestry and fire prevention under chapter 426, Laws 1925, is hereby authorized and empowered to contract for or accept the services of any and all persons whose aid is available, temporarily or otherwise, in forestry or fire prevention work either gratuitously or for compensation not in excess of the limits now or hereafter provided by law with respect to the employment of labor by such commissioner. Said commissioner may issue a commission, or other written evidence of authority, to any such person whose services are so arranged for; and may thereby empower such person to act, temporarily or otherwise, as fire warden, patrolman, or in any other capacity, with such powers and duties as may be specified in such commission or other written evidence of authority, but not in excess of the powers conferred by law on district rangers by chapter 407, Laws 1925, and laws amendatory thereof or supplementary thereto. (27C280 Sec. 1.)

4031-19. *Forester may require slashings and debris to be disposed of.* — Where and whenever in the judgment of the forester or any district ranger there is or may be danger of starting and spreading of fires from slashings and debris from the cutting of timber of any kind and for any purpose, or from any accumulation of sawdust, shavings, chips, bark, edgings, slabs, or other inflammable refuse from the manufacture of lumber or other timber products, the forester or district ranger shall order the person by or for whom the said timber or timber products have been or are being cut or manufactured to dispose of such slashings, debris, or refuse as said state employe may direct. Where conditions do not permit the burning of the slashings, debris or refuse over the entire area so covered, the forester may require such person to dispose of the same in such way as to establish a safe fire line around the area requiring such protection, the said fire line to be of a width and of a character satis-

factory to the forester, or otherwise to dispose of the same so as to eliminate the fire hazard therefrom.

When any person who has been directed by the forester or district rangers to dispose of such slashings, debris, or refuse fails to comply with such directions, the said person shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not less than twenty-five dollars ($25.00) and not exceeding one hundred dollars ($100.00) and costs of prosecution; and each day during which such failure to comply with said requirements of the forester continues shall be deemed a separate and distinct violation of this act, but any number of such offenses may be prosecuted as separate counts of one charge or information.

When any such slashings, debris, or refuse are not disposed of or are left unattended, contrary to the instructions of the forester or district ranger, the forester or any district ranger or patrolman may go upon the premises with such force of men as may be necessary and burn or otherwise dispose of the same, and the expense thereof shall be a lien upon the land on which they are situated and upon all contiguous lands of the same owner, and also upon all logs and other timber products cut or manufactured upon all said lands. Such lien shall have the same effect and may be enforced in the same manner as a judgment in favor of the state for money. An itemized statement verified by the oath of the forester or district ranger of the amount of such costs and expenses incurred in burning or otherwise disposing of such slashings, debris, or refuse shall be filed, within ninety days from the time said disposal thereof is completed, in the office of the register of deeds of the county in which said timber or timber products were cut or manufactured; and the amount of such lien shall also be a valid claim that may be collected in a civil action from the person who cut or manufactured the wood, timber, or timber products from which the said slashings, debris, or refuse were produced. Any moneys so collected shall be paid into the state treasury and credited to the forest service fund.

Any person who cuts or fells trees or bushes of any kind in clearing land for any road bed or right-of-way for any railroad, highway or trail shall in the manner and at the time as above prescribed burn the slashings and all combustible material, except fuel and merchantable timber which shall be promptly removed.

Any person who cuts or fells trees or bushes of any kind in clearing land for any purpose is hereby prohibited from setting fire to the slashings, brush, roots, or excavated stumps or other cumbustible material on such land and letting the fire run; but the same must be disposed of pursuant to the regulations or directions of the forester.

Any contractor who enters into a contract for the construction of a public road or other work, which involves the cutting or grubbing of woods, standing timber, or brush, shall pile in the middle of the right-of-way all the slashings and debris so cut or grubbed therefrom and shall burn and dispose of such slashings and debris without damage to adjoining timber or woods, which burning shall be done in a manner and at a time satisfactory to the forester; provided, however, that the foregoing provision shall not prevent the leaving of such trees along roads as will be useful for ornamental and shade purposes, and which will not interfere with travel.

Every contract made by or on behalf of any municipality or political subdivision of this state, which involves the cutting of any timber on the right-of-way of a public highway, shall provide in terms for compliance with the foregoing provisions, but that the failure to include such provision in the contract shall not relieve said contractor from the duty to burn and dispose of said slashings as aforesaid.

In all cases not herein provided for, where timber is cut in, upon or adjoining any forest land and no specific directions are given by the forester or district ranger for the disposal of slashings and debris resulting therefrom, all such slashings and debris within two hundred feet of any adjoining timber land or (and) any public highway, railroad, portage, or lake shore, shall nevertheless be piled in separate and compact piles ready for burning, which piling shall be done by the person by or for whom such timber was cut within fifteen days after such timber was cut, and such person shall thereafter make such further disposition of such slashings and debris as the forester or district ranger may direct.

No sawdust, shavings, chips, bark, edgings, slabs, or other inflammable refuse from the manufacture of lumber or other timber products shall be made or deposited upon any public highway, portage, railroad, or lake shore, or within one hundred feet

thereof. ('11, c. 125, secs. 15, 16; '13, c. 159, secs. 4, 5; G.S. '13, secs. 3797, 3798; G.S. '23, secs. 4015, 4016; '25, c. 407, s. 19; '29, c. 360.)

4031-20. *Camp fires.—Extinguishing.—Prosecution of persons responsible for.* — Every road overseer or assistant of a road overseer or other local officer having charge of any highway or highway patrolman, who finds that any person has left a camp fire burning in his district shall extinguish the same and take prompt measures to prosecute the person or persons who so left such fire. ('25, c. 407, s. 20.)

4031-21. *Fires to be extinguished before leaving.* — Every person who, when the ground is not covered with snow, starts a fire in the vicinity of forest or prairie land shall exercise every reasonable precaution to prevent such fire from spreading, and shall, before lighting the same, clear the ground of all branches, brushwood, dry leaves and other combustible material within a radius of five feet from the fire and shall keep such fire under his immediate personal supervision and control at all times, and shall carefully extinguish the fire before quitting the place. ('11, c. 125, s. 21; G.S. '13, S. 3803; G.S. '23, s. 4021; '25, c. 407, s. 21; '29, c. 261, s. 1.)

NOTE: Burden of proof in action for damages. Questions for jury. 178 M. 271, 226 N. W. 932.

4031-22. *Starting fires. — Where unlawful without permission. — Fire breaks. — Reports of unauthorized fires.* — It shall be unlawful, when the ground is not snow-covered, in any place where there are standing or growing native coniferous trees, or in areas of ground from which native coniferous trees have been cut, or where there are slashings of such trees, or native brush, timber, slashings thereof, or excavated stumps, or where there is peat or peat roots excavated or growing, to start or have any open fire, except for domestic purposes, or any back fire, without the written permission of the forester or other authorized forest officer, unless a fire break sufficient to check the spread of such fire shall have been freshly made or plowed around the place or area wherein said fire is set.

But furrows plowed in peat lands or bogs shall not be deemed a sufficient fire break as required by this section.

The occupant of any premises upon which any unauthorized fire is burning in the vicinity of forest lands, whether such fire was started by said occupant or otherwise, shall promptly report the said fire to the forester or to the nearest district ranger, patrolman, or fire warden. Failure to make such report shall be deemed a violation of this act; and the occupant of such premises shall be deemed prima facie guilty of negligence if such unreported fire spreads from said premises to the damage, loss, or injury of the state or any person. ('25, c. 407, s. 22; '19 Ex. Sess. c. 32.)

103.11. *Wilfully setting fires. Third Degree Arson. Criminal Liability.*

Every person who shall wilfully burn or set on fire:

1. A vessel, car, or other vehicle, or building, structure, or other erection, which shall be at the time insured against loss or damage by fire, with intent to prejudice the insurer thereof;

2. A vessel, car or other vehicle, or a building, structure, or other erection, under circumstances which would not amount to arson in the first or second degree; or

3. Any machinery, vehicle, pile or parcel of boards, timber, or other lumber, any stack of hay, grain, or other vegetable product, severed from the soil, whether stacked or not, or any standing grain, grass, timber, or other standing product of the soil —

Shall be guilty of arson in the third degree, and punished by imprisonment in the state prison for not more than seven years." ('35, c. 144.)

4031-23. *Permission to start fires.—Prosecution for unlawfully starting, etc., fires. — Evidence and burden of proof.* — Permission to set fire to any grass, stubble, peat, brush, slashings or woods for the purpose of clearing and improving land or preventing other fire shall be given whenever the same may be safely burned, upon such reasonable conditions and restrictions as the forester may prescribe to prevent same from spreading and getting beyond control. Such permission shall be in the form of a written permit signed by a regular forest officer or a member of the town board, designated by the forester, or some other suitable person to be designated by the forester as township fire warden,

said permits to be on blanks furnished by the forester. Provided, however, that the forester or any of his assistants or the township fire warden may at his discretion, in cases of extreme danger, refuse, revoke, or postpone the use of permits to burn when such act is clearly necessary for the safety of life and property. Any person setting any fire or burning anything under such permit shall keep such permit on his person while so engaged, and shall produce and exhibit said permit to any district ranger, patrolman, or other employe of the forestry service, or township fire warden, when and as often as requested to do so by any of them.

In any prosecution under this act for unlawfully starting or setting or having or permitting the continuation or spread of any fire or backfire, proof upon the part of the prosecution that such fire or backfire originated upon, or was permitted to burn upon, or that it spread from, lands or premises occupied by the person charged with such offense, and that such person had knowledge of such fire and made no effort to put it out, shall be prima facie evidence that he is guilty. And the burden of proof as to any matter in refutation of such prima facie guilt, or in extenuation or excuse, shall be and rest upon the person so appearing prima facie to be guilty. ('25, c. 407, s. 23; '19 Ex. Sess. c. 32.)

4031-24. *Fire wardens. — Appointment. — Duties.* — The forester may appoint supervisors, constables, and clerks of towns, mayors of cities, and presidents or presiding officers of village councils, to be fire wardens for their respective districts; and they shall do all things reasonably necessary to protect the property of such municipalities from fire and to extinguish the same. ('25, c. 407, s. 24; '11 c. 125.)

4031-25. *Neglect or refusal to perform duty. — Penalty.* — Every forestry employe of the state who shall unjustifiably refuse or neglect to perform his duty; every person who shall kindle a fire on or near forest, brush or prairie land and leave it unquenched, or be a party thereto, or who shall set fire to brush, stumps, dry grass, field stubble, or other material and fail to extinguish the same before it has endangered the property of another, every person who shall negligently or carelessly set on fire or cause to be set on fire, any woods, prairie, or other combustible material, whether on his own land or not, by means

whereof the property of another shall be endangered, or who shall negligently suffer any fire upon his own lands to extend beyond the limits thereof; every person who shall use other than incombustible wads for firearms, or carry a naked torch, firebrand, or exposed light in or near forest lands, or who, upon any such land or in the vicinity thereof, or on or along any public or private road, trail, path, railroad right-of-way or road bed, or other public or private way of any kind running over or along or in the vicinity of any such land, shall throw or drop any burning match, ashes of pipe, lighted cigar, or cigarette, or any other burning substance, and who fails to extinguish the same immediately; every person who drives upon or over forest lands in a motor vehicle with an open cutout or without a muffler on the exhaust pipe; and every person who shall deface, destroy, or remove any notice posted under this act; shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not less than twenty-five dollars and not exceeding one hundred dollars and costs of prosecution, or by imprisonment in the county jail not less than ten days and not exceeding ninety days. ('11, c. 125, s. 18; G.S. '13, s. 3800; G.S. '23, s. 4018; '25, c. 407, s. 25; '29, c. 261, s. 2.)

NOTE: Section applied to fire started by owner on premises where no effort was made to extinguish it except by trenching around fire. Op. Atty. Gen., Aug. 15, 1933.

4031-28. *Violations of law. — Penalty. — Civil liability. — Injunctions.* — Any person who violates any of the provisions of this act for which no specific penalty is herein prescribed shall be guilty of a misdemeanor and shall be punished accordingly.

Failure by any person to comply with any provision or requirement of this act to which such person is subject shall be deemed a violation of this act.

Any person who violates any provision of this act, in addition to being subject to any penalties herein prescribed for such violation, shall also be liable in full damages to any and every person suffering loss or injury by reason of such violation of this act, including liability to the state of Minnesota and any of its political subdivisions for all expenses incurred in fighting or preventing the spread of, or extinguishing, any fire caused by or resulting from such violation of this act. Whenever a fire set

by any person spreads to and damages or destroys property belonging to another, the person setting the fire shall be prima facie guilty of negligence in setting and allowing the same to spread.

At any time the state or any political subdivision thereof, either of its own motion or at the suggestion or request of the board or the forester, may bring an action in any court of competent jurisdiction to restrain, enjoin, or otherwise prohibit any violation of this act (whether here described as a crime or not), and likewise to restrain, enjoin, or prohibit any person from proceeding further in, with, or at any timber cutting or other operations without complying with the provisions of this act or the requirements of the forester pursuant thereto; and the court may grant such relief, or any other appropriate relief, whenever it shall appear that the same may prevent loss of life or property by fire or may otherwise aid in accomplishing the purpose of this act. ('15, c. 407.)