FOREST FIRE EQUIPMENT

7. FOREST FIRE EQUIPMENT

7.1 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 organisation 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 suppression the purpose of using the tool is to reduce combustion, in any one of several ways or combinations of ways.

Firstly, the person / tool combination may reduce combustion by removing potential fuel from the path of the fire. For example, the 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.

7.1.1 Basic considerations in choosing fire accessories and tools

Since the firefighting job varies, there is considerable variation in the relative importance of each criterion in a particular environment.

(i) **Effectiveness** - This is the capability of the accessories and tools to accomplish a desired task to an acceptable standard. The emphasis is on the quality of the result.
(ii) **Efficiency or Productivity** - Whether hand or motor-driven, an item of equipment should permit or produce a maximum amount of effective work of a given kind for a minimum energy requirement. For hand tools this is strongly influenced by the experience and training of the individual worker.
(iii) **Versatility** - The wider the range of use of a specific piece of equipment or tool the better, although efficiency also has to be considered.
(iv) **Portability** - Some fire equipment must be transported over long distances under difficult conditions, sometimes by aircraft. Under these conditions, heavy or bulky

equipment will increase transport difficulty and increase the frustration level of those responsible for forest fire control. Especially for fires in high altitudes (and in ecoligically sensitive areas such as Mt. Kilimanjaro in Tanzania) light, portable tools are required.

(v) **Durability** - Fire tools must be strong and not prone to breaking when most needed. The breakage of a personal tool may even result in the death of the fire fighter, such as in the event of a sudden change in wind direction.

(vi) **Maintenance and replaceability** - Minimum maintenance requirements are essential. Also essential is that key parts and assemblies can be readily detached and replaced (e.g. blades, flaps, and handles).

(vii) **Standardization** - It is desirable to use the same items as widely as possible, both within and between protection organisations. Standardized tools can be readily pooled, traded, and effectively used, with less time consumed on servicing and maintenance.

The conditions under which wildfires are often fought will place a heavy strain on both the equipment and the firefighter. Failure of accessories and tools at crucial times during suppression operations can have disastrous effects on the success of the effort and the safety of firefighters.

7.1.2 Availability of fire control tools

The availability of fire control tools is an obvious pre-requisite for any successful forest fire control work. Some possibilities need to be explored however when ensuring the supply and availability of tools and equipment. The ideal condition prescribes the concept of local tool manufacture. It is recognized that through the local production of tools in a certain country, their supply and availability is assured. Besides this, local manufacture will help promote employment opportunities, create new skills, and finally, reduce the outflow of foreign exchange associated with the tools' importation.

7.1.3 Local tool manufacture

The development of appropriate hand tools takes several years. It takes many years before any tool manufacturer can produce tools of good quality. The process involves the reproduction of imported tools in workshops and small factories on a trial basis. The aim includes the assessment of existing technical expertise and the assumed costs of the local tool manufacturer. The findings of the Forest Management Bureau / ILO project in the Philippines were as follows:

(i) Most of the deficiencies of locally-made hand tools are related to insufficient uniformity, occasional unsuitability of the raw material, and the lack of facilities, particularly in the process of heat treatment.

(ii) Discarded motor-vehicle leaf springs, which constitute the principal raw material in the manufacture of various hand tools, coming from different and often metallurgically unknown sources.

(iii) In manufacturing edge tools, tempering (heating of forged sections and subsequent quenching) is a vital process affecting the tools' quality. At present, most makers rely entirely on blacksmiths' experience. Though valuable, the experience alone cannot match the results attainable under methods utilizing measuring gauges.

(iv) Some of the deficiencies of tempering in small scale workshops are due to the overly simple type of heat furnace used. A muffle furnace, preferably equipped with a

pyrometer allowing for a more uniform heating, would considerably improve the degree of control of the tempering process.

(v) Manufacture of most forestry tools involves welding. Welders typically have a scant knowledge of the composition and properties of the metal to be welded. Consequently, they often choose an incorrect voltage, electrode, or welding rod, altering in the process the properties of the material and adversely affecting the tool's quality.

Most workshops however, not only do not possess, but cannot possibly contemplate investment in metal-testing facilities and the equipment designed for final controlled steel hardening, which is essential for the production of tools of more advanced design.

Two types of remedial action suggest themselves:

(i) uniform batches of steel having known compositions and specification suitable for the intended purpose could be purchased; and
(ii) final heat treatment of the pieces, using more advanced facilities, could be done on a cooperative or a sub-contracting basis.

There are other ways of improving the quality.

Firstly, in the arrangement of cooperation between the selected tool makers and the concerned institutions or agencies in matters of metal testing, quality improvement, and a contract-based heat treatment.

Secondly, there is also a possibility worth exploring of setting up a joint venture with foreign tool makers, whereby the local firm would start by assembling imported tool parts and gradually increase the domestic content.

7.1.4 Training

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.

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.

7.1.5 Tool maintenance, use, and storage

Fire tools and equipment should be stored in an adequately lit and well ventilated store room. The room should be large enough for tools and equipment to be stored in racks and bins, so that they are readily available when needed. It is desirable to have a room large enough for a work bench on which tools can be repaired and maintained. The wooden tool handles should also be protected from termites and other insects during storage, and the use of some wood preservative may be necessary. It would also be advantageous if the store room has an outside door which provides direct and easy access to vehicles for loading and unloading.

Fire tools should be identified with prominent and distinctive marks of some kind, such as a red band of paint 5 to 10 centimetres wide on the handle next to the head of the tool, or they may be stamped with an appropriate initial. Tools marked as such can be identified at a glance as fire tools. They are less likely to be misused on other projects if they are conspicuously marked as fire tools. Marked hand tools and equipment owned by the district or department can be easily be identified, especially if they may be used on fires where other units are also employed. Whatever identification is chosen should be used consistently throughout on all fire tools.

7.1.6 Description of hand tools

For the purpose of discussion, this book will limit itself to some of the important tools for use in the construction and maintenance of firebreaks and in fire suppression.

Hand tools used for fuel separation

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

During fire fighting they are used to construct a base line for back burning, or to separate burning fuel from unburnt material at the perimeter of a fire.

The main tasks 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; and
- rake-hoes; although
- spades, forks, and road brooms may be used in emergency.

None of these tools completely satisfies the main functions of cutting, chopping, dipping, and raking, but the uses of several are sufficiently versatile for the requirements of a fire crew. There has been a gradual move to develop standard equipment with a reduction in weight appropriate for working under conditions of heat stress, which is as important as strength and reliability.

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 thonged beaters are

used, the main point is that sparks should be swept towards a fire, not scattered in all directions.

Shovels also have a place for beating out flames; for smothering burning fuel with earth and for burying smouldering material.

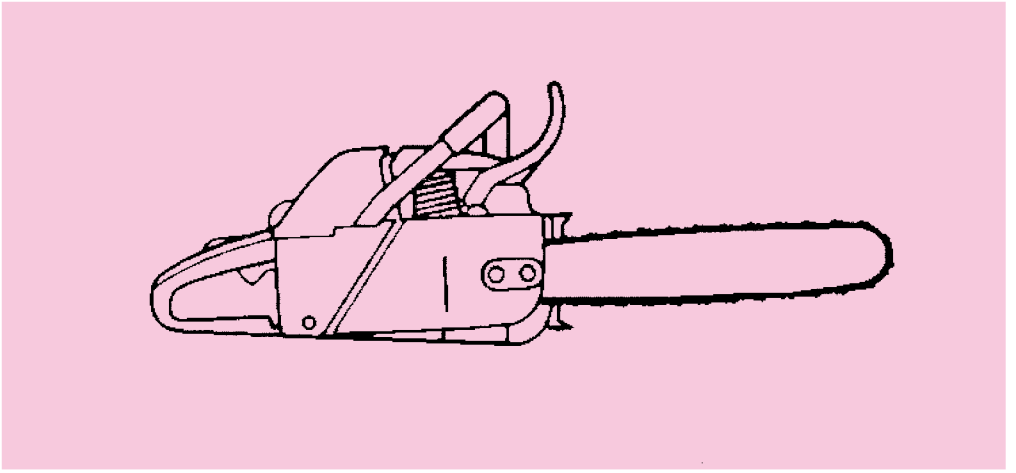
Hand tools for burning out fuel

It is not always possible to separate burnt fuels completely from unburnt fuels. It may be desirable to back burn so that unburnt fuel between a cleared control line and the main fire is disposed of under suitable weather conditions.

Torches made of bark or branches bearing dry leaves are often used. A rake may be used to spread burning material, although it may be necessary to use a more concentrated and reliable flame, especially if lighting up has to be done quickly.

Chain saws

Self-contained power saws are universally used and if they are maintained properly, they are the best means of cutting large material and felling timber and snags. Operators must have sufficient training and experience when they are felling trees. They should be required to observe the necessary safety precautions. Two men should work together.



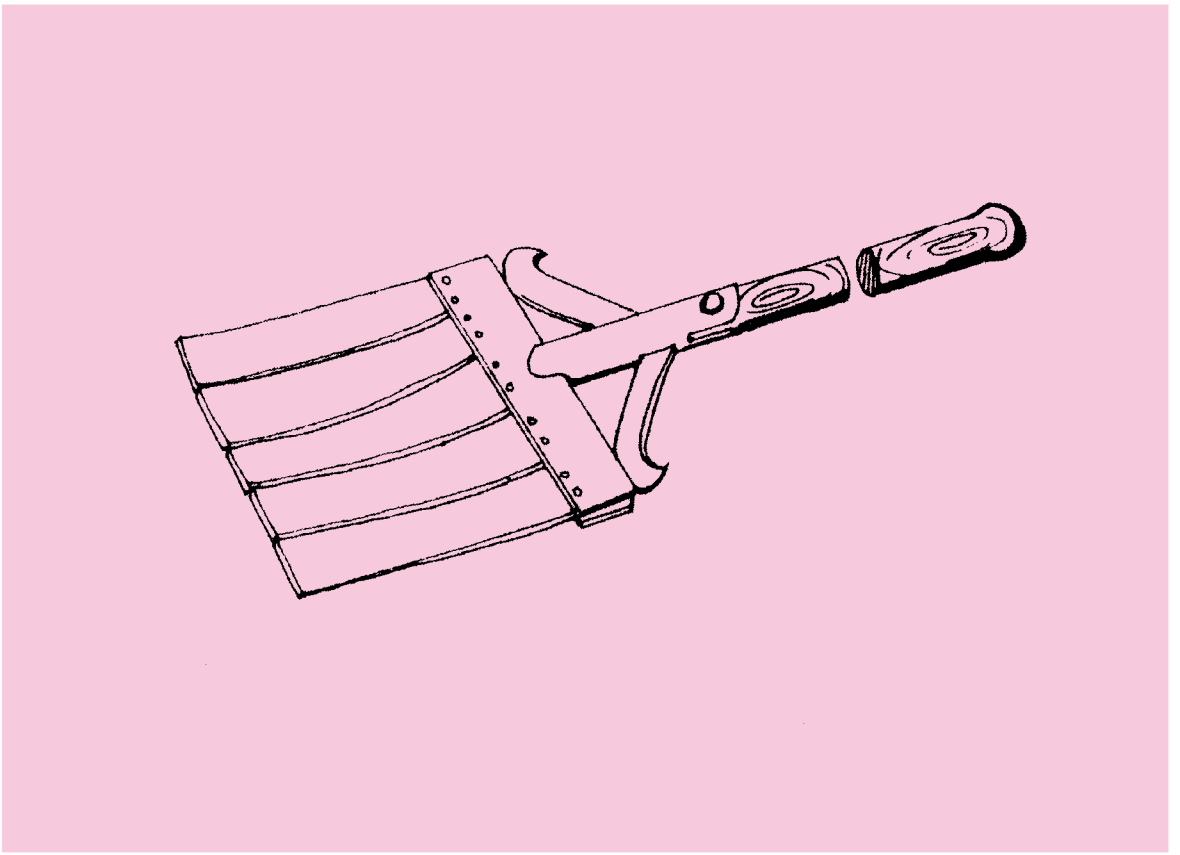
Use Cutting large material and felling timber and snags.

Maintenance Daily maintenance and regular sharpening essential.

Technical Specifications

Weight	:	5 kg.
Guide bar length	:	13".
Engine	:	49 cc, 2-stroke.
Special features	:	Chain brake; handle guard.

Fire swatter



Use

1. To extinguish the flames in grass fire suppression.
2. The hooks are designed for rolling of obstacles or burning debris.

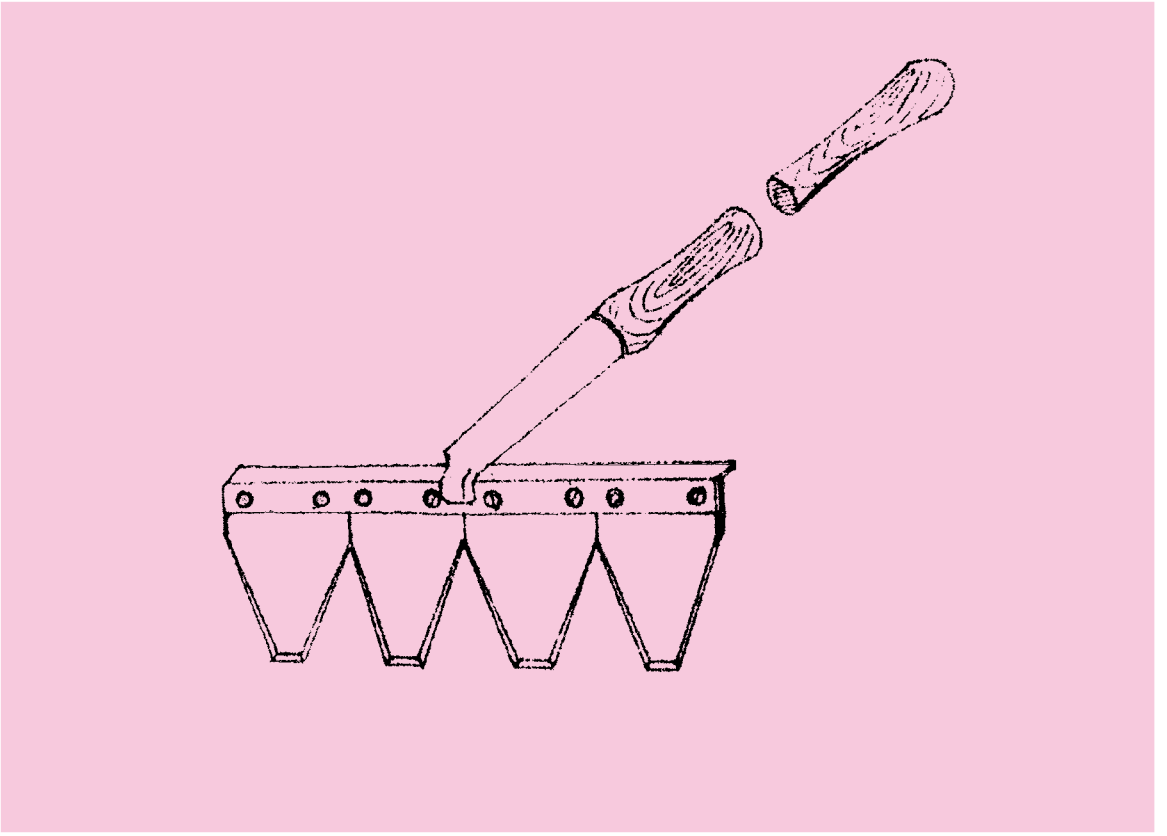
Maintenance

1. Tightening of the nuts and bolts with the an adjustable wrench.
2. Replacement of flaps when worn-out.
3. Replacement of handles, if damaged.

Technical Specifications

Weight	:	2.70 kg.
Length of handle	:	1520 mm.
Length of flaps	:	300 mm.
Width of flaps	:	50 mm.
Material	:	Conveyor belt for flaps, mild steel; tough wooden handle, e.g. *Parashorea.*
Function	:	Grass fire suppression.
Special features	:	Flaps can be replaced; safety grip (knob).

Fire rake



Use

1. For fireline construction.

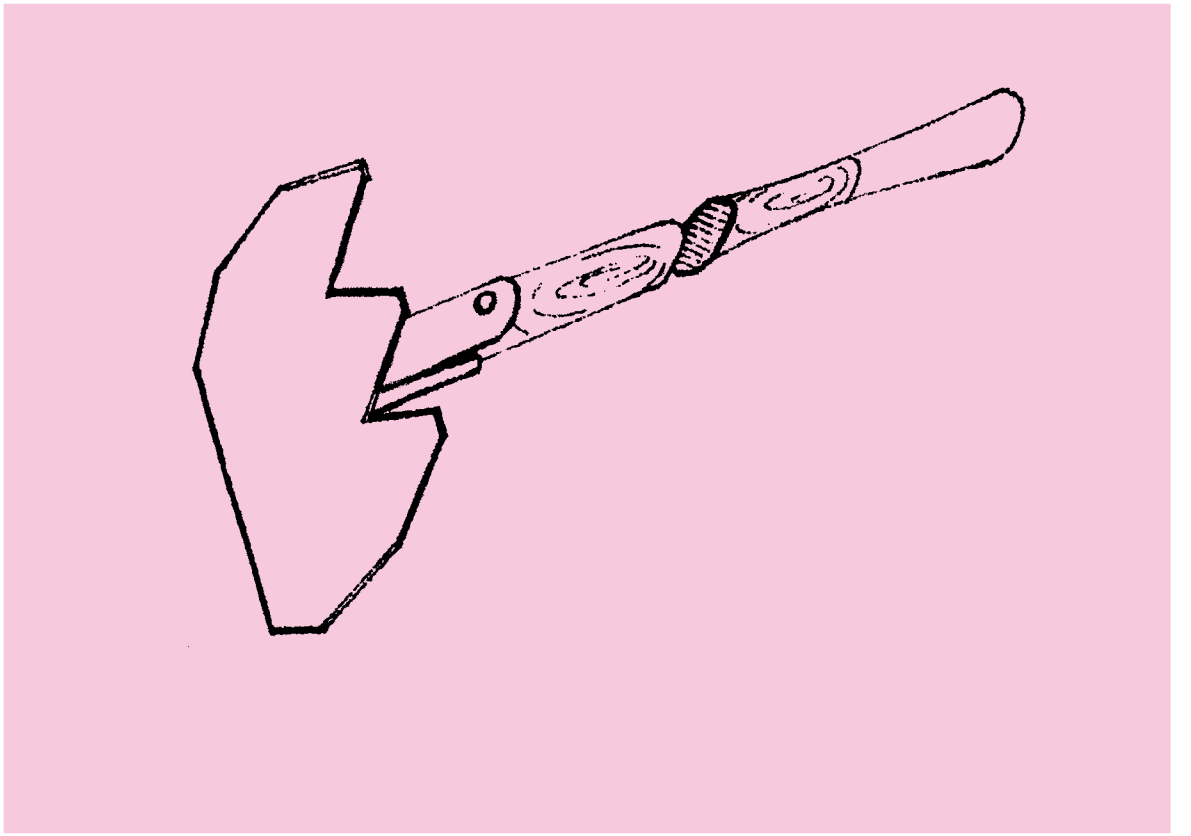
Maintenance

1. Tighten all nuts and bolts using an adjustable wrench.
2. Sharpen blades with a file.
3. Replace either the blades or handle when necessary.
4. Clean with water and wipe with oil after use.

Technical Specifications

Weight	:	2.20 kg.
Length of handle	:	1200 mm.
Width of metal head	:	305 mm.
Material	:	Mild steel; tough wooden handle, e.g. *Parashorea* or similar.
Function	:	For fireline construction.
Special features	:	Replaceable blades; safety grip.

Rake-hoe



Use

1. Used to rip up and remove the vegetative cover from the area of a fire break under construction.

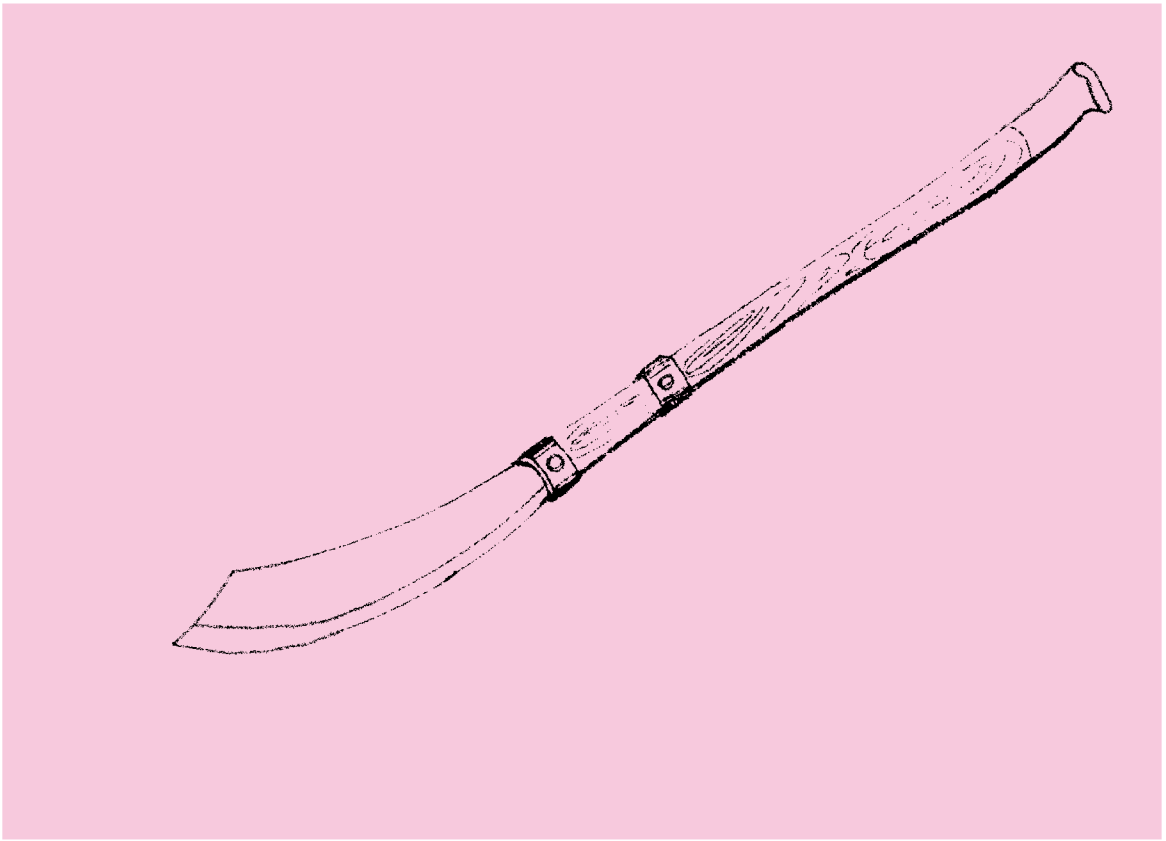
Maintenance

1. Sharpening on all four sides of the blade with a file or grindstone.
2. Tighten the nuts and bolts with an adjustable wrench.
3. Replace either the blade or handle when necessary.
4. Clean with water and wipe with oil after using.

Technical Specifications

Weight	:	1.80 kg.
Length of handle	:	920 mm.
Width	:	230 mm.
Material	:	Mild steel; tough wooden handle, e.g. *Parashorea* or similar.
Special features	:	Flat handle; safety grip; sharpening on all four sides of the blade.

Improved grass-cutting bolo



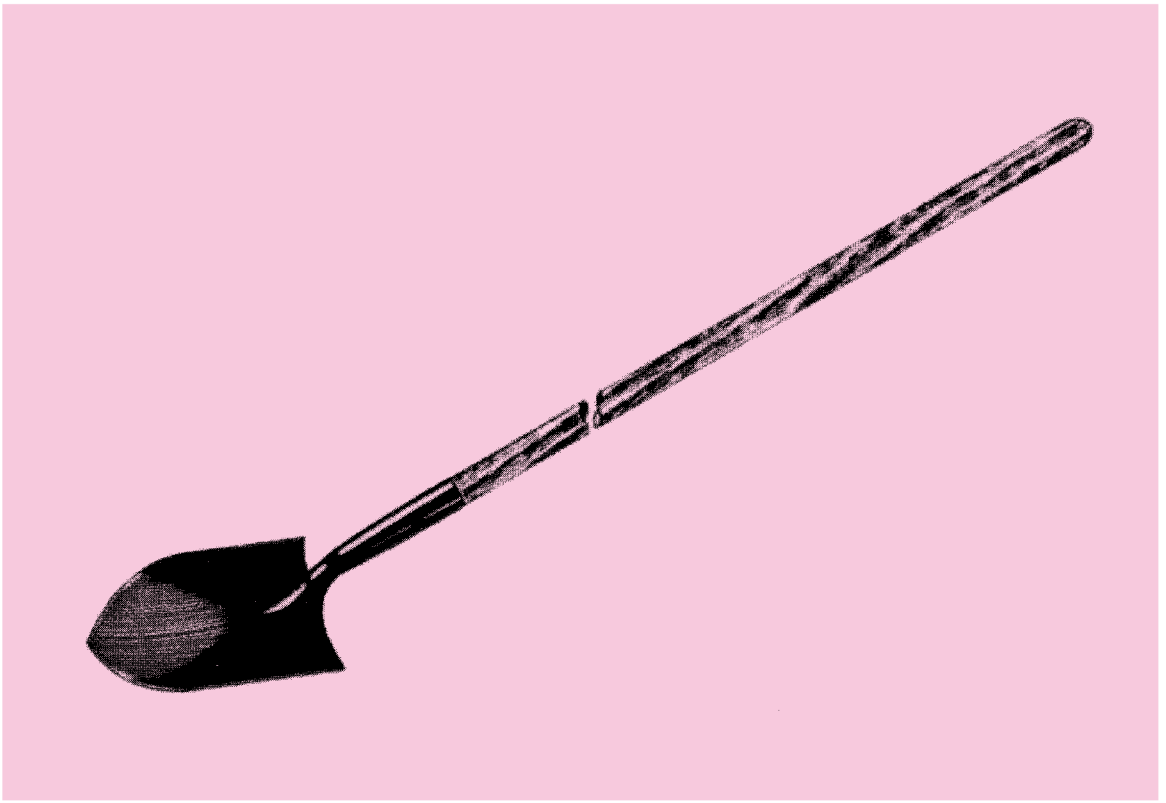
Use 1. Cutting of grass.

Maintenance 1. Sharpen the blade using a file and whetstone.
2. Wipe the blade with oil to prevent rusting.

Technical Specifications

Weight	:	0.5 kg.
Length of blade	:	300 mm.
Length of handle	:	560 mm.
Material	:	Discarded bandsaw blade and very light wood handle (such as *Shorea* spp.).
Special features	:	One or two reinforcing segments preventing splitting of handle; replaceable handle and blade; washer between nut and bolt.

Fire-fighting shovel



Use

1. It is mainly used for throwing soil to extinguish flames.
2. It can also be used to scrape firelines and to swat flames.

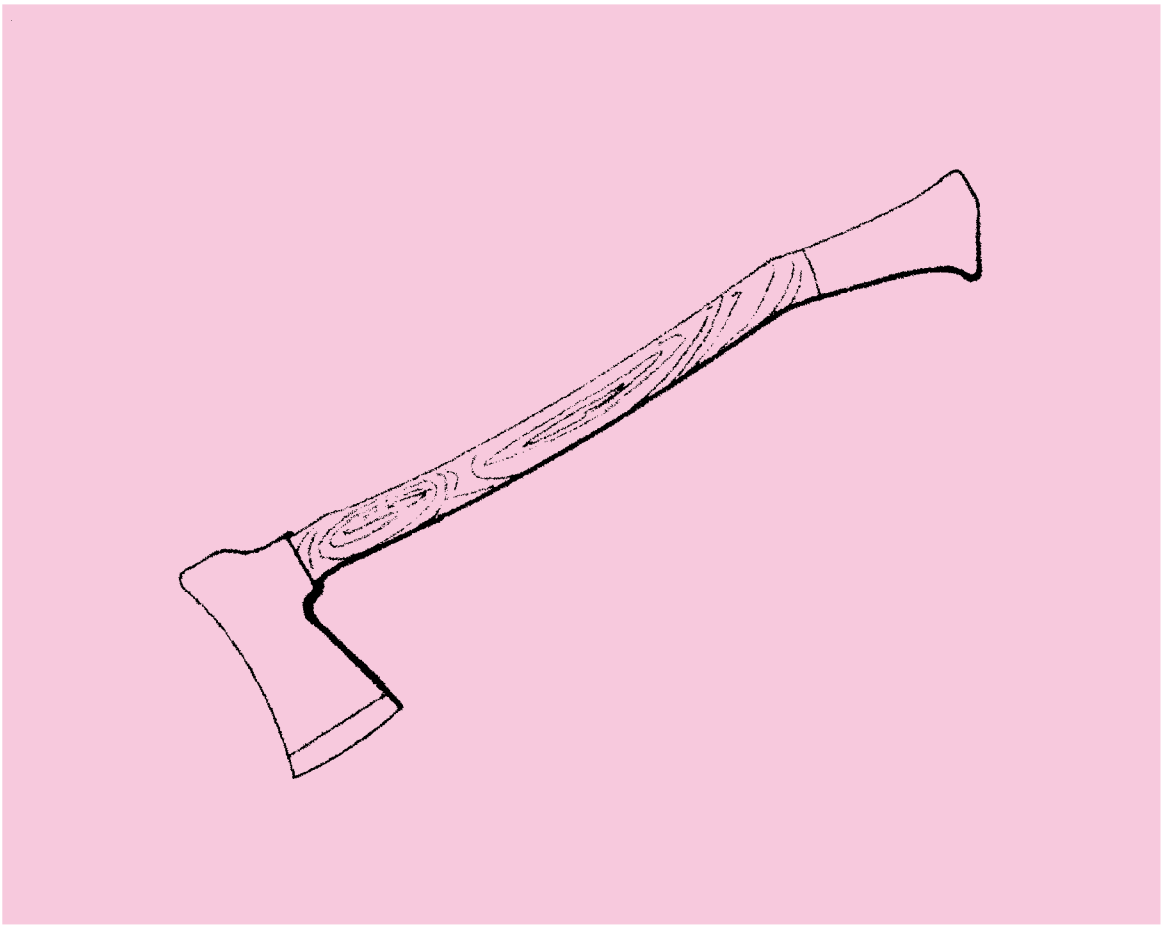
Maintenance

1. Shovels must always be kept in optimum condition by sharpening with a file or a grinding stone.
2. Replacement of handle, if damaged.
3. After use, clean with water and apply oil using cotton rag moistened with oil.

Technical Specifications

Weight	:	3.20 kg.
Length (handle)	:	1500 mm.
Length of blade	:	300 mm.
Width of blade	:	220 mm.
Material	:	Mild steel; tough wooden handle, e.g. *Parashorea* or similar.
Function	:	To scoop up top soil or double as fire swatter.
Special features	:	Cross grip; concave blade for structural strength.

Axe



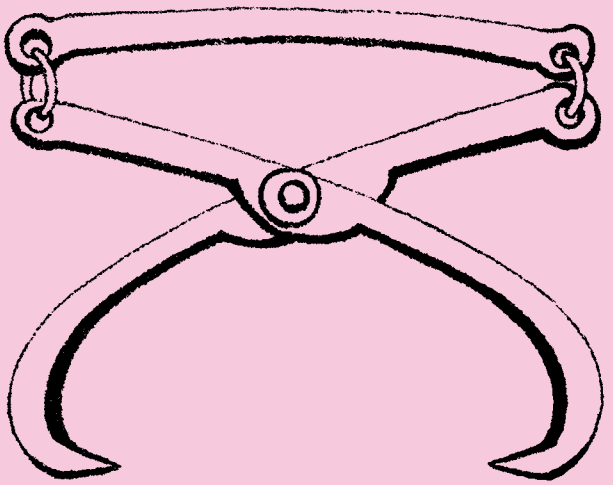
Use 1. For blazing and brushing.

Maintenance
1. Sharpen the blade using of file and whetstone, or a grindstone.
2. Replace handle if damaged.
3. Clean the tool and wipe the blade with oil before it is stored.

Technical Specifications

Weight	:	2.40 kg.
Length of axe	:	650 mm.
Width of head	:	93 mm.
Material	:	Handle - tough hardwood.
	:	Blade - high quality steel.
Special features	:	Hammer design of axe head for pounding tree felling wedge.

Teamwork tong



Use 1. For fire trail / line construction.

Maintenance 1. Sharpening of tips, lubrication of central joint.

Technical Specifications

Weight	:	2.30 kg.
Length, closed	:	590 mm.
Maximum grasp width	:	315mm.
Material	:	Leaf spring
Special features	:	Reinforced portions around the central rivet.

7.2 Fire Pumps

7.2.1 General

The engine driven firepump, or so called fire-engine or pumper, is the most important piece of equipment for the modern fire brigade at the scene of the fire. That is why fire-engines used to be called "the heart of fire fighting works", and fire hoses "the blood veins".

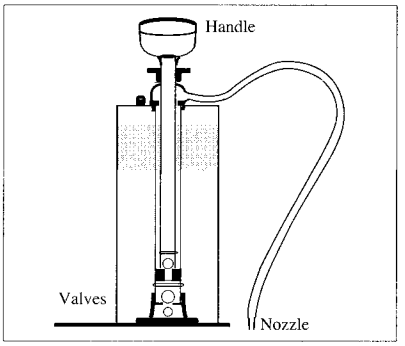
The target of the firepump is to give pressure and momentum to water at the scene of the fire. The firepump itself is driven by a gasoline or electrical engine or by human power.

7.2.2 Backpack pump

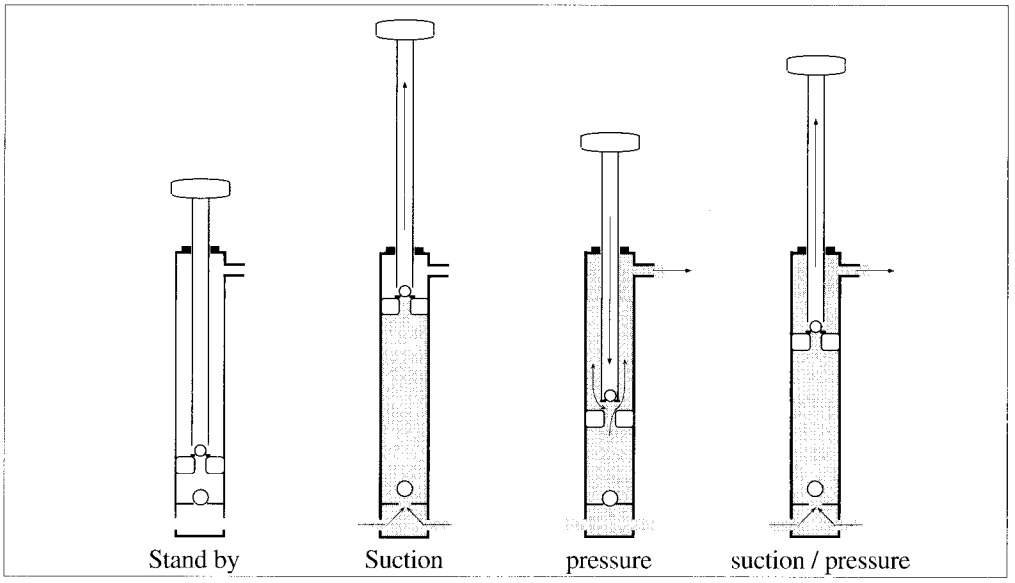
Backpack sprayers should be included in the fire fighting equipment because of their extreme portability and effective use of small quantities of water. The use of water in the forest fire should be limited by using the fog stream nozzle as much as possible. With the fog stream nozzle the heat of a fire can be cooled 4-5 times more effectively than with the straight nozzle spray. The fog stream nozzle spray is excellent for wetting down unburt fuel and for building a narrow but effective break in the fuel. The length of the straight stream can be more than 10 metres and the maximum water use can be 10 l/min.

When a backpack pump is used the following must be remembered:

- keep the pump full of clean water;
- keep the lid closed;
- check that the tube and nozzle are not blocked; and
- check and oil the pump regularly.



Typical backpack pump



Action of the backpack pump

7.2.3 Centrifugal pump

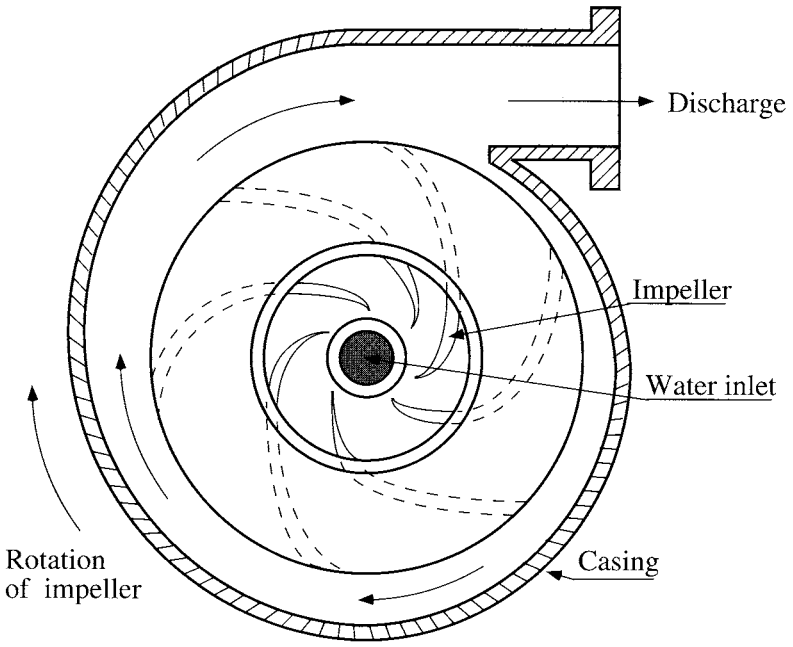
Pressure to pump water can be produced by a centrifugal pump. Such a pump consists of a casing within which there is an inner nest containing one or more impeller plates. The impeller plates are formed of two round discs held apart by the impeller blades. A pump with one impeller plate is known as a one-graded pump, with two plates as a two-graded pump, and so on.

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.

Use and characteristics of the centrifugal pump

Water may be raised to the pump through vacuum by using a suction pump. When the water reaches the impeller plates it is thrown with great force against the casing, on its way to being discharged. If a one-graded pump gives a discharge pressure of four atmospheres, a two graded pump will give up to eight atmospheres, and so on. However, if water is taken from a pipe, with a pressure of three bars for instance, the pressure at discharge from a two-graded pump will be eleven atmospheres (8+3).

A higher rotation speed in the pump will give a greater water pressure and volume. Higher rpm will increase the rotation speed, the water pressure growing with the revolutions.



The water capacity of the pump is calculated as follows:

$$W_1 = W \frac{r_1}{r}$$

where: W = Water capacity in litres/minute.
W_1 = Increased water capacity in litres/minute for rpm (r_1) of the pump.
r = Standard rpm in the pump.
r_1 = Estimated increased rpm in the pump.

The pump's water pressure is calculated as follows:

$$P_1 = P \frac{r_1^2}{r^2}$$

where: P = Standard water pressure in bars.
P_1 = Increased water pressure in bars when using increased rpm (r_1) in the pump.
r = Standard rpm in the pump.
r_1 = Estimated increase in pump rpm.

The energy requirements of the pump can be calculated as follows:

$$E = \frac{W \times H}{4500 \times \eta}$$

where: E = Energy requirement in kilowatts.
W = Water in litres / minute
H = Static pressure height of water in metres.
η = Efficiency coefficient (0,5 - 0,8)

The pump efficiency at different water capacities can also be calculated by modifying this formula and using the known energy of the pump (kW) for value E.

The suction pump

The centrifugal pump (which is nowadays the most common firepump) cannot by itself take water from the water source. It has to be equipped with a suction pump or vacuum pump.

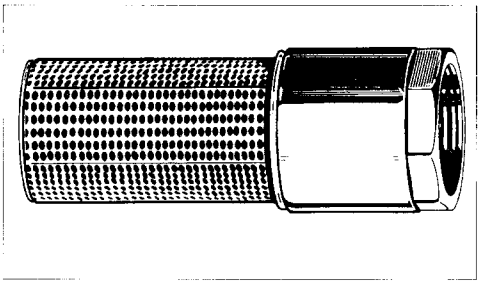
The suction pump is placed by the water source to suck water into the centrifugal pump. The highest theoretical suction height from the water to the suction pump is 10,3 metres, although in practice the maximum suction height is normally 4 - 6 metres. If warm water is being drawn the suction height decreases with the increase in temperature, as shown in the following table:

Water temperature		Loss of suction height (approx.)
(Centigrade)	(Fahrenheit)	(metres)
30°	86°	0,5
45°	113°	1,0
60°	140°	2,0
75°	167°	4,0
80°	176°	5,0
90°	194°	7,0
100°	212°	10,3

Suction height is also lower if the air pressure is lower, as at high altitudes.

When placing the suction pump at the water source one of the most important considerations is obtaining good strong suction. The pump should be placed as near to the water as possible, with the suction height remaining less than six metres. For uphill pumping, the hose between the pumps should be constantly rising upwards, with no downward sections. For example, always under an obstructing fence and not over it; since going over the fence would cause a downward section when coming off it.

The suction strainer should be placed deep enough into the water to prevent any air being drawn into it. It should be more than 20 centimetres below the water level. The suction strainer must be hung in a fire bucket to prevent sand and dirt entering the line and reaching the pump. It must also be equipped with a return valve in order to constantly hold the water in the suction hose.



7.2.4 Use of fire pumps and hose lines

Friction loss

Friction loss is a loss of pressure in the fire hose due to the turbulence created by the interior surfaces of the hose. Additional pressure is needed at the pump to overcome this loss and maintain the desired pressure at the nozzle.

Friction loss increases if water flow is increased or if the hose diameter is reduced. It is also affected by the roughness of the interior hose surface. To decrease friction loss, bigger diameter hoses and/or lower pressure must be used, or there should be a shorter hose line between pump and nozzle. Also, hose should be laid as straight as possible.

Elevation loss

Elevation loss is the pressure drop caused by raising water to higher elevations. To obtain the same pressure at the nozzle as at the pump, the calculated elevation loss must be added to the pump pressure.

Friction loss and elevation loss must be calculated for any type of hose operation.

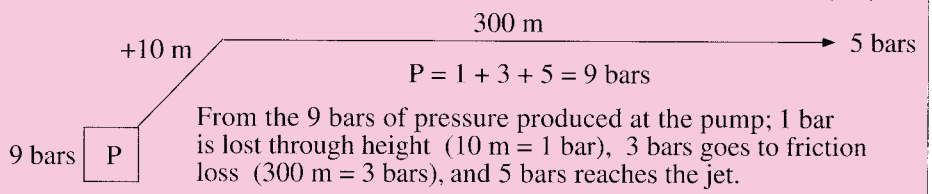
Rule of thumb

Friction loss is about 1 bar / 100 m of hose
and elevation loss is 1 bar / 10 m of elevation.

Friction loss and elevation loss can be calculated for several different situations as follows:

Example 1

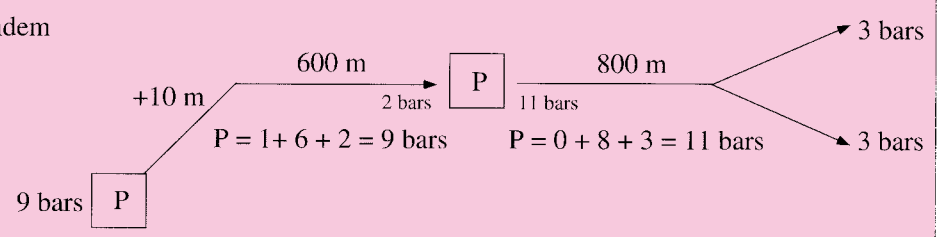
Single



From the 9 bars of pressure produced at the pump; 1 bar is lost through height (10 m = 1 bar), 3 bars goes to friction loss (300 m = 3 bars), and 5 bars reaches the jet.

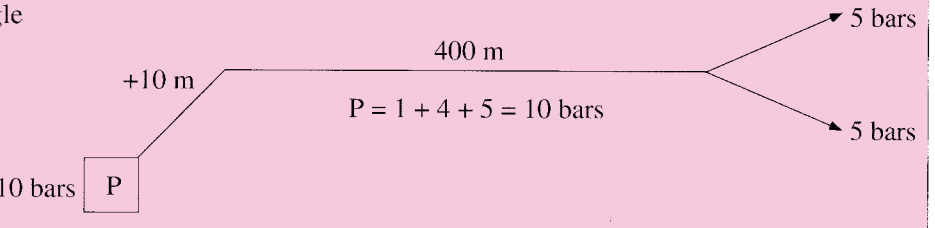
Example 2

Tandem



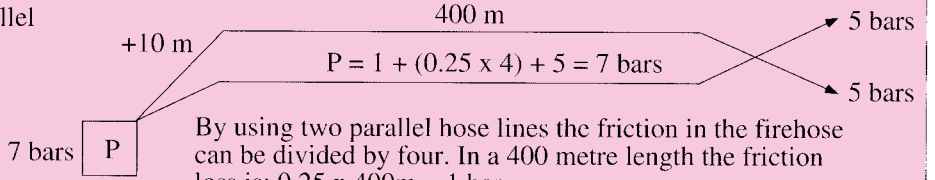
Example 3

Single



Example 4

Parallel



By using two parallel hose lines the friction in the firehose can be divided by four. In a 400 metre length the friction loss is: 0.25 x 400m = 1 bar.

7.2.5 Main categories of pumps

The pumps that are normally used at forest fires can be divided into two categories:

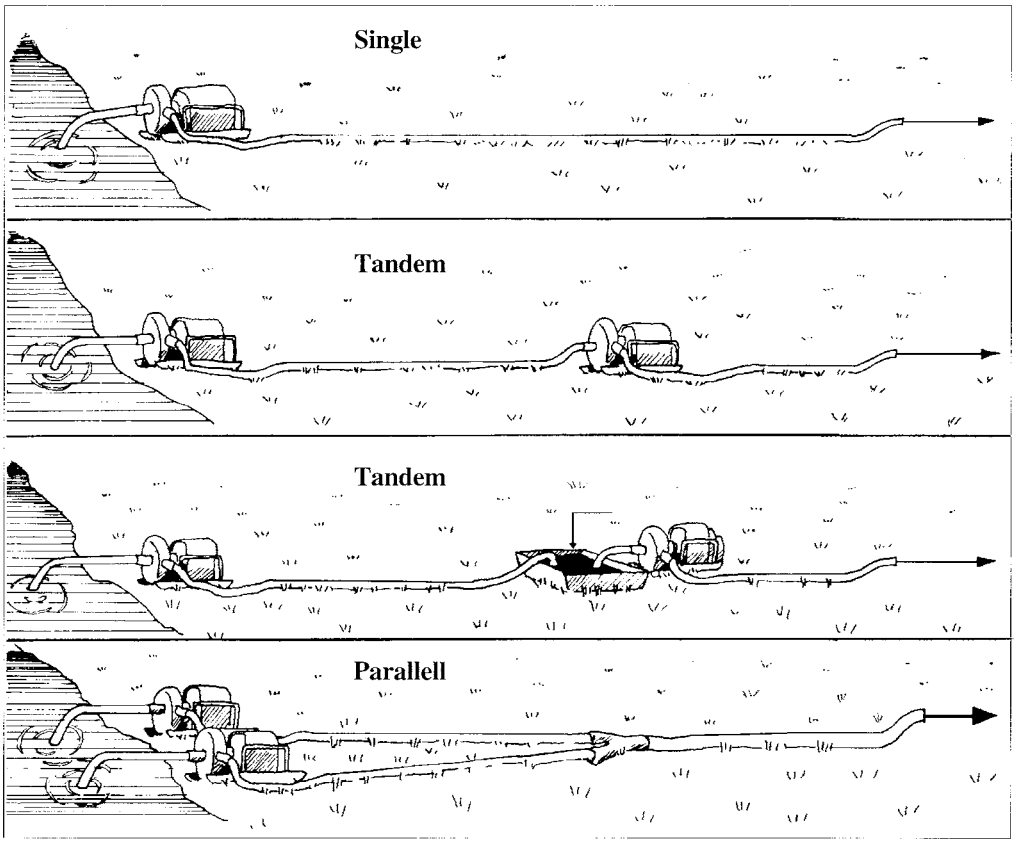
Fire-engine pumps - connected to a fire-engine and getting their power directly from its engine. The capacity of these pumps is normally very high, on average 10-20 bars pressure and 1000-3000 l/min. In addition to the pump, many fire engines are also equipped with an extra water tank.

Portable pumps - as used in forest fires must be of light weight because these will be easier to carry for long journeys in the forest. The capacity of portable lightweight pumps is usually 300 - 1000 l/min with a pressure of 5 - 15 bars. Portable pumps are useful if the water source is not accessible to fire-engines and if the water is close enough to the place of fire.

In addition, there are high pressure pumps used for fog spraying in an initial attack. These pumps are normally connected to fire engines.

7.2.6 The main pump hook-ups, booster pumps, and tanks

There are several ways to apply the water equipment supplying water in fire suppression. The crew boss, who is responsible for water supply, must know all the main applications and the advantages and disadvantages of each one.



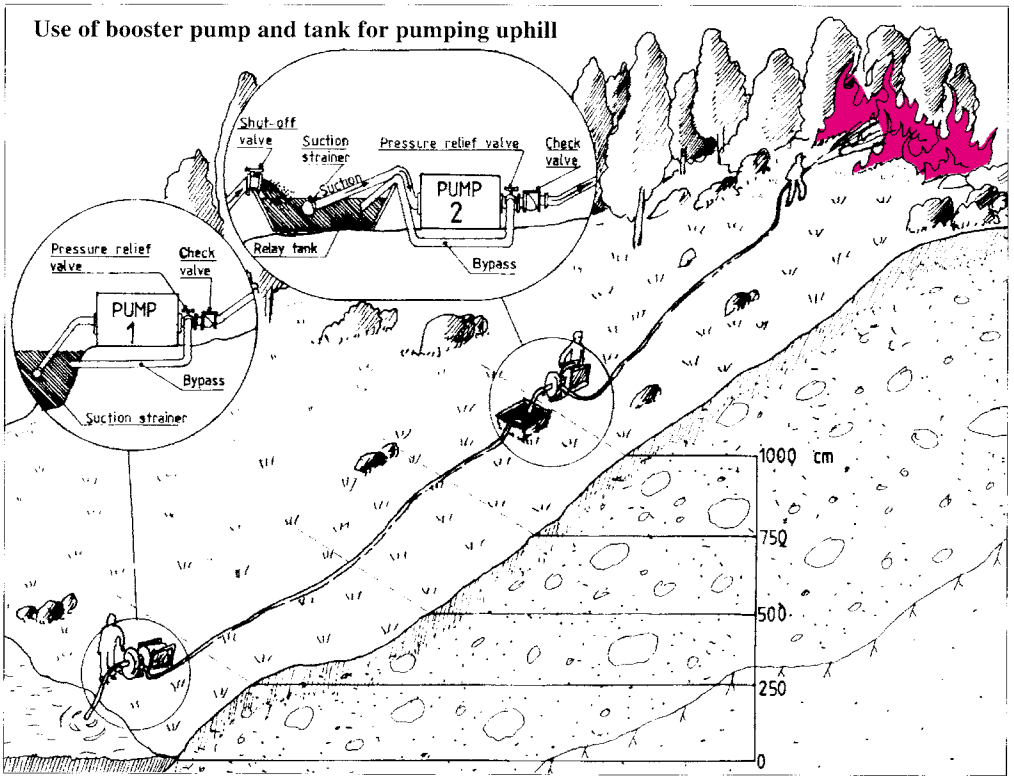
Selection of the application is affected by the:

- method of attack;
- fire intensity and fuel type;
- topography;
- water source and its quantity;
- fire fighting equipment in use; and
- the distance between the fire and water source.

If elevation or distance reduces water pressure below effective nozzle pressure an extra portable pump, preferably with a relay tank, should be installed between the nozzle and the main pump. The main objective with booster pumps is to raise the water pressure and capacity at the nozzle. The booster pump normally has a lower pressure capacity than the main pump.

Booster pumps can be set up in tandem or parallel fashion. When the booster pump is installed directly in the line, careful coordination is required and the pumps should be constantly attended. Communication between the pumps is highly desirable. Several booster pumps may be employed in one line, the only limitation being the suitability of equipment. It is usually impractical to connect more than three pumps directly (in tandem), but with relay tanks there are no limits except time and distance.

If the booster pump is only connected between the source and the final hose line an adapter coupling will be needed for the different diameter hoses. A special divider coupling will also be required for parallel operation.



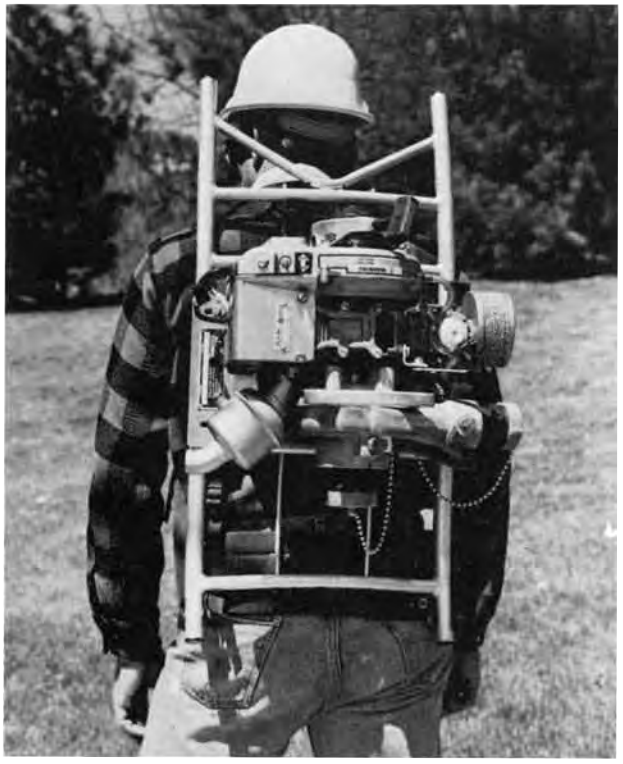
Mako backpack pump

Construction: The pump has a light and very sturdy container made of polyethylene and is designed for easy carrying. The detachable lid is waterproof. The filling hole is equipped with threads and is amply dimensioned to make filling the container quick and easy. The pump is supplied with a metal foot brace. This efficient pump is double-acting and gives an even and long spray. The cylinder and pistons are made of seamless drawn brass tube and the other parts are of cast brass. The spray is furnished with a flexible rubber hose as well as nozzles for straight and fog stream.

Technical Data

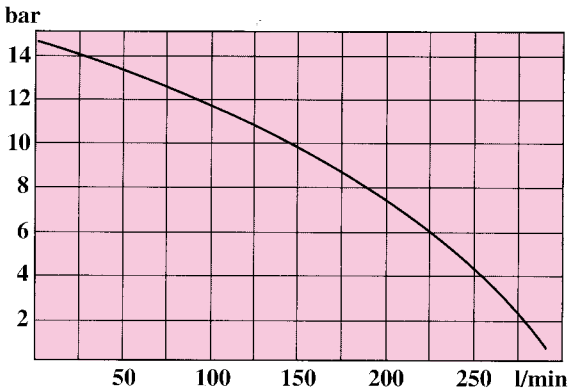
Fire type: A (fibre fires).
Fire agent: Water.
Capacity: 22 litres.
Weight: 5 kg.
Diameters: Length / width / height: 25 / 37 / 67 cm.
Hose length: 700 mm.
Hose diameter: ½".
Effective time of use: Straight stream 5 - 7 minutes, fog stream 10 - 15 minutes.

Hale fyr pak

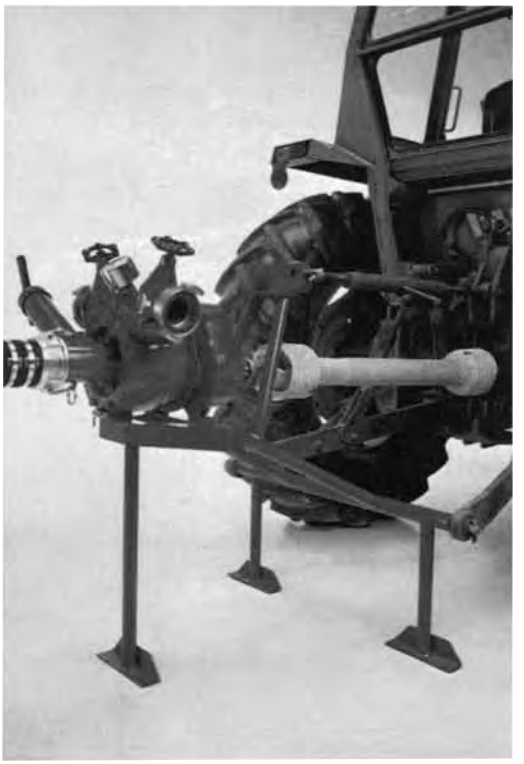


Technical Data

Motor:	U.S. Marine Co., air cooled, lubricated by oil/gas mix, features solid state ignition for easy starts and electrical overspeed protection. Spark-arresting muffler,standard.
Power:	8 HP at 7000 RPM
Weight:	15,4 kg.
Dimensions:	Length / width / height: 81 / 42 / 33 cm.
Ignition system:	Electronic.
Fuel:	Gasoline / oil 50:1 (2%).
Pump:	Centrifugal type bolted directly to engine.
Closed pressure:	14 bars.
Water capacity:	250 l/min.
Suction height:	2 m.
Suction equipment:	1½ -inch NPT.

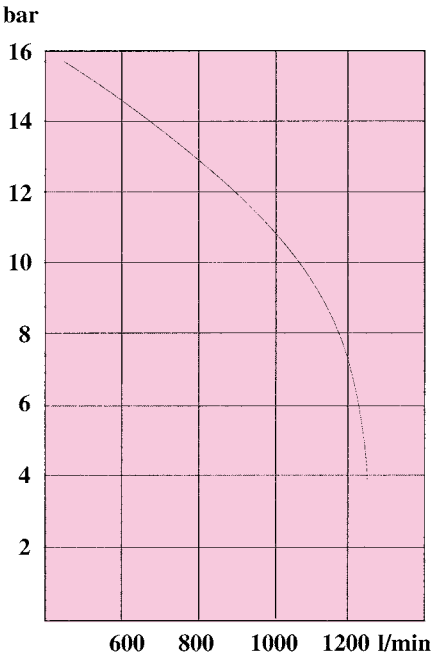


Tractor Esa



Technical Data

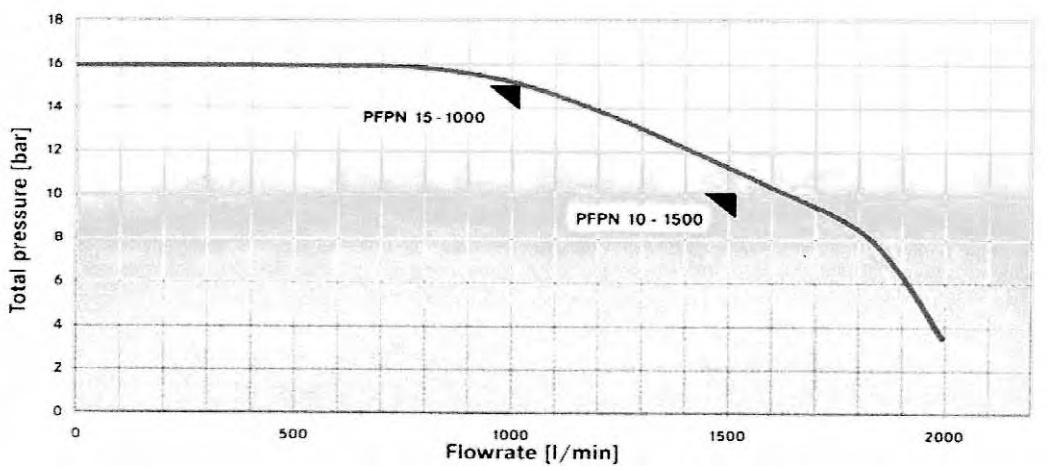
Construction:	Motor pump for tractor installation.
Pump:	l-stage centrifugal pump cast in anodized light metal with 1:10.8 gear box, suction inlet 3 ¼" and two 3" pressure outlets, regular pressure 17 bars.
Standard equipment:	4 x 2 m of 3 ¼" suction hose with automatic couplings, suction filter with bottom valve, intermediate and recouplings, suction inlet cover, power transmission shaft, installation equipment.
Weight:	Weight 76 kg with shaft and couplings.
Dimensions:	Length/width/height: 90/95/98 cm.
Water capacity:	1200 l/min at 8 bars.
Suction equipments:	Suction inlet screw R 3", pressure outlet screw R 2 ½".



Rosenbauer Fox III

Technical Data:

Motor:	BMW A 67 boxer 1170 cc.
Fuel tank:	20 litres (will last for 90 minutes at full speed)
Power:	55 kW (77 hp) 5200 rpm
Weight:	Between 160-167 kg with fuel added
Dimensions:	L/WH = 947 x 740 x 840mm
Pump:	One-stage Centrifugal pump with single plate release clutch
Closed pressure:	17, 5 bar
Water capacity:	1000-2000l/min (from 4-15 bar)
Suction equipment:	4 pieces of Storz DS 110
	4" suction hoses á 2 metres.



Hale Pump

Technical Data

Motor: Chrysler 2 stroke Power Bee air-cooled 8.2 cubic inch (131 cm^3) displacement and solid-state ignition. Die cast aluminium cylinder and crankcase. Hardened forged steel connecting rod and crankshaft. Self-lubricated with oil and gasoline mixture. Spark-arresting muffler, standard.

Power: 8 hp at 7000 rpm.

Weight: 22 kg.

Pump: Centrifugal pump bolted directly to engine.

Suction: 2 inch (non-threaded) with easily removable oversize screen.

Discharge: 1,5 inch NST male with cap and chain

Body: Light weight, high strength, corrosion resistant aluminium alloy with smooth waterways for maximum performance.

7.3 Fire Armature

7.3.1 Fire hoses

Discharge hose

These hoses are divided into three groups:

(i) linen hoses;
(ii) rubber-linen hoses; and
(iii) rubber-covered hoses.

The size of the discharge hose used on wildfire control varies from a 1 inch garden hose to a 3 inch rubber-lined hose. The most frequently used sizes are the 1 inch booster hose and the 1 inch woven jacket rubber-lined hose.

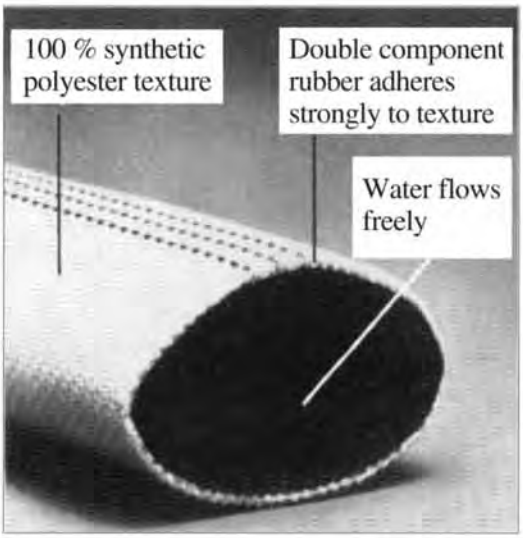
Linen hose is woven of flax fibres and synthetics. There is some leakage until the fibres swell and seal the tube. Minor sweating occurs during use, but this keeps the surface damp and resists burning. Linen hose is generally used in forest fire fighting

In general, hoses can be divided into two categories:

(i) small diameter hoses (1"- 1 ½"); and
(ii) large diameter hoses (2"- 3").

Large diameter hoses are used on main lines and small diameter hoses (or work line hoses) are used with nozzles.

Structure and test output of firehoses

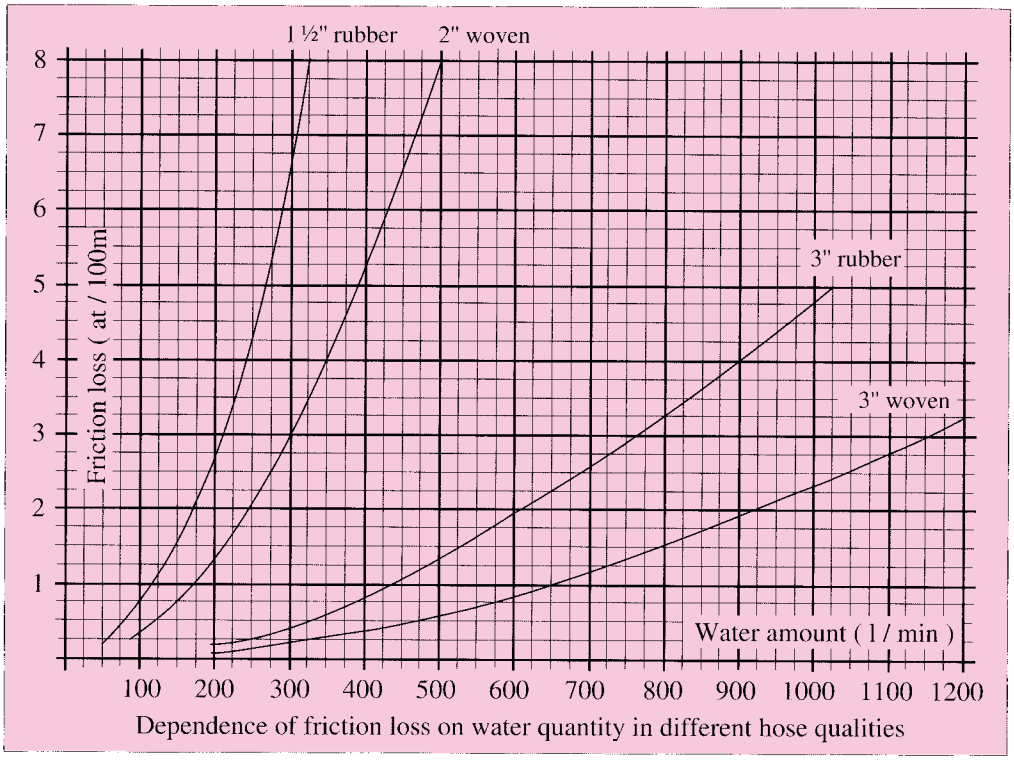


ø"	ø mm	weight g/m	break pressure bar	work pressure bar	test pressure bar
1½"	39	221	50	17	25
2"	57	294	50	17	25
2½"	63	388	50	17	25
3"	76	496	50	17	25
4"	102	633	35	12	17
4⅓"	110	750	35	12	17
6"	150	1066	20	7	10

Friction loss in fire hoses

Water input l/min	Friction loss in fire hoses / 100 m (bars)			
	3" rubber	3" woven	2" woven	1 ½" rubber
100			0.3	0.7
150		0.1	0.8	1.7
200	0.1	0.2	1.4	2.8
250	0.15	0.3	2.1	4.6
300	0.2	0.4	3.0	6.6
400	0.4	0.8	5.0	11.4
500	0.6	1.3	8.0	
600	0.9	1.9	11.0	
700	1.2	2.6		
800	1.5	3.3		
900	1.9	4.1		
1000	2.3	5.0		
1200	3.3			

Friction loss and water quantity in different hose qualities (bars)



Dependence of friction loss on water quantity in different hose qualities

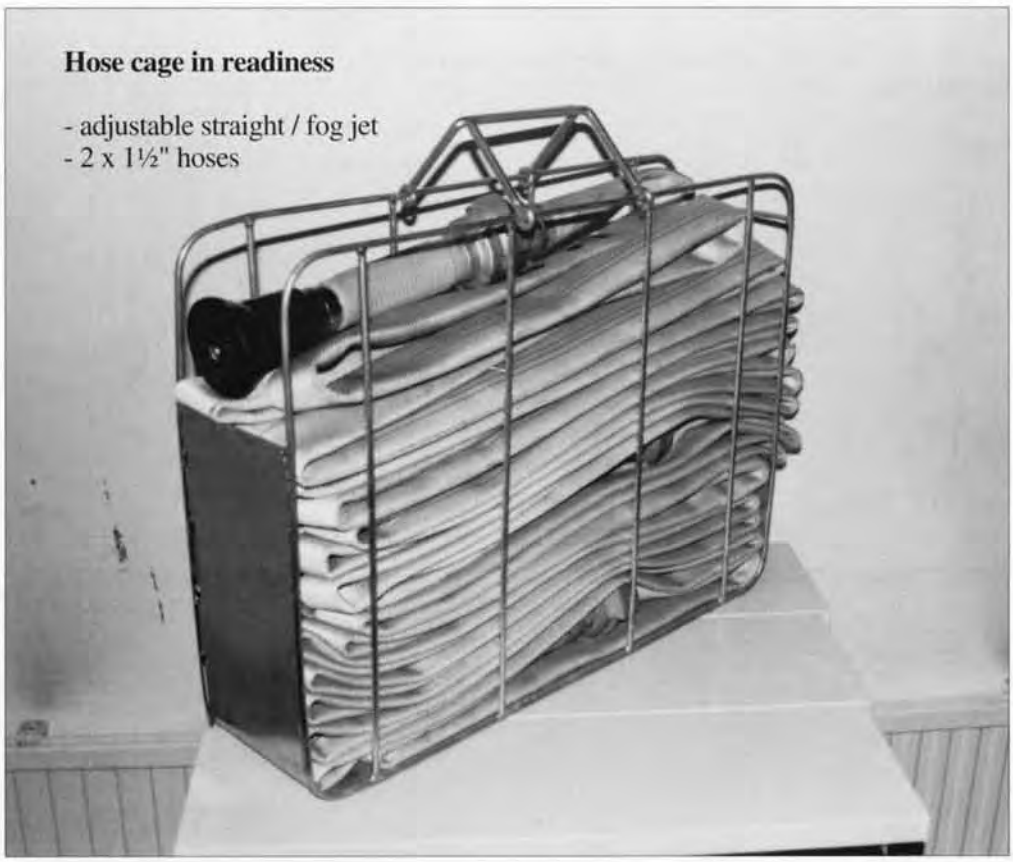
Hose lays

Often, the fire engine (pumper) can only reach one point at or close to the edge of the fire. In this situation the only way to supply water to the fire area is to lay lines of hose from the pump to the nozzleman. A simple way to lay the hose is to add hoses to the end of the line where they are needed. Gated wyes (dividing couplings) may be used at the intervals in the line.

Generally, the water supply line to the fire edge should be built starting from the pump to the main hose line, then dividing the main line with couplings, and finally adding two or three small hose lines at the edge of the fire to use as work lines. Three different hose lays can be defined.

(i) progressive high pressure hose lines (1" - 1½");
(ii) simple hose lays, or low pressure work hose lines (1½" - 2"); and
(iii) main hose and low pressure work hose lines (2" - 3").

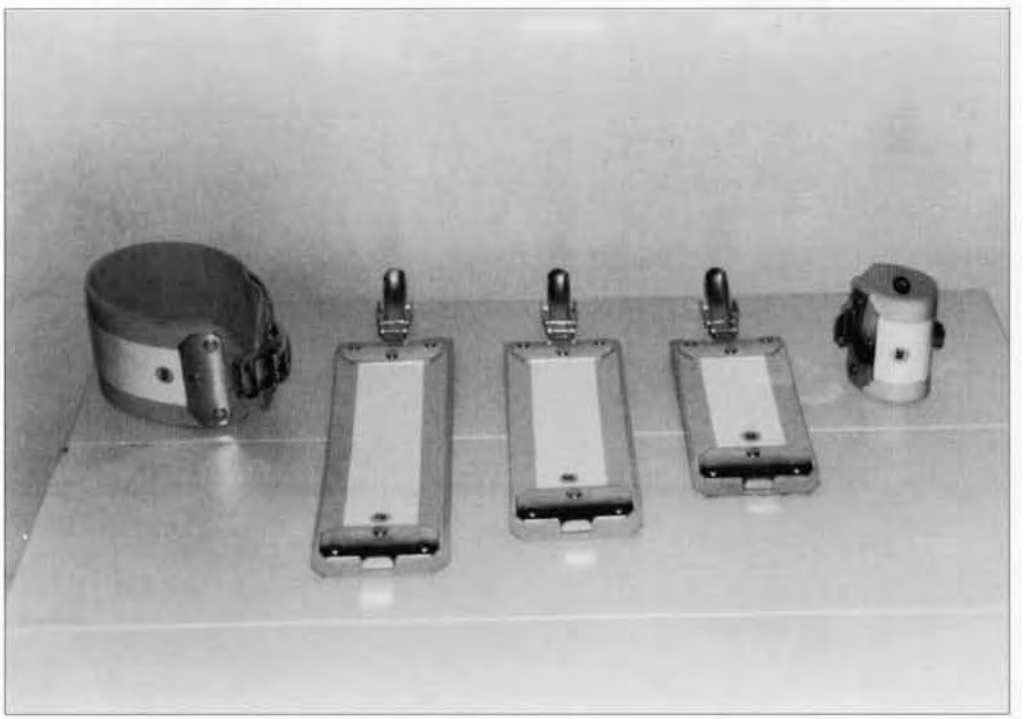
In any hose lay much will depend upon how much speed is required in applying water to the fire. If the forward speed of the fire is slow, one or two nozzlemen are enough to stop it by spraying their way up both flanks at one time. Hoses can be added to the line until a booster pump and / or portable tank is needed to obtain sufficient pressure for satisfactory nozzle performance.



Hose handling techniques

When handling hose, several important points should be observed.

(i) Do not drag the hose over rough surfaces or sharp rocks as the outside surface may become frayed and pinhole leaks may develop. Avoid hose lays over sharp objects as the vibration causes wear.
(ii) Use the best hose next to the pump where the pressure is greatest, and the poorer ones nearest the nozzle.
(ii) Lay hose in the most direct route from the pump to the point of use. Lay with a few short shallow curves on steep slopes and around trees and heavy brush so that the hose can be tied at intervals to keep it from slipping. When the hose is full of water its weight is enough to pull the line downhill unless anchored.
(iv) Never drop couplings to the ground or on stones: take care of care of them. Never use oil or grease in hoses. Handle hose threads carefully and keep hoses and couplings clean, maintaining and repairing them directly after use.
(v) Coiled hose is very easy to carry on backboards or in backpacks. Coiled hose is also very good when it comes to distributing the hose at a wildfire.



Repairing equipment for 3" - 2" and 1½" hoses used while fighting the fire.

7.3.2 Nozzles

Typical high quality nozzles (e.g. Sisu fogjet) for quick shut-off and stepless adjustment from straight stream to 90° fog and flush position are as follows.

M 12 - M 16 standard type

M 12 - M 16 shut-off ball valve type

M 10 short type for ¾" / 1" hose

Standard type:

- M 12/M 16 with coupling
- length 300 mm
- weight 1,5 kg

Can be equipped with a separate shut off ball valve:

- length 400 mm
- weight 2,6 kg

Material:

- body of chrome plated brass, top coated with weatherproof EPDM rubber bumper

Short type:

- M 10 with nipple for ¾" or 1" hose
- length 150 mm
- weight 0,9 kg

Function:

By turning the bumper round the stops the following functions can be obtained:

- shut-off
- straight stream
- stepless adjustment for up to 90° fog
- row of teeth for superior fog cone
- can be easily cleaned in a flush position (i.e. fully open)

The use of water is always limited in forest fires. That is why fog nozzles should be used as often as possible. When using a straight stream the diameter of the nozzle should be checked.

Water outputs in different Sisu jets with different pressures and options when producing straight stream and fog are given in the following table.

	Bars	Spray angle (degrees)	M 10		M 12		M 16	
			l/min	Reach (m)	l/min	Reach (m)	l/min	Reach (m)
Straight stream	2	-	90	18	135	23	200	25
	4	-	130	25	190	30	285	32
	6	-	165	30	240	33	360	35
	8	-	185	35	270	35	420	37
	10	-	210	37	300	38	465	40
Fog	5	30	130	12	185	15	290	15
		60	180	11	240	14	320	14
		90	320	10	320	13	390	13
	8	30	175	15	275	16	430	19
		60	250	14	350	15	490	18
		90	410	13	460	14	620	17

The general water output table for a straight stream is given in the table below.

Jet pressure (bars)	Jet diameter (mm)																
	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	Quantity of water (l / min)																
1.0	41	65	94	128	167	212	262	317	378	444	515	592	673	760	852	949	1052
1.5	50	80	115	157	205	260	321	389	463	544	631	725	825	931	1044	1163	1289
2.0	58	92	132	181	235	300	370	449	535	628	729	837	952	1075	1205	1343	1488
2.5	65	103	148	202	264	335	414	502	598	703	815	936	1064	1202	1348	1502	1664
3.0	71	113	162	221	290	367	454	550	655	770	893	1025	1167	1317	1477	1645	1823
3.5	77	122	175	239	313	397	490	594	708	832	965	1107	1260	1423	1594	1777	1969
4.0	82	130	188	256	335	424	524	636	757	889	1031	1184	1347	1521	1706	1900	2105
4.5	87	138	199	271	355	450	556	674	803	943	1094	1256	1429	1613	1809	2015	2233
5.0	92	145	210	286	374	474	586	711	846	994	1153	1324	1506	1701	1908	2124	2354
5.5	97	152	220	300	392	497	615	745	888	1043	1209	1388	1579	1783	1999	2227	2468
6.0	101	159	230	313	410	519	642	778	927	1089	1263	1450	1650	1863	2089	2327	2578
7.0	109	172	248	338	443	561	694	841	1001	1176	1366	1566	1782	2012	2256	2513	2784
8.0	116	184	265	362	473	600	741	899	1071	1258	1460	1675	1905	2151	2411	2697	2977
9.0	124	195	273	384	502	636	787	953	1136	1335	1549	1777	2021	2282	2558	2850	3158
10.0	130	206	294	404	529	670	829	1005	1197	1408	1632	1872	2130	2405	2696	3004	3328
11.0	137	216	311	424	555	703	870	1054	1256	1475	1710	1964	2234	2522	2828	3151	3491
12.0	143	225	325	443	582	735	908	1101	1312	1541	1787	2051	2333	2635	2954	3291	3646
13.0						765	945	1146	1365	1603	1860	2135	2429	2742	3075	3426	3795
14.0						793	981	1189	1416	1664	1929	2215	2520	2845	3190	3554	3938
15.0						831	1015	1231	1466	1722	1997	2293	2609	2945	3302	3679	4076
16.0						848	1049	1271	1514	1779	2063	2368	2694	3042	3411	3800	4210

7.3.3 Couplings

Quick couplings: 2" and 3" for hoses

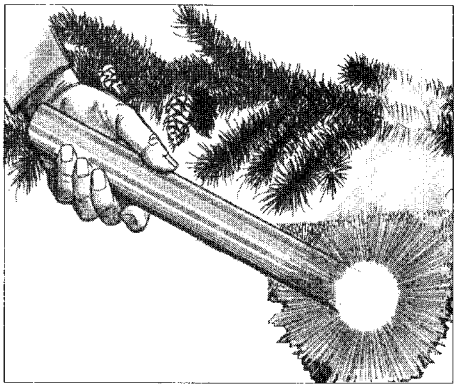
Dividing coupling: 3" - 3" + 2" - 2" quick couplings

Forest fire couplings: 3" - 2"

2" - 2" quick coupling

7.3.4 Firing devices

Fusees

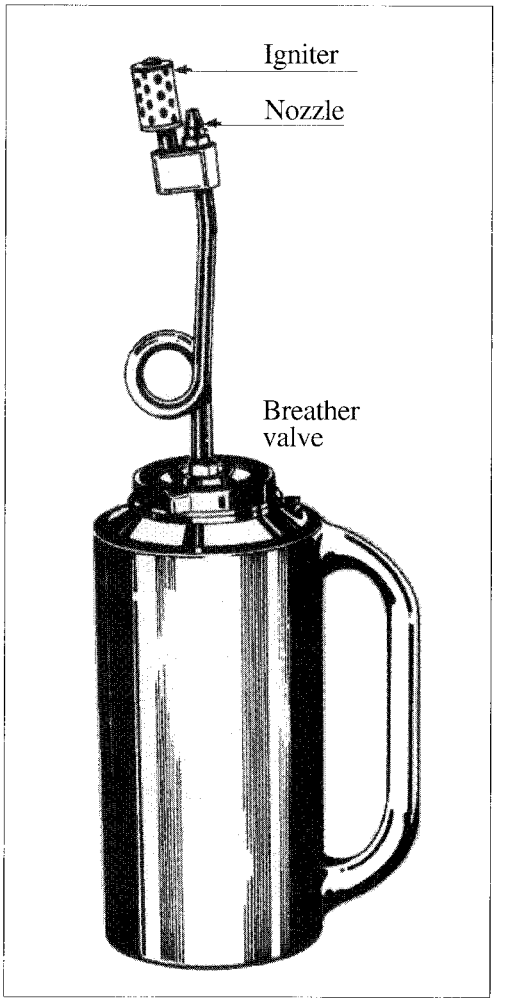


Fusees are produced in three to ten and twenty minute burning periods. They are self-contained and are started by striking the primer against the safety cap. They should be stored in a metal container in humid climates, or otherwise they will become soft and mushy.

Dispose of the remains so that livestock cannot eat them; they are poisonous to livestock.

Fusees are good firing devices and require relatively small investment.

Drip torches



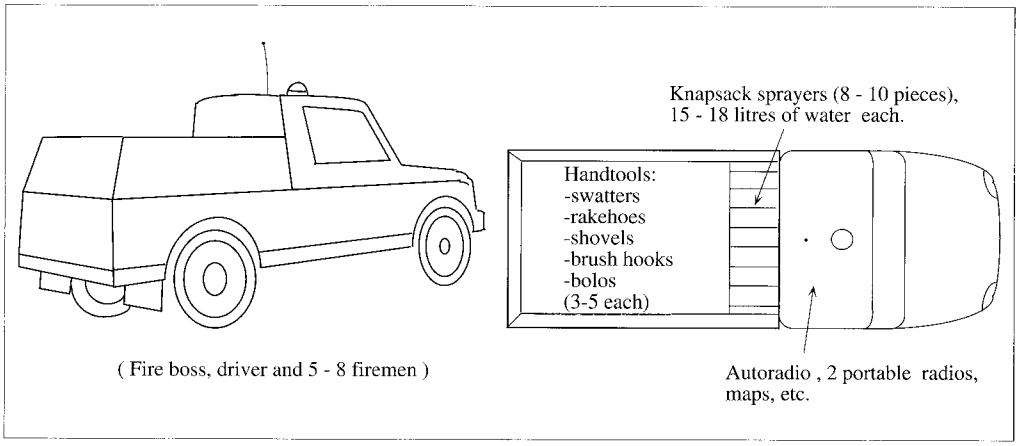
Sometimes referred to as a backfire pot, the drip torch is efficient, safe, and simple to operate. It is designed for firing semi-dry fuels that ignite slowly; when the burning oil is dripped onto the fuel, the operation can proceed without waiting for the fuel to ignite. Drip torches can fire a large area in a short time. These torches are equipped with a fuel trap on a spout to prevent flashback into the joint and a check valve in the cover to provide double protection against flashback. A breather valve, oilproof gasket, and sealed outlets prevent the slopping of fuel. They will operate best with a mixture of ⅓ gasoline and ⅔ diesel oil.

The torch should not be filled near an open flame or hot embers or while anyone is smoking, as the empty tank contains vapours that may explode. To operate, the torch is tilted forward until fuel flows over the burning igniter and the flaming oil is spread parallel to the direction of travel. To gain range, the torch is swung forwards and terminated with a snapping motion of the wrist. The igniter must have completely cooled before putting it out of service. Vehicle brackets are available for transport.

The drip torch is used to fire semi-dry fuels that are slow to ignite.

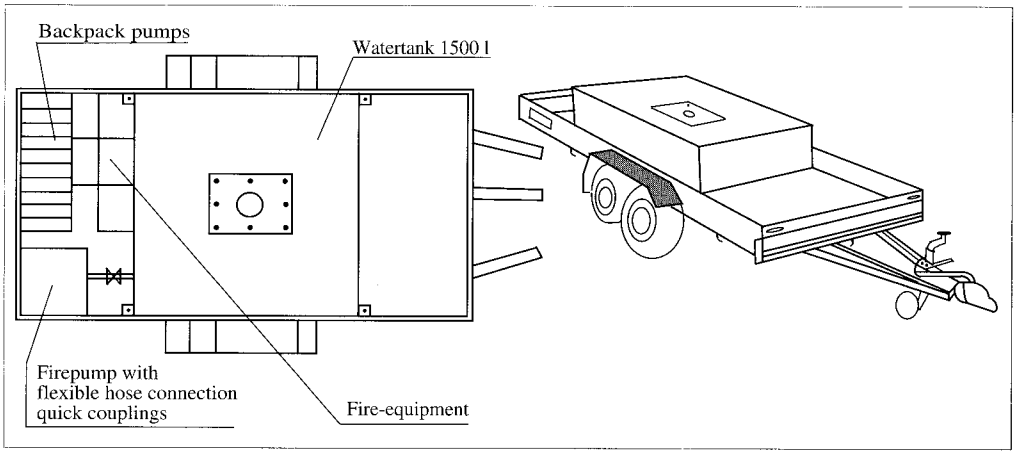
7.4 Fire Apparatus

7.4.1 Patrol or pick-up units



Tank-units designed for wildfire use are much less costly , better adapted to wildfire use, and more mobile than the standard fire department apparatus. Garden hose streams and adjustable garden hose nozzles or tips with quick shut-off are most often used on patrol tank units.

7.4.2 Fire trailer units



Fire trailer units consist of a trailer, watertank, portable fire pump, fire equipment, backpack pumps, and hand tools. Fire trailer units must be loaded and the water tank filled with water in high danger periods. Fire trailer units can be pulled with 4-wheel drive jeeps, trucks, or tractors.

7.4.3 Pumper units

4 x 4 bush fire vehicle used in NSW, Australia

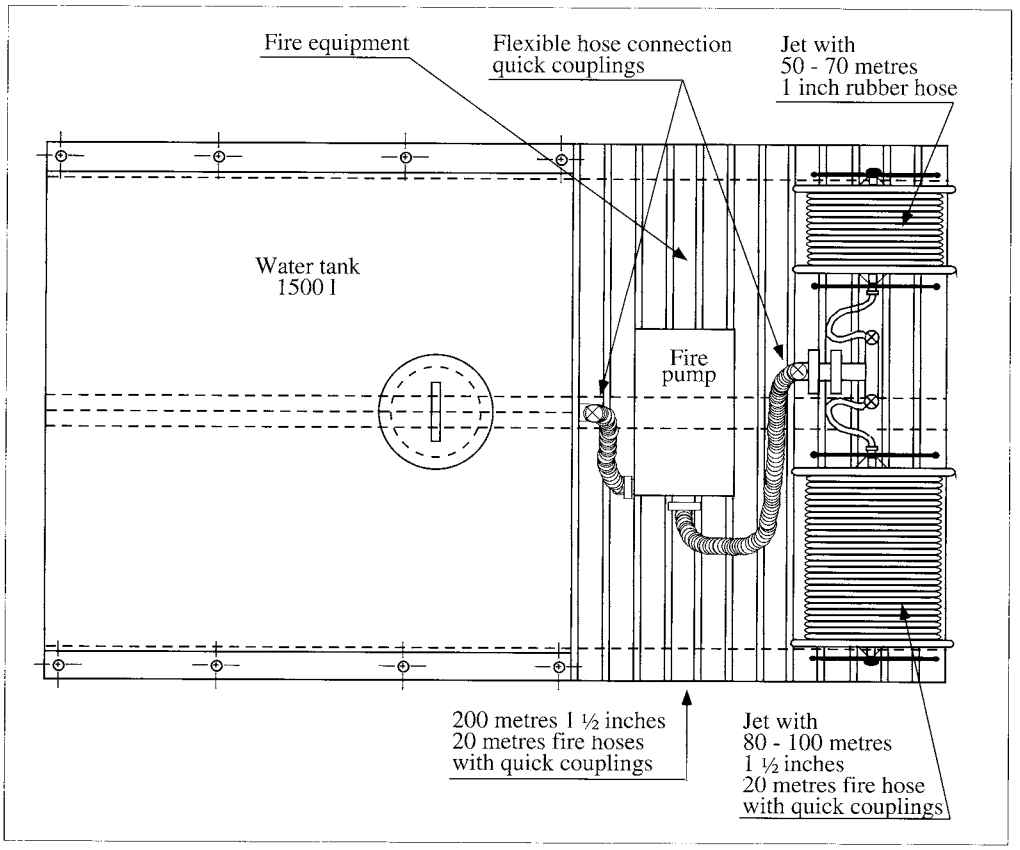
Pumpers for wildfire use have needs and characteristics distinct from those used in the regular fire service. Municipal pumpers can be and are used on wildfires, but they are most effective on structural fires. Because of their cost and high-volume capability, they should not be used on wildfires except as a last resort or backup to wildfire-type pumpers. Use of high-cost pumpers in off-the-road service is seldom justified.

Wildfire pumpers need not discharge large volumes of water under most conditions. Volumes of 50 - 150 litres per minute are adequate for wildfires. However, the ability to produce larger volumes of 500 - 1000 litres per minute is also needed on structures exposed by wildfires.

Wildfire pumpers need not discharge large volumes of water under most conditions. Volumes of 6 to 30 gallons per minute (gpm) are adequate for wildfires. However, the ability to produce larger volumes up to 250 gpm is often needed on structures exposed by wildfire. The latter capability is desirable if it can be afforded, but would require a high-volume pump in addition to the wildfire pump.

Wildfire pumpers are operated off the road and must be constructed for this use. The all-wheel drive trucks are favourites for this reason. Excellent pumpers have been built on surplus military vehicles such as jeeps and four-by-four and 2 ½-ton six-by-six trucks. The commercial four-by-four trucks should be considered if the military vehicles are not available. A pumper designed for wildfire use is much less costly, better adapted to wildfire use, and more mobile than the standard fire department apparatus.

7.4.4 Slip-on units



Slip-on units are self-contained and can be removed from the truck chassis without disturbing the plumbing. The tank, pump, and plumbing can be either a slip on type or an integral unit. Usually, the removal of a few anchor bolts is all that is required. The usual size varies from 200 - 2000 litres. The tank capacity should be compatible with the size of the truck chassis. Overload should be avoided for safety as well as for maintenance reasons.

Slip-on units can be of any convenient size but the total weight with water, men, and equipment must not be more than the carrying capacity of the vehicle. Loading is from a ramp or gantry. This tank is useless without a vehicle so it must be kept loaded in high danger periods.

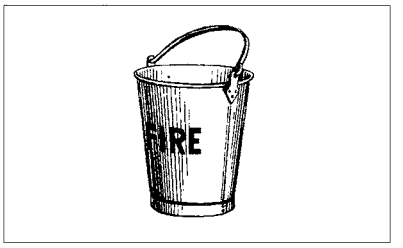
7.4.5 Tanker units

Tankers are primarily considered water supply vehicles for pumpers. They may or may not have a pump on board. The pump may be only capable of drawing and transferring the water, or it may have some capability of wildfire attack.

Tankers maintained for fire use only may vary in capacity from 2000 to 20000 litres. The larger semitrailer tankers are stationed in strategic locations where they can reinforce several fire control units.

7.4.6 Fire bucket and portable water bags

Fire buckets

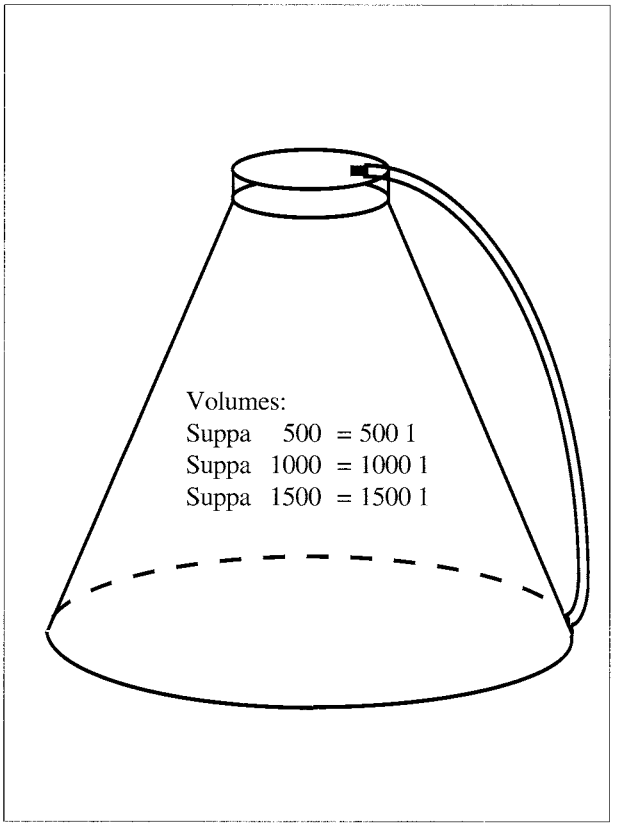


Fire buckets can be made of textile, plastic, or metal, and be painted in a red colour and marked "FIRE" with black letters.

The capacity of a fire bucket is 15 litres.

Portable water bags (Suppa bags)

Suppa bags are made of artificial fibre-reinforced, oil-resistant PVC fabric. When empty, the bags fold into a small space. Each bag has a discharge tube at the bottom (1" plastic tube) for filling backpacks with water and for other water supply.



Portable water bags are used in forest fires and oil spills, irrigation work, and for temporary water storage. When used to collect oil from water, the bag is filled with the contaminated water and then allowed to stand until the liquid separates.

Suppa bags have a large capacity but are extremely lightweight and take up a minimum of space. The water is then released by means of the discharge tube. Thanks to their conical shape, Suppa bags require no supporting structures.

7.5 Coordination of forest fire equipment

An example for the coordination of handtools and light mechanized motor pump groups in grass or bush fires and in minor forest fires is given below. Water use is 500 - 1000 l/min.