PRE-SUPPRESSION ACTIVITIES

6. PRE-SUPPRESSION ACTIVITIES

6.1 Introduction

Pre-suppression includes all the actions that are required in fire fighting for the successful suppression of a fire, with the exception of fire prevention.

This includes all kinds of preparation, such as the development of the organisation, maintenance of equipment, planning, cooperation and mutual aid arrangements with other authorities, personnel recruitment, and training.

Fire suppression will only be as effective as the quality and the continuity of the pre-suppression operations. A lot of work is required in the area of pre-suppression. In this work it is well to remember an old proverb;

'good planning is the work half done'.

6.2 Planning

Pre-suppression planning is one of the most important duties of the responsible organisation for forest fire control. Planning should be done at local, regional, and government level. Most of the details must 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 fire chief, or responsible authority for forest fire control is responsible for the preparation of the pre-suppression plan.

Regional and local fire plans should include all the recruitment of personnel, the purchase of equipment, and all the activities needed in forest fire suppression.

A forest fire control plan should cover the following:

(i) The organisation of suppression activities.
(ii) Cooperation with other authorities, their crews, and equipment.
(iii) Equipment, tools, machines, and transport.
(iv) Supplies for personnel and machines.
(v) Recruiting and payment of personnel.
(vi) Fire detection.
(vii) Communication.
(viii) Identification and maps.
(ix) Reporting and alarm systems.
(x) General suppression plan for different types and sizes of fire.
(xi) Management instructions.
(xii) Fire danger measuring and rating system.
(xiii) Closing high hazard areas to the public.
(xiv) Training programmes.
(xv) Issuing special radio and television messages or newspaper articles.

The general plan requires different maps and background data, such as:

(i) a map of protection areas (forests, plantations);

(ii) a map of hazard areas;
(iii) a map of forest roads and paths;
(iv) a map of the organisation for forest fire control, showing the location of headquarters, district boundaries, lookout towers, weather stations, equipment stores, telephones, etc;
(v) a map showing water supplies, firebreaks, natural barriers, and firelines;
(vi) annual statistics of fire occurrences by causes; and
(vii) lists and records of senior management, personnel, units, and equipment.

Most of this background information can be on one map which is called the REGIONAL FIRE PLANNING MAP, or in short, the fire map.

This special forest fire map should be in every headquarters and every 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, for a five year period for instance. This 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 authorities in order for them to evaluate resources and the personnel of the organisation.

6.3 Lists and Records

It is important for the fire headquarters and alarm centre to have accurate detailed lists and records of all the usable resources for fire suppression.

Using these lists and records, the fire chief can quickly alert all kinds of assistance, crews, and equipment that are needed in the fire suppression operations.

6.3.1 A list of senior management

One of the most important lists is one giving the names of the senior managers in the organisation. The list should include supervisory staff, and other heads of the fire suppression organisation, for example the:

(i) fire chief;
(ii) deputy fire chief;
(iii) service heads;
(iv) head of fire suppression;
(v) head of supplies;
(vi) head of communications;
(vii) head of transport;
(viii) line management (divisions, sections, crews);
(ix) head of air attack;
(x) head of first aid and safety; and
(xi) heads of village fire units.

It is also important that those in control have agreed to their duties and know what they must do if a forest fire occurs.

6.3.2 A list of fire crews

A list of the crews and personnel, as included in the fire suppression plan, must also be included in the fire plan. This record must list all the professional and voluntary fire crews and the personnel and crew heads in every village and in every fire district.

Village fire crews _____ **municipal fire plan**

Crew from _____ fire region

Fire chief	_____	add. _____	tel. _____
1 deputy	_____	_____	_____
2 deputy	_____	_____	_____
Crew boss	_____	_____	_____
1 deputy	_____	_____	_____
2 deputy	_____	_____	_____
Firemen			
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
Alerting :	_____	_____	_____
Transportation:	_____	_____	_____
Equipment:	_____	_____	_____
Person reponsible to collect the crew:	_____	_____	_____
Place to arrive:	_____	_____	_____

In general, many countries have a law that enables the fire chief to recruit civilian personnel for wildfire suppression work.

Both the crews and the civilian personnel should have the physical ability for wildfire suppression work. Payment of the crews for fire suppression work should be decided before the start of the fire season.

6.3.3 Lists of tools, equipment, machines, and transport

All tools, equipment, machines, tractors, and other vehicles which belong to the fire organisation should be listed and recorded at the fire headquarters or the alarm centre.

These lists must include the type, kind, and numbers. They must be compiled by the fire headquarters and by the section in charge of stores.

These lists must also name all the headquarters and stores staff who are responsible for the care and maintenance of the equipment. The drivers and the transport service must also be named.

6.3.4 Cooperation with other authorities

Very few forest fire service organisations can clear up unusual fires, serious fires, or very large fires on their own. It is also normal for the fire service not to have sufficient funds with which to purchase equipment, special machines, and vehicles to cover these circumstances. Therefore, the necessary arrangements with other organisations for help and cooperation in forest fire suppression must be planned and made.

These other organisations may have special machines and equipment which would be very useful in fire suppression, for example, the Air Force will have aeroplanes and helicopters.

The degree of co-operation and the arrangements will depend on the local situation and the resources of the fire service. National agencies can assist in the development of cooperation and agreements in accordance with local laws.

In many countries the forest fire services have reciprocal cooperation agreements with other governments or local authorities, such as the:

- Fire Department;
- Police;
- Army and Air Force;
- civil defence;
- rescue services;
- road construction units; and
- Red Cross.

All the special equipment, machines, and crews of these other authorities and organisations should be listed at the headquarters.

These lists must point out how to alert and who is responsible for sending help and resources to the other organisations.

6.4 Supply Service for Personnel and Equipment

Fire suppression activities will need food and water supplies. The longer the fire suppression takes, the more supplies will be required. If there are not supplies for the fire fighters, the manpower is quickly lost. During the first hours of fire fighting they will require drinking water, and after two or three hours of work they will require some kind of food. Therefore, for long and continuous work it is important to plan the supplies of water and food before the fire occurs. It must be known from where to obtain drinking water and food at any time of the day or night, and how to bring these supplies to the fire site.

There must also be a plan for the fire fighting machines to have a regular supply of their essential needs, such as petrol, diesel, and maintenance.

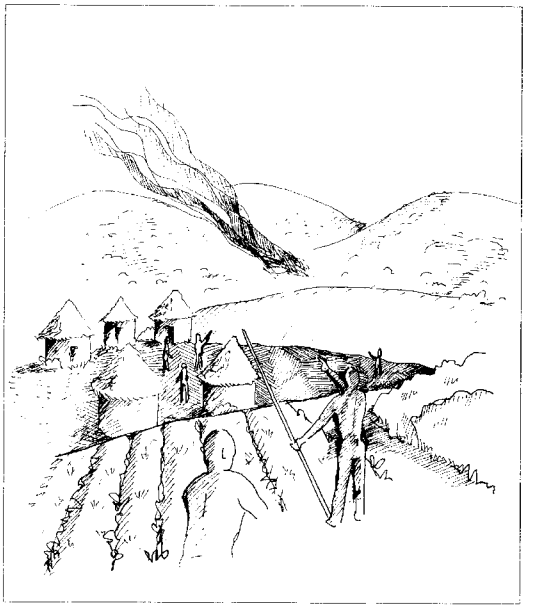
The person responsible for these supplies is called the head of supplies.

6.5 Forest Fire Detection

6.5.1 General

An essential part of forest fire suppression is the detection of 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 will be done by people who are living and working in the area, by travellers passing through the area, or by aircraft passing over the area. This type of detection is referred to as 'general detection' and it works if people are active and interested in reporting fires.

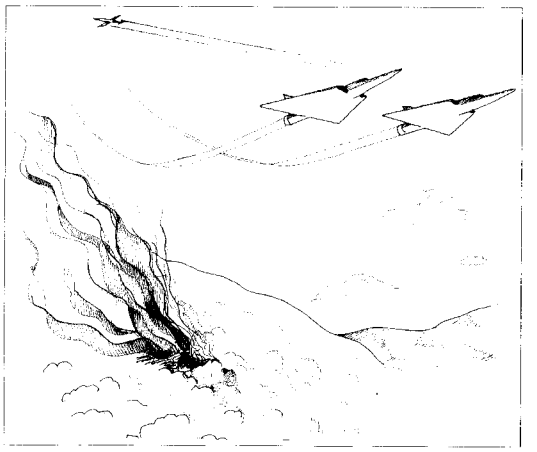
Although this general detection is effective in small sections of the protection area, a specific system of detection for the fire danger season must be planned and organised. This is referred to as 'organised detection'.

Most of the forest fires are detected by the public. However, in many countries forest fire detection still falls to the patrolman, ranger, observers in fixed lookout towers, or to aircraft.

Experience shows that fires near a village forest area, particularly those having a high population, have the largest proportion of fires detected by the public.

6.5.2 Detection planning

The discovery and reporting of uncontrolled fires can be accomplished in a number of ways.



The first step in fire detection planning is to find out where and how effectively the fire is discovered by general detection. Statistically, fifty to eighty percent of wildfires are reported by residents of the populated areas (in Europe).

It may be necessary for government to order the obligatory reporting of all forest fires to be a civic duty.

For fire detection to be effective everyone must know where and how to report a fire. It is also imperative that the reporting person gives an estimate of the size and location of the fire as accurately as possible.

If the general detection in some areas is active and effective the organised detection can be reduced or left out altogether.

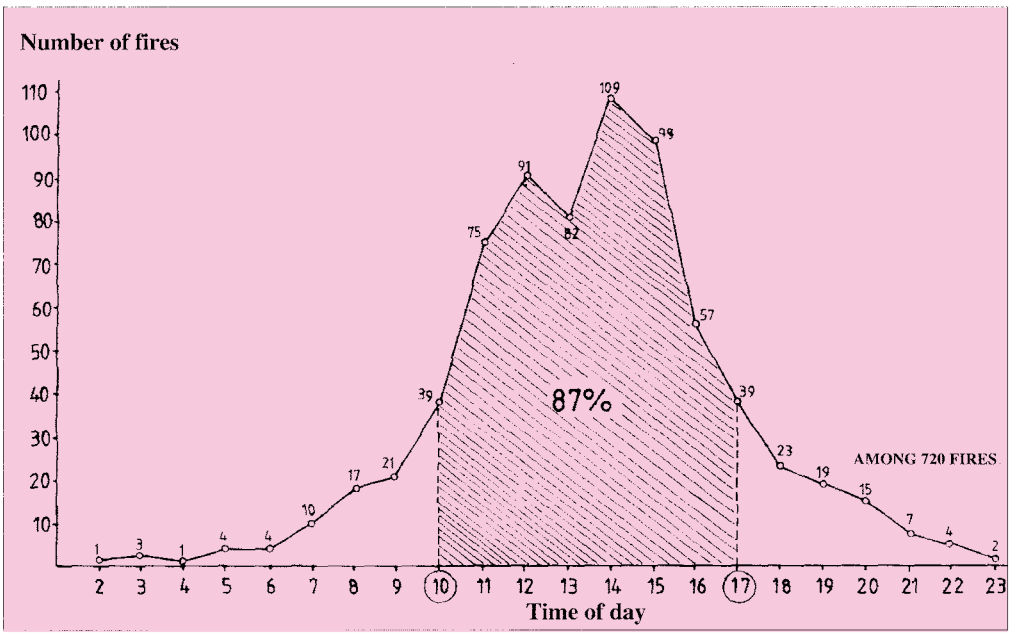
It is unnecessary to support organised fire detection in areas where the fires are discovered by general detection, as in:

- densely populated areas;
- areas of little fire occurrence;
- areas where the fire risk is very low;
- areas which have no significant value.

It is also unnecessary to support fire detection during those seasons when the possibility of a forest fire occurring is minimal.

As mentioned above, organised detection should be flexible, and it must relate to the actual fire risk. This is the way to keep the costs as low as possible.

The authority responsible for fire detection must have the means to follow the daily fire danger variations, as the effectiveness of the detection will be correlated to the actual fire danger.



Long-term statistics for fire occurrence may help in detection planning

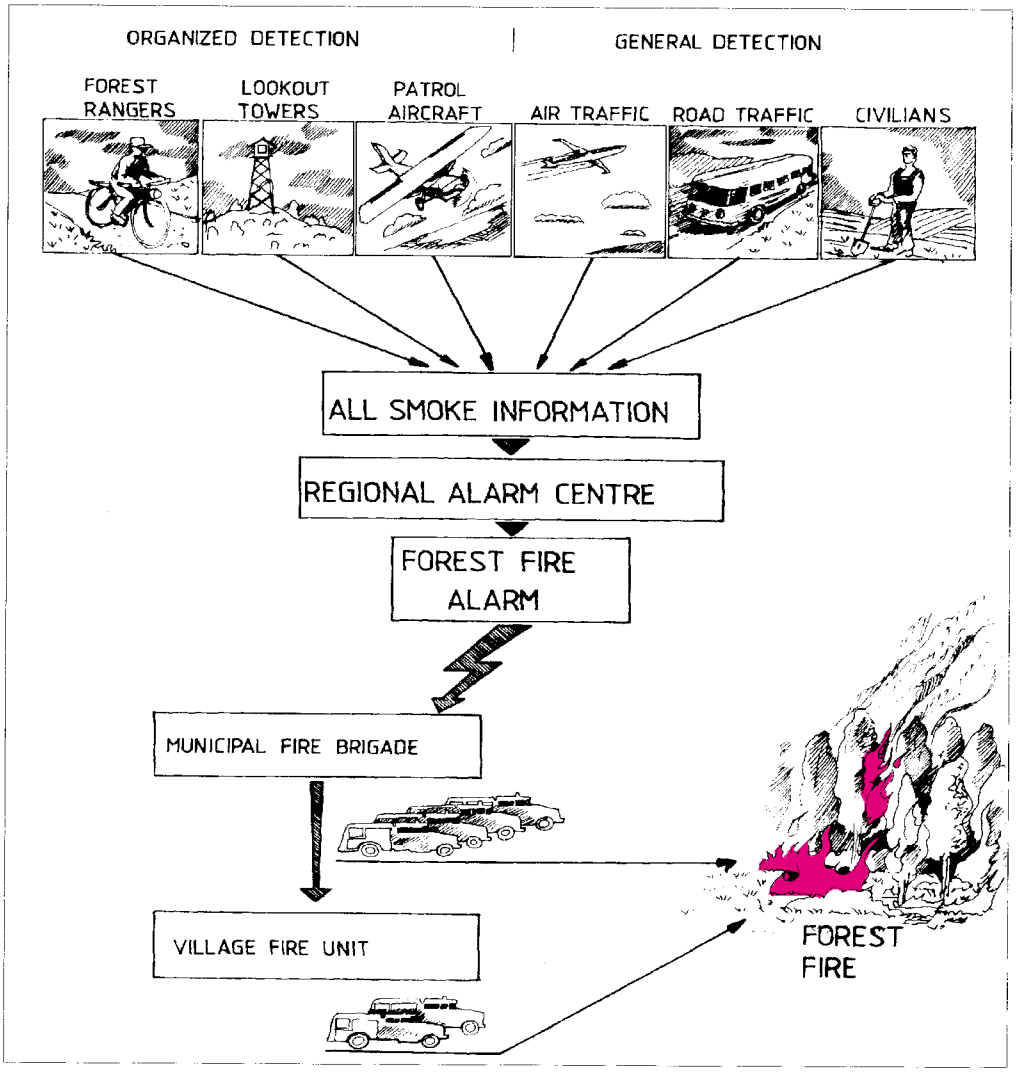
The accurate location of the fire requires good, identical maps in the fire towers, fire alarm centre, patrol aircraft, etc.

All fire and smoke reports should be concentrated in one place, the district fire alarm centre. This centre must be on continuous duty and be provided with good communications, maps, and information about fire crews and other units. The district fire alarm centre is also responsible for dispatching the fire crews.

The main methods of organised fire detection activities are:

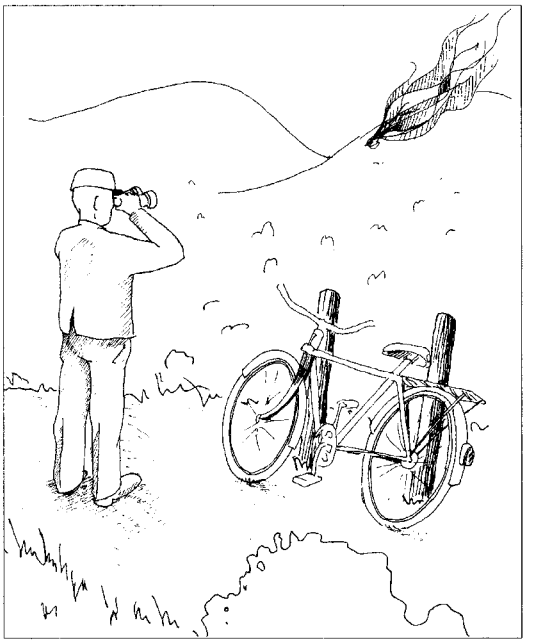
(i) ground patrolling;
(ii) lookout towers, points, and stations; and
(iii) air patrols and satellite.

A combination of these methods may be the most appropriate, and the most effective. Air patrolling is very effective, but at the same time an expensive method.



6.5.3 Ground patrolling

Ground patrolling can be carried out by using patrolmen who patrol the area around the forests for which they are responsible. They move along appointed routes, forest roads, forest paths, etc.



Patrolmen, or rangers, can travel in the forest on foot, bicycles, by canoe, or on horseback, and should be equipped to take initial attack against any small fire that may be found.

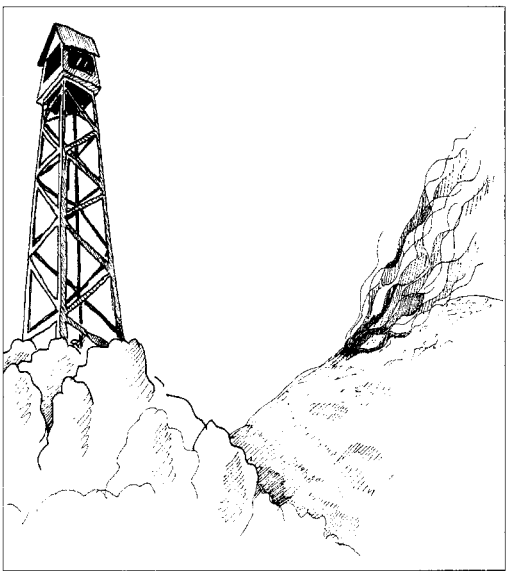
Patrolmen can also use motor vehicles, motorcycles, or mopeds. Forest fire patrols are often combined with general forest patrolling.

Ground patrols must have some kind of communication or alarm system and good maps to report the location of the fire.

6.5.4 Fixed lookout stations

Fixed lookouts can be fire lookout towers, or lookout points. Lookout towers are appropriate on flat terrain. Lookout points 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 the visibility, such as time of day, haze or smoke, and the position of the sun.

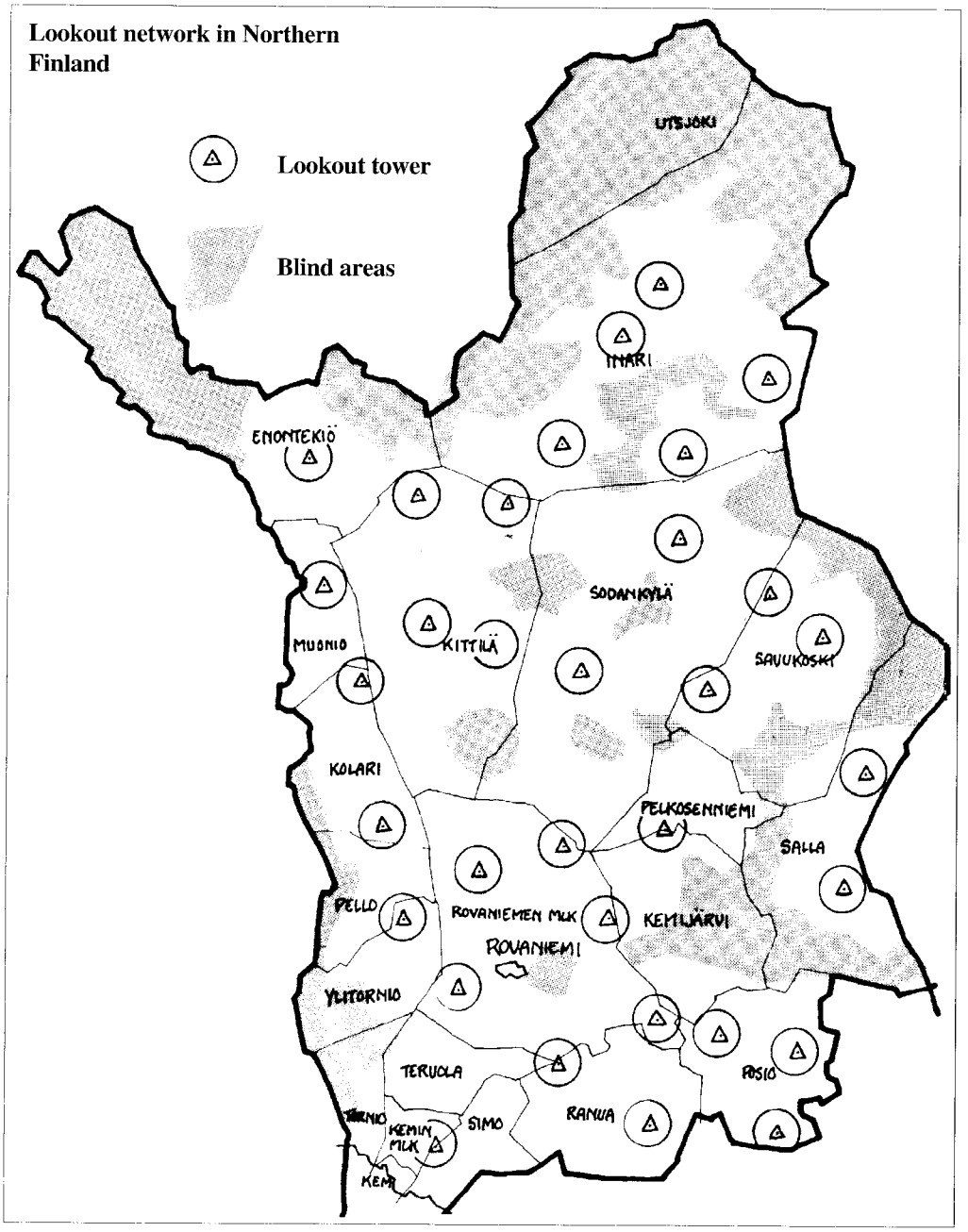
Lookout towers are normally built of wood or steel, and are from 5 - 25m in height, depending on the height of the surrounding forest and any visual obstructions.



If the fire detection is organised 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 to send information, and to receive notification of every other observation from the fire alarm centre.

Normally, the fire towers are supplied with some form of communication system, such as telephones or radio-telephones.

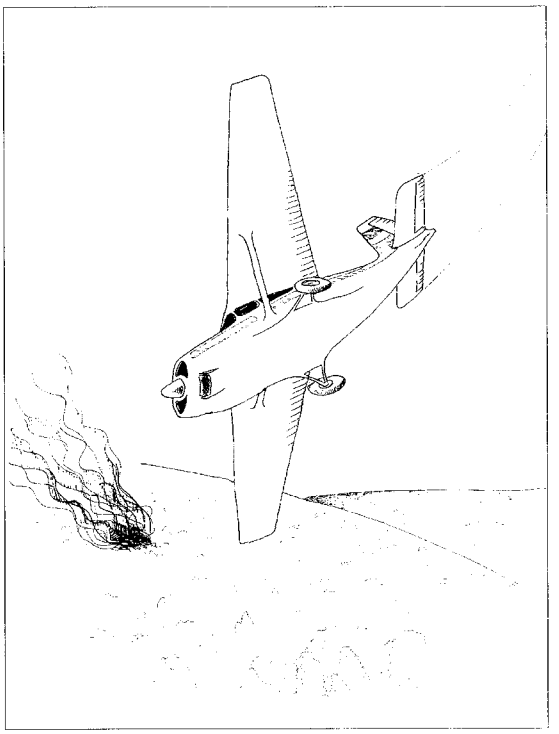
It is necessary to keep a day book in every tower, in which the observer has to note down reports of fire and other things that happen during the day. The other essential items of equipment for the towers are binoculars, maps, an angle bearing indicator and compass.



The responsible authority for forest fire suppression should agree on some sort of arrangement for observing with the local people before the start of the fire season.

6.5.5 Air patrols

Air patrolling is an appropriate method of fire detection in extensive, sparsely populated areas.



The great advantage of air patrolling is that the forest fire service can give prompt and reliable information, and an accurate location of the fire. Patrol aircraft can also guide the fire attack crews by the fastest and easiest route to the fire.

One other good aspect of air patrol is that it is flexible. The area to be covered and the frequency of flights can be changed daily or they can be cancelled, depending on the actual fire danger and risk.

In addition, an experienced pilot and observer in the detection aircraft can continue with the 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.

Normally, the distance between the air patrol route lines is approximately 50 - 60 km.

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

The fire detection aircraft must be supplied with fire service maps.

6.6 Communication

6.6.1 General

Since the beginning of organised fire protection, the need for reliable communication has been recognised as vital. More than any other support activity, the successful control of forest, brush, and grass fires depends on communication.

Adequate and reliable communication will mean less loss, because with good communication all the different activities can be quick and effective. Effective communication could, for instance, provide a successful conclusion to most fire fighting operations.

The fire service should consider the various requirements for communication in the following principal fire control duties:

(i) detection activities;
(ii) reporting activities and alarm systems;
(iii) fire suppression activities; and
(iv) cooperation with other organisations, authorities, and their units.

Some available systems and methods of communication are:

(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 the most effective method of communication in use today is the radio network, or radio-telephones. Written messages and visual signals should not be ignored however. Radio-telephones are very expensive compared to these.

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 suppression operations is important for the safety of the fire crews.

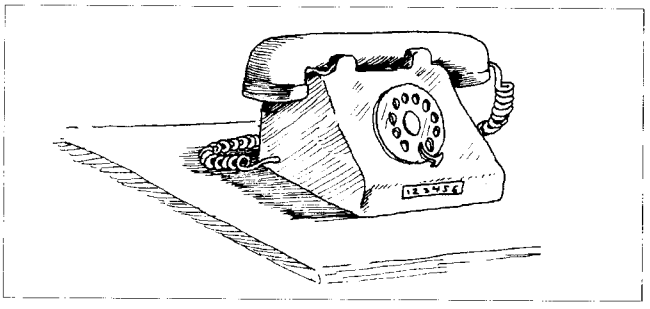
6.6.2 Communication equipment and methods

The different activities of forest fire control require different types of communication systems and equipment.

The following communication systems and methods are in common use.

(i) **Telephone**

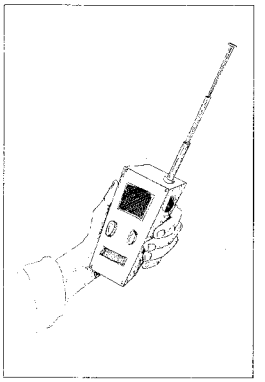
This is very useful for fixed lookouts and towers to report the discovery of a fire, and for general fire reporting.



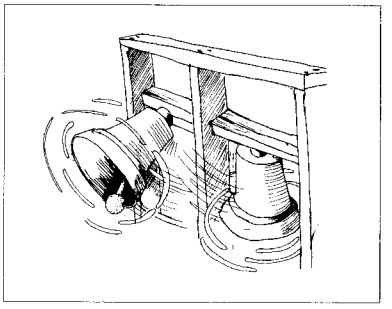
(ii) **Radio-telephone (radio networks)**

This is very useful for all forest fire control duties. In addition to the fire service communication network, the networks of the police, army, air traffic control, etc. can be used for forest fire suppression operations.

Radio-telephone networks can work on:

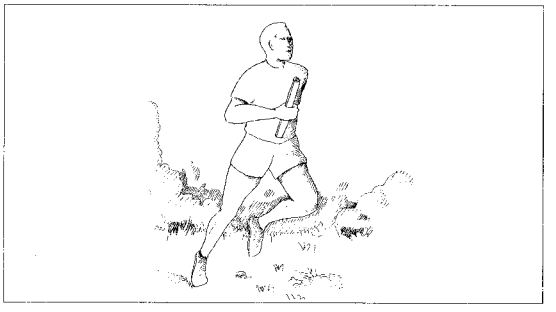


(a) LF-frequencies - these radio-telephones can be used only over very short distances, for instance, between section and crew leaders on the fire line.
(b) HF-frequencies - these radio-telephones can be used over a long distance, for instance between district headquarters and the alarm centre.
(c) VHF-frequencies - these radio-telephones can be used over a short distance, but are very useful in many different forest fire control activities, such as patrolling and fire suppression.



(iii) **Visual or sound signals**

These are used mainly during fire suppression operations, and for reporting fire alarms to the people of the villages. If visual or sound signals are used they must be clear and direct, in order to be fully understood by both parties.



(iv) **Messengers**

Messengers can be used, on the fire line for instance. The bicycle and the moped are suitable vehicles for the messengers, because they can be used on forest paths.

Primary communication needs in a fire attack operation are:

(i) between the fire chief and the site of the fire, and between the fire chief, division heads, and sector heads in a large fire;
(ii) between the fire chief and headquarters, or the alarm centre; and
(iii) between the fire chief and aircraft, and heads of other authorities if they are used.

6.6.3 General directives for organising communication systems

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.

The primary network in fire attack is the network of the forest fire authority, if they have one in use. Communication in fire attack situations must primarily be organised through management.

Communication in fire attack will depend on:

(i) the size of the fire and conditions at the fire site; topography, distance, etc;
(ii) the number of fire crews and units (size of fire); and
(iii) organising management in fire attack operations.

Radio operators for fire action should be selected and trained with care, and the head of communications should have a lot of experience in radio networks.

The maintenance of the communication equipment must not be neglected. For example, during fire attack operations there must be a reserve supply of batteries for the hand-portable radios.

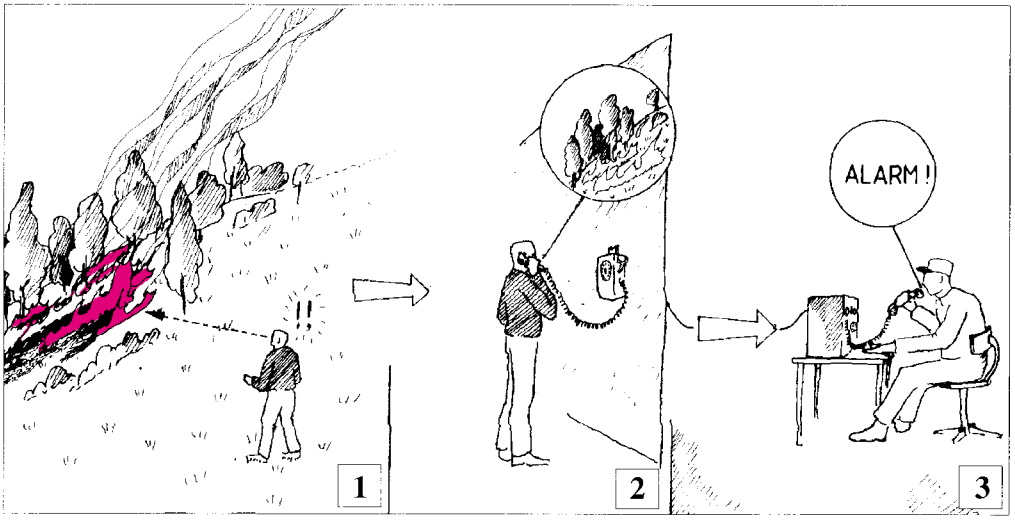
6.7 Fire Reporting and Alarm Systems

6.7.1 Reporting and analysis of smoke and fire

One essential part of forest fire control is the checking of all detected smoke, and finding out which of them are in fact forest fires.

If the fire service has done a successful prevention job the general public will, during the fire danger season report to the fire service any planned agricultural and other outdoor fires before they start to burn.

If the local people are concerned about wildfires and they are interested in fire prevention they will report all detected smoke seen in the forest areas, as this could be a forest fire. This assumes that the public know how to report fires and the telephone number or address of the fire report centres. This is also why the fire service must have a well known fire centre office where all reports of smoke and fire information will be collected.



This local fire centre is responsible for analysing and checking all the smoke reports to see if they are planned fires or real forest fires. One centre can be used to collect all the forest fire reports.

One suitable system could be that all smoke and fire reports are first collected at an appropriate centre in the village. This centre could be, for example, the local forest office, police station, telephone exchange, or any other government office which should be on duty 24 hours a day during the fire danger season.

The most common method for reporting fires is by telephone. That is why a local telephone number for reporting fires should be made widely known to the general public.

The local village fire centre should also be responsible for dispatching the local fire unit to the initial attack site.

All the smoke and forest fire reports received at village level must be sent to the regional forest headquarters, or to the regional fire alarm centre.

Reports from the lookout towers, patrolmen, and other detection organisations must be collected at the local fire centre, or the regional headquarters or alarm centre.

If there are too many places, or too many people handling and analysing the reported information, this might cause confusion and false alarms.

6.7.2 Regional fire alarm centre system

Experience has shown that it is advisable to concentrate all information and reports of smoke, fires, and the dispatching and alerting of crews to some regional fire alarm centre. This centre could be a regional forest headquarters. The regional fire alarm centre may cover many villages and municipalities.

One appropriate system for report analysis and alarm duties could be a combination of the village fire centre and the regional fire headquarters.

The principal duties of the alarm centre may be alternated, depending on the fire service organisation. The fire alarm centre can for instance:

(i) receive and record all smoke reports from the general public and detection organisations;
(ii) analyse and check all smoke reports as soon as possible, to confirm whether or not they are permitted forest fires;
(iii) give permission for outdoor fires, such as agricultural fires and prescribed burnings;
(iv) receive and record all reports of forest fires;
(v) coordinate and lead forest fire detection activities, ground and air patrols, lookout towers, and their times of duty;
(vi) alert the fire crews and dispatch any help and equipment required by the fire chief;
(vii) coordinate and guide all fire suppression activities;
(viii) alert other authorities and their crews to assist the fire service in suppression operations;
(ix) lead all the communication activities in the forest fire service; and
(x) keep up-to-date the lists and records of fire crews and all the equipment in use.

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 other things:

- 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, equipment, available aircraft, etc;
- alarm systems to alert fire crews, and other units for fire suppression; and
- trained personnel who are on duty 24 hours a day during the fire danger season.

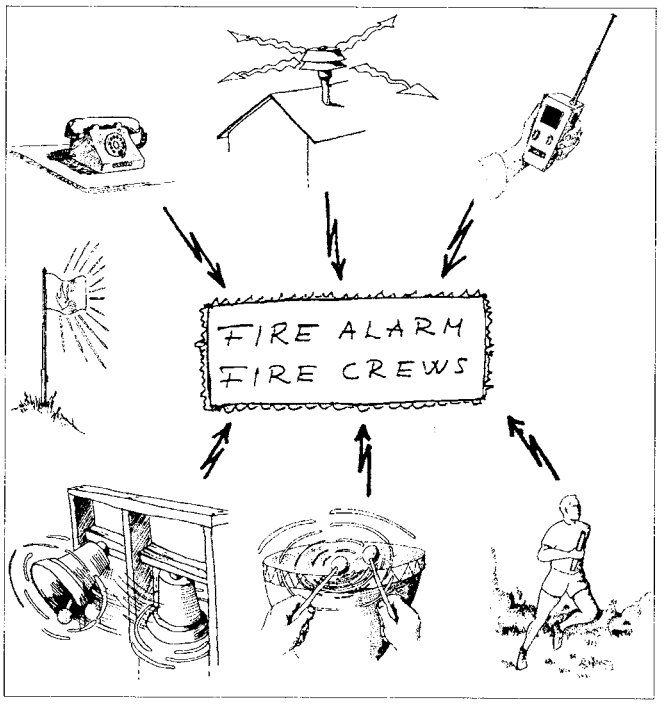
6.7.3 Methods to alert fire crews and other units

New technology offers many alternative means for alarm systems.

The simple, tried and tested methods for fire alerting are still in use today.

Some of these methods are:

(i) telephone;
(ii) radio-telephone;
(iii) fire sirens;
(iv) church, or other loud bells;
(v) drums;
(vi) messengers (by foot, by moped, etc.); and
(vii) flags.



6.8 Location and Maps

6.8.1 Location

The dispatcher or person on duty in the fire alarm centre is responsible for requesting from persons reporting a fire as much accurate information as possible, such as the location, access routes, etc.

Before any fire crew can be dispatched to the fire it is necessary to locate the fire on the map and in the field. Suitable maps are needed for this purpose.

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 and appropriate position definition systems used in the forest fire service, as described in the following pages.

Definition by map names and distance

With an accurate map, the fire location can be specified by using information obtained from the map, for instance:

- '2,5 km north of a lake called Long Lake'.
- '5,5 km west along road number 57 from the village of St. Caulle, and then to the right for approximately 500 metres'.

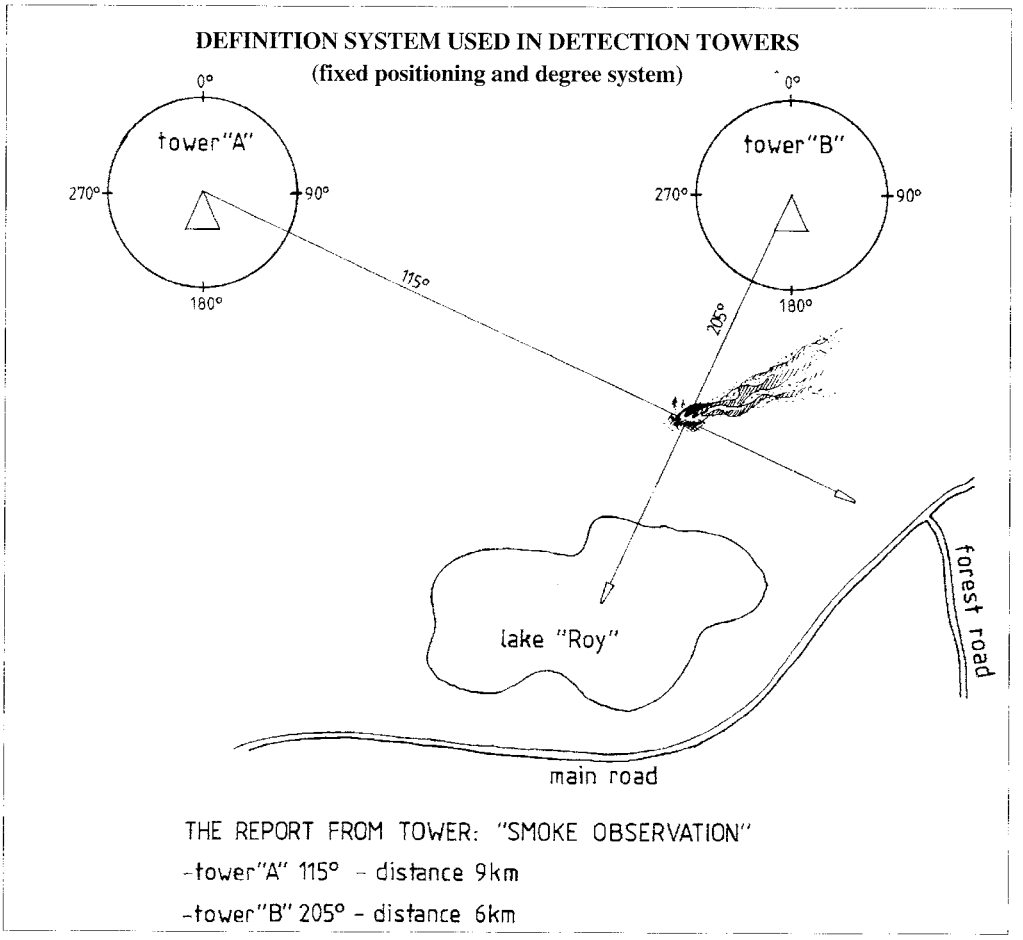
DEFINITION BY MAP'S NAME

-1/2km north of lake"Roy"

-3-4km north-west of road block main road/forest road

In this system no equipment is needed, but it must be sure that the other operator has the same map, can read the map, and can understand the directions given.

Fixed position and degree system



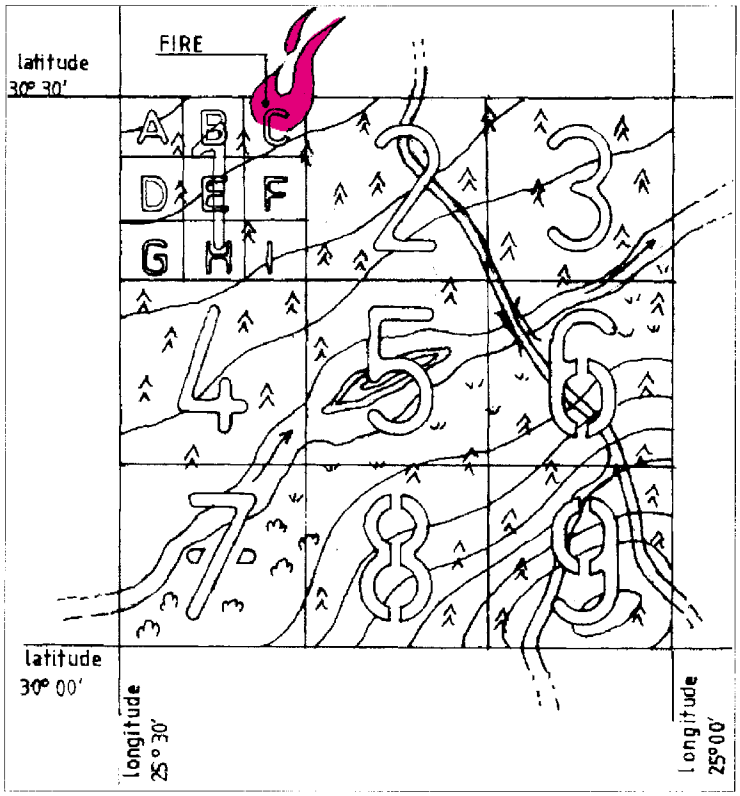
This is a very useful position definition system for fire towers and fixed lookout points. In this method the direction of any smoke that can be seen from a fixed pointis is read, in degrees (0 - 360), from a fire tower for example.

If smoke and fire can be seen simultaneously from two towers two bearings can be given and the fire can be found on the intersection of those bearings. The use of this system requires a compass and a special 'bearing indicator'. The regional fire alarm centre must have the 'bearing plastic' for location.

Remember that 'north' is not accurately given on a compass. It varies depending on the geographical situation (variation).

Grid location system

GRID SYSTEM



LOCATION OF THIS FIRE BY USING GRID SYSTEM:

LATITUDE 30°00' - 30°30'
LONGITUDE 25°00' - 25°30'
INSIDE BLOCK 1; C

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 co-ordinate.

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 co-ordinates 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 and latitudes which is known as the international method. This system does not require any plastic roamer grid.

6.8.2 Maps

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

Regional maps

The primary use of these regional maps is for:

- fire location;
- guiding the units to the fire site;
- cooperation with the units; and
- pre-suppression information, which must be added to the map in conjunction with the fire service.

The appropriate scale of these maps is between 1: 100 000 and 1: 500 000. These large scale maps must be in use in every fire alarm centre or headquarters, and in every fire unit. Regional maps must contain information about main roads, forest roads, 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 by the fire chief, section heads, etc. 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 a very important 'tool' for the fire chief, especially in large fires.

All senior personnel in the fire suppression organisation and the fire service should be trained in the use of maps.

6.9 Fire Weather Services

6.9.1 General

In most countries the weather forecast for the general public is not accurate enough for the forest fire service. For this reason many countries have developed their own specialised meteorological service to assist the forest fire service.

The responsible authority for forest fire suppression must have their 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 the general public of fire danger situations.

For the fire danger rating a weather index scale is needed and daily weather observations around the protected areas must be taken.

This information requires basic meteorological observations from around the country. This service can be organised by meteorological stations at airports, harbours, forest stations, etc.

6.9.2 Fire weather index

The fire weather index (FWI) is an important indicator of the burning conditions, because each day it indicates the expected fire behaviour 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 that there is no danger of a serious forest fire.

The fire weather index can be divided, for instance, into four index classes. Examples of these index classes are:

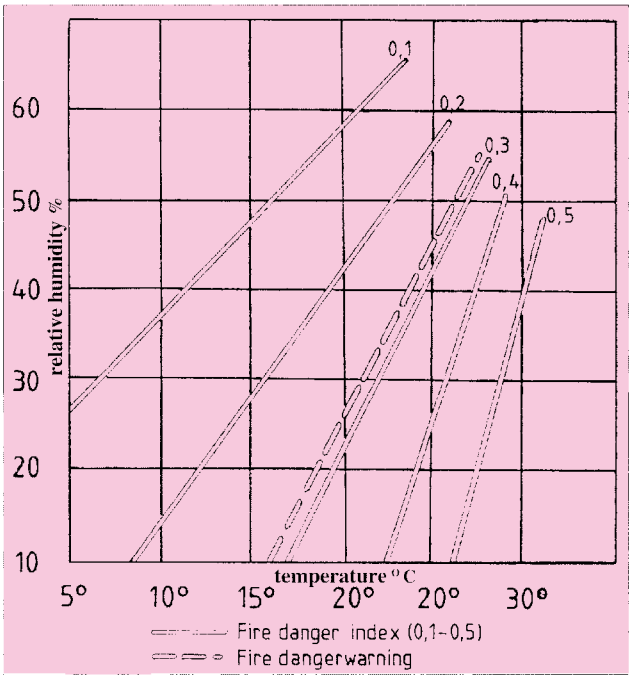
Numerical scale (Used in Canadian FWI)	Index class	Fire behaviour
0 - 3	Low	Creeping fire only
4 - 10	Moderate	Surface fire only
11 - 22	High	Running fire occasional crown fire
23 +	Extreme	Crown fires likely

6.9.3 Measuring fire danger

The realistic measurement of fire danger is difficult because there are many contributing factors to consider. Some of them are fire 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 behaviour, and of the daily fire control requirements.

All personnel responsible for the suppression of forest fires and grass fires must be aware of the daily fire danger and fire weather index.



6.9.4 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 a 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.

 wet	LEAF BURNS ONLY IF STRAIGHT DOWN (OR NOT AT ALL) All fuels too wet if this leaf in area to be burnt. O.K. if only wet types not to be burnt.
 moist	LEAF BURNS IF ANGLED DOWNWARDS BUT NOT IF LEVEL Fine fuels in this leaf's position will only burn if on slope or in wind.
 borderline	LEAF BURNS IF LEVEL BUT NOT ANGLED UPWARDS Fine fuels in this leaf's position will burn but very slowly unless helped by wind, slope, and fuel continuity. If on top of litter layer, wait another day.
 dry	LEAF CAN BE ANGLED UPWARDS AND STILL BURN Fine fuels in the same positions as this leaf are dry enough to burn. O.K. if this leaf is from top of litter. RISKY if from BOTTOM.
 too dry	LEAF BURNS IF HELD STRAIGHT UP All fine fuels very dry and flammable. Fire will run up stringy bark trees. Spotting likely, especially if windy. DON'T BURN!

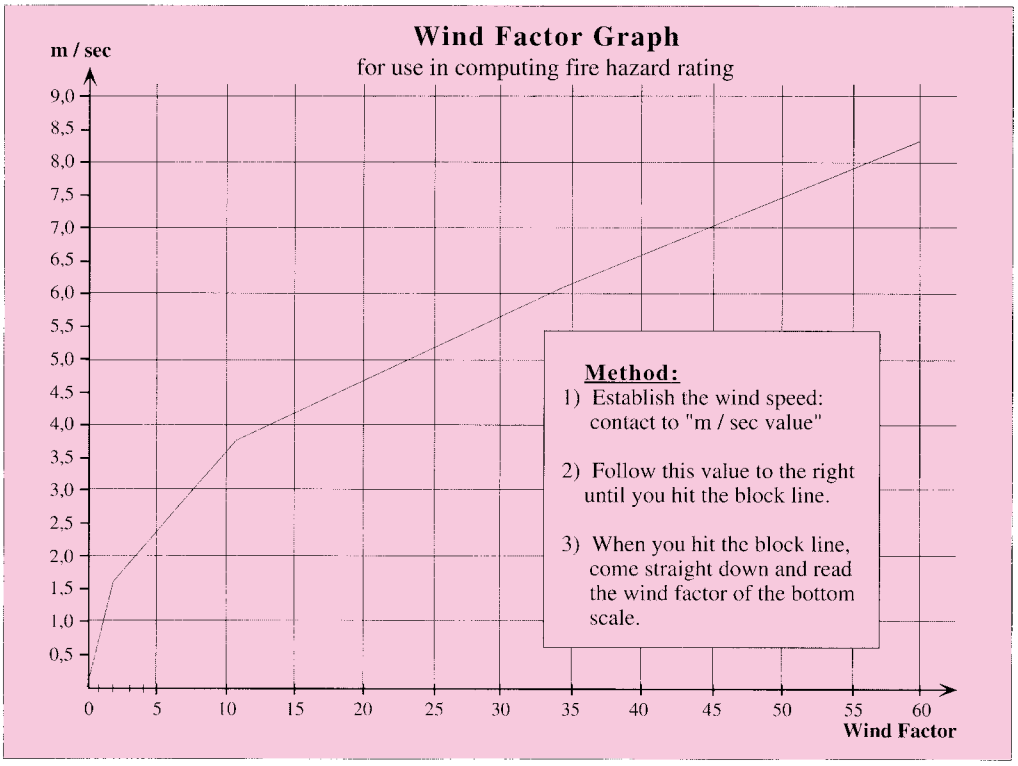
6.9.5 To compute a fire hazard index

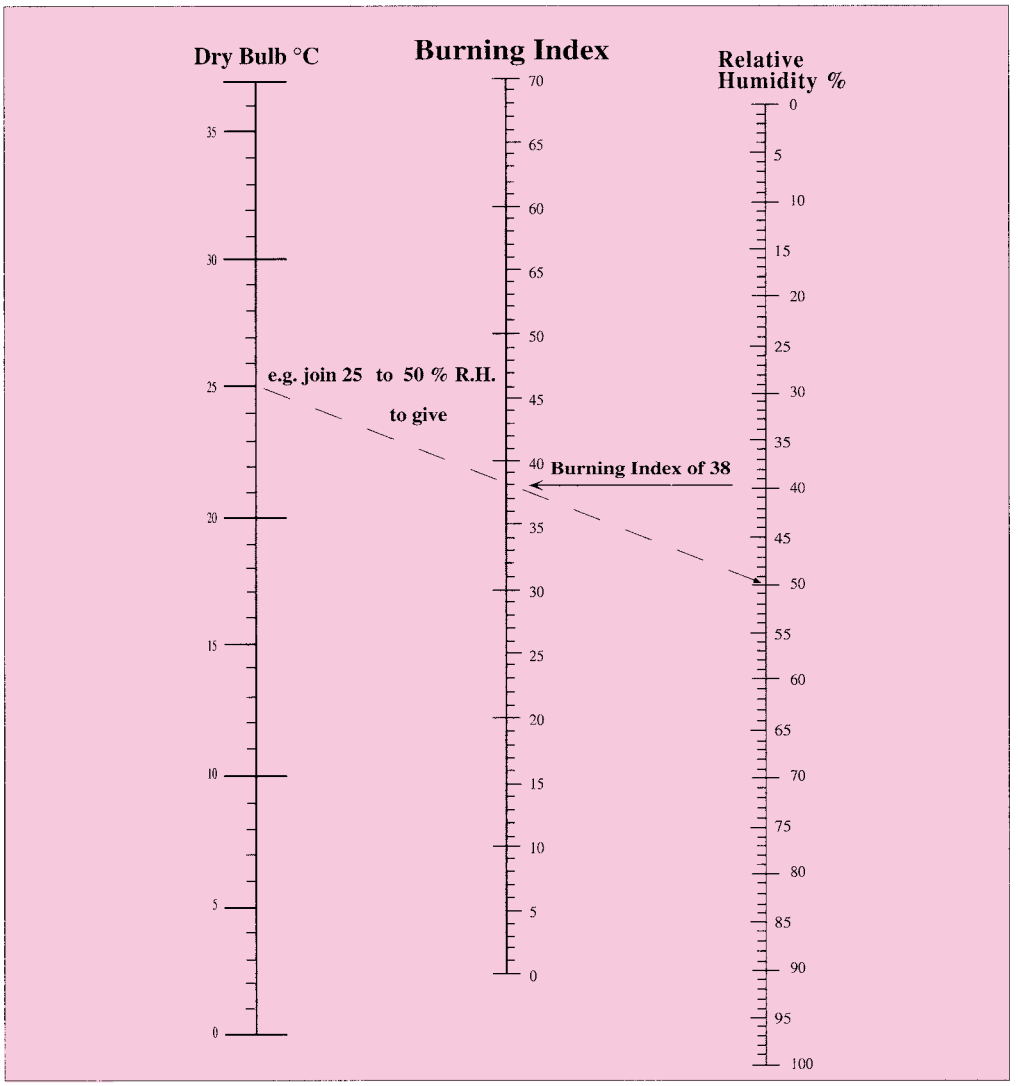
(i) Establish the relative humidity
(ii) Establish the dry bulb temperature (°C)
(iii) Using a straight edge, join dry bulb temperature to relative humidity on the alignment chart (next page); this gives the basic burning index.
(iv) Multiply by the appropriate "rainfall correction factor"
(v) Add the "wind factor" to the product of the rainfall correction factor

To calculate the rainfall correction factor, multiply the basic burning index by the appropriate value from the following chart:

Rainfall mm	Number of days since last rain								
	1	2	3	4	5	6	7	-	10
12.0 - 15.0 mm	0,2	0,3	0,4	0,5	0,6	0,7	0,8		
15.1 - 20.0	0,1	0,2	0,3	0,4	0,5	0,6	0,7		
20.1 - 25.0		0,1	0,2	0,3	0,4	0,5	0,6		
25.1 - 38.0			0,1	0,2	0,3	0,4	0,5		
38.1 - 50.0				0,1	0,2	0,3	0,4		
50.1 - 65.0					0,1	0,2	0,3		
65.1 - 75.0						0,1	0,2		

Rainfall correction factor is of doubtful worth if variables of potential fuel are considered. However, an arbitrary and subjective value could help in the computing of an otherwise difficult rating exercise. Because of changing climate patterns (hotter and drier) the influence of unexhausted moisture values is lessened when compared with a decade ago. Precipitation of less than 12mm is discounted, as are falls of more than 10 days ago.





Burning Index Alignment Chart

Example from Zimbabwe - Fire Hazard Index (0-39 = green, 39-59 = orange, over 59 = red, do not burn)

Data:	Dry bulb temperature:	25°C
	Relative humidity:	50%
	Rainfall:	15 mm 3 days ago
	Windspeed:	5m / sec
Method:	Basic burning index of	38
	Rainfall correction	0.4 x 38 = 15.2
	Add wind factor of	25.0
	Fire hazard index	**= 40.2**

6.9.6 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 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 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 should be completely mobilised and on stand-by for immediate action. Reserve forces should be on call.

Extreme fire danger (FWI 23 and over)

Explosive conditions. 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 should be available on call and emergency action should be taken as required.

6.9.7 Definition of terms

Duff - The layer of decomposed and partly decomposed dead vegetation forming a mat covering the ground. In this layer the unit structures have not decayed to the stage where their original form cannot be recognised.

Top-layer duff - The upper horizon of duff consisting of loosely compacted, undecayed leaves or needles. This is the layer which dries out first and in which fires start or spread.

Litter - The loose debris of dead sticks, branches, and twigs lying on top of the duff.

Humus - The layer of decomposed organic material found between the mineral soil and the duff. Owing to the decomposition, unit structures cannot be readily recognised in this layer.

Fuel - Any material which supplies a medium to support combustion.

Hazard - The relative amount, character, arrangement, and moisture condition of the fuels.

Risk - The relative chance, or probability, of fire starting, determined by the presence or absence of causative agencies. Risk refers only to the agencies which cause fires.

Inflammability - The susceptibility of the fuels to ignition.

Danger - The sum of risk, inflammability, and hazard, together with damage probability and the degree of difficulty with which a fire can be put out.

6.10 Training

Specific training programmes must be provided for the fire service organisation. The section on training in this chapter outlines the background, problem areas, and practice in training.

6.10.1 Background and problem areas

The problems of forest fire prevention in the tropical, sub-tropical and temperate regions of the developing world are in many respects very different from the problems in the so called western world. One very big difference lies in the occurrences of fires. Natural fire incidents frequently occur in North America and Europe where lightning and other natural incidents very often causes wild fires.

In the Tropical Regions, most fires (90 % or more) are caused by man. Thereby the bias towards fire prevention (work to prevent fires from happening) rather than towards fire suppression (actual fire fighting) is quite understandable in the countries in the tropics.

The forest fire control work in industrialised countries therefore differs quite a lot from the work to be prioritised when planning to prevent natural fire disasters in developing countries. The differences are:

(i) the basic educational level of the people;
(ii) the literacy rate;
(iii) the agricultural traditions, i.e. the practice of using fire for clearing agricultural land; and
(iv) the attitude of people towards the environment, which is unfortunately tied up with the living standards of the local population.

It is said that only rich people can afford to protect the environment. Therefore, it is also known that Canada, the USA, Germany, the Scandinavian countries and Japan at present have the strongest environmental movements.

If natural disasters are excluded, such as the Mt. Pinatubo eruption in the Philippines, then forest fires come close to being the worst kind of all known disasters, in that their ecological destruction usually has a very long lasting effect, in some known cases from 40-80 years.

Strong winds, such as typhoons, may have a heavy toll on human life and massive material damage, but the ecological damage is generally short, 1-5 years. The ecological effects of floods are similar to those of strong winds, except that floods are always related to the destruction of forest cover, and thus to forest fires, which destroy the forest vegetation and the soil texture of the forest floor, i.e. the water retaining capacity of the top soil.

When the microfauna of the soil is destroyed by repeated forest fires, the water absorbing cavities (created by the micro-organisms) in the soil also become compacted, and when tropical rain occurs the water seepage into the soil is minimal, leading to high speed run-off

of water. Since the curve of the soil eroding effect of running water is almost logarithmic, the importance of not allowing large scale burning of the forest floor in flood-prone areas is obvious, such as in Nepal (which is the primary reason for the flooding in Bangladesh).

The involvement of FTP/Finland in international training in Forest Fire Control was started in 1981. In the initial stage FTP tried to implement the philosophy of providing information in the form of lectures, training material, and case studies.

This approach was found weak because the key points of information were already found to be available in most developing countries.

A second approach was to focus on European or North American sophisticated technology (satellite and computers) in combination with a heavy bias towards actual fire fighting (suppression).

This approach also failed, because it soon was found out that:

(i) The main problem in fire control in developing countries is human attitudes towards forests and fires.
(ii) Another problem is how to reach and educate the tens of millions of shifting cultivators in upland forests living "outside the society".
(iii) There was a strong need to develop fire suppression with the minimum use of water, and to find ways of how best to start up the manufacturing of local quality fire control tools.

The main areas of insufficient knowledge found out in the process of developing training methodologies in forest fire control were the:

(i) lack of knowledge on efficient application handtools in forest fire control;
(ii) lack of knowledge in how to plan and implement forest fire control; and
(iii) lack of knowledge in how to mobilise fire fighters.

The early training experience of FTP thus led to the revision in thinking, regarding the most efficient methods and techniques in forest fire control. The present training procedures are now concentrating on developing the skills and the planning capabilities of the participants.

6.10.2 Overall training strategy

All training has to be based on the collection of reliable or realistic estimates of fire damage in each country.

Even here, FTP has met a lot of resistance, because fire statistics form a part of national policies and politics. A regional natural resources officer could lose his job if the fire statistics he produced showed too many burnt areas. Thereby, many authorities concerned (district/ regional) have been forced to annually "clean" and trim their fire statistics to look more favourable.

The Thai authorities (Forest Fire Control & Rescue of the Royal Forest Department) selected an opposite approach to the one mentioned above, namely to put a concrete price tag on the trees lost through fire every year.

When a true figure for the annual burning is achieved, the politicians will have to react, as was the case in Thailand. This may be the only way for the local authorities responsible for forest fire control to obtain funds for training.

His Majesty the King of Thailand, who himself is a nature preservationist, has now given a directive to the Cabinet to urgently start the training of 4000 villages of shifting cultivators.

Tanzania may in many respects be one of the few African countries where good results have already been achieved in long term education and training of people in the negative effects of forest/biomass burning. In 1992 14,000 fire volunteers (villagers) turned up on a radio call to fight a forest fire on Mt. Meru in the Arusha Region in Tanzania, this is the only region that has been able to reduce 1 million hectares of unnecessary savannah burning per year.

On a global scale it is therefore quite clear that the fire risks have to be minimised as much as possible. FTP/Finland considers that the best way to tackle this problem is by providing specialised training in the:

- building of an institution responsible for forest fire control for each country;
- creating reliable national fire statistics for each country;
- providing pedagogical and technical training in forest fire control and in networking high risk countries (such as in Indonesia, Brazil, the Philippines, India, and Nepal);
- creating regional training centres for the training of forest fire extension workers (forest fire instructors);
- the start-up of the manufacturing of ergonomically sound high quality forest fire control tools in each country. At the present time only the Philippines qualifies, these high quality tools having been developed under an ILO/Finland project in the Philippines between 1976-1982;
- training in the skills of using manual (labour intensive) tools and their maintenance; and
- the forming of voluntary village fire brigades.

In the following section a typical lay-out of a course on forest fire control is presented.

6.10.3 Example of a course on forest fire control (3 weeks)

Objective

The objective of the course is to train the participants in theoretical and practical aspects of forest fire prevention and fire fighting and to demonstrate the use of manual and light motorised forest fire fighting equipment so that they can better plan, organise, and 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 organisational, technical, and tactical aspects of forest fire fighting;
- be familiar with methods to control different types of forest fires using manual or light fire fighting equipment;
- be able to draw up fire fighting plans and advise the responsible regional authorities on fire fighting measures.

Course background

Forest fires have become an increasingly serious problem in developing countries. This is especially disastrous in the present situation, with the area of natural forests having rapidly decreased and forest fires often destroying tree plantations. The situation is even more alarming since these plantations have been established to compensate for the disappearance of natural forests.

There are a variety of reasons for the extent of forest fires today, and aside from those caused by slash and burn cultures one main problem is the lack of expertise and equipment in actual forest fire fighting. The main emphasis in the course programme will be on finding proper solutions for both problem areas; social and technical.

The course will last three weeks and will consist of lectures and discussions, group work, case studies, and study visits. The participants will be required to prepare beforehand a report on fire fighting organisation and methods in their respective home areas. The following main topics will be discussed during the course:

- general organisation of forest fire fighting authorities and their respective responsibilities, etc;
- forest fire prevention, control, and communication systems;
- identification of forest fires;
- the behaviour of forest fires in various types of forests, different climatic conditions, etc;
- forest fire equipment and its use;
- forest fire fighting tactics and techniques for different types of forest fires;
- management of forest fires; and
- safety hazards planning for fire protection.

Theoretical part

Forest fire prevention; methods and possibilities.
Preparation of a fire plan.
Fire suppression organisation.
Fire service organisation.
Mobilisation 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 handtools.
Maintenance and control of fire fighting equipment and handtools.

6.10.4 Training of personnel

Training of the firemen must be carried out before the start of the fire season. Training includes

both the practice required to perform operations efficiently, and the learning of all the necessary background information. The objective of the training is to develop each fireman in fire prevention methods to be able to control fire with minimum loss of life and property. Training is also necessary in safety measures for the use of hand tools and equipment. The training of firemen must be continuous, and be repeated at least once a year, before the fire danger season.

6.11 Public Awareness of Large Fires

In many countries, fifty to eighty percent of wildfires are reported by the general public. It is important for the fire service to have close cooperation with the general public, because both may need help in the case of a large fire.

During high and extreme fire hazard situations, when there should be no permission given for outdoor fires and some forest areas may be closed, the fire service must be able to inform the public by radio, television, or other means.

In the case of large, serious fires the fire service should have plans to warn and evacuate any person from the area where the fire is spreading.

6.12 Field Preparation Prior to the Fire Season

It is necessary for the field manager, together with the local fire chief, to check the responsible organisations and prepare all the necessary duties for fire protection. There are a number of checks and preparations to be done before the start of the fire season. Some of the most important preparation duties are given in the following sections.

6.12.1 Forest roads

Most of the protected forest areas should be accessible by forest roads. It is important therefore to consider the aspects and requirements of fire protection when planning these forest roads.

Before the start of the fire danger season, all forest roads should be made ready to take fire trucks and other vehicles.

6.12.2 Lookout towers

Lookout towers must also be checked before the start of the fire danger season, to see if they are safe or in need of repair. Lookout points should have in place all the equipment needed for fire detection and reporting. Communication systems must be checked and confirmed to be in working order.

6.12.3 Warning signs and boards

In order to prevent fires, all notice boards should be along the main roads and in the protected forest areas. In some countries the warning boards are collected and put into store after the fire danger season is over.

The field manager, together with the local fire chief, should carefully consider the sites for the warning signs.

6.12.4 Firebreaks and fire lines

One of the most important operations is to check and prepare adequate firebreaks and firelines in the protected areas. If they are old they must be cleared of all fuel. They must also be wide enough to prevent a fire from spreading.

6.12.5 Hazard reduction (Fuel management)

All high hazard areas which may become risk areas within the forest or plantation should be eliminated before the start of the fire danger season.

Typical hazard and risk areas are, for example, dry grass along the roadside and large dry grass areas inside, or nearby, the plantations.

These areas can be reduced by cutting and collecting the grass before the start of the fire danger season, or by controlled burning.

With adequate equipment and trained fire crews, controlled burning is easy to carry out, and at little cost. At the same time, controlled burning is good practice for the fire suppression crews.