Fire Prevention and Protection in the Douglas Fir Operations of the Northwest

by

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TABLE OF CONTENTS

I. INTRODUCTION

Fire prevention and protection is a problem that the Douglas Fir logging operator of the Northwest is, and should be, increasingly concerned with. Although much money is already spent on controlling and preventing fires in the woods, losses are still too great. Heavy losses due to fires are not only accounted for by the burning over of standing and felled timber, but also by the loss in expensive equipment, bridges, and camps.

Losses due to fires, to evaluate fully, must be considered not only from the direct standpoint but also in the light of indirect losses. These may be summed up under the economic damage fires do as follows:

(a) "Actual loss to the owner of the intrinsic value of the stumpage killed and not salvageable, and of logging or other equipment or improvements in the path of the forest fire.
(b) "Loss to the community of the money that would have been spent in lumbering this timber had it not been burned.
(c) "Loss to transportation interests on the tonnage of freight that might have originated from the forest, had it not been burned.
(d) "Loss to public agencies of tax revenues that the green forest contributes, but the burned-over land does not, thus shifting the tax burden suddenly and disturbing public credit, debt retirement, etc.
(e) "Wrecking of recreational values, including game, that pertain to the forest only so long as it is green and attractive, and the indirect losses and inconvenience to various interests from the smoke nuisance.
(f) "Loss of water conserving and erosion control functions which the green forest performs, but the burned area does not.

(g) "Increasing the fire hazard on the burned area itself and on all surrounding forest areas, for, paradoxical as it may seem, a forest fire predisposes an area to more fire.
(h) "Fire fighting expenses that in the case of great fires become very large, and at last analysis have to be borne by the public as well as by the landowners. Almost every year there is somewhere in the state one or several very destructive fires and very large expenditure for battling them.
(i) "Loss of immature trees and of potential growth in the case of fire in young forests. The repeated burning of logged-off land, preventing new forest growth, is perhaps the most serious and most neglected sore spot in the present forest protective system." (1)

Statistics indicate rather heavy losses from fires caused by logging. In the State of Oregon in 1939, logging was responsible for 35 fires out of a total of 1089, or 3.2%, which burned over 25.1% of the total area burned during the season. The loss in equipment and logs alone due to this cause amounted to 53.9% of the total loss in these two items. Total damage caused by logging fires comprised, however, only 16.7% of the total for all causes for the season. The merchantable timber destroyed was valued at $31,878 as compared with a total of $564,149 for all causes. (2) The heavy loss in logs and equipment is due mainly to the fact that most logging fires start at or near the immediate vicinity of the operations, where the major portion of equipment and logs is concentrated. The burning of cold decks is a factor that contributes considerably toward the large loss in logs.

The Report of the Washington Forest Fire Association for 1933 gives the number of fires caused by lumbering as

49, or 8.8% of the total number from all causes. The area burned over amounted to 5,084, or 15.5% of the total area burned over during the year. Timber and logs destroyed scaled an estimated 4,105 M. B. M., or 17.4% of the total. Logging equipment destroyed was valued at $66,770. (14) The following year, however, was not nearly as disastrous, due probably to a less hazardous fire season. The 13 fires caused by lumbering activities made up only 1.5% of the total. The 13 fires burned over 275 acres in all, or .9% of the total acreage burned. The 350 M. B. M. of timber and logs destroyed comprised 10.0% of that destroyed by all causes. Logging equipment showed a similar drop, the loss amounting only to $1,435. (3)

The Tillamook fire of August 1933, which may be cited as one of the most destructive fires, was caused by the friction of a steel cable passing around a stump. Spread of the fire was rapid, being favored by low humidity and a high wind. By the time the fire was brought under control, it had covered 267,000 acres with a stumpage loss alone of $200,000,000. The area was estimated to contain 12 billion board feet, more than two-thirds of which was virgin timber. The loss to industry, labor, the public, etc. was estimated at $350,000,000. (4)

On an average, lumbering is responsible for more than half of the monetary damage resulting from forest fires. During the four year period, 1928 to 1931, the value of

timber, logs, equipment, and improvements destroyed by lumbering fires averaged $390,836 per year, whereas similar values for all other causes combined were only $298,867 per year. (1)

In view of these few citations of losses from fires caused by logging operations, it is quite apparent that fire prevention and protection in woods operations is of great importance, and when fully pursued will inevitably result in greater returns with the reduced loss in time, timber, and equipment by fire.

Fire prevention and protection must, however, be practiced more intensively than formerly. This is gathered from the fact that logging operations contribute factors operating to increase the fire hazard in Oregon and Washington at a pace faster than the protective effort can keep up with. These contributing factors may be summed up as follows:

> 1. "A growing acreage of logged-off land, and the connecting of one logging operation with another to make huge areas unbroken by green timber; recognizing that logged land, regardless of whether the slash had been burned or not, is several times more ignitable than virgin forest.
> 2. "A gradual increase in the amount of logging activity, which means more acres of fresh slashings, more slash burning, and more spark-emitting equipment. (1)

This requires more intensive fire control measures to keep losses at a minimum. The increasing value of stumpage, logs and of equipment makes it increasingly important that

this investment be protected, and it is only through constant application of more adequate fire control measures that this may be accomplished. Herewith are discussed measures that are designed with the above thought in mind.

II. FIRE PREVENTION

Causes of Forest Fires and Their Prevention

It has been found that the majority of logging fires start from the following causes:

(1) Cigarrettes, burning matches, etc. discarded by smokers.
(2) Live coals from ash pans.
(3) Lunch fires.
(4) Blasting fuse.
(5) Sparks from steam, oil, and gas equipment.
(6) Sanding flues and dumping ashes in hazardous places.
(7) Sparks from brake shoes.
(8) Block and line friction.
(9) Operation during dangerous fire weather. (5)

Fires caused by smokers in the woods may be prevented by prohibiting smoking during the fire season except at designated places. Smokers have been the cause of many fires, and although absolute stopping of all smoking in the woods is a difficult matter, much can be done to eliminate the possibilities of fires from this cause. Designated places for smoking may be at donkey settings or other places where several men stay continuously and can watch for fires that may develop. The fire starting agency may be localized by this measure, providing further, however, that the "designated" place is not a moving car or out in the slash area away from travel. Cooperation in

the prevention of fire by smokers may be promoted in the woods men by impressing them, in an effective manner, of the dangers of smoking in the woods, even at designated places, and that great care must be exercised when disposing of cigarrette butts, pipe heels, and matches.

To prevent fires from ash pans requires that they be made tight enough to prevent live coals from dropping out. For certain types of machines this may require the addition of metal shields. (5) To insure that ash pans are in effective condition at all times, frequent inspection is necessary. A little time spent inspecting ash pans may often times aid in preventing a disastrous fire. The fire laws of both Oregon and Washington require adequate devices for preventing the escape of fire or live coals from ash pans. (7),(8)

Lunch fires or fires used for repair work, to minimize the possibilities of fires from them, must be confined to mineral soil. All debris should be cleaned from the ground for several feet around the fire. A fire should never be started against a log or stump. Before leaving a fire, it should be completely extinguished, and not merely covered with dirt. Fires covered with dirt may break out again during dry, warm weather, even after several days of cloudy, moist weather.

Blasting fuse, used for blasting stumps, choker holes,

and hang-ups, has been the cause of many logging operation fires. The use of blasting fuse, especially during periods of dry weather, should be discontinued entirely, and electric detonators used exclusively. The danger of fires is not wholly from smoldering fragments of fuse, but also from the flaming match dropped by the choker setter, or whoever performs the blasting, in his haste to get away before the powder explodes.

Fires caused by sparks from steam, oil, and gas equipment can be avoided by the installation of spark arresters on all such equipment, and the constant surveillance of the spark arresters to see that they remain in condition for their effective operation. State laws of both Oregon and Washington require that spark-arresting devices be provided for all spark-emitting machinery, including steam, gasoline, diesel, and oil-burning locomotives, donkeys, tractors, and motor logging trucks. (7),(8)

Some operators claim that they never have had a fire started by oil-burning equipment, but again other operators contend otherwise. It has been found that "oil-burning locomotives frequently start fires by ejecting sheets of incandescent carbon which have apparently formed as a scale on some of the cooler parts of the furnace or tubes. An unprotected oil-burning locomotive is looked upon as more of a menace than a wood burner equipped with a proper arrester." (9) It is imperative, therefore, that oil-

burning equipment also be provided with spark-arresters.

Most of the spark arresting devices are good if properly installed and maintained. On steam equipment, outside exhausts with no forced draughts may be substituted for spark arresters if not in conflict with state laws, which is believed by many to be better than inside exhaust with spark arresters. (5) Where spark arresters are used, the greatest need is the necessity of maintaining the screens in perfect condition. Frequent inspection is necessary to ascertain the development of any faults which may pass a spark.

On diesel and gas equipment, an effective spark arrester may be made by substituting a "T" and 8-or 9- inch length of pipe for the usual elbow employed at the exhaust manifold to allow the exhaust to extend upward and high enough to carry the dangerous exhaust gases away from the operator. Capping the short pipe at the outer end will catch any solid hot matter that may be expelled from the engine since this pipe extends straight out from the engine and the long exhaust pipe turns sharply at the T-joint. (5)

As an added precaution against fires started by sparks from steam donkeys, all debris around the donkey setting should be cleaned up. This will reduce the danger of fire from sparks that may happen to escape through the spark arrester or ash pan. In addition, the area immediately surrounding the donkey, especially that to the leeward side,

should be frequently wet down during fire weather. This is done by the watchman, one of which should be provided for every donkey engine. Generally, the watchman remains at the donkey for several hours after the crew has completed the day's work to watch for any dormant sparks that may break out into flame.

The sanding of flues and dumping of ashes should be confined to designated places that have been "fireproofed" by frequent slash burning and clearing. Although fires may and do start in such places, there is a greater possibility that they can be prevented from escaping from such areas than on areas that have not been given such treatment. The places where sanding of flues and dumping of ashes should be done may be designated by signs. This aids in localizing fires, making it easier to find and extinguish them if and when they do start.

Fires started by brake shoes are quite frequent, especially on grades. These may be extinguished before their spread becomes very great by a patrolman following behind the train. Speeder patrol should be provided on five miles or more of road, in which case the patrol follows about 20 minutes behind the train. The Washington fire laws require the patrolman to carry at least two shovels, an ax, and a five-gallon fire extinguisher. (8)

The Washington fire laws also require that every locomotive be provided with track sprinklers, which are

very effective prevention devices. Ties and bridge timbers on steep grades are wet down sufficiently to prevent brake-shoe sparks from starting any fires or if they do start, the wet material slows down their spread. With the arrival of the patrolman, the fire can be put out before the fire has spread to any great extent. The track sprinkler may be readily made of a piece of 2 inch pipe fastened parallel with the ties along the rear running board of the locomotive. Holes are spaced in the pipe directly above each rail so that the water will strike the ties for about half a foot or so on either side of the rails. Water is forced through the sprinkler pipe by a connection with the boiler injector or pump. (5)

Friction created by a line siwashing a dry stump or log, or a line cutting in the shell of a block improperly hung is another common cause of fires in logging operations. To prevent fires from this cause, care should be exercised to see that all lines are run straight, particularly the haulback line, to remove the points of friction. Light, inflammable debris should be removed from in front of the blocks to prevent small limbs from being caught up by the line and wedged against the block, and also to minimize the danger from sparks, in the case of the corner block, should the butt-rigging strike the block. In addition to clearing out in front of the block, the debris should also be removed for a few feet on each side of the block.

Operation during dangerous fire weather is conducive toward the starting of fires through the causes mentioned above. Operation at such times heightens the possibilities of fires, when special care must be exercised in all respects. Fire weather may occur before the legal fire season and after it. The term has been defined as "any period during the entire year when by reason of humidity, inflammable condition of debris, and character of wind, fires will start and spread." (5) The preventive practices and precautions should be followed "during fire weather", and operations ceased entirely during extreme fire weather, which will be discussed further below.

The Measurement of the Fire Hazard and the Closure of Operations.

Although authority is had by the State Foresters in both Washington and Oregon to close all operations for the duration of hazardous periods of protracted low humidity or combinations of low humidity and high wind which make operating conditions extremely dangerous, operators should take it upon themselves to close operations during short periods of dangerous fire weather, when it is known fires will be hard to control once started.

Relative Humidity

Dangerous fire weather is determined largely by relative humidity, with fuel dryness and wind velocity

playing no small part. The most disastrous fires have occurred during periods of low humidity, and since relative humidity is the most dependable yardstick for determining fire weather, it is imperative that instrumental measurement of relative humidity is made available in each operation. Preferably, there should be two hygrothermographs, one at headquarters and one centrally located in the operation. The working condition of the hygrothermographs should be checked frequently with a sling psychrometer.

The danger point for fires is around 35 per cent relative humidity. (10) When the relative humidity drops this low extreme precaution should be taken, and operations ceased entirely at 30 per cent. The best policy is to anticipate the weather before it arrives, in which the U. S. Weather Bureau gives assistance by issuing regular weather reports of wind and humidity trends over the radio. (11) When a humidity of only 40 per cent is anticipated , patrolmen should be stationed at corner blocks and along lines; sprinkling should be done oftener around donkeys, and track patrol maintained at full efficiency. In hazardous regions, some logging operators have adopted the plan to operate from 4:00 A.M. till noon to get in the days work before the humidity drops too low. Patrolmen and watchmen are left in the woods in the afternoon to watch for fires that may eventually develop.

In making plans for extra patrols or early closure of operations, interpretation of the U. S. Weather Bureau forecasts can be made more fully by the following statements:

"1. That an unusually low relative humidity throughout the night or early in the morning is usually indicative of extremely low humidities and a very high inflammability later in the day. (For the Douglas fir belt a humidity as low as 60 per cent at sunrise constitutes a warning.)
2. "That extremely low humidities prevailing for two hours or more will normally result in extremely high inflammability. The degree of inflammability tends to increase materially with the duration of the low period. (In this connection humidities below 35 per cent are classed as hazardous. For the Douglas fir Belt the degree of danger increases rapidly at considerably higher humidities. Normally, however, its spread is slow at humidities above 50 per cent. Between 40 per cent and 50 per cent it will pick up and under favorable conditions of material and wind or slope may run with some rapidity.)
3. "That high humidities (60 per cent or higher) after a period of two hours or more will so reduce inflammability of critical fuels that there is little danger of fires being started from sparks or making any material spread except where intensely hot fires already burning in heavy slash may carry on, through the drying out of materials adjacent to the fire, or when there is a high wind.
4. "That the hold-over effect of rains which may have occurred within the last two or three days will naturally tend to reduce the risk and modify the normal effect of low humidities. In this connection, however, experience has proved that extremely low humidities may bring about conditions favorable for start and rapid spread of fire in less than 24 hours after a heavy rain.
5. "That unusually low humidities occurring several days in succession or within periods of prolonged drought result in the most dangerous fire conditions.
6. "That the rate of spread of fire varies roughly with the square of the wind velocity. In other words, if the spread is moderate with a 5-mile wind, it will be four times as great with a 10-mile wind. A slight increase in wind greatly increases the problem of control." (5)

The U. S. Weather Bureau gives special warnings in addition to the regular broadcasts when the control of fire will be difficult or practically impossible. However, this does not release the operator of the necessity of watching conditions in his own territory, as fire weather is very often localized.

Fuel Moisture Content.

Fuel moisture content affects the fire carrying capacity of fuels, and is measured by "hazard sticks" consisting of 3-½ inch square ponderosa pine sections weighing 100 grams in dry wood substance. The absorption or evaportion of moisture is measured by special scales which read in per cent. The sticks are kept in the open on wire racks and measured several times during the day. They afford a direct indication of burning conditions. (4) Even though relative humidity is high, it is often the case that the moisture content of the fuel is affected very little thereby as indicated by the hazard sticks, pointing out the fact that a protracted period of high relative humidity does not necessarily make fuels appreciably less inflammable. Therefore, precautions should not be relaxed during periods of so-called favorable weather, as fuels steadily become drier and drier as the season advances, regardless.

Wind Velocity.

Wind velocity affects the rate of spread of fires, as seen above, and the rate at which fuels are dried out. A high wind accompanied by low relative humidity indicates hazardous fire weather, when extreme precautions must be exercised. Wind velocity is measured by the wind velocity indicator, and should be read several times throughout the day. Information regarding such instruments may be procured from the Northwest Forest Experiment Station, Portland, Oregon.

Fire Detection.

Despite the most intensive fire prevention and fire-proofing measures that may be practiced, fires may and do start. It is only through prompt detection that they may be found and put out before they spread to a size difficult of control. Fires allowed to develop into large size are hard to control, do a lot of damage generally, and are most expensive to control. As mentioned above, a speeder patrol following locomotives, watchmen at donkey settings, and a foot patrolman along the haulback line and at the corner blocks can detect and extinguish many little fires before they have reached the stage where extinguishment would be quite expensive. Fires in areas not otherwise covered by the regular detection system may be discovered by a lookout strategically located.

Communication

It is essential that an adequate means of communication be provided to insure prompt and immediate action after fires are discovered. Not only is a communication system needed for relaying news of fire discovery but also for fire prevention and fire suppression. As soon as shutdown notices are received they can be relayed from the camp to the woods without delay. Likewise, immediate word from the woods to the camp can be sent if it becomes necessary to ask for aid in fire suppression. If the woods operation is near enough to the main camp, whistle signals can be used, but generally a telephone is quite necessary for moderate and large sized operations. Telephone communication with each side is preferred. Most essential are direct telephone connections with outside lines for reception of shut-down notices and fire weather forecasts.

III- FIRE SUPPRESSION

Although operators are not held for the cost of suppressing fires on their holdings when they pay fire tax, or otherwise belong to a fire protection association, they, nevertheless, must take action on such fires, and extinguish them. It is herein that the operator must be prepared for immediate action on fires occurring on his holdings. Loss in equipment, time, and timber can only be kept to a minimum with adequate fire suppression. It

is, therefore, to the best interest of the operator that he give due consideration to fire suppression in all its aspects.

Fire Plan

A definite systematic fire plan, from the standpoint of both protection and suppression should be formulated and adopted by each logging operation. This plan, the responsibility for which should begin with the logging engineer or superintendent, should be made out in advance of the fire season. It will of necessity vary in scope and detail so as to fit local conditions, the size of the operation, and the desires of the superintendent.

The fire plan should cover all points pertinent to the promotion of an efficient fire prevention and suppression organization. It should name the fire chief-generally the camp fire warden- and the next person in charge. The personnel of each side should be divided into fire fighting crews in charge of crew bosses, who are to have assistants in case the crew boss is absent. The location of equipment for each crew must be clearly stated. Each fire crew foreman should be given instructions in regard to fires occurring in his territory; similarly, the train crew in the event of fire along the right-of-way. The person responsible for patrol along the haulback line should be named, likewise the person responsible for patrol after

trains. Any other provisions that have been made for fire detection, especially in extra hazardous areas, should be mentioned. The system of communication decided upon for reporting fires, calling for help or relaying shut-down orders must be definitely stated. The responsibility for keeping fire fighting tools and equipment in good condition must also be set forth. Arrangements must also be made to keep a responsible official in camp during fire weather to take charge of any fire that may occur. (5)

Camp Warden

A camp fire warden should be employed to take charge of all fire prevention and suppression activities during the fire season in logging operations in which spark emitting machinery is used and more than 30 men are employed. He should be put on duty before the commencement of the danger season, and held until after the fire season is passed. The nature of his job requires that he be on duty continuously during the fire season.

Duties of the Camp Warden

1- "Arrange for securing and placing in commission all fire tools, water barrels, tank cars, sprinkler systems, telephones, pumps, hose, etc., prior to the opening of the fire season.
2- "Frequently inspect spark arresters, ash pans, etc., on all locomotives and logging engines. Secure the sanding of oil-burning locomotives only on safe designated stretches of track; see that tank cars and speeders are always in the clear.

3- "Supervise the work of all patrolmen and watchmen.
4- "Post camp rules and state laws regarding fire.
5- "Enforce the rules and laws, using patience, tact, or firmness as the case may demand.
6- "Superintend brush burning operations or other incidental use of fire.
7- "Through cooperation with the logging foreman see that proper slash disposal is effected or that areas on which logging is completed are made ready for burning before the burning season commences.
8- "Cooperate with other forest protective agencies to guard against fires running into the operation from the outside, or from adjoining operations.
9- "Reduce the inflammability of cut-over areas of high risk; for example, clear along rights-of-way and about donkey settings, trestles and bridges, fall snags.
10- "Watch or prohibit entrance to the operation or adjoining cut-over lands by berry pickers, hunters, fishermen, or others, as a precaution against fires being started.
11- "Be on hand when logging engines are moved to see that no fire is strewn along the route.
12- "Make sure that the company itself is complying with every detail of the state forest fire laws.
13- "Have a well thought-out plan of how to fight fire that might start anywhere on the works, i.e., be prepared for emergency. This should include such details as where water would be secured for portable fire-fighting pumps or for gravity system, where fire lines would be constructed, where auxiliary fire fighters and equipment could be secured, etc.
14- "Observe weather conditions, relative humidity, temperature, wind, etc., to determine the days of extreme fire risk. Put on extra patrol and warn everyone to take precautions against starting fires." (6)

It is the responsibility of the camp warden to see that prompt and strong action is had on all fires. Such action means a saving for the operator, and possibly the saving of timber and equipment from loss by fire. Mop-up work should not be slighted, as fires break out quite easily when wind and humidity conditions are right.

The inclusion of the territory, where logging is in

progress in the general protective system of the locality, does not mean that the operator is relieved of most of the responsibility of fire prevention and suppression. However, it may be possible in some instances for the general protective system to take care of detection in areas not covered by patrols or watchmen. The necessity of coordination of the operator's fire plan with the general fire protection plan is apparent, and should be developed to the fullest possible extent with the definite fixing of responsibilities of each organization.

Fire Fighting Equipment

The fire laws of both Oregon and Washington require a minimum of fire-fighting equipment for each logging operation. The fire-fighting equipment called for in the Forest Practice Rules of the Douglas Fir region (see Fig. 1) are no less exacting than that required by existing state fire laws, and in some instances provides for additional equipment. (5) Further precautions may be taken by providing fire-fighting tools at gas and steam donkeys occupied at cold decks or otherwise isolated from the tools required for each logging side. Fire-fighting tools should be kept in good condition, and used only for fire suppression. They should be kept in sealed boxes specially provided for the storage of such tools.

The hand-tank pumps should be kept filled with water

and the pump tested frequently. The chemical fire extinguisher, which is the proper kind to carry on gasoline and diesel motor trucks and donkeys, should have not less than 1½ quart-capacity, and should be either of the carbon compound or the foaming type. To avoid spilling or accidental discharge, the container should be the pump type.

The adequate provision of fire-fighting tools, coupled with a well organized fire plan, insures prompt and effective action in fire suppression. After fire prevention has been practiced to the fullest possible extent, it is only through prompt and effective fire suppression that losses from fire may be kept to a minimum.

IV- HAZARD REDUCTION

Hazard reduction, which aims to reduce the danger of fires starting and their subsequent spread, is accomplished by felling snags, slash disposal, and right-of-way clearing. Clearing around corner blocks, which is also a hazard reduction measure, has already been discussed.

Snag Felling

Snags make the control of fires in cutover areas very difficult because sparks from the tops of snags start spot fires far ahead of the fire fighters, especially in a high wind. Therefore greater ease of fire control is had by felling the snags in woods operations.

The Oregon Fire Laws requires that all snags over 15 feet in height and within 150 feet of a steam donkey engine be felled, and all snags over 25 feet in height and 16 inches in diameter be felled currently with the felling of the timber. (7) The Washington Fire Laws are similar in this respect except that no requirements are specified regarding the felling of all snags over 25 feet in height and 16 inches in diameter currently with logging. (8)

Right-of-Way Clearing

Right-of-way clearing for principal railroad or truck roads produces areas of high hazard immediately adjacent to the roadways. This is due to the concentration of "especially hazardous inflammable debris" in such areas. This concentration of very inflammable material is most ideal for the starting of fires from live coals and sparks from locomotives and trucks, and from cigarettes and matches that the smoker has thrown away without being sure it is out. Fires start most readily in such areas, and, furthermore, are also difficult to control.

Reduction of the hazard due to right-of-way clearing will accomplish much toward lessening the chances of any fires starting. Fires that may happen to start can be brought under control more easily and with less expense. Spot burning has been found to be quite well adapted to elimination of the hazard created by right-of-way clearing.

This method of disposing of the debris should be done with the same care exercised during larger slash burning. Along cuts or fills, it is generally found unneccesary to clean up for more than 10 or 15 feet from the edge of the roads. However, along bridges and trestles, it is good practice to clean up all debris for a distance of 50 feet, and sometimes 100 feet, on both sides of the bridge or trestle. This precaution, besides reducing the danger of fires starting, also makes the control of fires easier, with the possibility of loss in bridges reduced to a minimum. The state fire laws of Washington require that the debris resulting from right-of-way clearing must be piled and burned as clearing progresses, a burning permit being required during the closed season.

Slash Disposal

Slash disposal is the burning of the debris that remainsafter logging. This reduces the fire hazard and materially aids in controlling subsequent fires. Ease in control is had by the fact that slash disposal reduces the amount of fuel, which will tend toward retarding the spread and intensity of fires that may start in the area. It must be recognized, however, that slash disposal does not remove the fire hazard permanently.

Unburned slash is the biggest contributing factor in the rapid spread of fires and one of the principal causes

of heavy fire fighting costs. (12) It is for the best interests of the operator, therefore, that he give his slash the attention it deserves. The cost entailed in slash disposal may be considered as an investment through the saving effected in fire-fighting costs entailed in the control of subsequent fires in the area.

Broadcast burning, under present economic conditions, is the only feasible way of disposing of the slash where clear-cutting is practiced. However, with the increase in second-growth fir and caterpillar logging in which a considerable residual stand of timber and small trees is left, broadcast burning accomplishes little from a protection standpoint and violates all silvicultural practices. Piling and burning is economically impossible for private operations, however, spot burning is practiced some by small operators. At present, a move is under way to limit burning in such areas as much as possible, and to provide adequate protection through fire breaks. (2)

Although slash burning is compulsory in both Oregon and Washington, exemption may be had in areas selectively logged. (7),(8) Exemption is mainly dependent upon the State Foresters' judgement of the impracticability of burning the area. The granting of exemptions is largely limited to very low percentage selective cuttings.

Since broadcast burning is the more general practice in the Douglas Fir region for disposing of the slash, it

is to be expected that it should be given the greatest amount of study. It is for this reason that the discussion on slash disposal herein consists mainly of broadcast burning.

In broadcast burning, certain preparations should be made before burning is actually undertaken. Besides snag felling, which is required currently with logging in Oregon, debris should be cleaned from around trestles, bridges, machinery, equipment, and buildings. In addition, fire trails should be constructed where necessary to restrict slash burning to definite boundaries. Grades, streams, green timber, or an old burn also serve as good boundaries for the area to which the slash burning is to be restricted. Besides restricting the fire to the area, the boundaries serve as a definite line from which to set back fires.

If burning is to be done during the closed season, a permit must be obtained from the local fire warden in both Oregon and Washington. (7),(8) Weather forecasts should be watched, and everything should be in readiness to start burning when a general rain is expected. Burning should never be done in very dry weather, when a dry spell is expected, or in very windy weather.

The firing shouldbe done when the heat of the day has passed, and the wind has died down. However, firing may be done any time of the day when there is a rain. Control

may be had in effect during fire days when the humidity is rising, during which slash burning will run only for a short time. (13)

Sufficient equipment should be on hand to meet any emergencies that may arise should the burn get out of control. A sufficient number of men to carry out the burning in a pre-arranged plan are also necessary to secure both a good burn and a controlled fire. The burning plan should be so drawn up that it not only is properly understood but also achieves coordination. Each crew must have its duties and responsibilities clearly set forth.

The edges, ordinarily, are first fired so that the fire will run together towards the center. The existing wind and topography are very important items to be considered in firing the area. It is preferable to make the fire burn downhill by setting it on the up-hill side sometime before the down-hill side is fired. Also better control may be maintained by making the fire burn into the wind than with it at the start. A good rule is to set the leeward side first, then the flanks, and finally the windward side. (6) To promote the rapid setting of fire, which is preferable, a torch of some kind should be used. The Hauck torch is well adapted to the fast starting of fires, although a back pump filled with saw oil, coal or diesel oil, or distillate gives just as good results.

The area burned should be well patrolled if heavy rains don't immediately follow. Careful watch should be kept until a heavy rain has extinguished all smoulders and there is no further danger of fire springing up and spreading. Where spring burning has been done, it is necessary that every spark is put out. One small smoulder carried over into the fire weather period may cometo life and spread over a considerable area before control forces can be moved into action.

V- CONCLUSION

The foregoing fire prevention and protection techniques are set forth as generally applicable to the Douglas Fir region. Local conditions will of necessity require that certain phases of fire prevention and protection as herein outlined be departed from. Methods substituted to meet local conditions should be consistent, however, with a high standard. The neglect of certain phases of the prevention and protection system will tend to nullify the advantages to be gained from an otherwise effective system.

The full application of the preventive and protective measures found to be best applicable to local conditions are certain to bring results in the way of less fires. Fires that do develop will be found to be easier to bring under control with a resultant saving in both time and expense.

At best, no protective and preventive measures can be considered as absolutely effective. It will be found that in some instances limitations will be imposed upon an otherwise effective system that will have to be tolerated. In spite of this, effective measures may still be pursued that will aid materially in reducing the number of large and costly fires in woods operations. Adherence in all respects to well developed preventive and protective measures may have prevented the disastrous Tillamook fire of 1933.

However, with operators assuming responsibility for fires caused by their operations, they cannot be held for fires caused by the public. Fires caused by the public are increasing year by year, which demands that public authority, more than ever, must assume those responsibilities which public carelessness and indifference has placed upon it. (3) Under the present set-up, however, the logging operator is forced to shoulder part of the cost of fires caused by the public, and in some cases all of it. Such complications may be cleared up by the payment of the amount originally authorized in the Clarke-McNary Act, whereby public authority contributes to the timber states, in proportion to the state and private expenditures made for forest protection, the sum of $2,500,000. (3) Pro rata authorization has never been met, but smaller sums have

been granted. Public authority must assume responsibility for fires caused by the public. Logging operators do their share when they assume responsibility of fires in their operations and holdings.

	Each Locomotive	Speeder Patrol-man	Motor Logging Truck	Each Logging Side	Each Steam Donkey	Gas and Diesel Donkeys	Corner Haulback Block	Each Operation of 1 or more sides
Spark Arrester	1	—	1	—	1	1	—	—
Axes	3	1	1	3	—	—	—	—
Shovels	6	2	1	6	—	—	—	—
Hand water pumps	1	1	—	1	—	—	1	—
Bucking Saws	2	—	—	2	—	—	—	—
Mattocks or grub hoes	3	—	—	6	—	—	—	—
Water Buckets	2	—	—	—	—	—	—	—
Steam pump	1	—	—	—	1	—	—	—
Portable power pump	—	—	—	—	—	—	—	1
Hose (No. feet)	300	—	—	—	300	—	—	1000
Tank car or truck with pump, and adequate supply of hose	—	—	—	—	—	—	—	1
Chemical fire extinguisher	—	—	—	—	—	1	—	—
Track sprinkler	1	—	—	—	—	—	—	—
Fire danger indicating instruments	—	—	—	—	—	—	—	1

TABLE NO. 1

References cited:

1- Report of the Committee on Prevention of Forest Fires to Gov. Julius L. Meier and the Thirty-seventh Legislative Assembly, Nov. 14, 1933.

2- 28th Annual Report of the State Forester of the State of Oregon, 1939.

3- 28th Annual Report of the Washington Forest Fire Association, 1935.

4- "The Art and Science of Protecting Forest Lands from Fire", by George H. Schroeder.

5- Forest Practice Handbook, Pacific Northwest Loggers Association, 1937.

6- Prevention of Fire in Logging Operations, Chapt. VIII. Western Fire Fighters Manual.

7- Oregon Fire Laws, 1939.

8- Washington Fire Laws, 1934.

9- "Steam-Generating Apparatus in Forest Areas as Related to Causes of Forest Fires", by A. C. Conradt. MECHANICAL ENGINEERING 5, 1:599-604, Aug. 1929.

10- "Relative Humidity and Forest Fires", by L. F. Cronemiller. THE TIMBERMAN, 26:142, July, 1925.

11- "Forest Fires and Weather", by A. G. Simpson. THE WEST COAST LUMBERMAN, May 1, 1927.

12- "Slash Hazard Control in Coast Types Selection Cuttings", by L. F. Cronemiller. Western Forestry and Conservation Association Proceedings, Conference 1930.

13- "Putting Fire Weather to Work", by J. V. Hofman. THE TIMBERMAN, 25:65-66, May 1924.

14- 27th Annual Report of the Washington Forest Fire Association, 1934.