NOTES ON

FIRE CONTROL

METHODS AND EQUIPMENT

Issued November, 1936.

FORESTS DEPARTMENT, WESTERN AUSTRALIA.

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FOREST FIRES AND WEATHER CONDITIONS.

General.

Among foresters the term "Burning Weather" whether it be in connection with controlled burning operations or risk of bush fires, has a definite meaning. Briefly it refers to a condition of fuel and atmosphere which is favourable to the start and spread of forest fires.

While past records have broadly indicated the period of fire weather by giving the commencement and close of fire seasons, no definite information has been available regarding the degree of danger on particular days or reasons for fires burning more fiercely on any one day than on another. The number of outbreaks during a given period may give some indication, but as fires are almost solely the result of human agency this is not, by any means, a satisfactory measure of the degree of fire danger. The behaviour of fires must be considered in conjunction with the weather conditions before it becomes possible to express the degree of danger for any particular day.

It is common knowledge that heat will produce a fire if applied to fuel long enough, and that weather elements have various effects on fires. For example, fuels ignite better on a hot day than on a cold one, but a wet fuel will not burn even on the hottest day. Fire burns much more briskly under the influence of a wind, but considerably less so, if at all, under the influence of rain.

In order to obtain more detailed information regarding the phenomena relating to forest fires, a Fire Hazard Research Station was established at Dwellingup two seasons ago, with a subsidiary station at Duncan's, operating as from last year.

General notes on some Climatic Factors and their Measurement.

To arrive at a better understanding of the relationship between these elements and fires, measurements of the following have been taken regularly at the Research Station:

Barometric Pressure, Temperature (maximum and minimum), Relative Humidity, Evaporation, Rainfall, Wind (direction and velocity), moisture content of wood cylinders.

Temperature.

Temperature is measured by a thermometer, with which everyone is familiar, and it has been found that this is a fairly reliable indicator of maximum fire hazard conditions in hot, dry weather, although unsatisfactory at other times.

Relative Humidity.

Relative Humidity is a measure of the percentage of moisture in the air at any given time, and is obtained from readings of wet and dry bulb thermometers. Low values indicate an exceptionally dry atmosphere when the degree of fire danger becomes comparatively high. On very bad days figures as low as 13% have been recorded at the Dwellingup Station.

It may be generally stated that Relative Humidity approaches 100% during the night and falls to approximately 40% at 8 or 9 a.m. Further reduction in humidity conditions is governed by the type of day.

Rainfall.

The amount of rainfall is measured daily in a standard Rain Gauge. It has been found that rainless cool changes reduce the fire hazard to a certain extent, but further reductions depend almost entirely on the amount of measurable rain falling. An amount of 15 to 20 points of rain reduces the fire hazard to "Low" while it requires 30 to 40 points of steady rain to reduce the danger to nil in mid-summer, and this condition pertains for only one day unless further rain falls. Steady rain is much more beneficial than thunder-storms, the main reason being that it is a general fall accompanied by generally cool conditions and not a local fall associated with high temperatures.

Wind Force.

Wind force is measured by an instrument known as an Anemometer, and is recorded in miles per hour. It is not very great in the Jarrah forest and, during the summer months, rarely approaches a force of 8 miles per hour at a height of six feet above the ground.

Wind Velocity.

It may be generally considered that wind velocity is no direct measure of fire hazard, but may be an important indicator in comparing otherwise identical days and in this way may prove an important factor in bringing about alterations in fire hazard conditions. For instance, dangerous conditions may occur on a calm day, but if these conditions of temperature and relative humidity were associated with a fairly strong wind, the danger from a fire viewpoint would rapidly increase. Under these circumstances wind velocity may be considered the most important factor effecting an alteration from"dangerous" to "blow up" conditions.

Wind direction is of extreme importance.

The Forecasting of Fire Weather.

From a study of the daily readings of the various weather elements, and the daily weather map prepared by the Divisional Meteorologist it has been possible to forecast fairly accurately overnight or at early morning the degree of hazard to be expected throughout the following day.

Such hazard, together with additional information regarding the type of fire to be encountered under average conditions in the Jarrah forest is broadcasted from the National Broadcasting Station, 6WF, the first forecast being given within 5 minutes of the opening of the Station at 7 a.m. each morning.

The Scale of Fire Hazard.

From observations of meteorological data and moisture contents of fuels at Dwellingup, the following scale of fire hazard for the Jarrah bush has been decided upon.

Degree of Hazard	Class of Fire to be expected (based on Jarrah forest not burnt for two years).	Check Meteorological Data	
		Temperature does not exceed	Relative Humidity does not fall below
Nil	Ground fire will not run.		
Low	Ground fire spreads slowly in dry leaf litter.	80°	40%
Moderate	Ground fire spreads freely in leaf litter and low scrub is ignited.	85°	32%
Average Summer	All undergrowth burns freely and crowns of saplings may be ignited.	90°	25%
Severe Summer	Hot fires spread rapidly, burning crowns of saplings and frequently reaching into crowns of pole growth.	95°	20%
Dangerous Summer	Approaching "blow up" conditions when severe fires destroy whole canopy of the forest.	Over 90°	Under 20%

The establishment of absolute standards is not possible on account of the wide variations in forest conditions and the difficulty of measuring and correlating all the meteorological factors which influence the rate and spread of fire. The meteorological data included in the table are not a definite basis for measurement, but may provide a useful hour to hour check on the day's forecast.

Fire Hazard and Controlled Burning.

The dangers associated with controlled burning are too great to permit of its being carried out when the hazard reaches Average Summer in the above scale. On the other hand satisfactory burning of most country may not be effected when the hazard is Low, so that for best results in average Jarrah forest conditions for optimum burning exist when the hazard lies between Low and Moderate.

CAUSES AND CLASSES OF FIRES.

The following notes concerning the origin of forest fires in the South-West of this State are based on observations made and recorded by field officers of the Department over a period of many years. Although fires arising from lightning or other natural causes are not unknown in our South-West, they are so infrequent as to be a negligible factor in fire control work. This means that practically the whole of our fires are due to preventible causes arising from wilful or negligent acts of individuals or to errors of judgment by persons endeavouring to use fire for some purpose or other. Education of people living in or around the forest or travelling through it is, therefore, a matter of paramount importance in reducing the number of outbreaks to be dealt with each season, and forest officers should not lose sight of the importance of this aspect of fire control work.

Our records emphasise the importance and danger of fires arising from burning off operations by neighbouring settlers. This source of danger is ranked first in importance by all observers. Fires arising from locomotives or from hunters and persons travelling through the forest are ranked next in order of frequency, and, by most observers, in similar order of greatest damage.

It will be readily realised that the order of frequency of the causes of fire will vary from district to district. Some divisions, for example, are surrounded on all sides by settlers whose main concern lies in obtaining a satisfactory burn of scrub paddocks, regardless of adjacent forest land. Such conditions naturally increase the fire danger at certain periods of the year, and consequently require greater vigilence and efficiency of the fire detection and suppression staffs.

These difficulties are being overcome to a certain extent by co-operation in burning off operations, the installation of telephones to the houses of settlers, and a general improvement in public education regarding the development of a forest fire conscience. The experience in most centres has been that the average farmer is only too willing to co-operate with Departmental employees in this direction, for he has everything to gain and nothing to lose. It is felt that every possible effort should be made to earn the goodwill of our neighbours, and every confidence is held in the outcome of any overture that may be made.

The education of the travelling public regarding the danger and rapidity of spread of forest fires should be advanced at every opportunity, and an important move in this direction has been the daily broadcasting of fire weather forecasts together with short descriptions of the type of fire that may be expected under average forest conditions. At week-ends and on public holidays, when tourists and visitors make the greatest use of forests and forest roads, longer talks on the dangers and destruction associated with forest fires have been broadcasted.

THE HANDLING OF CONTROLLED FIRES.

(a) General.

Controlled burning is carried out in both spring and autumn, at which times suitable conditions for burning occur over limited periods. These periods vary with the seasons, and it is often found that satisfactory weather pertains for very short times. It is necessary for everybody to observe the effects of fire on all types of forest at different periods, so that the controlled burning may be carried out when conditions are most suitable.

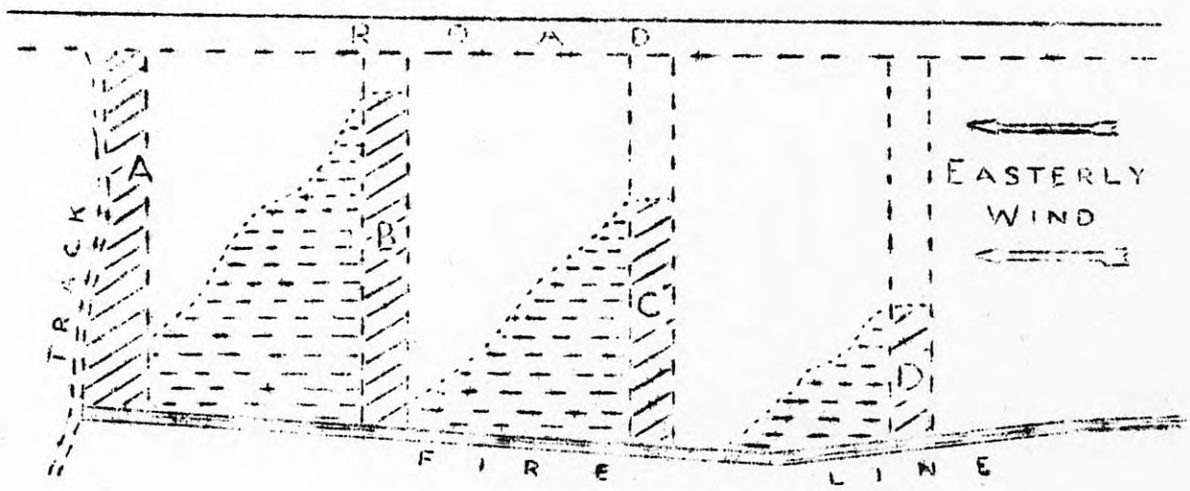
Where fires are lighted in very cool weather in Spring, it is usually found that they will not run but burn in patches only, scorching and killing the leaves of shrubs and blackboys, thereby increasing the hazard for the coming summer. When extreme conditions in the opposite direction are encountered, considerable damage is occasioned to regrowth and sapling growth, with a subsequent heavy leaf fall to render the breaks inflammable again in summer.

The optimum conditions, therefore, seem to be obtained on cool days after warm dry spells on which little or no breeze is blowing.

(b) The lighting of Fires.

Although conditions for controlled burning may be considered very satisfactory, attention must be given to the method of lighting fires in order that at all times the minimum length of face may require controlling. This result may be best obtained by burning in narrow strips, the lighting to proceed at right angles to the direction of the wind. That is, with an Easterly breeze the lighting of the strips will proceed from North to South or vice versa. By this method only two narrow edges of fire require attention, and not an extensive face as commonly occurs. It entails much more walking and lighting, however, but these are fully justified by the quality of the burn resulting and the ease of control.

Suppose, for example, that it is required to burn a break extending in an East-West direction and the prevailing wind is Easterly. A method frequently employed is to light the eastern and large portions of the Northern and Southern boundaries, necessitating control of a comparatively extensive face of fire in addition to providing a large and hot fire burning vigorously with the wind. A more satisfactory burn, however, is obtained by lighting narrow sections in approximately a North South direction commencing from the Western boundary. It is essential to ensure that the first strip along the Western boundary is lighted along a fire line or road and allowed to burn back for a chain or two before lighting up the second and successive strips, which should be at intervals of two or three chains, depending largely on the climatic conditions and the degree of inflammability of the ground cover and undergrowth. By this means all the burning is done with the wind, dangerous areas may be more satisfactorily burned in hot weather and only small strips of fire on the Northern and Southern boundaries require attention at the same time.



Diagrammatic Sketch of Strip Burning.

A. represents initial strip burnt along track.

B. represents first strip burning with wind to A.

C. represents Second strip, lighted a little later than B, burning with wind towards B.

D. represents Third strip, lighted a little later than C, burning with wind towards C.

Hachure indicates burnt country.

Distance between strips to be governed by weather conditions and inflammability of fuel.

Whether the strips are directly North and South will be governed largely by variations in wind direction and the location of the areas of most dangerous hazard.

Numerous examples on similar lines could well be quoted, but it is desired only to emphasise the necessity for sound thinking and reasoning before action is taken in these matters. Many of our so-called controlled fires become extremely difficult to handle when started on wrong lines and in unsatisfactory weather. It must be remembered that satisfactory burning is not associated with luck or good fortune but is the result of good management.

The main causes of controlled fires becoming difficult to handle rest on the lighting of too long a section at a time or attempting to burn too much in the short period when suitable weather pertains. Under no circumstances should more fire be lighted at any time than can be easily kept under control, should the wind change at unexpected moments. The tendency with most men is to light large areas when conditions are good, regardless of the difficulties ahead should these conditions suddenly alter. On the other hand it is often found that controlled burning is delayed unduly, awaiting satisfactory weather conditions, until such time is reached that unnecessary risks are taken in order to complete the burning before the commencement of the fire season.

Where large areas have been lit it is often impracticable to make the fires safe before 5 p.m. each day, so that on some occasions fires are left unattended. These fires do not present any danger at the time they are left, but variations in wind direction and velocity may render them highly dangerous under certain circumstances.

A thorough knowledge of the hazards in the surrounding country is essential to successful controlled burning; so that officers should make themselves well acquainted with those before any burning operations are commenced.

(c) Torches and Firelighting Apparatus.

(i) Simple Torches:

Several types of torch have been prepared and brought into general practice, some with greater success than others. The standard type now being supplied is the Pipe Torch, which consists essentially of a piece of 1" cycle frame tubing 4'6" long with the lower end so curved that it is approximately at right angles to the main shaft or handle. The wick container or horizontal portion is detachable, permitting the threading of a cotton stranded wick. The hollow vertical tube serves as a reservoir for kerosene and is provided with a threaded plug or stopper at the upper end.

Satisfactory service has resulted generally from the use of this type, although workmen should be warned against using them as "props" or "leaning sticks" if leaky joints are to be avoided.

(ii) Pressure Torches

The simplest type consists of an ordinary painters' blow lamp mounted on a long wooden handle and may be used where greater initial heat is required to start a controlled burn than is obtainable with an ordinary torch. It is used most commonly in top disposal work.

As with a primus stove best results are obtained by using methylated spirits for heating the generator in the first instance - pumping and lighting in the usual manner. Kerosene may be used for the initial heating but requires a longer period.

The number of cases where this instrument has special value beyond the pipe torch is few and far between, and its use is subject to special approval by the Divisional Forest Officer.

The Hauck Type Kerosene Pressure Torch.

This torch throws a good hot flame approximately 15" - 18" in length, and is valuable for starting a continuous line of fire under special circumstances. It is of great value in burning grass and low scrub under poor burning conditions when a good hot fire is required at the outset, and for burning rushes, etc., around culverts and bridges when slashing is a difficult and costly operation.

Its principal disadvantages lie in the frequency with which the projector or generator becomes carboned or choked up and the amount of kerosene required.

The torch consists primarily of a metal tank with the necessary fittings to enable it to be carried on the back, knapsack fashion. To this tank are fitted a pump for maintaining pressure in the tank, a pressure gauge, and a filler cap which is also designed to form a pressure release. A length of rubber hose connects the flame projector to the tank. A stop valve is fitted at the tank end of the hose and another at the projector end. The projector end is so designed that the kerosene before finally leaving the jet, passes through a coil of copper tubing surrounding the flame and is highly vaporised. The filter is built into the projector, and all sediment is thus prevented from reaching the jet. A conveniently placed handle is attached to the projector for carrying and directing purposes.

To operate the torch turn off the two stop cock valves and fill the tank from two thirds, to three quarters full of kerosene and screw filler cap down tightly. Hand pressure is sufficient, as, if a wrench is used the rubber washer under the cap is quickly ruined. A wrench may be required on old models - and when the rubber washer becomes slightly perished.

Pressure of approximately 40 lbs. may then be put into the tank.

Open the valve at the tank end of the hose.

Slightly open the valve on the projector and run about ¼" of kerosene into the little tray under the burner and then turn off. Place a small piece of bag, rag, binder twine, bark, leaves, or other material in the tray to act as a wick and light. Allow to burn for four or five minutes - probably longer depending on the age and conditions of the burner - when the coil should be thoroughly heated, and then open the valve on the projector about one eighth of an inch. Should kerosene run through, the coil is not yet hot enough to vaporise the kerosene. Allow the coil to heat until, when the valve is opened on the projector, the kerosene vapour spurts out in the form of a bluish flame about 15 inches long. The torch is then ready for use.

It should only be necessary to open the valve on the projector end very slightly to obtain the maximum intensity of flame, not more than one eighth of an inch movement of the wheel forming the handle of the valve, usually being found all that is required. To open further than this is merely to waste kerosene and, if the torch will not burn properly unless a much wider opening is given, there is bound to be an obstruction in some part of the projector which should be cleaned out.

It has generally been found that 2 gallons of kerosene will last approximately 3 hours.

The pressure in the tank should not be allowed to fall below 20 lbs. per square inch. This, of course, may easily be checked from time to time by the gauge on the tap of the tank. Some types of gauge have a stop which should be released before the true pressure in the tank may be read. It is not advisable to pump above a 40 lb. pressure.

Care should be taken when operating the torch to see that it is not directed into a strong wind.

To shut off the flame, tightly close the valve on the projector. If the torch is to be put away for a lengthy period, the kerosene should be emptied out of the tank and the hose thoroughly drained.

Practically every failure of this torch to function properly can be traced to the projector.

The two most vulnerable points are the jet and the gauze strainer.

If the flame burns fitfully, either the jet is obstructed or the pressure in the tank is low. A small wire pricker is supplied for removing loose obstructions from the jet, and should always be carried when using the torch (unfortunately this is seldom so and consequently difficulty is experienced in keeping the jet clean). The remedy for the latter is obvious.

FIRE FIGHTING PRACTICE

(a) General.

Although methods of fire fighting that have given satisfactory results under various conditions may well be brought into general use, it should be realised at the outset that variations in the type of fire encountered, governed by forest and vegetative types and climatic conditions, will necessitate some modification of any general principles outlined.

On forest within areas brought under fire control the suppression of outbreaks is the principal responsibility of all employees during the summer months, and it is essential that all hands shall receive adequate instruction in fire control methods before the fire season commences.

Where country is burnt at frequent intervals, the fires to be contended with are usually "surface fires", burning through undergrowth and surface litter. Depending largely on weather conditions and, to a certain extent, on undergrowth types, these fires vary in their intensity, the damage done by them and the ease of their suppression.

The nature of a fire.

On a calm day when there is no wind, a small circular fire will be observed burning slowly away from the starting point with equal intensity in all directions.

With a wind blowing, a fire rapidly assumes a long oval shape, and the fire has three distinct parts -

(a) Head Fire - this is the hottest portion, it travels the fastest and must be controlled first.

(b) The Side Fires - On either side of the rapidly spreading head fire are slowly spreading side fires. These become of great importance if the wind changes, when one will become the head fire. These must be left until the head fire is under control.

(c) The Tail Fire - This is burning against the wind and is, therefore, not strong. It must not be neglected, but should be put out last.

On days of bad fire weather and in broken country carrying heavy leaf litter and dense scrub, the head fire may develop a lengthy face and extend in several tongues or narrow strips which burn vigorously. With a choppy wind these tongues commonly unite to form a more extensive face of very hot and vigorous fire.

Principles of Attack.

No time must be lost in travelling to a fire. The important thing is to stop a fire before it gains headway. To do this fire fighters should tackle the head fire first and then work sufficiently far round to either side to prevent the danger of wing fires developing into new head fires.

Preliminary reconnaissance is of the first importance, and makes for well-directed effort. The lie of the country, the condition of the bush, and the strength and direction of the wind should all be studied, and the best method of tackling a fire rapidly decided before actually commencing operations. Badly directed effort, however strenuous, gets nowhere and knocks up fire fighters for little or no result.

It is necessary here to stress the importance of an early reconnaissance and accurate detection of the spread and extent of the fire, rapidity and direction of burning, local hazards, etc. The determination of the best methods of attack, the gauging of effect of wind, variation in direction and velocity etc. are of great importance.

It must be realised that no two fires may be treated in exactly the same manner, so that a study of the local factors affecting the fire should determine the method of attack.

One man at a fire may do useful work early in the season or in country burnt within the last 2 years, but under other circumstances his work may be of little value. When working alone it is usual for a man to wait until late afternoon and then to light along a road or track so far in advance that he is liable to burn much more of the country-side than did the original fire. This refers to fires in protected country. In burning back to keep a fire in waste marginal forest from encroaching onto good quality forest one or two men may frequently do very valuable work in this manner.

Extinguishing a fire.

A fire which has been merely "beaten out" is not extinguished. It is only "stopped". If a fire is stopped by direct beating, care must be taken to sweep or rake in the ends to leave a strip 18" to 24" wide along the boundary of the burnt country. Just as some men are "Accident prone", so will it be found that some have their fires start up repeatedly after having been considered safe; in fact only a small percentage of men engaged in fire fighting effectively put the fire out until they have been given detailed instruction in this work. Innumerable explanations are offered to account for the recurrence of fires, but successful suppression depends largely on the care and attention devoted to the raking and cleaning up after the fire is considered "safe".

Sources of Danger.

Near the edges of burnt country the following require special attention:-

(a) Burning Trees. The country adjacent these should be well burnt for a sufficient distance to ensure that sparks or pieces of burning bark will not be blown onto unburnt country. Where the tree is well alight and burning vigorously at some distance from the ground it should be felled as soon as possible before it may be considered safe. It is cheaper and more satisfactory to fell a tree than to have a man patrolling the fire for one or two days. It must be remembered that burning trees are often very difficult to detect and that the report of a workman regarding the safety of a fire should not be accepted until it is known by experience that his opinion is reliable, despite the fact that he may be proved a good man in all other directions.

(b) Burning stumps. These are a common source of further trouble which require to be burnt around and sometimes covered with soil.

(c) Burning logs. These should also be burnt around, cut off, and rolled into the burnt country or covered with soil.

(d) Burning debris. Heaps of sleeper chips, bark, blackboys, thick litter, etc. all require burning around before they may be considered safe.

Patrol of Fire.

Fire or smouldering embers in such places unnoticed in the haste of attack on the main fire can be made safe only by the patrol. Patrol of the extinguished fire by one or two men should be maintained until no reasonable doubt remains, the actual period during which a patrol will be necessary depending on local climatic conditions and the inflammability of the adjacent country. No burning or smouldering logs should be left near the edge of the fire, no burning trees likely to fall outside the burnt country should be left standing or unattended, nor should any other potential source of fire be considered safe until actually out or burnt around.

Whether a patrol is required on the following day will depend on how well the early patrol has been maintained and the number of danger points remaining after the fire has been stopped. Under ordinary circumstances there should be little for the patrol to do on the second day.

The breaking out of a fire which has been stopped is merely evidence of lack of care and sufficient attention to detail in the first instance. Various and repeated excuses have been advanced in explanation of certain fires getting away again after having been put out, but the essential point to remember is that such things should not happen, if each man is trained to do his work thoroughly.

(b) Use of Water in Fire Suppression under Jarrah Forest Conditions.

Fire Truck Equipment.

(i) The following list of equipment has been satisfactorily packed and used on the Standard Fire Trucks - 15 cwt. well sided utilities - brought into use, and should be adhered to whenever possible, although certain modifications may be made to meet local circumstances:-

(a) Semi Rotary Pump - To take 1" inlet and outlet hoses, fitted with a fixed elbow at the intake to minimise damage to the hose. It is fixed on the nearside ledge close to the canopy, the inlet pipe passing through a hole in the ledge 9" from the canopy and 3" from the inside of the truck. Two methods of supporting the pump have been used -

(i) Iron brackets bolted to the ledge itself;

(ii) Two pieces of Jarrah 8" x 3" x 2" bolted vertically to the outside of the main body of the truck to which the pump is bolted.

(b) Hoses - (i) Intake Hose. 40 ft. of 1" hose in sections of 15 ft. and 25 ft. - the extension to be fitted with an iron connecting rod.

(ii) Outlet Hose. 10 ft. of 1" hose.

(iii) Siphoning Hose. 10 ft. of 1" hose for siphoning water from tanks to packsprays if necessary.

(c) Water Strainer - A Gnangara type water strainer for use on the intake hose.

(d) Water Tanks - Two tanks of 22 gauge galvanised iron, size 2' x 1½' x 1¾' to hold approximately 33 gallons each. These are fitted with collapsible handles and screw top and are carried adjacent to the canopy in the body of the truck. Owing to variations in the width of truck bodies there is sometimes a space of 1" between these tanks. A softwood chock approximately 18" long and of the required width should be inserted between the tanks to prevent any unnecessary movement.

(e) Water Drums - Four 4 gallon drums fitted with suitable handles and screw tops are carried in a framework to prevent movement immediately behind the flat tanks. The wooden framework (f & f1) is fitted with iron pegs for attachment to the floor and allowing for rapid removal.

(g) Knapsacks - Four standard type knapsacks fitted with double action hand pumps and standard adjustable nozzles. Two of these are carried on the floor of the truck immediately behind the drums, and the remainder on the ledges, well forward adjacent the flat tanks.

(h) Rakes - Three Standard Yankee Pattern fire rakes with fixed handles are carried under the near side ledge, and held in place by a hinged pin (i) which passes through holes in 1/2" soft iron attached to the ledge.

(j) Axes - Two good axes are carried in spring steel clips on the near-side vertical ledge.

(k) Shovel - One short handle shovel is carried in a spring clip fitted to the off-side vertical ledge.

(l) Water Bags - Four, fitted with soft iron handles and snap catches to attach to eyebolts through the ledges. They are carried underneath the ledge and outside the body of the truck, one on either side at the forward end and two side by side at the rear on the near side. Framework of ½" round soft iron is provided to stop unnecessary side-swinging of the water bags.

(m) Crib Box - A galvanised iron box with a felt lined lid is attached under the offside ledge at the rear. It is 20" x 11" x 11" in size, and the lid is hinged at the top and fitted with staple and padlock.

(n) Spare parts box - A spare parts box is fitted on the front offside between the ledge and the mudguard. Its largest dimensions are 12" x 12" x 6", and is shaped at the rear end to conform with the shape of the mudguard (see sketch). It is fitted with a staple and padlock.

The spare parts for knapsacks, etc. to be carried are:-

2 cone nozzles
1 standard adjustable nozzle
6 hose clips
6 washers of each size
3 hose connectors
1 screw driver
1 6" Crescent wrench
1 handle for semi-rotary pump.

First-aid Outfit - To be fully stocked and kept under the driver's seat.

Field Telephone - A small leather cased field telephone is carried on a hinged tray fitted to the dashboard of the truck immediately in front of the passenger. Aerial hock and earth pin should be carried on the floor of the truck beneath the passenger's legs.

Fire Lighters - 1 Pipe Torch and small tin of kerosene for lighting back fires, carried on floor of truck.

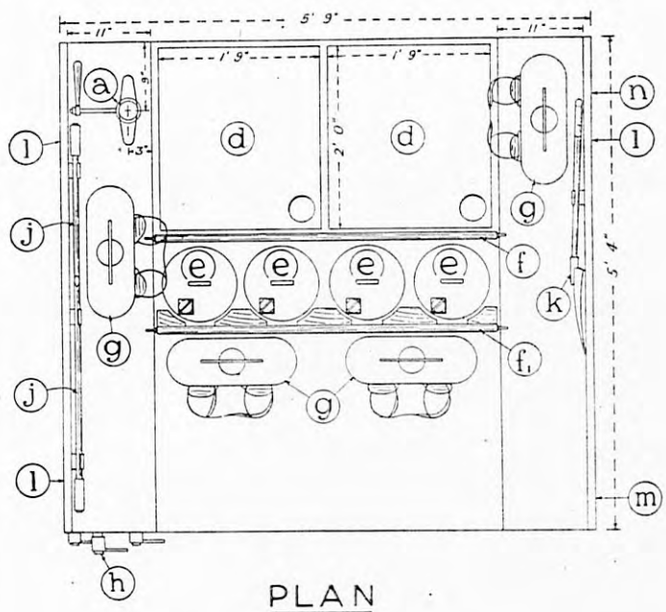
District Plan - A plan of the area drawn to scale of 80 chains to an inch showing compartments, breaks, roads, lookout towers, water supplies, telephone lines and all essential information, is folded and attached to cardboard covers for ease in carrying.

Compass - A prismatic compass is regarded as desirable equipment in certain districts only.

Crosscut Saw - Carried in special frame fitted to lower side of outside ledge of truck.

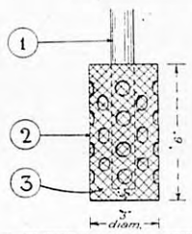
Book of Fire Report forms, F.D. No. 260.

FIRE TRUCK EQUIPMENT



PLAN

BACK ELEVATION



GNANGARA TYPE
WATER STRAINER

Attention to Water Supply and equipment.

The tanks on the fire truck are kept full so that no time is lost when a fire is reported. Their refilling at creeks, wells, etc. is usually carried out by means of the semi-rotary pump mounted on the side of the truck. The long intake hose - to which a sieve is attached - is dropped down the well and water pumped up in the usual manner, approximately 12 minutes being required to lift 70 gallons with the 1" pump. This pump may also be used for refilling knapsacks, small drums, etc.

In loading the knapsacks on to the truck, it is essential to see that as little movement as possible may occur for all types are subject to damage from bumping and denting on bad roads. The outlet pipes in particular are often damaged.

The water supply at the scene of the fire under Jarrah forest conditions is usually limited to whatever supplies can be economically transported to the scene of the fire in small tanks. The playing of a stream of water onto the flames from the fire truck, utilising a long hose,has not been very successful under conditions pertaining in the South West, and while further investigations into such methods are being continued, the use of knapsack tanks and suitable spraying equipment has been developed.

Standard Type Knapsack Spray.

Many types of knapsacks have been tried out under field conditions for several years, and it is now possible to standardise the type commissioned for general use. This type embraces several modifications resulting from detailed investigations of all types, so that it represents the most desirable knapsack available for fire fighting purposes.

The standard knapsack consists essentially of a squat compact galvanised iron tank, approximately the width of the shoulders of the average man, and 15" high, and built to hold 4¼ gallons of water. It is equipped with a well-fitting water tight lid, easily removable for refilling, and a ridged outlet pipe to prevent the easy disconnection of the hose. A strainer is provided at the inlet and clips for the spray and a handle for carrying the outfit are also provided. The trappings consist of broad leather straps which pass from near the top of the tank, over the shoulders of the operator, to fasten by spring clips to catches near the bottom of the tank. These straps are sufficiently long and adjustable to permit of crossing over the operator's chest, a position much favoured by most men, and one which allows considerable freedom to the shoulders. A generous back pad is provided to render the outfit as comfortable as possible to the user, together with a girth band to hold the tank close to his back.

Operation of the Spray Pump.

The standard type of spray pump is a double action pump without a stuffing box, which throws a strong stream of large and fine drops to a distance of 25 ft. with an effective fighting range of 12-18 ft., i.e. with the type of nozzle in general use. It is attached to the ridged outlet pipe of the tank by means of a short length of ½" rubber hose.

With the operator standing at a distance of approximately 15 feet, a stream of water should be directed on to the face of the fire by a steady pumping action in which both left and right hands are brought into use. The left or foremost hand should remain as steady as possible and act more as a director of the stream, while the pressure is maintained with the right hand. It is found that much movement of the left hand results in waste of water and inefficiency of the water stream to suppress the flames.

The maximum effect of water on the flames is obtained when operating side-on to the face of the fire.

A little attention from time to time to the leather washers on the plunger and the ball valve governing the double action of the pump ensures maximum efficiency of the spray.

A reduction in pressure or effective fighting range of the spray stream is usually attributable to worn or damaged washers, while the conversion from double action to single action spraying is invariably associated with a blocking of the ball valve. This should be inspected from time to time regardless of the apparent efficiency of the spray.

The loss of water along the shaft of the plunger is due to faulty packing and is easily remedied.

Spray Nozzles.

A common type is cone-shaped and possesses a single aperture. It uses water at twice the rate of the Bordeaux Cyclone type and so should be used only at a very hot fire when the head is difficult to suppress. Once the head fire is more or less under control, this nozzle should be replaced by the cyclone type for more efficient working.

The most useful type for fire fighting purposes has two apertures which throw (1) a comparatively straight stream from a small aperture; and (2) a more spreading and broken stream from what is called the "Reverse" position. This produces an effective fighting stream of 12-15 feet which is considered satisfactory under many circumstances. For very small fires, however, it has been found that the spray from the "direct" jet, half on, gives good results, throwing a wide fine spray which puts out small flames and at the same time dampens the ground for about 18 inches on both sides of the fire.

Some nozzles after little use become either very loose or very tight, and should be adjusted and greased to ensure their working efficiently at all times.

Care of Sprays and Equipment.

Throughout the fire season it is essential that all parts of fire fighting equipment be constantly inspected and kept in good working order.

At the close of the season it is necessary to drain the knapsacks, stack them in inverted positions, oil the leather trappings and grease all the leather washers in the pumps.

The larger tanks and hoses should be drained of water and inverted when not in use.

The semi-rotary pump should be emptied of water and a thin coating of grease spread over the valves and other parts.

(ii) Organisation of Fire Gang.

A small gang consisting of an overseer in charge and 3 or 4 active men has been found sufficient to cope with most fires occurring in the Jarrah forest, provided they have been quickly and accurately located. Where fires have been burning for some time and have developed a large face it has been found necessary to augment the number.

Upon receipt of instructions to proceed to a fire the gang and equipment should be ready to move off immediately. In anticipation of such instructions the water tanks, knapsacks and water bags should be kept full,and all equipment carefully checked and held ready in position on the truck.

The truck should be driven as close as possible to the edge of the fire commensurate with adequate safety in order to reduce the carrying of water to a minimum, and to do this it may often be necessary to partially open up old tracks etc. by removing logs and debris.

Where adequate water supplies are available and the danger from "flashbacks" is small, three or even four men may use knapsacks on the face of the fire to bring it under control as quickly as possible. Under other circumstances only 2 men may direct the water attack on the fire, the others raking in the ends or providing a constant supply of water to the head of the attack. Such variations in the division of labour will be governed by the type of fire, the country in which it is burning, climatic conditions, etc.; decisions in such directions to be made by the officer in charge.

The treatment of "flashbacks" may be either by spraying or raking by a patrol man following upon the sprayers attacking the face of the fire. The degree to which this work is carried out will be governed solely by the type of fire and the conditions under which it is burning.

In all cases, however, it is desirable, as far as practicable, to leave the overseer free of any specified duty in order that he may co-ordinate the work of others, pay strict attention to all phases of the work to ensure their satisfactory execution, assist in any instance where a member of the gang is hard pressed and be on the alert for burning trees and other danger points overlooked in the haste of the initial attack.

(iii) Method of Fire Fighting.

The fire should be tackled in the usual method of head fire first then side fires and tail fire.

Where an adequate water supply is not available or where a fire is burning in dense undergrowth containing many twigs and branchwood, best results may be obtained by subdividing a gang of 4 men into 2 sprayers, 1 raker and 1 water carrier; the water carrier to do as much raking as practicable. Larger gangs may be similarly divided but only at very light fires is it desirable to allow sprayers to work singly. Best results are obtained on the average fires by the sprayers working in pairs on the head fire at the outset, and then working singly on the side and tail fires. Where the head fire is burning very strongly and proves difficult to control,a battery of three or more sprays may be effectively used for a short period. At large fires the No. 1 sprayer should be equipped with a "cone" nozzle to obtain the maximum effect of "dousing" the fire, the No.2 sprayer using the standard adjustable nozzle, either in the reversed or straight jet position. These men should practically kill the fire or at least deaden it sufficiently for the raker to push in the ends with comparative ease. It is essential, as stressed in the section dealing with methods of beating and raking without the use of water, that a clean strip 18" in width be raked around the boundary of the fire before it may be considered safe. In these cases, it may be considered that the rake remains the mainstay of the suppression unit.

An adequate patrol of the extinguished face should be constantly maintained to ensure that the fire does not start up again or blow across the raked break. On bad days with a strong wind, and particularly where a long face of fire is to be extinguished, it may be necessary to augment the personnel of the fire gang with additional men to serve as patrolmen and water carriers. Fresh fires started from sparks, burning bark, etc thrown from burning trees are of the utmost importance, and must be constantly guarded against.

Trees which are alight up to 30' from the ground may often be satisfactorily extinguished with the knapsacks, while those at a greater height may be dealt with by means of a ladder or larger and more powerful pump. The desirability of including these in the standard equipment is being investigated.

It is essential to remember that every man cannot use a packspray effectively, so that these men should be selected and trained at every opportunity, and when tackling a fire they should assume the positions of No. 1 and No. 2 men and remain there. Unless a number of good sprayers are available, they should not be allowed to return for refilling their knapsacks, but a supply of water maintained ready for their use.

Method of using a packspray.

The actual method of applying the water to the face of the fire is of greatest importance, and represents the most common error made by all beginners. The operators should stand at least 12' to 15' from the fire and direct the stream on to the outer edge of the flames, using a steady pumping action, maintaining the left arm as stationary as possible in order to direct the water in a constant stream. With greater experience,

movement of the left or foremost hand is not such an important feature as the operator may then direct the stream at will. Inexperienced and sometimes experienced men direct the stream at right angles to the flames instead of moving to the side-on position as soon as a break has been made in the head fire. Best results are obtained by moving along the edge of the fire with the feet in the embers of the fire suppressed, directing the water at least 12' ahead, at which distance the stream breaks up, and is most effective in killing the fire. By walking along the edge of the fire the sprayer ensures that the fire is sufficiently dead for the raker to push or rake in the ends, without approaching too closely to any flames.

Another common fault, where sprayers are working in pairs, lies in the No. 1 man travelling too fast for the next man in the gang to keep up, so that the fire he has temporarily "knocked down" is burning vigorously again before the next sprayer has an opportunity of killing it completely. The work of the first sprayer is thus rendered practically valueless. This is of great importance on bad days when the fire starts up again very readily, so that in these circumstances only a few feet should separate the two sprayers.

Conditions affecting methods of fire fighting.

Less training is required for the rakers than for the sprayers, but they should be careful and conscientious in their work and see that they do not lag too far behind the sprayers or otherwise the flames will be too hot to permit of their raking to the greatest advantage. They should be trained or coached in this work so that they may have a complete understanding of conditions permitting of a light raking in the first instance and of conditions requiring a complete initial raking. Where adequate water supplies are available and used on a light fire, raking may be reduced to a minimum, and they should learn to appreciate the fact that while leaf litter extinguished by water may not require raking, twigs and light branchwood, carrying smouldering bark, should be carefully raked in. In these cases it may be considered that anything giving rise to the slightest smoke should be carefully raked. On light fires where water is not readily obtainable, the sprayer should not dampen small flames burning slowly in leaf litter but should conserve the water and allow the raker to make it safe unaided. An appreciation of these and innumerable other small points will readily follow experience and guidance by observant officers.

Little or no training is required for the water carriers, and those men less suited to other jobs should be placed at this work. It is their duty to maintain an adequate supply of water to the sprayers at the head of the attack, in addition to caring for the supply of drinking water to all members of the gang. At most fires it should not be necessary to carry water any great distance, in which case men employed in this manner may render valuable assistance to the rakers.

Where a very large fire is encountered it may be necessary to backfire against the head and suppress the side and tail fires by means of packsprays. Only under exceptional circumstances, however, should this method be adopted, and where such is necessary strict attention should be given to the difficulties and dangers associated with it, as emphasised in the section dealing with the suppression of fires where water and packsprays are not available.

It has seldom been found necessary with a trained fire fighting unit, but, as indicated elsewhere, suppression under all conditions has not been investigated so that it may be necessary to modify the technique to meet other requirements.

Maintenance of Water Supply.

The suppression of fires by these methods, stipulates a satisfactory water supply at the head of the attack, and to do this water carrying often becomes essential. Under ordinary circumstances, at the average fire, a pack spray of water should account for three to four chains of face. Several methods of keeping water up to the fire have been used successfully where adequate roads have not been available:-

(a) Where plenty of knapsacks have been available the water has been carried in them, the foremost men sending the empties back for refilling.

(b) Where all the knapsacks have been employed at the fire, and where water carrying to 20-30 chains has been required, five-gallon drums have been successfully used. These were filled at the truck and carried two at a time to the sprayers and deposited slightly in advance of them or emptied into the knapsacks as required. One carrier could maintain the supply to 2 sprayers up to a distance of 20 chains after which it became necessary to increase the number of carriers. It was found, however, in difficult country that these drums were a little heavy, and possessed unsatisfactory handles and lids.

(c) A more suitable container has been found in a 4-gallon drum provided with a solid top, a good handle, and a screw top lid.

Where satisfactory roads and tracks exist it often becomes practicable to shift the trucks from time to time in order to bring the source of supply nearer the main attack.

It is essential to remember that the water attack must be maintained and supplies got to the sprayers under all circumstances if the suppression is to be successful. Progress must not be made too rapidly, however, and the fire should be definitely stopped before proceeding too far along its face.

Points to note.

The following points are of importance where packsprays are used in fire suppression:-

1. Every man is not capable of being a first class sprayer. Select the best men, train them for the job and endeavour to keep them at the head of the attack. All men in the district should, however, be well versed in the use of packsprays.

2. Keep the water supply up to the head of the attack.

3. The sprayer should stand back 12-15 feet from the flames.

4. The head fire should be attacked directly in the first instance, changing to tangentially or side-on, as quickly as possible for maximum benefit from the water.

5. Conservation of water is of great importance. See that no water is sprayed on to dense coppice growth, tops of fallen trees, etc., when burning fiercely, but wait until the fire has burned through them.

6. Don't let the sprayers work too far apart or too far ahead of the rakers. On bad days, the fire will start up again very quickly, and a lot of good work will be rendered valueless.

7. Water supplies to the sprayers should be maintained from the outset. Don't wait until the spray is empty before arranging for a refill, or the first work will be of no avail.

8. The fire should be definitely stopped before proceeding far. Hasten slowly to ensure that the fire does not start up again.

9. Work quickly for the maximum results.

10. Maintain an adequate patrol of the extinguished face, paying particular attention to burning trees, logs, stumps, etc.

11. A packspray should be retained for use by the patrolmen, especially where one or two trees are alight at considerable distances from the ground. One man with a packspray may do more effective work than 5 or 6 men with rakes when putting out small fires started from sparks, etc. blown from burning trees.

Patrol of Fire.

After the fire has been brought under control and the flames checked on all sides, it may only be rendered completely safe by the provision of adequate patrol. The edges of the extinguished fire should be carefully raked, smouldering twigs, embers, logs, stumps, etc. thrown in and made safe, as set out in the general notes on Fire Fighting Practice.

Should it be necessary to leave patrolmen at the scene of the fire after the main gang have left, a supply of water and a knapsack spray should be included in the equipment left for their use.

(c) The Suppression of fires at which water and Packsprays are not available.

(i) Suppression by Direct Beating.

In some cases the head fire is burning too strongly and vigorously to be tackled at the outset, and the best results are obtained by beating out the flank fires and working gradually along the face until the head is reached. It will then be found that the degree of the heat from the fire is considerably reduced, and will permit of more easy approach and rapid extinction. But wherever possible the head fire should be brought under control as quickly as possible.

The actual operation of attack by direct beating needs little elucidation, although the type of beater in common use varies from place to place, and is governed primarily by the material available and the type of fire encountered. The most important types include leather beaters, either solid or in strips, attached to wooden handles, canvas or bag beaters similarly designed, or bushes of suitable size and formation. In forest country bushes are commonly used as beaters; and those selected should possess a compact and dense head and a short handle, 3' - 4' in length. A common mistake is made in the selection of a large unwieldy bush with a long handle and open head which may allow the operator to stand further away from the flames, but reduces his efficiency so greatly as to render his work practically valueless. A smaller, striffer branch which may be used more quickly and vigorously is far superior.

In beating a fire it is essential to stand over the flames and to use considerable weight in bringing the beater into contact with the edge of the fire. It is the actual blow or force imparted by the beater on the burning material which puts out the flames, making it easier to rake in or sweep in the burning and smouldering embers.

Where a fire is burning slowly in open country, carrying much grass and low scrub so that the flames are only a few inches from the ground, good progress may be made along the face of the fire by using an inwards sweeping motion. A man working by himself may do useful work under these circumstances because the fire is not hot, and he may stand over the flames for lengthy periods. Even at hot fires one man may extinguish considerable faces of fire if opportunities are taken of permitting the fire to burn through dense patches or clumps of regrowth and beating it out in the open areas.

Should the fire be burning more fiercely and yet be not too hot for actual beating, it is desirable that gangs of two or more men be employed. In this case two men - or more if available - should do the actual beating and others sweep in the burning ends, using a dense and compact bush. Where further men are available more rapid progress may be made by detailing one or two for patrol work - thus allowing the experienced beaters to cover greater distances.

It is essential at all fires to leave a carefully swept path 15" to 18" wide along the whole face of fire extinguished. This path should be quite free of leaves or twigs so that the fire may not cross it. In many cases it will be found that it becomes well worn by patrol men walking backwards and forwards and all workers going to and from the head of the fire.

At this point it might be stressed again that, with all methods of attack, best results are obtained by selecting the correct method of attack. It is obviously futile to attempt beating out a fire in blackboy tops, or dense coppice or sapling growth. These moments should be chosen for resting the members of the gang, who will then be able to attack with renewed vigour the smaller and slower burning fires in the low ground scrub.

Where rakes are available, the members of the gang employed on rendering the edges of the fire safe after the flames have been beaten should be equipped with them, when they will work more efficiently than with a bush or a beater. They should push the edge of the fire - already beaten out - and the numerous twigs, leaves, etc. into the burnt country and not pull them outwards to the unburnt country. The general experience is that the path around a fire may be cleared more quickly and effectively with a rake.

Rakes may also be used effectively in cases where only one or two men are available, although only after beating. Only under exceptional circumstances, when the fire is a very light one, should they be used alone.

(ii) Suppression by Counter Firing.

Fires which have gained too great a headway to be suppressed by beating, or which are too hot to permit of beating for more than a few minutes at a time, may have to be attacked by means of a back fire lighted along a cleared track or path. This method should only be used to meet an emergency as there is always a serious risk of the back-fires becoming more difficult to handle than the actual outbreak. In addition to increasing the area of country burnt, the adoption of such practice requires considerable experience in fire fighting, appreciation of fire hazards, and an intimate knowledge of the surrounding country.

Preparation made for backfire.

If sufficient men are available a raked track should be prepared from which to commence a back fire, but if not, it will be necessary, particularly at night, to fall back on nearby fire lines, tracks, roads, scraper tracks, or any suitable cleared line.

Depending on the severity of the fire and the rate at which it is travelling, the distance from the flames at which the break will be prepared may vary from 1 to 10 or 15 chains to be decided by the officer in charge; when a study of local conditions involving weather conditions (temperature, wind direction and velocity, etc.) topography, condition of the undergrowth, value of the stand endangered, etc. will govern decisions made on the ground. Only at big fires on bad days will it be necessary to keep more than a chain or two away from the flames, if enough men are available, for care must be taken to avoid making a big fire out of a small one by burning too much country in advance of the fire.

Care should be taken to rake around trees near the edge of the raked strip, so that the backfire will not run up the bark to be thrown over the break into the unburnt country. With particularly dangerous trees it is advisable to light the piles of leaves and debris raked from around their bases before the backfire is started to reduce to a minimum the danger of their catching alight.

Having decided the route to be taken it will be necessary to start the men raking at, say, one to two chain intervals in order that they may hinder one another as little as possible. One good pull or sweep with the rake is all that is required to clear a strip approximately 2 ft. wide - such strips having been found satisfactory in most cases. The lighting of the backfire should proceed fairly close behind the rakers, not in one long line but gradually in sections, so that each section can be made safe before another section is lit.

Burning should always be done with the wind wherever practicable, so that in back-burning, once the initial strip along the raking has been made safe, a further line of fire should be lighted in the area to be covered by the backfire, in order to make it as extensive as possible before meeting the oncoming fire.

Combined backfiring and beating.

It is commonly found that the head fire may be suppressed by raking and backfiring and the wing and tail fires by direct beating and sweeping. This again will be a matter controlled by local conditions and to be decided by the officer in charge. It is to be remembered that the aim is to put the fire out as quickly as possible for numerous reasons, so that a combination of methods of attack may frequently be used to this end.

Depending on the number of men available and the length of line to be formed, it is desirable to have two or more men raking, one man lighting and one man keeping a careful eye along the line of backfire. It will be understood that at the outset all men may be used as rakers until sufficient line has been prepared to warrant lighting. (See section dealing with the Lighting of Fires.)

Most patrol men exhibit a common fault in looking at the flames of the backfire instead of keeping an eye on the opposite side of the track where the outbreaks, if any, will originate. It is the duty of these men also to take care of the water bags and to see that they are kept up to other members of the gang.

Where long lines of break are to be prepared, in country supporting dense undergrowth, mattocks, shovels and axes are commonly employed to great advantage.

PRELIMINARY FIRE REPORTS.

A report on every fire attended throughout the season shall be furnished to the local office by the man in charge of the fire suppression gang, on Form No. F.D. 260 - Preliminary Fire Report - and a supply of these forms should be carried as part of the equipment of the Fire Truck.