

## **Section 2.2 Wildfire Prevention**

In addition to using this section of the Guidelines and Manual in formal training, it is most useful to be read out and translated in the local dialect during community meetings especially before the danger fire season.

Forest fire prevention is the means of reducing the number of unwanted, uncontrolled, or escaped wildfires.

### **Activities for the Prevention of Wildfire**

Wildfires may occur in any vegetation type when conditions are favourable for burning. Every fire requires some spark or flame to start it. At the beginning of any fire protection work, it is important to investigate and establish the source of sparks or flames which under favourable conditions could start a forest fire. The prevention of unwanted or escaped fires must be understood as a job that never ends.

In addition, direct fire prevention activities are often the most economical way of reducing fire damage and losses. Basically, wildfire prevention means stopping all unwanted, man-caused wildfires from starting in the first place. Fire prevention work can be started without any expensive equipment.



However, effective fire protection assumes, amongst others:

- Knowledge of fire and its causes;
- Trained community fire fighters or others for fire prevention activities;
- Good advanced planning for fire prevention; and
- Funds.

The best ‘ tools’ that can be used for the prevention of fire are:

- Education of the community and other stakeholders;
- Elimination of the fire hazards; and
- Fire enforcement laws and byelaws.

## Risk

Risk can be defined as the chance of a fire starting from one cause or another, such as people, lightning, ' electricity, etc.

## Hazard

This is the fuel complex by type, arrangement, volume, condition, and location that forms a special threat in the case of ignition or constitutes a difficulty in suppression. Areas covered with grass, brush, and forest trees are examples of a hazard.

In organizing wildfire prevention in a particular area, one must first know what the usual causes of fire are, and the risks and hazards involved. Fire prevention efforts should be effectively tailored to eliminate or reduce the causes, the risk, and the hazards. The overall objective should be for everyone to know how to prevent wildfire, their causes, risks, and hazards, each of which may vary in different parts of the country.

A fire prevention plan is needed for the effective organization of fire prevention operations. The written part of the fire prevention plan should include maps, tables, and graphs. The material should be updated at least once a year.

The first step in fire prevention planning is to collect all the basic facts and data from fires that have occurred previously. This information could be compiled, for instance, from data collected over the past five years on:

- How or why the fire started?
- When did it start? (month, day, time of day)
- When did they occur most frequently? (weather, hazard, time)
- How many fires were started from different causes? (number of fires listed under each cause)
- Where did they occur? (map location, forest type)



This analysis determines the realistic and logical goals of the fire prevention plan. It also helps in the development of a summary of the main problems, such as

responding to the following questions:

- What are the main causes of wildfire? (shifting cultivation, debris burning, etc.);
- Location of very high risk areas;
- Location of areas that should be protected;
- What are the main objectives and methods of fire protection?

The first step in wildfire prevention should be education. The second step should be to enforce the laws and regulations which control fires caused by agriculture, shifting cultivation and pasture management.

After the above, the next step could be the preparation of regulations to control camping fires by tourists and fires caused by hunters. This should be done through education.

After the summary of responsibility for fire prevention actions has been completed, the following decisions will have to be taken:

- Will any new laws or byelaws be needed?
- Who will talk to the community and when?
- Who will talk to school children and teachers?
- Who will work on the problems of fire hazard reduction?

### **Main contents of a wildfire prevention plan**

The following example for a fire prevention plan is a general guideline.

1. Basis of the fire plan:
  - 1.1 Fire occurrence map
  - 1.2 Fire statistics, graphs
  - 1.3 Fire risk area(s) map(s)
  - 1.4 Slash and burn and pastures operations map(s)
  - 1.5 Hazard areas map(s)
  - 1.6 Signs (panels) and warning board map(s)
2. Fire prevention objectives
3. Summary of problems and measures to be taken
4. Resources for fire prevention operations



- 4.1 Use of trained community fire brigade, forestry personnel, etc
  - 4.2 Contact persons and co-operation with village leaders
  - 4.3 Finance (funds)
5. Laws, regulations, byelaws, rules, and management restrictions for fires;
  6. Public and community education, mass media, and guidelines for tourists, hunters, etc.
  7. Rules and regulations for graziers, farmers, hunters, etc.
  8. Reduction of the physical hazards in high risk areas;
  9. Signs, posters, stickers, panel boards with warnings, etc.
  10. Fire prevention training and education;
  11. Feedback information on aspects related to wildfires on the landscape.

For every fire prevention plan there needs to be individual information and statistics on each of the above guidelines. The goals and methods of fire prevention will be based on this information.

After the fire prevention plan has been prepared, any fire occurrence during the fire season must be analyzed to determine what effect the planning had.

### **The Causes of Wildfire and Risk**

One part of fire prevention planning is to make an analysis of the fire risk and causes. The various types of risks and hazards in the protection area should be considered in a wildfire prevention analysis.

### **Land owners, farmers, and local communities**

- (i) Agricultural burning such as in shifting cultivation, and fires in pastures to control vermin, insects and to encourage the growth of new vegetation for livestock together with the many variations of rubbish and debris burning, are major causes of wildfire.

This type of wildfire is often the result of a failure to select the proper time, place, and method of burning or in the supervision and control of the burning operation.

In order to minimize the number of escaped fires caused from agriculture and pasture related burning, there should be local regulations or bye laws which require that:



A burning permit or other form of authorization is obtained;  
Burning should be carried out only in designated areas; and  
Burning should be carried out only under certain weather conditions.

- (ii) The best way to reduce the causes of wildfire is by education. First of all, communities and the general public should be taught how to burn safely. Then they must learn how to minimize all hazards safely. Communities and the public should then learn how to minimize all outdoor burning during fire hazard periods. Good results can be obtained during fire hazard periods by diffusing information through the local radio and television especially when weather conditions show a high risk factor. Regulations and byelaws should prohibit anyone from starting an outdoor fire during such fire hazard periods.

There is also need for effective patrolling and fire detection during all periods of high fire risk. The National Fire Service should cooperate with local communities and traditional authorities. The objectives' of this cooperation and the education of the public and communities should be to encourage the right attitude towards wildfires. When communities and the public understand the value of forests and other natural resources and the loss that comes from wildfires, they will be more careful when lighting outdoor fires. In addition, there must be byelaws and regulations to forbid outdoor fires at certain times. However, before these laws and regulations are made, the living conditions, religious and cultural traditions, and the realistic needs of the rural people for outdoor fires must be taken into account.

When outdoor fires are allowed, communities should be educated to know the following:

- (i) Burn only during safe conditions, for example, when there is little or no wind and after rainfall if possible.
- (ii) Obtain a permit or an authorization from the local fire authority or service.
- (iii) Start the fire in a safe place, not too close to the forest or woodland. Clear all hazardous material from around the fire area.
- (vi) Burn at a safe time and never on a windy day. Generally, early in the morning or late in the evening are the best times.
- (v) Before starting a large outdoor fire, there must be stand-by fire suppression equipment and people available to prevent the fire from spreading.

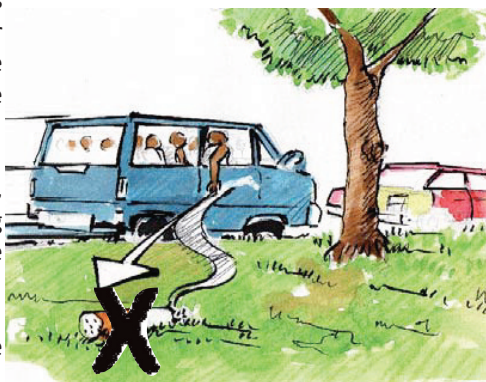
### **Cigarette Smoking**

One of the major causes of wildfire is the careless smoker. Picnickers, campers, hikers, fishermen, hunters, tourists, or local community residents who smoke while in a forest, farm or grassland area can, through carelessness, cause a disastrous fire.

To reduce the number of wildfires caused by smoking, each smoker should be made aware of the danger and precautions to be taken.

During the fire danger season, smoking while walking or working in a forest area should be prohibited.

For instance, some very simple basic rules for smoking could be:



- (i) Smoke only in designated safe places where there is no hazardous fuel. These areas could be next to a stream or lake, on sandy soil.
- (ii) Crush the butt-end of the cigarette against a bare rock, or into a sandy soil.
- (iii) Use a cigarette lighter or make sure that the match is extinguished.
- (iv) Use the ashtray in the vehicle.

## Campfires and fires from temporary farm sheds

Campfires are a frequent cause of wildfires in areas where camping, farm sheds, hunting, fishing, and picnicking are popular.

- (i) The campfire should be contained in a specially constructed fireplace which should be well away from overhead and surrounding hazardous dry or flammable matter.
- (ii) The campfire should be kept small.
- (iii) The campfire should never be left unattended, as wind could spread the fire into nearby dry or flammable matter.
- (iv) Make sure that the fire is properly extinguished before leaving the site. This can be done by pouring water or sand over it and stirring the embers with a stick. By feeling with your hand, check that no burning material remains.

To reduce the damage caused by campfires, the public and local communities should be educated and well informed about wildfire prevention methods.

Signs and warning panels should be erected and information on how to prepare a safe camp site available at all public camping sites and in areas where farmers stay in temporary sheds on farms during the cultivation or crop harvesting seasons.



## Logging and related forest interventions

Frequently, logging and other forestry operations including trawling can cause wildfires. Careless employees and the use of different machines, such as power saws, tractors, and bulldozers in hazardous areas during the fire danger season can be the cause of wildfires.

The use of approved spark arresters in tractors in the forest as well as on other power driven equipment is one way to reduce the risk of fire. Welding operations should be restricted to designated safe areas and some of the more

dangerous forestry operations should be restricted by local regulations and bye laws. While working in the forest the employees should be trained in the use of, and have nearby, fire suppression equipment, such as fire extinguishers, shovels, and backpack pumps.

### **Arsonists**

Arson has taken the top spot as the cause of wildfire in recent years.

General investigations have revealed that the number of wildfires started by arsonists is increasing at an alarming rate.

Law enforcement however has proved to be a general deterrent to arson.

It remains problematic to prevent arson without emphatic investments in behavioral change.



### **Children**

Children who play with matches or with other sources of fire cause an ever increasing number of wildfires each year. Children are generally too young to understand what could constitute dangerous playing. Training, relevant education, and proper parental supervision are necessary to prevent this cause of wildfire.

### **Lightning**

Lightning is one cause of wildfire that is not preventable. Usually lightning is accompanied by rain, but occasionally a 'dry' lightning will start many fires. Fires started by lightning strikes may smolder for days before conditions become favorable for the spread of the fire.



Constant monitoring is a requirement for the location of these dormant or sleeping fires. Lightning storms usually follow a definite path across the landscape.



A map which shows the fires caused by lightning over a period of several years will usually show the lightning fire pattern. Prompt detection is the best defence against fires caused by lightning.

### **Secondary causes of wildfire**

The carelessness of people is a major cause of wildfires.

Secondary causes of wildfire include amongst others: broken power lines and poles, army training operations, negligent people, fire knock-outs, children's fireworks, fire sparking toys etc.

It is important to analyze these fire causes over a long period of time.



The wildfire prevention effort of the fire service and community fire brigade must consider every possible type of fire that occurs in the protection area and community landscape.

### **Methods of Wildfire Prevention**

There are different methods employed to prevent wildfires; some need a lot of human effort while others require relatively more money. If satisfactory results are to be expected from the fire protection objectives some of these methods should be combined. It is therefore important that the fire prevention plan should have estimates of both financial and human resource requirements. Generally it should be acknowledged that fire prevention requires intensive and patient work regularly and on an annual or year to year basis.

## **Mass media**

The mass media includes radio, television, newspapers, and various publications designed to reach the general public, community or specific groups.

Use of the mass media is one of the best means of public education in the prevention of wildfires. However, efforts must be made to ensure that the method used reaches the target audience. For example, the number of people who can read and the number who own a radio or television set should be known. Advertising over the radio, on television, and in newspapers during the high and extreme fire danger periods against external burning activities, will help keep down the numbers of escaping fires. These warnings to the public and communities should be done through the local weather forecasting service, as well as the local radio or TV stations.

## **Associations and groups**

In fire prevention, useful co-operation could be obtained from associations and special groups of people. These groups could be, for instance:

- Specific project beneficiaries;
- Environment groups;
- Sensitized pupils and students i.e. Boy Scouts and Girl Guides;
- Camping and tourism associations;
- Holiday and tourist home owners; and
- Community associations.

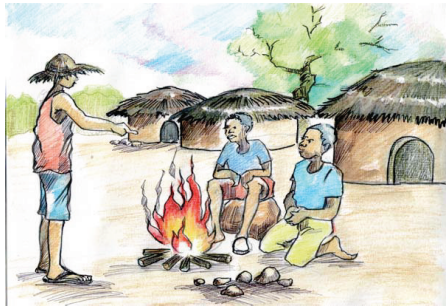
These groups, and many others, can assist in the detection and prevention of fires. The more people you have on your side, the more effective will be the elimination of wildfires caused by human errors and carelessness.

## **Schools**

Fire prevention training in schools and colleges is an important part of any prevention effort. How to introduce the material will depend on the particular school or college system. The best approach is to first contact the Head Master / Mistress, Principal or Manager to find out the most suitable type of presentation to be made. Teachers can be involved by providing them with information and furnishing them with relevant materials. The main benefit of school contacts is that in addition to the students, the parents are also reached through the message that the students carry home.

## Personal contact

Personal contact is probably the most effective method of fire prevention, if done correctly. The best place to demonstrate fire prevention techniques is at the site of a potential fire, where i.e. it can be demonstrated how to build a safe campfire, how to smoke cigarettes carefully, and how to prevent the different types of fire from starting.



The most far-reaching results are gained through public and community understanding and cooperation which in turn depends on the awareness, interest, attitude, opinion, and beliefs of individuals in the community or general public.

## Signs, warning panels and notice boards

Fire prevention signs can be used to inform the public and communities about fire regulations, restrictions, and procedures to reduce or prevent wildfire. Signs should be erected in carefully selected places, where they will be most effective:

- Along roadsides;
- At camping grounds;
- At petrol stations; and
- Anywhere, where people congregate such as around village markets.

Timing is also important, for example, a sign warning of extreme danger should be removed as soon as the danger has passed or else such signs will lose their significance and effect in future.

Signs should be placed so as to be clearly seen as well as clear in order not to be in conflict with other notices.

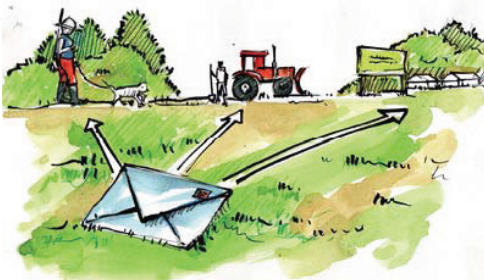
## Posters

Posters can also be used in places where the public assembles, such as market places, bus and railway stations, public offices, and schools.

## Other methods of fire prevention

There are a number of other methods that can be used in fire prevention such as using totem animals with fire prevention messages around them. In such cases, a revered or nationally respected animal portrayed as a flagship species is used to teach about wildfire prevention. The message around the species generally gives good advice and instructions on the appropriate way to use a fire in the forest and on other landscapes. Such programmes are effective, especially for children, when presented in films on television, in posters, cartoons, and in advertisements.

Also, well conceived letters aimed at a specific aspect of fire prevention dispatched with a clear message to a group or several groups of stakeholders may be very effective. For example, wildfire prevention letters sent to local hunting associations just before the hunting season or to herdsmen just before the transhumance season, could produce very favourable results.



## Fire danger forecast

The national weather forecasting or meteorological service should be able to send out a fire danger rating daily, throughout the fire danger season. Agreements can be reached with radio and television stations to include in their regular weather forecasts, some fire danger warning, particularly when the fire rating is high or extremely high. This is a useful service both for fire prevention and for fire suppression. It is also an appropriate means to make the general public more aware of the dangers of wildfire.

## Firebreaks and fuel-breaks

Firebreaks or fire-lines may be either natural barriers, such as a road or a stream, or specially constructed barriers to limit the spread of fires and consequently provide an established control line in the event of a fire starting.

The width of the strip will depend on the type of vegetation, location, the topography of the landscape, and weather conditions. Generally, the width of

the clearing will not be less than one half the height of the tallest tree whose foliage and stock supplies the combustible material. A fuel-break is a wide strip or block of land on which the natural vegetation has been permanently modified so that when a fire burns into it, it can be more readily extinguished with relative safety. It may or may not have fire-lines built into it. Fuel breaks are generally placed strategically along ridges and in valleys. They also include any access roads. Firebreaks and fuel-breaks should also be constructed to prevent wildfire from spreading from one area into another area. A greenbelt is an adaptation of a fuel-break in which the vegetation is kept green and living through irrigation.

## Laws and Regulations

An important basis for success in wildfire prevention is the development and application of local laws and regulations against wildfires, as well as from knowing how to behave with outdoor fires.

National laws, byelaws and regulations for smoking, as well as for the establishment of campfires, and debris burning are important for wildfire prevention. Laws, byelaws and regulations must be impartial and aggressively enforced. Enacting legislation which advocates the collection of fire suppression costs from those who cause wildfires is a good method of wildfire prevention.



Cooperation with the national and municipal police agencies may be required to enforce such a provision.

## Fire Investigation

For every wildfire, immediate investigation of possible causes and protection of evidence at the fire site is necessary. The first fireman or trained community firefighter to arrive at the fire scene should be responsible for preserving the evidence. It is important that the scene be preserved in its original condition.

On the way to the fire and around the fire, the community fire-fighter should:

- (i) Record information about anyone or anything that could relate to starting the fire;
- (ii) Observe vehicles, motorbikes, bicycles, and other mobile equipment near the fire area and those moving away from it; as well as,
- (iii) Take note of the license plate numbers, descriptions of vehicles, people, descriptions, and the location and moving direction of the fire.

Fire hazard (fuel or concentration of flammable vegetation) is one factor which can contribute to the starting of wild fires. Potentially hazardous areas such as the boundary of forest reserves or forest plantations must be monitored through a fire prevention objective of the fire service or community fire brigade. Prevention consists of eliminating the hazard or the potential causes of such fires.

### **Controlled Burning of Fire Hazard Areas**

The most effective fire hazard reduction intervention is to eliminate the fuel or inflammable material from hazardous areas. This can be done by burning off all hazardous vegetation, known as controlled burning (or prescribed burning). For example, dry grass along roads forms very hazardous fire risk areas. Such grasses should be burnt before the hazardous fire season. It is also possible to engage in controlled burning of slash in production forests after timber cutting, which reduces the hazard on such areas. The technique of “early firing” is also used especially around conservation areas in drier zones, to control eventual wildfires as well as achieve other management objectives. Controlled burning needs knowledge and experience from those undertaking the activity otherwise the fire can easily escape to devastate unintended areas.

Meanwhile, controlled burning is useful for understanding fire behavior and provides an opportunity for training in the use of hand tools and equipment. It also provides practice for men and women to work with hot flames and inside smoke. Controlled burnings or “early firing” is usually done just before the fire season. Inflammable material in the control burning area should be dry enough for burning, but not too dry, or else the fire may easily escape, facilitated by strong winds.

As a summary, the following points should be considered before engaging in controlled burning:

- (i) The fuel or inflammable vegetation should be dry enough, but not extremely dry. Relative humidity should be between 40-60%. Below 30% relative humidity, fire could become dangerous, with an increasing risk of spot fires.
- (ii) The weather conditions should be favorable and safe for burning. Slow wind is good and its speed should be monitored and the operation stopped if it increases remarkably. Increased wind constitutes a risk as the fire can escape and develop into spot fires, which are difficult to spot and control.
- (iii) Before setting an early fire, the burning area must be surrounded by a sufficiently wide fire-line. Generally, the safe width depends on the height and volume of the inflammable vegetation.
- (iv) There should be sufficient amounts or quantities of extinguishing equipment and materials on the site, such as: swatters, backup-pumps, shovels, hooks, rakes, etc. Moreover, there should be enough fire men and or fire women for patrolling and controlling the fire. If possible, there should be enough water for backpack pumps and / or fire pumps.
- (v) There must be only one fire leader of the controlled burning operation. The leader should have enough knowledge and experience of controlled burning-techniques.
- (vi) Before starting the controlled burning operation, the fire leader must explain the plan of the burning to the local fire service chief and/or fire headquarters, village chief, and neighbors.
- (vii) The best time to start firing is in the afternoon, because the humidity is most appropriate and the wind is stable.

Before controlled burning is started, it must be verified that the fuel moisture and conditions are favorable for burning. This can be done by using small test fires. The firing technique in controlled burning, for dry and humid inflammable vegetation is basically as follows:

**Dry fuel** – the fire starts and spreads easily:

- (i) The fire is started beside the control / fire-line, from the downwind side to the upwind side. The control line surrounds the area (on flat land).
- (ii) On slopes, the fire is started from the upslope and spreads to the down-slope.
- (iii) Firing should continue on both sides from the starting place, so that the fire' s edge becomes like a horse shoe.

- (iv) Later on, spot-fires can be made inside the fire control area, which creates suction to the central direction as the entire flames move towards the centre.



- (v) After more than half of the area has been burnt, firing can be started on the upwind side of the fire control area' s (backfiring).

- (vi) The fire' s own suction helps to keep flames inside the area. When the main fire and backfiring meet in the centre of the area, they become a torch.

**Humid fuel** – fires do not start and spread easily:

- (i) Firing can be started from the upwind side to the downwind side (on flat land).
- (ii) For effective burning, spot-firing should be used inside the control area.





- (iii) To ensure effective burning, the finger burning technique should be used inside the control area.



- (iv) When on slopes, firing should preferably be started from the down-slope towards the upslope.

## **Section 2.3 Wildfire Pre-suppression**

In addition to using this section of the Guidelines and Manual in formal training, it is most useful to be read out and translated in the local dialect during community meetings especially before the danger fire season.

Wildfire pre-suppression includes all actions required in fire fighting for the successful fire suppression with the exception of fire prevention. This includes all sorts of preparation, i.e. organization, maintenance of equipment and materials, planning, cooperation and mutual support arrangements with other agencies, and training. Fire suppression will only be as effective as the quality and the continuity of the pre-suppression operations. A lot of effort is required in pre-suppression. In these efforts, it is wise to remember an old proverb;

**‘ Good planning is the work half done’ .**

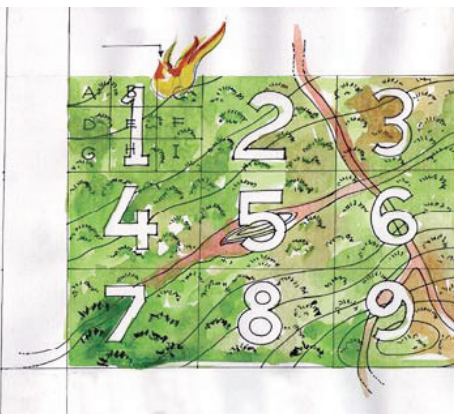
Pre-suppression planning is one of the most important duties of the agency or community organization for forest fire control. Planning must be done at the local community level, regional, and governmental levels. Most details should be included in the local or regional fire plan. Pre-suppression plans must cover all the required activities, from single fires outside the fire season to the most difficult situation when several large fires occur at the same time. The community fire leader or responsible agency for forest fire control is responsible for the preparation of the pre-suppression plan. Regional and local fire plans should include personnel, paid or voluntary as in the case of local community fire volunteers, the procurement of equipment, and all the activities needed in forest fire suppression.

The forest fire control plan should cover the following:

- (i) The organization of suppression activities.
- (ii) Cooperation with other agencies, their crews, and equipment.
- (iii) Equipment, tools, machines, and transport.
- (iv) Fire detection.
- (v) Communication, including identification maps, radio, TV and newspaper articles.
- (vi) Reporting and alarm systems.
- (vii) General suppression plan for different types and sizes of fire.
- (viii) Fire danger measuring and rating system.
- (ix) Measures for closing high hazard areas to communities and the public.
- (x) Training programs.

The general plan requires different maps and background data, i.e.

- Map of hazard areas;
- Map of forest roads and paths;
- Map of the organization for forest fire control, showing the location of headquarters, contacts of fire brigades, lookout towers, weather stations, telephones areas, etc;
- Map showing water supplies, fire-breaks, natural barriers, and fire-lines;
- Annual statistics of fire occurrences by causes; and
- List and records of management of the fire service , community brigade members, equipment and materials.



Most of this background information can be on one map i.e. the fire map.

This special forest fire map should be in every District Assembly and every fire alarm centre. The fire map, together with all records and lists, must be checked and brought up-to-date before every fire season. Government may also prepare a long-term fire plan, i.e. for a five year period. This medium to long term plan should include the objectives for developing forest fire control, finance for forest protection, care of equipment, and any other duties. Background data and records are useful to the fire service agencies and fire projects for the evaluation of resources including personnel.

### **Cooperation with other authorities**

Very few forest fire agencies can clear up unusual fires, serious fires, or very large fires on their own. It is also not abnormal for the fire agency to have sufficient funds with which to purchase equipment, special machines, and vehicles for fire management. Therefore, the necessary arrangements with other organizations and communities for help and cooperation in forest fire suppression must be planned and pursued. These other organizations may have special equipment which will be useful in fire suppression, i.e. the Air Force can predispose light aircraft and helicopters. The degree of cooperation and arrangements will depend on the local situation and the resources of the fire agency. National agencies can assist in the development of cooperation and agreements in

accordance with local laws. All the special equipment, machines, and crews of these other authorities and organizations should be listed at the fire agency headquarters and known to senior members of the community fire brigade.

## **Forest Fire Detection**

### **General**

An essential part of forest fire pre-suppression is the ability to detect the fire. The capability of discovering and locating the fire starts in the protection section of the forest fire service and is the basis of effective fire suppression. The occurrence of a wildfire must be observed and reported as soon as possible in order to start the suppression activities while the fire is still small.

A certain part of the detection is done by people who live and work in the area, by travellers passing through the area, or by aircraft passing over the area. This type of detection is referred as 'general detection' and is effective if people are active and interested in reporting fires. Although general detection is effective in small sections of the protection area, a specific system of detection during the fire danger season must be planned and organized. This is referred as, 'organized detection'. Most forest fires are detected by communities and the public. The first step in fire detection planning is to find out where and how effectively the fire is discovered by general detection. Generally, up to 80% of wildfires are reported by community members. The government should order the obligatory reporting of all forest fires as a civic duty.

All fire and smoke reports should be concentrated in one place, i.e. the District Assembly fire alarm or information centre. This centre must be provided with communications, maps and information about fire crews, community brigades and other units. The centre is also responsible for dispatching the fire crews.

- (i) Ground patrolling;
- (ii) Lookout towers, points, and stations: and
- (iii) Air patrols and satellite if possible.

A combination of these methods may be the most appropriate, and effective.

### **Ground patrolling**

Ground patrolling can be carried out by forest guards or rangers who patrol the area around the forests for which they are responsible. They move along appointed routes, forest roads, forest paths, etc. and should be equipped to take initial attack against any small fire that may be found. They must have some kind of communication or alarm system and good maps to report the location of a fire.

## Fixed lookout stations

Established lookouts can be fire lookout towers, or points. They are appropriate on flat terrain and are normally built on the top of high hills. The effective detection range of the lookouts is approximately 30 - 40 km around the tower or point. There are a number of factors that have a strong influence on visibility, such as time of day, haze or smoke, and the position of the sun.



Lookout towers are normally built of wood or steel, and are from 5 - 25m in height, depending on the height of the surrounding forest and any visual obstructions. If fire detection is organized through the use of lookout towers, they must be built sufficiently close to each other, as it is essential to locate the same smoke from two towers at the same time. It is also essential for the lookout towers to have some way of transmitting information, and to receive notification of every other observation from the fire alarm centre. Normally, the fire tower is supplied with some form of communication system, i.e. mobile or radio-telephones. Other essential items for the towers are binoculars, maps, an angle bearing indicator and compass.

The responsible agency for forest fire suppression should agree on some sort of arrangement for fire observation with local communities before the start of the fire season.

Air patrolling is an appropriate method of fire detection in extensive, sparsely populated areas. Its advantage is that the forest fire agency can give prompt and reliable information, and an accurate location of the fire. Patrolling aircraft can also guide the fire attack crews and brigade by the fastest and easiest route to the fire. Another importance of air patrol is that it is flexible. The area to be covered and the frequency of flights can be changed daily or cancelled, depending on the actual fire danger and risk. Additionally, an experienced pilot and observer in the detection aircraft can continue with fire scouting if the smoke turns out to be a fire. The number of daily patrol flights and the patrol routes will depend on the actual fire risk. For this reason the supervisor of the air detection unit needs to know the rating of the fire risk in the area. It should

be possible to report all fire discoveries directly from the patrol aircraft to the district fire alarm centre.

## **Communication**

More than any other support activity, the successful control of forest, brush, and grass fires depends on communication. Effective communication could provide a successful conclusion to most fire fighting operations.

Some available systems and methods of communication include:

- (i) Fixed lines, such as telephone and telex;
- (ii) Wireless communication networks (radio-telephone):
- (iii) Written messages (messenger on foot, on bicycle. etc.); and
- (iv) Visual or voice signals.

The most popular and effective method of communication in use today is the radio network or radio-telephones. The efficient and appropriate use of any of the available technical communication systems requires experienced specialists and trained personnel. In addition, good communication during fire pre-suppression and suppression operations is important for the safety of the fire crews and community fire brigades.

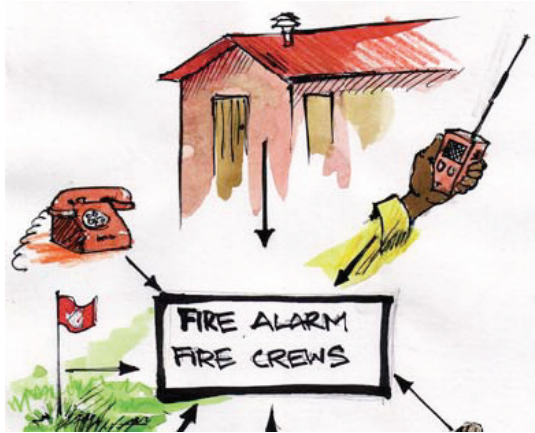
## **Communication equipment and methods**

The different activities of forest fire control require different types of communication systems and equipment. All detection units such as fixed lookouts, towers, watchmen, and patrol aircraft must have some communication system for reporting fires to the District fire alarm centre.

## Regional / District Assembly fire alarm centre system

It is important to provide and concentrate all information and reports of smoke, fires, and the dispatching and alerting of fire fighting teams at some regional or District Assembly fire alarm centre.

The regional or District Assembly fire alarm centre may cover many villages and municipalities. The alarm centre could also serve as a supply store for fire tools and equipment.



The effective and successful working of the fire alarm centre assumes among others:

- Good communication networks, radio-telephones, telephone connections, and other communication equipment as required;
- Sufficient supplies of appropriate and accurate maps, which should cover the entire district;
- Exact and up-to-date information and records of fire crews and brigades, equipment, available, etc;
- Alarm systems to alert fire crews and brigades, and other units for fire pre-suppression and suppression, and trained personnel who are on duty during the fire danger season.

### Methods to alert fire crews or community fire brigades and other units

New technology offers many alternative means for alarm systems. The simple, tried and tested methods for fire alerting are still in use today.

(i) Cellular telephone;

(ii) Radio-telephone:

(iii) Fire sirens;

(vi) Church, or other loud bells;

(v) Drums;

(vi) Flags etc.



## Location and Maps

### Location

Location can be reported by using symbols and marks on the map in use. It is easier and more accurate to report a fire if we have a method for location. There are three general appropriate position definition systems used in the forest fire service, as described in the following pages.

Many countries have developed a position definition system of their own for forest fire control. In addition to forest fire location, this system is in general use by other rescue services. In this system, the location of the fire is reported as the numerical coordinator.

Location systems could be developed as follows:

- (i) A special local grid system, developed for a particular country. Usually, the local grid system requires a 'plastic roamer grid'. By using this instrument the coordinates of the fire site can be read. It should be remembered that senior staff must be trained to use the position definition system before prompt and accurate fire locations can be expected.
- (ii) A grid system related to longitudes the latitudes, which is known as the international method. This system does not require any plastic roamer grid.

### Maps

Basically, only two types of maps are needed for forest fire control: regional maps and local maps.



## **Regional maps**

Regional maps must contain information about main roads, forest roads, and natural water supplies, contours of the forest areas, and district and provincial boundaries. These maps should also contain a position definition system.

## **Local maps**

For large fires, a local map surrounding the actual fire site is required. The primary use of this map is for the management of fire suppression. A good scale for these maps is between 1: 10 000 and 1:50 000. Local maps must contain exact information of the local wilderness, villages, roads, forest roads, paths, natural water supplies, contours, electric power lines, fields, types of forest or vegetation, etc. A local map is an important ' tool' for the fire chief, especially in large fires. All senior personnel in the fire suppression agency and the fire service and community brigades should be trained in the use of maps.

## **Fire Weather Services**

Generally, weather forecast for the general public is not accurate enough for the forest fire service. The responsible agency for forest fire suppression must have its own system of measuring and rating the daily fire danger. For forest fire control a daily fire danger rating is needed for:

- Pre-suppression planning;
- Detection action;
- Planning of suppression tactics; and
- Alerting communities and the general public of fire danger situations.

For the fire danger rating a weather index scale is needed and daily weather observation around the protected areas must be taken. This information requires basic meteorological observations from around the country. The service can be organized by meteorological stations at airports, harbors, forest stations, etc,

## **Fire weather index**

The fire weather index (FWI) is an important indicator of burning conditions, because each day it indicates the expected fire behavior situation in the forest fuels. The fire weather index is calculated on the basis of relative humidity, wind speed, rainfall and temperature. A very high fire weather index indicates that the forest fuels are dry, and very inflammable. A low fire weather index indicates that the forest fuels are not very inflammable, and there is no danger of a serious forest fire.

## **Measuring fire danger**

Measurement of fire danger depends amongst others on weather factors. Other factors that must be considered are fuel type, hazard, fire risk, and the probability of lightning. Fire danger is also a related measure of the expected fire behavior, and of the daily fire control requirements. All personnel responsible for the suppression of forest fires and grassfires must be aware of the daily fire danger and fire weather index.

### **A practical example of assessing fuel dryness and flammability for controlled burning**

The moisture of fuel affects its flammability and so has a major effect on fire behaviour. The single leaf test described below gives direct indication of how a burn will behave.

#### **Single leaf test**

Sheltered from any wind, light the end of a dead leaf and, once lit, take the ignition source away. The aim is to discover the angle at which a small flame either goes out or flares up.

#### **Fire danger conditions in different scales**

The following conditions will generally apply under the different index classes.

##### **Low fire danger (FWI 0 to 3)**

Fires spread slowly from slash piles, campfires, and other sources of heat, and are easily controlled. Lightning fires may start. On windy days the detection system covering high hazard and special risk areas should be in operation. The regular suppression crew and community fire brigades should be on call.

##### **Moderate fire danger (FWI 4 to 10)**

Fires start readily from an open flame, burn briskly, and tend to spread rapidly as they increase in size. The detection system should be in operation and the regular suppression crews and community fire brigades ready for immediate action. A secondary force should be on call.

## **High fire danger (FWI 11 to 22)**

Fires start readily from flame, glowing cinders, cigarette butts, and so on, spread rapidly and tend to grow in suitable fuels. Regular suppression crews and community fire brigades should be completely mobilized and on stand-by for immediate action. Reserve forces should be on call.

## **Extreme fire danger (FWI 23 and over)**

Explosive condition! Fires start immediately from sparks and burn fiercely. Crown and spot fires are often uncontrollable during the afternoon heat. Relief supplies should be arranged. Relief crews and community fire brigades should be available on call and emergency action should be taken as required.

## **Training**

### **Objective**

The objective of the training is to build the capacity of participants in theoretical and practical aspects of forest fire prevention and fire fighting. The training also seeks to demonstrate the use of manual and light motorized forest firefighting equipment to facilitate better planning, organization, and to implement forest fire prevention, control, and safety measures.

After completing the course the participants should:

- Be familiar with the measures taken to prevent forest fires;
- Be familiar with organizational, technical, and tactical aspects of forest fire fighting;
- Be conversant with methods to control different types of forest fires using manual or light firefighting equipment;
- Be able to draw up fire fighting plans and advise the responsible regional authorities on fire fighting measures.

### **Theoretical part**

- Forest fire prevention; methods and possibilities.
- Preparation of a fire plan.
- Fire suppression organization.
- Fire service organization.
- Mobilization and management of personnel.

- Leadership during the fire.
- Control and maintenance after the fire.
- Reporting the fire.
- Equipment care.

### **Practical part**

- Leadership in forest fire fighting.
- Use of various methods and tactics in fire fighting.
- Use of various types of equipment and hand-tools.
- Maintenance and control of fire-fighting equipment and hand-tools.

### **Warning signs and boards**

In order to prevent fires, all notice boards should be along the main roads and in the protected forest areas. One of the most important operations is to check and prepare adequate firebreaks and fire-lines in production forests and protected areas. If they are old they must be cleared of all fuel and must be wide enough to prevent fire from spreading.

### **Forest Fire Equipment**

#### **Forest fire hand tools**

Successful forest fire suppression depends on a well balanced combination of people equipment, tools, and training. For any forest fire control organization to be effective, it is important that they are provided with appropriate fire control tools and equipment. These are necessary in the prevention and suppression of any forest fires.

There are five basic work functions in forest fire control where hand tools are used. These are:

- (i) Line location;
- (ii) Clearing and construction of trails;
- (iii) Grubbing, trimming, trenching;
- (iv) Burning off; and
- (v) Suppression/ Mop-up.



In fire pre-suppression and suppression, the purpose of using the tool is to reduce combustion, in any one or a combination of ways.

Firstly, the person / tool combination may reduce combustion by removing potential fuel from the path of the fire i.e. use of a fire rake to remove forest litter of dry leaves. Secondly, a tool can be used to cool the burning fuels directly in front of the fire to a temperature that will no longer support combustion. An example of this is the application of water or sand to the burning fuel. Thirdly, a tool can be used to smother a fire to prevent it from obtaining the amount of oxygen it needs to sustain combustion. Fire swatters of various kinds are used in this way. In the course of fighting a fire a good fire fighter uses a fire shovel, for instance, in three ways: to remove the fuel, to cool-off the burning flaming fuel, and to smother a fire to prevent it from getting the oxygen it needs to sustain combustion.

### **Local tool manufacture and training in the use of tools**

Tool supply and training in proper use and maintenance must go hand in hand. The training of workers in the efficient handling of tools is of no use if such tools are not available or not properly maintained once training is completed. Supplying tools to untrained workers is just as useless if the worker is not instructed in proper maintenance and efficient working techniques. The effective use of fire control hand tools requires several weeks of practice before the proper working techniques are fully adopted. On-the-spot training with frequent follow-up is required to secure good results.

### **Hand tools used for fuel separation**

Hand tools are frequently used for separating fuels when constructing firebreaks before the beginning of the fire season.

During fire fighting, they are used to construct a baseline for back burning, or to separate burning fuel from un-burnt material at the perimeter of a fire.



The main role of hand tools are:

- To cut trees, logs, and shrubs;
- To chop grass and other low vegetation;
- To dig out half-buried fuel; and
- To remove surface litter so that the ground can be cleared of inflammable fuel.

The hand tools commonly used are: axes, saws, brush hooks, shovels, rakes, rake-hoes, spades, forks, and road brooms. Chain saws meanwhile provide the best means for cutting large material and felling timber and snags.

### **Hand tools for smothering fire – swatters or beaters**

However primitive they may seem, and however unpleasant and exhausting they are to use, swatters or beaters are useful for smothering flames. They come in all shapes and sizes.

Whether green branches and wet bags or leather flappers and thronged beaters are used, the main point is that sparks should be swept towards a fire, not scattered in directions. Shovels can also be used for beating out flames, smothering burning fuel and for burying smoldering material.



### **Water sprays**

The engine driven fire pump, or fire-engine, also called pumper, is the most important piece, of equipment for the modern fire brigade at the scene of the fire. The goal of the fire pump is to give pressure and momentum to water at the scene of the fire. The fire pump itself is driven by a gasoline or electrical engine or by human power. Backpack sprayers should be included in the firefighting equipment because of their portability and effective use of small quantities of water. The use of water in the forest fire should be limited to use of the fog stream nozzle which can be cool fires 4- 5 times more effectively than with the straight nozzle spray. The fog stream nozzle spray is excellent for wetting down un-burnt fuel and for building a narrow but effective break in the fuel. The length of the straight stream can be more than 10 meters and the maximum water use

can be 101/min.

Pressure to pump water can be produced by a centrifugal pump. Such a pump consists of a casing within which there is an inner nest containing one or more impeller plates. The impeller plates are formed of two round discs held apart by the impeller blades. A pump with one impeller plate is known as a one-graded pump, with two plates as a two graded pump, etc. Both the pump nest and casing are equipped with valves to empty the pump of water. The pump should also be equipped with pressure and vacuum gauges.

## Section 2.4 Wildfire Suppression

In addition to using this section of the Guidelines and Manual in formal training, it is most useful to be read out and translated in the local dialect during community meetings especially before the danger fire season.

### **General**

Suppression relates to all the procedures which start on, or after the fire alarm. The main objective of suppression is to extinguish the fire. To start suppression, the community brigade volunteer needs to know about the fire-line. It is the line around an actual fire that is cleared by men or machines. It does not include live barriers. The fire-line, or simply the line, is usually prepared by removing all the vegetation and burnable material from the top of the ground so that the mineral soil is exposed. The line may also be made by using a water spray to wet the fuel in a strip of adequate width in those areas such as grass, crops, short brush, leaves, and weeds.

The required clearing width of the fire line depends on the kind of vegetation, the topography, the burning conditions, and the location in relation to the spread, that is, along the flanks or in front of the fire. The line may vary in width from an ordinary narrow cattle trail in light grass, to several bulldozer blades wide in a tall timber forest.



The fire-line about half a metre wide, is usually made with hand tools unless scrapper blades, ploughs, or other suitable earth moving equipment is available. Water spraying is most effective in light fuels. In all these cases the main objective is to keep the fire inside the fire-line until control is certain. The meaning of the term ' fire-line' is – an obstruction line build during a fire in order to encircle it. Sometimes, the fuel-breaks which are prepared inside the protected forest before the fire danger season are also called ' fire-lines' . Another principle to know is sizing-up. It is the evaluation and estimation of a fire by the fire person to determine a course of action for suppression of the fire. It is the first action upon arrival at the scene of the fire. Sizing-up begins on the way to the fire, as soon as the smoke is seen and the location is determined.



Sizing-up is a constant process which starts from the time the alarm is received to the time the fire is completely under control. Wildfire control is a large problem solving and decision making process. Firstly, the problems must be analyzed by taking into consideration all the facts and conditions that can be seen or determined. Secondly, on the basis of the analysis and the expected fire behavior, a course of action must be formed to control the fire. Consequently, follow-up operations are undertaken to ensure that the correct action has taken. Sizing-up the situation is of great importance because it provides essential information and develops a definite plan of action for effective control. Without a reasonable size-up the attack may be completely ineffective.

Knowledge of fire behavior is a basic requirement when sizing-up. If someone has a lot of experience of forest fires and fire behavior they are able to make an accurate and prompt size-up. They must analyze the fuel, weather, and topography, and how these will affect the behavior of the fire. The following questions will help in guiding decision making:

- What is the direction of spread?
- Is the wind steady, or gusty or changeable?
- What is the shape of the fire area, its size, and its length?
- How intense is the burning and rate of spread?
- Are there fingers or danger spots that need immediate attention?
- Judging from the smoke, what is the direction and the speed of the wind' ?
- What is the fire weather forecast?
- Is the fire starting or slowing down? White or grey colored smoke will indicate this.
- What kind of fuel is adjacent to the burning area, and ahead of it?
- Are sparks causing spot fires?
- Can anything be done to stop the spot fires?
- What is the main fuel and how does it burn?
- What is the topography?
- How will it affect the spread of the fire?
- Where is there access to the fire edge?
- How many natural barriers can be used?
- What length is the perimeter of the fire estimated to be?

### **Safety (hazards to life)**

Hazards to life are the first priority in any fire. If buildings are threatened with fire, or if it can threaten to spread to buildings, they must be evacuated. It must be checked whether there are any other areas where there could be a fire hazard. Also, any hazards to the community fire volunteers, such as steep slopes, blind area, rolling rocks, falling snags, and power lines must be verified.

## Threatened property and some tactical advice

After the hazard to life has been determined, property, buildings, non-flammable storage, livestock —have the next highest priority.

If the fire is beginning to start spot fires in the forest, extinguish them and then concentrate on the buildings. Keep a sharp look out for spot fires. If the wildfire is burning in a uniform fuel and at a constant speed towards the property, and if it is probable that it cannot be controlled before reaching the property, concentrate on saving the property.

It is important to prepare a fire line around the buildings or estate i.e. economic trees facing the fire. The distance will depend on the type of fuel and the effects of heat radiation. If possible, wet down the roof and walls of the buildings or valuable trees just before the first rush of heat reaches them. Consider burning back from the line towards the fire if circumstances are favourable and if the spot fires can be controlled.



## Resources

The resources available to control the wildfire are an important factor in sizing-up the operation. Before a fire suppression tactical plan is made, the following should be known:

- How many fire-fighters are available for assignment?
- What kind and amount of equipment is in use, or can be assigned?
- Accessibility of the fire and the condition of the roads?
- How many and what type of reserves are available, and when can they be expected?
- What is the time of day and expected daytime changes in relation to the size of the fire suppression work?
- What are the natural barriers and sources of water that can be used?
- What communications are available?
- Are maps or aerial photographs available on which to plot the fire and control strategy?
- What are the environment considerations?

## **Situation evaluation (calculation of probability)**

There are a variety of methods that can be employed to control a wildfire. To calculate which will be the most effective in a specific situation, the rate of spread must be determined, the type of the fuel must be classified, the size of the fire must be estimated, and the needs of the line control forces must be determined. The weather, time of day, and time of year are also factors needed for planning.

Water is the best and most effective control method if it is available and can be applied with efficiency. In most locations, hand-tools are the most useful method of building the fire-line. The use of hand-tools is best restricted to daytime use, while machines are best worked at night. Earth-moving equipment, such as a bulldozer, is very productive; however, it still has to be followed-up by manual labor. Normally, during the day, when the fire behavior is difficult to assess and the fire is spreading rapidly, it is a risk to move any heavy machinery too near to the fire perimeter.

If possible, natural barriers should be used so that manpower and equipment can be applied only to those sections where they can be most effective. All the forces available should be used to get the situation under control quickly and efficiently. The best advice for any particular area can be obtained from a local forester who is working in the area daily.

One of the most important factors in the evaluation is the estimation of time. At all times estimations and calculations must be carried out in order to assess the fire fighting progress and the spread of the fire.

## **Priority of control action**

Some factors to be considered when deciding priority action include the following:

- Evaluate the hazard to life;
- Estimate property values;
- Estimate the relative value of the ground cover and/or resultant damage;
- Cut off the fire from the most dangerous fuels;
- Cut off the fire spreading on the head, or try to confine it by surrounding the fire with a fire-line;
- Make all the work contribute to the final control by becoming part of the final control line or by delaying the spread until the final line location can be built

- Use equipment in areas that are too hot for manpower, or where it can be used effectively;
- Provide a line of retreat; and
- Estimate the relative cost of control and evaluate any alternative action

## Methods of Attack

There are two basic methods of attack.

**Direct:** fighting the fire itself directly on the edge by using a water spray, throwing soil, using beaters, or building a line down to the mineral soil and throwing the burning edge into the fire, and then widening the line as needed.



**Indirect:** building a line some distance from the edge of the fire, when the fire is too hot to fight directly.

### Direct attack

Direct attack is used mostly on ground or surface fuels, such as grass, brush, duff, underground fires, or on the flanks or rear of large fires. It is also used in the later stages of a large fire, and on any fire where the burning intensity, heat, and smoke are not too much for the fire volunteer fighters to work on the fire edge. Direct attack is commonly used on the head of smaller fires, and on the flanks or rear of large fires where the heat intensity is such that the fire edge cannot be worked directly. It is also used on most grass fires, of any size, where pumps can be applied directly.

If the fire is small, and if the head can be attacked with safety, the control action is applied at the head first. After this, both flanks can be attacked from head to rear. When the head is spreading fast and it is unsafe to get in front of it, the best method is to flank the fire on one or both sides. This method is used like a pincer movement, eventually cutting off the head.

The pincer action is normally done on both sides of the flank at the same time. However sometimes topography, vegetation, or resources will determine that flanking can be carried out only on one side. After the head is cut off, and most

of the spreading is stopped on the flanks a secure line must be prepared along the flanks. When this control line is established, mopping-up, spot fire control, and patrolling must be started in order to complete the operation.

### **Indirect attack**

With the indirect method the line is located some distance from the fire's edge. How far it is located from the fire is of prime importance. All the factors of fire behavior must be used in making the decision. Since the intervening material must be burnt out, the line must be located where it will be effective when the fire reaches it. The intervening area must be kept as small as possible so that no more is burnt as is necessary, otherwise the fire can build up enough to jump the line. The right location can only be decided by experience and judgment.

The line must be wide enough so that the radiant heat developed by the type and amount of fuel inside will not ignite fuels outside the lines.

- Ability and efficiency of the line workers;
- Time of day;
- Intensity of the burning;
- Speed and strength of the wind;
- Topography and the degree of slope; and
- Vegetation cover.

Since the indirect method is used where the fire edge is too hot to approach directly, it is the method that is most used on large fires and at the head of hot, fast running fires. It is also the method that is most used in the high fire danger classes.

The indirect method is often combined with the direct method in total line construction. The indirect method may be used during the time of day when the fire danger conditions are highest. When the conditions get easier, the attack may return to the direct method.

With the indirect method, the line is built some distance away from the fire's edge.

The main variations of the indirect method are as follows:

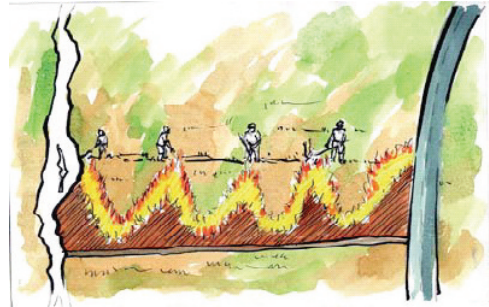
#### **(i) Surrounding/parallel method**

In this method, the fire line is made about 0, 5 - 10m from the fire edge. The

distance away from the fire edge will depend on the fuel, the intensity of the fire, and the topography. In some cases the line can be built along one flank. The fire lines must be joined to a secure anchor point, such as a forest road, a stream, lake, or swamp. In any indirect line construction the intervening space between the line and the fire edge should usually be built-out to secure the line. This is called building-out. Burning-out on the flanks is not nearly as hazardous as burning-out from a line in front of the head of the fire.

## (ii) Hot spotting, or point and cut off technique

Because of the large variety of conditions, a number of methods are possible with the indirect method of attack. One method is “the combination of methods”. In practice, this method means that all the fingers of the fire are attacked first, and also the so called hot spots along the fire’s edge are also attacked by constructing part of the line across those edges that are burning faster.



Rule of thumb:

The most effective place to stop a fire is at the advancing flame edge. However this may not be practical or possible in many situations.

## Burning methods

### Burning-out or clean burning

Burning-out is one part of line construction. It consists of starting a fire along the inside edge of the control line so that the fuel in the area between the fire-line and the fire edge will be burnt. Pockets and islands should be burnt-out after the line is made so that they do not pose a threat of spreading at a later time. This burning forms a wider barrier to the spreading main fire. The burn-out can be started with a torch, or by pulling burning material along with a rake. If the burn-out is patchy and not complete it may be more hazardous at a later time when burning conditions increase.

On hillsides, the burn-out should start from the top and work downwards.

The burning-out procedure must be determined by:

- The type of fuel, particularly in relation to several storied fuel
- The ability to obtain a clean burnt.

The hazards relevant to clean burning are snags, piles of heavy ground fuels, live trees with branches extending to the ground, and tree covered with moss. These must be removed and broken up.

### **Backfiring**

Backfiring is one form of the indirect attack method. It is normally used against a rapidly spreading fire. Backfiring is the process of intentionally starting a fire inside the fire edge or fire barrier in advance of a fire head, or along the forward flanks.

The person in charge of backfiring must have a lot of fire fighting experience.

Backfiring implies that the area between the control line and the fire head is burnt-out to eliminate all the fuel in front of the fire. This will widen the control line, change the direction of the fire, or slow the progress of the fire in order to gain time for line construction. The backfire is usually started a considerable way in front of the fire head. It is important that the fire that is started can be controlled, and that any spot fires from it can be extinguished quickly. There is no need to use backfire tactics on small or ordinary fires.

One qualified person must be responsible for controlling and directing the backfiring operation. On small fires, the backfiring operation will be done under direct instructions from the head of the fire operations. In large fires, the head of operations would delegate the operation to a qualified team head, or head of the community volunteers involved. Constant communication between the person in charge and the fire teams is of prime necessity. Timing is another important factor in backfiring. The right time to start the backfire will depend on the:

- Fuel, weather;
- Resources of the crews;
- Speed of spread of the main fire and topography.

If backfiring is started too late it could result in an unsatisfactory burn. In large fires the best estimate and location of the backfire can be obtained from an airplane or helicopter flying over the area.

## Factors affecting choice of attack

Bringing a fire or part of the fire edge under control depends on a number of factors, which can be determined after scouting the fire. These factors, which are also a check-list for the head of fire operations before the start of planning the suppression tactics, are:

- (i) Fuel - volume, size, type, arrangement, condition pattern, moisture content;
- (ii) Topography - degree of slope, and aspect;
- (iii) Wind - direction, velocity, effect;
- (iv) Values to be protected - human life, property - natural and recreational, timber;
- (v) Soil type;
- (vi) Water sources;
- (vii) Access to the fire - paths, forest roads, etc;
- (viii) Available equipment;
- (ix) Available manpower; and
- (x) Fire behavior at the fire site.

## Suppression Technique

Suppression technique means having a good knowledge of the methods of fire suppression together with the experience for selecting the right equipment.

### The basic methods for extinguishing a fire

It should always be remembered that a fire cannot burn without HEAT, OXYGEN and FUEL in suitable combinations. This is known as the fire triangle. The extinguishing of a fire is therefore based on the removal of one or more of the components represented in the fire triangle. The following methods are advised:

- (i) **Cooling:** a method of extinguishing where the temperature of the fire is reduced below the point of ignition. After cooling, the fire will not start by itself. In forest fire, cooling can be done by the application of water, and is called 'cooling the fuel'.
- (ii) **Smothering:** a method of extinguishing fire where the oxygen is removed from the fire. This can be accomplished in a forest fire by an application of sand or soil or beating with the back of a shovel, as well as by swatting the fire with a fire-beater.



- (iii) Starving: a method of extinguishing fire by removing the inflammable fuel. In a forest the fire can be starved by removing the supply of available fuel, or by allowing it to burn into a natural barrier or fire-line.

In general practice, several tools and pieces of equipment can be used to combat the fire. Their choice depends on:

- (i) Type of fuel.
- (ii) Topography and situation (water sources).
- (iii) Fire intensity.
- (iv) Method of attack.
- (v) Manpower and experience.

### **Some special advice for line construction**

The clearing or the line, (cutting standing trees and bushes, removing branches and logs) can be done by axe, brush hooks, hand (bow) saws, or power saws.

Line digging can be done by using an axe-hoe, hoe, rake-hoe, shovel, or rake. The type of tools, or combination of tools, depends on the type of fuel, amount of rock, and the type of soil. The line must be dug through the humus, right down to the bare mineral soil. All duff, litter, and humus from the digging must be removed to the outside of the line.

Burning-out can be one part of the operation in indirect attack. It is usually a critical operation that requires careful timing. The torch-man follows the digging crew and must be ready to start the burning. He is usually assisted by men with shovels or backpack pumps, whose job it is to keep the fire inside the line. If the line is being built up a slope it should be fired downhill, against the line.

**Undercut lines:** The fire-line must be built horizontally across a slope, and below the fire. It should be built as a trench or ditch to catch any rolling and burning fuel material from above. Such pieces of burning material, even logs often roll downhill as the fire burns around them, thus scattering burning material down the slope. An undercut line should be built as a deep trench that is well banked with earth along its entire length.

Inflammable fuels outside the fire-line, which are not burning, such as rotting stumps and logs can be covered with mineral soil. Stumps and logs should be covered with enough soil so as to insulate them, or if possible, they should be wetted through.

**Ringing a snag tree:** A snag tree is a standing dead tree or part of a dead tree from where leaves and small branches have fallen. If the snag trees are inside and close to the fire line, but are not yet burning, and if there is insufficient time to fell them, the trees should be circled with a line and all burnable material removed from inside the ring. The circle should be at least 3 – 4m in diameter, depending on the type and amount of ground fuel adjacent to it. This action prevents the snag tree from catching fire and throwing sparks across the line.

### **Water suppression techniques**

Water is the most widely used extinguishing agent for most fires because it has a high capacity to absorb heat. It is usually readily available in most forest areas, but there are many areas where water is not available at all, especially in the dry season.

### **Rule of thumb**

When water and adequate water equipment is available it should be used for fire suppression. It constitutes the most effective method. This method will also save manpower because one nozzle-man and his assistant are equal to 4 - 8 men with hand tools.



However, water alone will not do all the work in the control of wildfires and hand tools and patrolling will always be required.

### **Principles of water suppression techniques**

In planning fire tactics it is worth considering water suppression techniques. Usually, the forest patrolling objective at the fire site is to check if there is an available source of water nearby. The water source could be a river, a lake, a dam, etc. The quantity and accessibility of the water is another important point to consider. If the water source is situated down a very deep ravine it may not be available to the equipment. If the water source is far from the fire there must be enough hose and several pumps (booster pumps) to transfer the water. When water is taken from a natural water source, a portable water pump is normally used. The other supply method is to carry the water to the fire in a fire truck or

other type of vehicle. This implies that vehicles should have easily accessible routes to the fire site.

### Procedure for attack and methods of nozzle use

In the case of a small fire, one or two nozzle-men are enough to keep down the flames, especially if the fuel type is light. If the fuel type is heavy, and the flames high and hot, several nozzle-men should be used, and they must work close to each other.

In crown fire attack, there must be many nozzles in use at the same time. They should work very close to each other.

The pressure in the nozzles must be high enough to produce a long straight stream of water because the nozzle-men cannot work close to the fire edge.



The first objective for the nozzle-man is to stop the fire from spreading by knocking down the flames at the head of the fire. If this is not possible, then the nozzle-man should start to attack the flanks on both sides, or on the surrounding fire edge. If the fire is small and fire weather conditions are moderate or low, the head of the fire is hit with a direct attack. This stops the fire from spreading. After that, the flank attack is continued and work progresses from the rear along flanks, around the head, and then back to the point of start. The point of start on the flank depends on the extent of the fire and the amount and type of manpower and equipment available. If a part of the flank appears to be dead, attack starts where the fire is burning intensely. The edge must be checked out to ensure that it is secure. If the fire starts again behind the fire fighter it may not be too long before he is outflanked and caught in pocket between two fires. He should continue to work around the head to pinch off the spread.

To break into a burning line, the fire fighter should reach into it with a straight stream of water, aiming at the base of a hot spot. Bounce the straight stream of water off the ground to make more spray and to cool fuel. As soon as a part of the edge has been knocked down, move into it fast. Then towards the head, change to a spray, cover only the burning fuel to stop the burning, and use the spray as a protective shield. Hit the hottest edges first and then tie in the whole

perimeter. If the fuel type changes, or there are dead and slow burning sections, hit the worst places first and then mop-up the other areas.

The volume of the water supply and the capacity of the pumps should be known.

In the case of a surface fire or a crown fire, it should be eliminated by the cooling and smothering effects of the water, and the condition of the fuel is changed by the addition of moisture.

The arrangement of the surface and sub-surface fuels can be altered by the force of the water from the nozzle. In the sub-surface layers the separation between the burning and un-burnt fuels with water pressure is a most important action. In general, the angle at which the water stream is directed onto the fire edge will determine the effectiveness of the separation. In light fuels the angle should be nearly parallel to the fire edge, and the stream should hit the fire edge about 5 - 8m from the nozzle-man. As the sub-surface fuel or the flame front increases in depth, the angle of delivery should increase accordingly, and the stream should hit the fire edge almost at right angles, approximately 1, 5 - 3 m in front of the nozzle-man. At all times the primary objective of an initial attack is to place the line in a condition of ' being held' .

Some good advice for the nozzle-man on the type of nozzle used in different fire situations is as follows:

**Crown fire** - direct or scattered nozzle with sufficient pressure and water flow, depending on the intensity of the fire.

**Low surface fire** - scattered nozzle, not very high pressure and water flow. Instead of nozzles, backpack pumps can be used. Although backpack pumps are not the most useful and effective of the wildfire tools, they are however the most efficient and economical means of delivering water onto a fire when they are skillfully operated. Backpacks are very useful in initial attacks.

When the pump is used, one hand should be placed close to the forward end and held steady, aiming the pump to where the water is needed and as close to the base of the flame as possible. Pumping is done with the other hand. By holding the forward hand steady, accurate direction is given to the stream. If a fan-shaped spray is needed, the stump is placed over the nozzle end.

Water carried in a backpack becomes very precious. The quantity of water carried is not very much and it must be therefore used as effectively as possible. Backpacks are very useful in initial attack, especially to stop the fire spreading in lighter fuels. They also serve to cool down hot spots along the line, and to knock fire out of snags. They are especially effective if they can be readily filled.

Backpacks are almost indispensable on spot fires, as adjuncts to hand tools in the initial attack and especially in mop-up operations and patrols. If plenty of backpacks are available they may be scattered along the line by whatever transport is available, so that they are on hand when they are needed to combat flare-ups and to mop-up. Often the use for a water tanker or fire truck is to supply the backpacks with water, especially if they themselves cannot reach the fire area.

Practice and training is necessary for the correct use of this equipment and the only way to achieve a satisfactory performance is to practice with the equipment available.

### **Mopping-up**

Mopping-up is the process of putting out the whole fire, or putting out the fire in most of the area around the perimeter so that spot fires and breakaway fires cannot occur.

The size of the area to be mopped-up will depend on the fuel, the location of any smoldering fire in relation to the perimeter, and any possible changes in the weather. The burnt area should be mopped-up for at least 30 m from the perimeter towards the centre of the fire. In some fuels, and in small fires, it is necessary to mop-up all of the fire inside the line.

In heavy fuels the cost of a complete mop-up may be excessive. If all the fuel inside the line cannot be burnt completely, or if the fire cannot be completely extinguished, the area must be patrolled until there is no possibility of any ignition outside the line.

Mopping-up can mean the success or failure of the entire fire control operation. More fires have been lost because of poor or incomplete mopping-up than for any other reason. Mopping-up should begin as soon as the line is complete. In many situations the mopping-up may start during the line construction of the initial attack. Control is not achieved until enough mopping-up is accomplished to make sure the fire is permanently confined to a definite area.

Mopping-up is dirty, hard, and dangerous work. It is a real test of the effectiveness of the fire fighting team and its leaders. In many cases it is better to take a fresh fire fighting team to do the mopping-up work, because the first team will be tired after the initial control operations.

Snags inside the fire line and in places where sparks can be thrown across the line should be felled away from the line and extinguished.

- Remove the roots from across the line.
- Fire can travel underground along the roots and can break out on the surface many meters away, and up to two weeks later.
- Fire in heavy duff may smolders for a long time.
- A trench, dug down to the mineral soil, should be made around the outside of the area of burning duff. The area can then be allowed to burn-out, or be drenched with water.

In mopping-up, all the smoke must be out, all hot spots must be cooled and all burning material must be extinguished. Patrolling must be carried out after the mopping-up working order to make sure that the underground fires are really out. Where water is not available, or is in limited supply, hand tools are very effective when they are used correctly.



In fact, hand tools should be used with water for the best possible mopping-up results. The shovel, backpack pump, axe-hoe, pole axe, rake, and saw are the best tools for mopping-up.

Trouble spots should be eliminated before they flare-up and endanger the line. Keep the fire out of heavy fuels, concentrations of fuel, and un-burnt islands. Break-up any concentrations of fuel that are burning. Improve the line and make sure it is secure and continuous. Turns logs over 180 degrees in their bed of ash, and cool the log and the bed. Do not cover burning stumps, logs, or large pieces of wood with soil and expect them to go out completely. Usually the soil drops away as it dries and the smoldering material underneath breaks into flame sometimes allowing sparks to be carried by the wind. It is much better to completely extinguish all burning material by using water.

Mopping-up with water may be carried out with backpacks or pumps and hose lines. It is not the amount of water that is used, but how effectively it is used. A fine light spray is usually the best, and it saves water. Any burning material should be separated and exposed and a fine light spray applied until it is certain that all the fire is extinguished. In some instances a straight stream may be needed to penetrate or reach the burning material. If enough water is available some areas can be drowned. In heavy fuel areas, or around stumps and roots, a high pressure and straight stream can be effective for digging out hot spots from under the ground.

