NFPA

295

WILDFIRE CONTROL BY VOLUNTEER FIRE DEPARTMENTS 1978

NATIONAL FIRE PROTECTION ASSOCIATION
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Standard for

Wildfire Control by Volunteer Fire Departments

NFPA 295–1978

1978 Edition of NFPA 295

This document was prepared by the Forest Committee and this present edition was adopted by the Association on November 15, 1978, at its Fall Meeting in Montreal, Quebec, Canada. It was released by the Standards Council for publication on December 4, 1978. This edition replaces the previous edition (1973) and succeeds editions which bore the titles: Wildfire Control and Environmental Improvement (1972); Forest, Grass and Brush Fire Control (1965); Community Organization and Equipment for Fighting Forest, Grass and Brush Fires (1956); and the original Standard No. 295, Community Forest Fire Equipment, adopted by NFPA in 1934.

Explanation of Intent of NFPA 295

The current text has been developed to help the thousands of small community fire organizations which exist in the rural and forested areas of North America. Many of these communities can be exposed to the dangers of a large fire involving many acres of forest, grass or brush. In preparing for such emergencies, the organizations and individuals having the responsibility for fire control should be informed of the most useful fire control equipment, training and operations.

Most of the illustrations in this guide were made available by the U.S. Forest Service and the Department of Forestry, Ottawa, Canada. Acknowledgement is also extended to individuals in these agencies, and in the other agencies and organizations represented by the Committee membership, who helped to prepare and revise this text for publication.

Throughout the text, superior numbers are used to indicate publications and other sources of reference on particular subjects. These reference sources are listed on pages 295–64 and 295–65.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

Contents

Standard for

Wildfire Control by Volunteer Fire Departments

NFPA 295-1978

Notice: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Chapter 1 Introduction

1-1 Scope. This standard describes the fundamentals to be considered by volunteer fire departments including the type of equipment that is necessary or useful, and some basic tactics which are essential for the safety of personnel and successful control of forest, grass, and brush fires.

1-2 Purpose. The current text has been developed to help the thousands of small community fire organizations which exist in the rural and forested areas of North America. Many of these communities can be exposed to the dangers of a large fire involving many acres of forest, grass, or brush. In preparing for such emergencies, the organizations and individuals having the responsibility for fire control should be informed of the most useful fire control equipment, training and operations.

Most of the illustrations in this guide were made available by the U. S. Forest Service and the Department of Forestry, Ottawa, Canada. Acknowledgment is also extended to individuals in these agencies and in the other agencies and organizations represented by the committee membership, who helped to prepare and revise this text for publication.

This publication is for volunteer groups in small towns, suburban, and rural areas that need information on how to organize a fire department, select equipment, and train personnel to fight small forest, grass, and brush fires.

1-3 General. This standard was prepared by the NFPA Forest Committee and replaces the previous edition adopted by the Association during the Annual Meeting in St. Louis, Missouri in May, 1973. This edition also succeeds previous editions which bore the titles: *Wildfire Control and Environmental Improvement* (1972); *Forest, Grass and Brush Fire Control* (1965); *Community Organization and Equipment for Fighting Forest, Grass and Brush Fires* (1956); and the original Standard 295, *Community Forest Fire Equipment*, adopted by the NFPA in 1934.

This committee functions in a technical and educational capacity in cooperation with forest and range fire control organizations of the United States and Canada to assist in forest, grass, brush, and tundra fire control, including coordination between all fire protection agencies regardless of federal, state, provincial, county, and municipal boundaries.

Detailed information on large equipment, heavy power tools, specialized forest fire fighting equipment and techniques is available in other publications. The standard includes a list of mandatory requirements which must be met if the volunteer groups are to be effective in the prevention and suppression of wildfires. It is suggested that fire groups consider the adoption of this standard by using a form like this, to be voted by members of the fire department or by citizens of the protected area:

The .....
Name

Fire Department of the .....
County, Town, City, Province

of .....**accepts the mandatory requirements of NFPA 295 as a working charter providing reasonable guidance to reduce, as far as practicable, hazards to life and property from fire.**

Legal counsel should be consulted to explain how the adoption of this standard affects the department and its members.

In many rural and wildland areas, forest, grass, and brush fires are a continual problem. These fires, if not controlled, can endanger human life, cause serious property damage, cause air and water pollution, and destroy natural resources which may never be replaced. Careful evaluation of outdoor fires in the United States and Canada for many years has shown that tremendous damage can be prevented if such fires are attacked by trained crews in the early stages of fire development.

Chapter 2 Organization and Management

2-1* General.

2-1.1* A volunteer fire department that adopts this standard as minimum requirements shall have a fire chief who will be in overall command at all times. However, when the department responds to a fire, the first officer to arrive shall assume command until relieved by someone with higher authority.

2-1.2* Each fire company or crew shall operate under command of a designated officer or fire boss.

2-2* Members of the fire department shall keep in good physical condition and otherwise protect themselves in the hazardous task of fire fighting.

2-2.1* Prospective members of the fire department shall undergo and pass physical examination before selection.

2-3* A headquarters building shall be selected to house vehicles and equipment and otherwise serve as the center of communications for fire and other emergencies.

2-4* When a fire occurs, members of the fire department shall be notified immediately so they can respond with apparatus and equipment.

2-4.1 Members shall be familiar with the entire area protected by the department.

2-4.2* Members shall be trained in the methods of fire control, in the safe use of tools and fire fighting equipment, and in the procedures of safe and effective response to alarms.

2-5* Written fire control plans shall be prepared. Even in outline form, these plans shall include boundaries of the area to be protected.

2-5.1 Mutual aid agreements with adjacent fire departments and other agencies shall be prepared and followed.

2-6* A fire prevention program shall be planned and carried out for the entire year.

2-6.1 Members shall be familiar with the fire laws and regulations of their state or province.

Chapter 3 Protection and Safety

3-1 Personnel safety shall be the first consideration in all fire suppression operations and decisions.

3-2* The fire chief shall require that protective clothing and head gear be worn by fire fighting personnel, that fire apparatus be driven, used, and maintained properly, and that persons riding such vehicles follow the department's safety regulations.

3-3* First aid kits shall be available on all emergency responses, especially for fireline use. An adequate quantity shall be kept where suppression tools are stored.

3-4 The organization shall have sufficient hand tools for outdoor fire control.

3-4.1* Fire tools and equipment shall be for fire emergencies only and shall be marked distinctly.

3-4.2* The organization shall consult with local forest fire protection agencies for advice on selection of tools and equipment.

3-4.3 The cutting edges of all tools shall be covered with guards.

3-5* Power saws shall have adequate spark arrestors and shall be serviced and maintained carefully. Operators shall wear hard hats and have nearby a portable fire extinguisher, a backpack pump filled with water, or a shovel for extinguishing fires started by the hot exhaust of the saw.

3-6* All tractors (dozers) shall have protective canopies and shall be equipped with effective spark arrestors and adequate lights for night operations.

3-7* Care shall be exercised in the use of all chemicals in fire protection.

3-8* The safety principles recommended in this standard and in other applicable NFPA standards and in the publications of federal, provincial, and state forest fire control agencies shall apply in training and fire fighting.

APPLICATION FOR MEMBERSHIP

.....FIRE DEPARTMENT

This form is to be completed by the Proposer and the Applicant and filed with the secretary at a regular meeting of the..... Fire Department. The reverse side of this form is for recording action taken by the.....Fire Department on this application. ....., an active member of the department in good standing, proposes for membership in the..... .....Fire Department:

Name..... Occupation.....

Address..... Business address.....

Age.....Married.....Single..... How long have you been employed by your present employer.....?

No. of dependents..... How long on your previous job?.....

Formal Education.....

Fire Service Experience.....

Physical ailments or disabilities.....

Are you willing to take a physical examination as required by the department? .....

Do you realize that the fire department is not a social club and that as a member you will be required to give freely of your time to attend fires, meetings, drills, and work on committees?.....

I do hereby signify that this application is made with my knowledge and consent.

Signature..... Date.....
Employer

I realize that if.....is accepted for membership in the fire department he or she will be giving part of his or her time to public service. I further realize that giving some form of public service is the duty of every citizen and hereby give my consent to this application.

Signature..... Date.....
Spouse, near relative, parent or guardian

Proposer's signature..... Date.....

Applicant's signature..... Date.....

Sample application for volunteer fire department.

Appendix A

This Appendix is not a part of the NFPA Standard for Wildfire Control by Volunteer Fire Departments but is included for information purposes only.

A-2-1 Organization and Management. To protect itself against forest, grass, and brush fires, a community should establish the following:

A-2-1.1 An officially designated organization headed by a fire chief or fire warden charged with the responsibility of preventing and suppressing fires.

A-2-1.2 A well-organized, equipped, and trained crew which will operate under the authority of the fire chief, fire warden, or subordinate officers.

Most small forest, grass, or brush fires can be handled by a well-trained squad of two to five men if prompt action is taken. Large or rapidly spreading fires require more fire fighters and equipment, expert supervision, and extensive radio and telephone communications.

Three or four small squads of five or six fire fighters, with squad leaders, are grouped together under the command of a crew boss. This boss may be one of several crew bosses who command similar groups and all persons under his command and others concerned should know who he is and the scope of his authority. The crews may be assigned to fight only part of the main fire, usually called a sector.

A-2-2 Selection of Personnel. Members of the fire control organization must be in good physical condition. Fire control operations often demand long hours of vigorous activity. Outdoor fires in particular require much climbing, carrying, and use of tools and equipment, often for several days and nights. Persons unable to pass rigid physical examination may be used within their abilities as pump operators, dispatchers, or in other capacities.

PHYSICAL EXAMINATION REPORT

FOR.....FIRE DEPARTMENT

Name .....

Address..... Date.....

Age.....Yrs. Weight.....Lbs.

Height ..... In.

(1) Pulse..... Respiration.....
Blood Pressure .....

(2) Hearing Watch L Ear...../36
Watch R Ear...../36

(3) Vision L Eye 20/.....
R Eye 20/.....

(4) Evidence Diseased Condition of:
Nose?..... Tonsils?.....
Gums?..... Tongue?.....

(5) Indication of disease of heart?.....
Veins or arteries?.....

(6) Indication of disease of lungs?.....

(7) Has applicant hernia or enlarged inguinal rings?.....
.....

(8) Has applicant hydrocele or varicocele?.....

(9) Is applicant free from indications of disease of nervous system?.....

(10) Has applicant any defects of arms, fingers, hips, legs, body or joints of lower or upper extremities?.....

Remarks .....
.....
.....

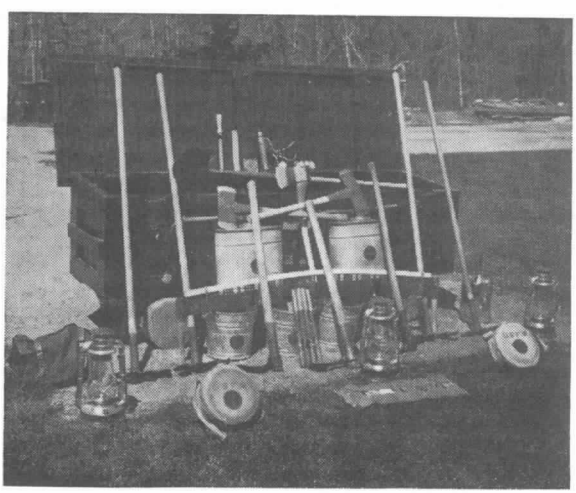
I believe this applicant (not to be) (to be) physically qualified to be a fire fighter.....

Signed ..... M.D.

Sample form for physical examination of applicants for membership in a volunteer fire department.

A-2-2.1 Persons selected as active members of the fire department should undergo a physical examination by a physician and medical files should be established to keep a history of any accidents or disability that the fire fighter receives in service. One of the first acts of the newly formed fire control organization should be to set up its membership requirements according to the provisions of state or provincial legislation which may apply. This would include provisions for workmen's compensation or other insurance for fire fighters. Requirements for professional fire fighters are included in NFPA 1001, *Professional Qualifications for Fire Fighters*. The Forest Service, U. S. Department of Agriculture, uses a "step" test for evaluating the physical condition of new and experienced personnel.

A-2-3 Fire Stations. A building should be selected to house vehicles and equipment. Initially this may be a private structure, but plans should be made to develop an adequate public fire station which may also serve as the communications center for emergencies. Other sites may be selected for storing certain tools and equipment which will be readily accessible in forested areas.



Standard tool cache of National Forest fire warden.

Typical storage arrangement of forest fire fighting tools. Note grouping of axes, shovels, and brush hooks. Neat storage permits access to large number of tools.

A-2-4 Response to Alarms. Volunteers or other members of the fire control organization must be notified immediately so they can respond with apparatus and equipment. They should be familiar with the entire area protected by the organization and, for each emergency, should report to the fire chief or other officer in charge.

The organization should include training to achieve safe and effective response to alarms.

A-2-4.2 Training the Fire Crew and Supervisors. All crews should receive frequent training in techniques and methods of fighting forest, brush, and grass fires. Training with hand tools, other equipment, crew organization, and fire line safety should be given periodically. Crew leaders need special training in fire control tactics to assure their competence when directing fire suppression. Enough regular and reserve crews and leaders should be available for major emergencies so cooperative training with other forest fire organizations is recommended. Federal, state and provincial forest fire officers have technical training material and are usually available to help.

Many states and provinces have established programs through which fire fighters can receive training in structural fires. Special training in forest fire fighting tactics and techniques can be obtained from state, provincial, or federal forest agencies which frequently

conduct special fire schools, seminars, and other forms of instruction. A number of publications dealing with forest, grass, and brush fire control are available from your State Forester's Office, or the National Audio-Visual Center, GSA, Order Section, Washington, DC 20409.

A-2-5 Plans for Operations. Written fire control mobilization plans are important, even when prepared in outline only. They should list all decisions that have been made in advance and outline other information needed for planned action. Such mobilization plans will allow a substitute to take emergency action in the absence of the chief fire officer or other key individuals. Copies of the plans and maps should be distributed to all key fire officers. Fire control plans should be updated at least annually.

A.	Fire Chief —	Name — how to contact
	Alternate	" " " "
B.	Personnel	" " " "
C.	Other facilities —	" " " "
D.	Cooperating Agencies	" " " "
E.	Equipment	Type and location

(1) List available reserve personnel, equipment and facilities and how to contact.

F. Map of protected area — include such items as:
- (1) Boundary of protected area.
- (2) Roads and other means of access.
- (3) Location of manpower, equipment and facilities.
- (4) Water sources.
- (5) Areas of dangerous fuels.
- (6) Dangerous sources of fires such as:
  - (a) dumps
  - (b) sawmills
  - (c) logging operations
  - (d) other activities that may cause fires.

G. Fire weather information
- (1) Source of information
- (2) Displays or other means of notifying public.

Sample fire plan.

A-2-6 Community Fire Prevention. A major responsibility of each fire control organization is to keep the community informed of the methods and needs for sound fire prevention. A fire preven-

tion program must be planned for the entire year, stressing the common causes of fire and the special fire hazards which exist in and around the community. Since weather plays an important role in the frequency and severity of outdoor fires, the community should be informed at all times of the current fire danger rating. Many fire departments in forested areas use large signs or devices to indicate this rating.

Public Education. People in the community can be informed of required fire prevention practices by means of leaflets, posters, booklets, and similar items distributed by the fire control organization. Newspapers, radios, and television stations will also give their support to a year-round fire prevention campaign particularly with respect to control of outdoor fires. Young children can be taught fire prevention principles in the primary school grades or through periodic instruction by members of the fire control organization.

A-3-2 Clothing and Protective Equipment. Wear hard hat while on fire line. Wear laced leather boots with slip resistant soles. Wear flame resistant clothing when available. If fire fighters are not equipped with flame resistant clothing, loose, cuffless trousers and shirts made of cotton or wool should be worn. Loose fitting clothing reduces chafing and affords more protection against burns caused by radiant heat. Long-sleeved shirts should be worn to protect the arms from heat, burns, scratches, and insects. Wear gloves to protect hands and make hand work easier.

A-3-3 First Aid Kits. First aid kits should be available at all locations where suppression tools are stored. Contents of these kits depend upon the size of crew, the type of country where the work is to be performed, the tools normally used, hazards peculiar to certain areas (prevalence of poisonous snakes, etc.), availability of safe drinking water, or other considerations. Many first aid kits commercially available may be adequate, but items may have to be added. Kits should be checked regularly and restocked after each use.

A-3-4.1 Location. Communities should have sufficient hand tools to equip a crew of at least ten men. These tools should be for emergencies only, and should be marked distinctively to guard against their being used for other purposes. Some communities distribute such equipment among their fire wardens who are responsible for the servicing, safekeeping, and availability of the tools. Organized fire fighting crews usually store tools at a central location. This allows fire fighters to pick up equipment at a well-known place enroute to a fire.

A-3-4.2 Selection. Tools needed will vary by sections of the country, due to difference in vegetation, soil, and topography. All equipment selected for fire control should be dependable and used for the type of work for which it is designed. Many national standards and specifications are available to help fire control organizations to purchase the right equipment. The following general information may assist community fire fighting organizations in purchasing specific hand tools. Assistance in selecting appropriate tools can be received from the local forest fire suppression agency.

A-3-5 Power Saws. The power saw has generally replaced the crosscut saw for control work. It is not necessary that fire control organizations own power saws; they are frequently available from woods operators, the same operators upon whom communities may rely for fire fighting manpower.

Data on power saws can be secured from the manufacturers and from operators who have used the various makes and types. Because fire suppression may necessitate carrying saws long distances over rough terrain, the important factor is weight. Saws shall have adequate spark arrestors to minimize the possibility of igniting nearby fuels by hot exhaust sparks.

A-3-6 Dozer-Equipped Tractors. Tractors with dozers are costly compared to hand tools or the majority of power tools used in line construction and mop-up work. Communities ordinarily will not find it economical to own bulldozers but should make a careful study to determine possibilities of use under existing conditions of terrain, fuels, and rates of fire spread. Heavy tractor equipment is frequently available from logging and construction operators whose names and telephone numbers should be kept on file. Protective canopies shall be required on all tractors with dozers which are used in the woods.

A-3-7 Chemicals. Chemicals have been used in fire control in three general ways: as an additive to water to wet fuels more efficiently; as a fire retardant to supplement or reinforce the extinguishing action of water in direct application and, in advance of a fire, to create or reinforce natural or constructed barriers; and as a chemical to aid in the prevention and control of fires by reducing flammable vegetation, such as killing grass and brush on firebreaks and rights-of-way.

A-3-8 Safety Principles. Fire fighting requires fast action, sustained effort, and greater energy than most other work. The fire is always potentially dangerous, and a high rate of accidents and injuries can occur unless special attention is given to safety at all times. Most accidents can be prevented by careful procedures and training before emergencies.

Appendix B

This Appendix is not a part of the NFPA Standard for Wildfire Control by Volunteer Fire Departments but is included for information purposes only.

The following contains useful and explanatory information about subjects related to wildfire control but not covered in the text of the Standard for Wildfire Control by Volunteer Fire Departments.

Growth of the Organization.

Many of the large fire departments and other fire control organizations now in existence started as small volunteer groups. When people move into a forest or other wildland area, and a settled community begins to develop, fires occur with increasing frequency. Initially, the fire incident may be handled by a small volunteer group possessing very few tools and equipment. As the community develops, however, fires and other emergencies generally require more refined equipment and apparatus. The volunteer group may purchase or receive donations of portable pumps, trucks with slip-on tanks and booster pumps, and subsequently large tank trucks and heavy duty pumpers. Eventually, the number of fire incidents may require the community to employ a paid fire chief and forest fire warden and perhaps paid drivers for apparatus. This has been the traditional growth of many of today's organized fire departments.

Communications System.

A communications system is needed by which fires may be reported to the fire organization. Telephone communications to some central location which serves as the dispatch center are essential. In the absence of a telephone network, 2-way radio communications are very useful. Whatever system is chosen, it is essential that *all* persons in the community and surrounding areas be notified of how and where to report an alarm of fire or other emergency.

Command.

The first responsible fire authority, ranger, warden, or other officer who arrives at the fire is the fire boss, until someone with higher authority assumes command. Whenever a new fire boss takes command, the crew bosses and others under this command should be notified immediately. The fire boss is responsible for: planning the fire control efforts and bossing the job; assembling crews and telling them where and how to work; making the best use of personnel; arranging for communications, rest periods and relief crews; making the best use of equipment and tools; getting supplies; and making sure that the fire is completely extinguished before the crew leaves the area.

Fire Control Principles.

Fire fighting is dangerous, so all fire control organizations need good leadership, training, an established "chain of command," and effective communications. Community fire fighting groups need to perfect their teamwork to achieve the best and safest fire control operations.

Special Characteristics of Forest Fires.

Fire is a rapid chemical combination of fuel, heat, and oxygen. A basic principle of fire suppression is to remove one or more of these elements. Forest fires have special characteristics which can be drastically changed when one of these elements is removed.

Fuels.

Fuels are usually continuous over large areas, with openings or breaks widely scattered. Fuel volumes are frequently very heavy, with deep forest duff combined with tree height fuels up to the height of a 6- to 8-story building over hundreds of acres.

Fire Development.

The variety of fuels, from fine dry grass and leaves to heavy logs and tree trunks, makes forest fires extremely sensitive to climatic factors, especially wind and relative humidity. Strong winds and low humidities may cause long distance fire spotting and rapid fire spread through treetops. Fires burning deep in roots and stumps may continue for many days or weeks and may require much work before extinguishment is complete.

Weather Forecasts.

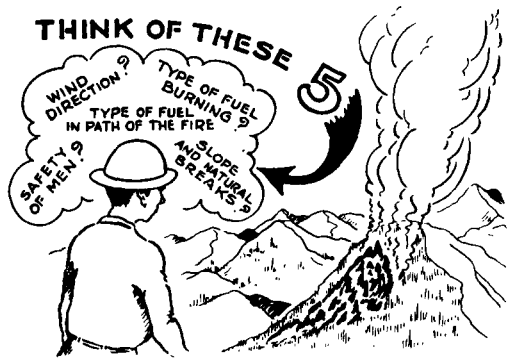
Since weather has such a major effect on fire behavior it should always be taken into consideration in fire suppression planning. Organizations should consult with their state forester to arrange for appropriate fire weather forecasts.

Mobility.

Fire areas are frequently inaccessible to pumpers and tankers and thus require a mobile control force and portable equipment which can reach the most distant parts of these fires quickly and effectively.

Traffic Control.

Curious spectators often cause major problems for fire fighters by getting in the way, blocking access, and causing traffic jams. Avoid these problems by having your state police or county sheriff take charge of traffic control and the exclusion of unauthorized people from the fire area.



From "Water vs. Fire"

Size Up.

Officer's Decision. The first thing to do at the scene of a fire is to size up the entire situation to determine how to attack the blaze. You can usually make reconnaissance while fire fighters are unloading equipment and getting ready for action. However you accomplish it, sizing up the fire is of great importance for it will provide you with essential information about the fire and the territory in which it is burning. Without such knowledge in the beginning, your attack may be completely ineffectual.

When you size up the fire, ascertain quickly as much as you can of the following information. However, don't use too much valuable time.

(a) **Location of the Head or Heads.** The head is generally considered the most critical part of a fire and should be controlled immediately. Once the head is controlled, the rest of the fire is less difficult to handle.

(b) **Pertinent Burning Conditions.** Consider intensity of burning and rate of speed in planning your attack.

(c) **Type of Fuel.** Note the fuel actually being consumed and the fuel in the path of the fire. Consider how fuel changes could affect the spread.

(d) **Size and Length to Be Controlled.** Estimate the size of the entire fire. Estimate the length of the perimeter segment that will require the most extensive control action.

(e) **Special Hazards.** Spot fires, burning snags, developing heads, close proximity of flames to unburned flash fuels, and other "hot spots" should be dealt with quickly.

(f) **Critical Areas and Available Personnel.** Consider how you will employ available fire personnel to control critical areas.

(g) **Natural Barriers.** Look for streams, roads, fields, swamps, old burns, and other natural barriers that might be utilized.

(h) **Access Roads and Trails.** Look for roads and trails that may be used in moving your crew or bringing in additional personnel and supplies. Look for a suitable location for fire headquarters.

(i) **Water Source.** Locate the nearest water source and access to it.

(j) **Line of Retreat.** Look for a line of retreat for emergencies.

(k) **Natural Factors Affecting Burning.** Consider the entire scene and situation in terms of the natural factors.

Planning the Attack.

As soon as you have completed your reconnaissance of the fire, you should plan an immediate attack, taking into consideration the fire situation, available fire personnel, and the expected influence of the daily burning cycle. A planned attack is better than a haphazard, disjointed assault that could involve a lot of work and accomplish nothing.

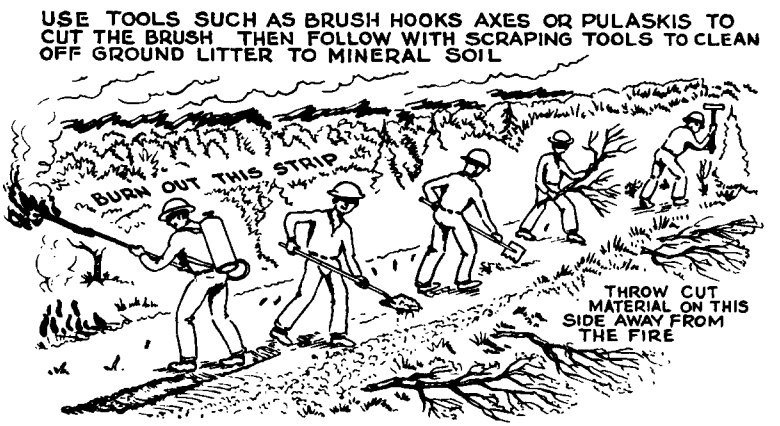
On most large forest fires, the head is usually the most critical spot since it travels fastest and does the most damage. When the head is brought under control, the flanks and rear of the fire are comparatively simple to extinguish. At times, there are conditions that make attack on the head impossible with the fire fighters available. If such is the case, don't wait until night to attack the fire; work on the flanks and rear. After nightfall, most fires die down somewhat. Then effective action can be taken on the head to stop the progress of the fire and bring it under control.

Your plans should make allowance for the physical limitations of your fire fighters. Never try to accomplish the impossible. Don't risk the lives of fire fighters by careless planning or by taking foolish chances. Don't waste fire fighting strength by scattering your crew ineffectually. The best attack is a concentrated assault by a smooth-working team.

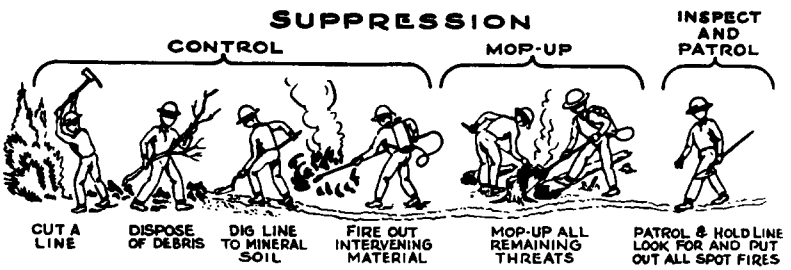
Any plan of attack should include taking advantage of any natural fire barriers in the vicinity, such as streams, roads, open fields, old burns, and the like. Making use of natural barriers can free your crew for more work elsewhere, thus increasing the amount of area you can cover. By combining skillful use of natural barriers with shrewd anticipation of forest fire behavior, you can do much to overcome the limitations of a small crew.

The Ten Standard Fire Orders.

1. Keep informed of fire weather conditions and forecasts.
2. Know what your fire is doing at all times.
3. Base all actions on current and expected behavior of fire.
4. Have escape routes for everyone and make them known.
5. Post lookouts when there is possible danger.
6. Be alert, keep calm, think clearly, act decisively.
7. Maintain prompt communications with your men, your boss, and adjoining forces.
8. Give clear instructions and be sure they are understood.
9. Maintain control of your men at all times.
10. FIGHT FIRE AGGRESSIVELY, BUT FIRST PROVIDE FOR SAFETY!



From "Water vs. Fire"



From "Water vs. Fire"

Methods of Forest Fire Attack.

There are two basic methods of forest fire attack, the DIRECT and the INDIRECT. The direct method is action taken directly against the flames of a going fire. The indirect method consists of control techniques carried on at variable distances from the edge of an advancing fire to remove fuel from its path and thereby halt its progress.

In both methods, the general procedure is the same. First, control the critical areas (or "hot spots") to stop the spread. Then, work around the perimeter until the entire burn is encircled by a control line. Mop up any remnants of the fire as found, and patrol the entire burn.

The Direct Attack.

The direct attack method, as the term implies, consists of a series of related direct actions to cool, drown, smother, beat out, starve, or otherwise extinguish the flames of a going fire. The control line is constructed along and directly on the edge of the fire.

The direct attack is most often used on light running fires in grass, leaves, and brush; on duff (underground) fires; on the flanks and rear of larger fires; in later stages of large fires; and on any small- or medium-size fire where the area to be controlled is not too large and the burning intensity, heat, and smoke are not beyond human endurance.

Direct Attack Techniques.

The usual procedure on smaller fires is to start at the head and work around the perimeter until the fire is entirely surrounded. The crew may be divided into two units if the situation permits. If the head is too difficult to handle immediately, you can begin at the rear and work forward around the flanks until you pinch off the head.

Water, if available and properly applied, is one of the fastest ways to stop fire in light fuels. The crew should work parallel to the edge of the blaze in a coordinated attack, with each person backing up the next person. Direct the spray close to the base of the fire immediately in front of the flames and use sparingly to conserve water. To maintain a continuous attack, the tanks should be refilled, if possible, by relay from the nearest water source. While there probably won't be enough water to completely extinguish the fire, wetting down and cooling the flames will make subsequent control actions easier. You should always follow up a water attack with hand tools to complete the job.

If regular fire tools are not available, wet gunny sacks, green boughs, and other flails or brooms are often used to good advantage against fires in grass or low brush. The swinging action is directed toward the flames so that embers and sparks are whipped into the burned area. The idea is to separate the fire from the fuel.

Like water, damp mineral soil will help cool and smother a fire if used properly. Soil should be thrown in a swinging motion to scatter it in a thin layer at the base of the flames along the fire edge. The best results are obtained by fast, continual action. In rough terrain, several persons should keep a stockpile of soil stacked up for the thrower. Soil is especially effective for checking flames in felled snags, stumps, logs, or brush patches. However, never consider hot material safe when covered with soil. Fire may smolder for some time under a soil covering and later break out to cause considerable trouble. A common practice is to feel for fire heat with the hands.

All buried fire, including duff (underground) fire, should be dug out and extinguished as soon as the spread is checked. Once underground fire has been exposed, it should be scattered and soaked down with water.

In the direct attack method, a control line is built right on the edge of the fire to enclose the burn and prevent further spread of breakovers. The line is normally cut after the flames on the edge have been sufficiently cooled for close action. Where necessary, use hand tools such as axes and brush hooks to clear away heavy growth and debris. Never fail to make maximum use of areas where the fire has already burned itself out.

With fire rakes, hoes, shovels, and other such line tools, a clean, safe control line approximately 12 to 18 in. (30 to 46 cm) wide should be cleared along and directly on the edge of the fire. This line should encircle the entire perimeter of the fire, although short cuts across areas already completely burned out are permissible. Rake down to bare mineral soil. All flammable material should be removed from the control line and raked, pushed, shoveled, or carried into the burned area inside the line.

Large, heavy fuels such as logs, felled trees, heavy branches, and the like should be carried or thrown well into the burned area. Cut up with axes or saws if necessary. Dig and chop out burning roots extending under the line.

Water and hand tools are necessary for the extinguishment of deep burning fires. Patrols should not leave areas for which they are responsible until all smoldering fires have been eliminated. (*U. S. Forest Service Photo.*)

Heavy fuels on either side of the control line should be separated and moved to a safe distance back from the line. Logs should be trenched or placed lengthwise up the slope of a hill to prevent them from rolling down across the line.

Snags should be felled since they are especially hazardous as spark producers. The usual rule is to fell any snag away from the line for a distance up to 100 ft (30.5 m) inside the line.

Mop up is a vital part of any method of forest fire attack, and will be described in more detail later. However, it is important to note here that a mop-up crew of several persons equipped with back pack pumps should follow the line rakers to clean out any patches of fire still burning within the line, especially smoldering stumps, logs, snags, and similar slow-burning materials. If necessary, use torches carefully to burn out any unburned areas close to the inside of the control line.

Part of the mop-up operation is to make certain that all fire initially attacked with water and soil is actually extinguished. Never trust appearances. A simple way to resolve doubtful spots is to feel for fire with the bare hands. The slow-burning materials are the critical items to be so inspected.

During the course of the fire, a close watch should be maintained for spot fires or breakovers caused by flying sparks or embers. Immediate action should be taken against such outbreaks before they develop into something more serious. Spraying with water is usually effective.

Never leave the scene of a fire without making absolutely certain that all remnants of the fire have been properly controlled and that the burn area is completely encircled by a clean, safe line. You

should patrol and inspect the entire control line, checking carefully all areas where another outbreak of fire could be dangerous.

Indirect Attack.

Indirect attack is simply falling back a calculated distance from the edge of the fire and constructing a planned control line (or fire line, as it is more commonly known) along a predetermined course that parallels the fire perimeter. The usual procedure then is to burn out deliberately all intervening material between the fire line and the advancing edge of the fire so there will be no fuel left in the path of the fire, thus causing it to stop and eventually die out.

With the direct and indirect methods of attack, mop up should begin as soon as the line has cooled down sufficiently to permit close work on the remnants of the fire.

Dangerous Situations.

1. You are building a line downhill toward a fire. This situation can be very dangerous if the fire makes a fast run and overtakes the crew. Have a well-defined and usable escape route. Keep a lookout on the fire below.

2. You are fighting a fire on a hillside where rolling material can ignite a fire below you. If fire starts below, you can be pocketed between it and the main fire. Patrol for spot fires below, and have a definite escape route. Maintain a lookout.

3. The wind begins to blow, increase, or change direction. Watch for spot fires, snags that catch fire, and possible mass transport of embers. Be ready for a blowup. Check escape routes.

4. The weather turns hotter or drier. Prepare for increased fire activity. Post lookouts and check escape routes.

5. You are on a line in heavy fuel with unburned fuel between the fire fighter and the fire. Be aware of flare-ups, spots across the line, and difficult, if not impossible, working conditions.

6. You are in an area where the topography and/or cover makes travel difficult and slow. Have an escape route planned in case a run occurs in your direction. Provide for observation of the fire's progress. Try to avoid this situation.

7. You are in unfamiliar country. Travel cautiously; watch out for cliffs, steep grades, and other travel hazards; know the fire weather; and provide for communication.

8 You are in an area where the fire fighters are not familiar with local factors influencing fire behavior. Arrange for local information, and maintain communications.

9. You are attempting a frontal assault on a fire with pumpers. This method should never be attempted under extreme fire conditions. It should never be attempted in light or fast-spreading fuels unless the fire weather conditions are known to be low or low to moderate and you are sure the conditions will remain low. If possible, work two pumpers together for mutual support, preferably, attack the head from the burned area.

10. Frequent spot fires are crossing the line. Be sure an escape route is planned. Try to eliminate the source of spot fires.

11. You cannot see the main fire, and you are out of communication with anyone who can see it. Arrange for correction of these conditions, or at least maintain communication. Be certain a satisfactory escape route is available and known to the crew.

12. You do not clearly understand your assignment or instructions. Obtain clarification. Correlate your assignment with that of adjacent crews.

13. You are drowsy and feel like taking a nap near the fire line. Keep awake and keep moving. Do not lie down or go to sleep.

Low Flying Aircraft Retardant Drops.

Personnel can be injured by the impact of retardant drops. Clear men out of target area when retardant drop is to be made. If an individual is unable to retreat to a safe place the safety procedure is to:

(a) Lie face down with head toward oncoming aircraft and hard hat in place.

(b) Discard hand tools to the side of, behind, and downhill from your body.

(c) When lying on the ground grasp something firm to prevent being carried or rolled about by the dropped liquid.

(d) Do not run unless escape is assured.

(e) When in timber, get clear of dead snags, tops, and limbs in drop areas. Do not remain in area where rocks or other material may be dislodged by the liquid drop.

Extinguishment.

Put the fire out — mop it up. The mop up occurs after the spread of a fire, or any part of a fire, is controlled, but before suppression work is reduced to a patrol and inspection. Mopping up consists of making a fire safe by extinguishing or removing burning and hazardous material, including snags along or near the control line.

(a) Extinguish all smoldering material for a distance of at least 100 ft (30 m) inside the fire edge after the spread has been stopped.

Burning material can be extinguished most quickly by uncovering, stirring, and mixing. Deep-burning material should be dug out with shovels or other hand tools and thoroughly soaked with water. Water alone will not penetrate deep-burning forest fuel sufficiently to extinguish the fire. A good team is a man with a shovel and a nozzleman.

(b) Put all fuel into such a position (or trench below it) that it cannot roll across the line.

(c) Spread, rather than bury, smoldering fuel that cannot be put out. If high winds are blowing sparks across the line, remove smoldering fuels to a safe distance inside the line.

(d) Bury burning fuels only when that is the fastest way of stopping spread or the possibility of sparks being blown across the line; but uncover the fuels and be certain that no fire is left in them before leaving the fire area. Buried fuels will burn and char for long periods, posing a constant threat.

(e) Allow fuel to burn out inside the fire line where it will do so promptly and safely; elsewhere, take steps to either extinguish or remove it.

(f) Eliminate promptly, inside and outside the line, all special threats such as snags, rotten logs, stumps, singed brush, and low-hanging limbs of trees.

(g) Look for and remove all burning roots that are near the line. Fires have escaped control by creeping along burning roots that extended under the control line to fuels on the other side.

Building a fire line. Note hard hats, canteens and spacing between crew members.

(h) Extinguish *all* fire in the mop up of small fires. Mop up enough of the material adjacent to the line on large fires to be certain that fire cannot blow, spot, or roll over the control line.

(i) Search for smoldering spot fires across the line in front of the main head of the fire. Do this constantly during the whole life of the fire.

(j) Patrol and inspect all fires until the last spark is out. Work back and forth along the control line watching for and extinguishing all smoldering spots near the line. Maintain patrol until there is no spot hot to the touch.

(k) When crews return to quarters, all tools and equipment should be serviced and stored in preparation for the next call.

Mop-up.

Mop-up is the process of making a controlled fire safe by removing or extinguishing all burning material along or near the fire line. The thoroughness of mop-up operations may be the factor that determines whether the fire will be safely controlled within a single twenty-four hour period or whether it will break out again, requiring additional control work.

Mop-up Techniques.

The secret of successful mop-up is to seek out and eliminate trouble spots before they flare up and endanger the safety of the line. This may require considerable additional hard work, but it will pay off in terms of a safe, secure line around the fire.

On small fires, the entire burned area should be gone over carefully by the mop-up crew. On larger fires, a definite strip at least 100 ft (30.5 m) wide and adjacent to the fire line should be made safe by careful mop-up.

Determining the Cause of Fire.

Investigate the fire cause as soon as possible. This investigation can be carried on simultaneously with the fire fighting work. The effectiveness of future fire prevention may depend upon the thoroughness of fire investigation. Train crew members to protect the point of fire origin for postfire examination.

Safety Principles.

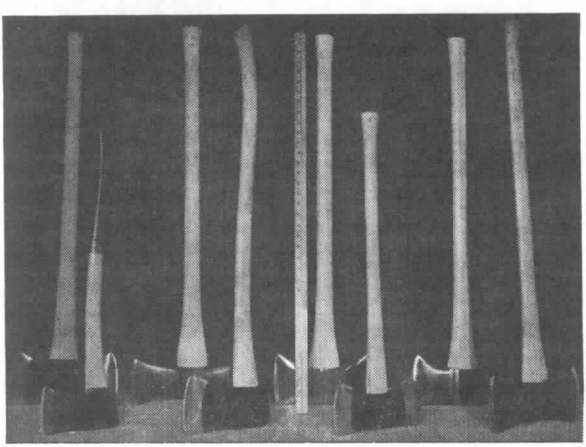
Hard Hats. Hard hats greatly reduce the number of serious accidents, particularly where dead trees are prevalent. They should be worn by all fire suppression crew members and should be stored with tools or on apparatus. Lightweight "bump" hats do not provide adequate protection in forest fire control.

Tool Guards. Guards must be used on all tools with cutting edges. These provide for safe carrying of tools to and from the fire line, and when transporting them in a vehicle. A suitable guard can be made from nonserviceable rubber-lined fire hose split along its length and fastened by strap, rubber band, spring hook, wire, or string.

Lights. During fire fighting, or travel, adequate lights must be provided. A wide variety of electric flashlights and lanterns are readily available. Minor repair parts and extra batteries should be available.

Clothing. Wear sturdy, serviceable clothing, heavy shoes with 6- or 9-in. (15- to 23-cm) tops, and medium heavy wool socks to prevent blisters. Carry an extra pair of shoes and extra socks on fires that may be of long duration.

Protective Materials. A face shield, developed specifically for fire fighters, clamps to the brim of a hard hat. The lower portion of the shield, protecting the face and neck, is aluminized asbestos cloth. The top portion is fine metal screen, which reflects heat from the fire fighter's eyes yet permits vision. Fire fighters report the device allows them to work in comfort close to flaming fuels. The U. S. Forest Service has adopted bright colored fire resistant clothing as a standard item for those normally exposed to hazardous fire line conditions. The material is fire resistant and will char under direct contact of flames or burning embers but will not support flame.

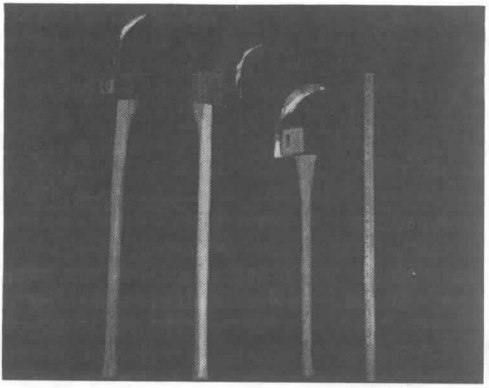


Axes: single and double bit.

Chopping, Felling, and Clearing Tools.

Double Bit Axe. The "Western Pattern" double bit swamping axe is for general chopping. The edge of one bit may be kept relatively sharp for smooth cutting, while the other bit may be used for chopping roots or material on the ground. This pattern of the axe is usually preferred in a 3½ lb (1.6 kg) weight. The overall length of head is about 10 in. (25 cm) and the width of bit about 4⅝ in. (12 cm).

Single Bit Axe. The single bit axe commonly weighs about 3½ lbs (1.6 kg), has a bit width of 4⅞ in. (12.3 cm) and a head, or flat hammer-like surface, about ¾ in. (1.9 cm) by 1 in. (2.5 cm). It is particularly useful in mop-up work, where the head serves well in knocking stumps, logs, and other heavy fuels apart. A 30-in. (76-cm) handle is a commonly preferred length. In the hands of unskilled men, the single bit axe may offer an added feature of safety.



Brush hooks: single and double-edged.

Single-Edge Brush Hook. The single-edge brush hook, sometimes called a bush hook, is good for cutting small trees, brush, heavy weed growth, etc. When necessary, it can be used for chopping heavy material, but an axe is preferred for this type of work. The head of the single-edge brush hook is shaped like a letter "J," with a metal eye welded to the back of the straight portion to accommodate the handle. The straight part of the tool should be used for heavy work. This brush hook is sharpened only on the inside of the curved portion and along the continuing adjacent straight edge. Usually, the point of the tool is left unsharpened as a safety precaution. The brush hook may be fitted with either a straight or curved single-bit axe handle. Overall weight is approximately 5 lbs (2 kg).

Double-Edge Brush Hook. The double-edge brush hook is designed for the same purpose as the single-edge type. The metal eye which receives the handle is welded on the opposite side of the "J." The blade is sharpened on both sides. The inner concave portion is usually used for light cutting work and the straight outside portion for heavy cutting or for scraping and chopping fire out of logs or stumps. Some fire control men prefer the double-edge brush hook to the single-edge. Blade length is about 11 in. (27.9 cm) and overall handled tool length is 36 in. (76.2 cm). The double-edge brush hook may also be fitted with either a straight or curved handle. Weight is 4 lbs, 10 oz (2.1 kg) or slightly less than the single-edge type. A straight or curved handle can be used. Caution must be exercised in the use of all cutting tools.

Pulaski tool.

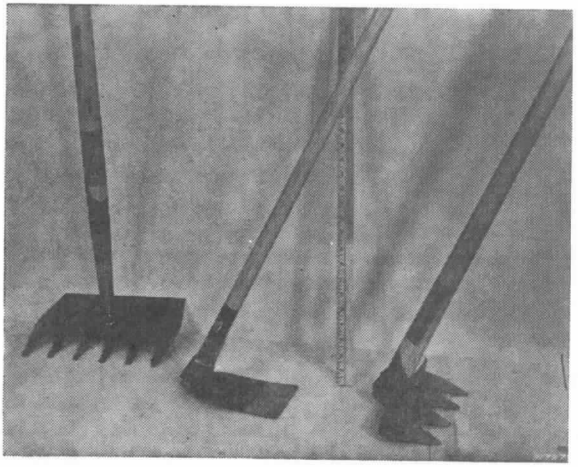
Pulaski Tool. This combination tool has features of the axe and grub hoe or mattock, and so is suitable for cutting and digging. The Pulaski tool weighs approximately 3¾ lbs (1.7 kg) and is an excellent substitute for the axe when small trees are to be cut. On large material, the grub hoe side of the tool interferes where deep notching is necessary. This is a well-balanced tool, employing a regular double-bit axe handle. The grub hoe portion is 6 in. (15 cm) long and the hoe is 3⅜ in. (8.6 cm) wide. The Pulaski tool, when used in line construction, makes possible the shifting of crew activity from digging to cutting, or vice versa, with a minimum loss of time. It works well in rocky soils and does an excellent job of cutting and scraping on mop-up work.

Wedges. It may be necessary to use wedges to prevent a saw from binding in wood. Hardwood wedges made from hickory, oak, or other tough stock are good for this purpose. Aluminum, magnesium alloy, and plastic wedges may be used safely with power saws.

Hammers. In fire suppression work, hammers should be used for driving wedges. Axes should not be substituted for striking hammers, and particularly not used to drive steel wedges, as this upsets the eye of the axe and soon renders the tool unfit for service. When hardwood wedges are employed, the danger of axe damage is somewhat lessened.

Raking, Hoeing and Trenching Tools.

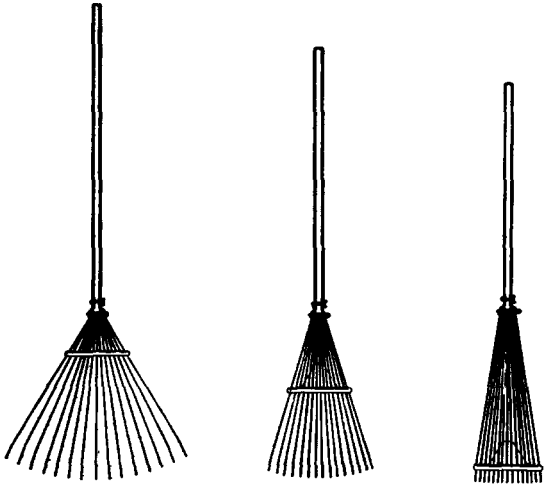
Fire Rakes. A fire rake is often referred to as the Council tool or the Rich tool. It is constructed from four mowing machine cutter sections riveted to a piece of 1-in. (2.5-cm) angle iron which has a planter's hoe eye for the accommodation of a 60-in. (1.5-cm) hoe handle. The tool is especially well adapted to fire line raking and cutting in light brush and duff where roots are small. The tool with handle weighs about 4 lbs (1.8 kg).



(Left to right) McCleod tool, Hazel hoe and Councilor Rich tool.

McLeod Tool. The McLeod tool, a combination heavy duty rake and hoe, is designed for cutting matted brush and heavy duff, and for general rake work in medium cover. It is used best in soil conditions where rocks and small shrubs, such as huckleberry, are not too abundant. The rake section is of the nonclogging type, pressed from tool steel and tempered to medium hardness. Width of both the cutting edge and the rake side of this tool is about 11 in. (28 cm). The tool is equipped with a 48-in. (1.2-m) straight handle and weighs approximately 5 lbs (2.2 kg).

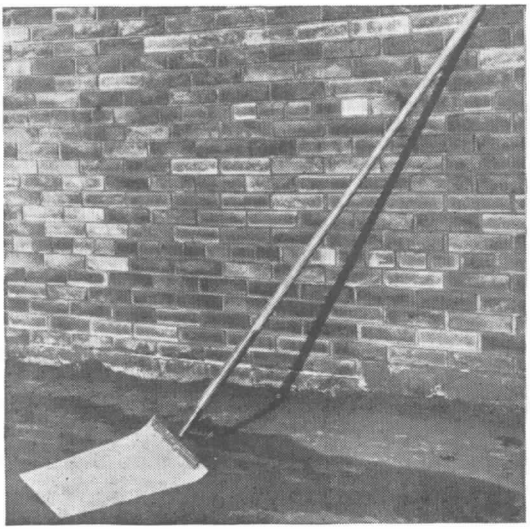
Leaf Rake (Rake, Broom or Lawn Comb). Various types of leaf or broom rakes are used in fire line construction in light fuels such as hardwood leaves, where little grass or brush is involved. Popular types are those used for raking lawns, preferably with metal tines or teeth. In fire suppression work, metal tines are subject to heating and cooling and therefore should be of good steel alloy to resist softening or loss of spring-tension action. Adjustable-width, broom-type fire rakes with steel tines are being developed for suppression work. As the width of the broom is decreased, the tension or "stiffness" increases. This type rake is very efficient in heavy leaf litter. A rattan broom, used in some areas in the northeastern United States for fire line construction, is a standard item of equipment in tool caches. This broom may not be as durable as the steel-tine types, but it has the advantage of being lower priced.



Typical heavy duty aluminum broom rake. In the open position the tines spread to 20 in. (51 cm) width; half-open position provides a 10-in. (25-cm) spread; and in closed position the spread is only 7½ in. (20 cm).

Shovel (Long Handle, Round Point). The long-handled, round-point shovel is commonly used in fire suppression work. Two sizes have been favored by fire control men: the No. 0 and the No. 2. The No. 0 size, often referred to as the "lady" shovel, is preferred in many areas. It is smaller and lighter than the No. 2. The blade of the No. 2 size is 9½ in. (24 cm) wide and 11⅜ in. (29 cm) long, with a 48-in. (1.2-m) handle and an overall weight of about 5½ lbs (2.5 kg). The No. 0 size has a blade 8 by 10 in. (20.3 by 25.4 cm) in size, equipped with a 37½-in. (95.3-cm) handle; overall weight is approximately 3½ lbs (1.6 kg). The long-handled shovel, in the hands of a skilled worker, is very effective for general fire-suppression work. It is a common practice to sharpen one or both edges of the blade to use the shovel as a scraping tool in creating a clean fire line to mineral soil. When only one side is sharpened, it is usually the left side and the sharpening extends along the blade from the point to within about 1 in. (2.5 cm) of the top. This last inch or so is preferably left unsharpened as a safety measure. If a man's foot were to slip off the top of the blade, there is the danger of striking his foot, ankle, or lower part of leg on the corner of the blade. For left-footed workers, sharpening of the right side of the blade would be more logical. When a blade edge has been sharpened, the shovel is a substitute for the brush hook under light working conditions.

Forest Fire Shovel. A forest fire shovel developed specifically to meet the requirements of the job is now available. Its design represents a combination of features necessary for effective fire line construction and fire suppression work. Although lighter in weight than shovels in present use, the forest fire shovel is strong enough to withstand severe punishment without breakage or excessive wear. It is good for scraping, chopping small limbs and light brush, digging out burning material, and throwing soil on flaming fuel. The new shovel compares in size with a conventional No. 1 shovel, but the similarity ends there. To improve its scraping ability the curved cutting edges were lengthened, and a narrower point was formed to facilitate working around rocks and roots, and cutting through heavily matted vegetation. The handle is 4 in. (10.2 cm) longer than that of the No. 0 shovel, and the lift is higher. This increases leverage and allows for better posture when scraping. The steps on the blade are turned forward for greater safety and improved blade strength (an important requirement), and to reduce wear and tear on the boot soles. The turned steps, together with a deeper blade dish, give this shovel the same soil throwing capacity as the No. 2 shovel. The diameter of the handle just above the socket is smaller and easier to grip. The standardized handle and socket aids in faster rehandling.



Typical swatter or flail has a wooden handle at least 60 in. (1.6 m) long and weighs between 5 and 7 lbs (2.3 and 3.1 kg).

Fire Swatter (or Fire Flail). The fire swatter or flail is used mainly to smother fire in light grass or grain field fuels. Usually, it is laid on the fire edge and moved progressively along the line. Hard swatting, especially in a vertical manner, should be avoided since it tends to spread the fire. This tool should be of rugged construction as it is in frequent contact with the burning fuel. Ordinarily, the head of the swatter is made from a flap of 4-ply heavy rubber vulcanized belting stock about 12 by 15 by ¼ in. (30.1 by 38.1 by 0.6 cm). This flap is attached to a wooden handle at least 60 in. (1.5 m) long, bringing the total weight of the swatter to between 5 and 7 lbs (2.3 and 3.1 kg). The swatter has replaced such makeshift tools as the tree bough, the gunny sack, the green cowhide, and articles of clothing.

Pumping Equipment, Hand-Operated.

Pump. Hand-operated pumps can be used in brush, grass, or forested areas. Probably the most common is the back pack or knapsack type pump, which is very effective when used in conjunction with other hand tools. Each organized crew of 10 to 12 workers should have 2 or 3 of these pumps. Be careful to lift and transport filled pumps properly to prevent back injury.

Containers. Back pack pumps with capacities of 4 to 5 gals (15 to 19 *l*) are available with metal, plastic, or neoprene fabric containers. When space must be considered, as in boats or aircraft, many more pumps with unfilled collapsible bags can be stored in a given space than those with rigid containers. During the fire season, pumps equipped with metal containers should be kept filled and stored where they are readily accessible and not subject to freezing.

Pump Construction. Single- or double-action sliding pumps are used on these back pack units. Single-action pumps charge on one stroke and discharge on the return; double-action pumps discharge on both strokes. These pumps should be carefully built of materials resistant to local conditions of corrosion. Construction should permit easy dismantling and reassembly without the aid of special tools. Hose connections and nozzles should also be corrosion resistant. Back pack pumps should be equipped with nozzles capable of discharging either a solid stream or a spray. A hand pump should project a solid stream of water vertically at least 17 ft (5.2 m) above the nozzle to ¼ to ½ lbs (0.1 to 0.2 kg) of water per discharge stroke when operated at 17 strokes per minute. Hand pumps should be fitted with weather and kink resistant, rubber-covered, rubber-lined hose.

Tanks. Tanks for back pack pumps should be of material resistant to local conditions of corrosion. Metal and plastic tanks should have tight joints; be easy to clean; have snug fitting, removable, brass or copper strainers; and a tight fitting cover with a nonslopping vent over a filler opening not less than 3 in. (6.6 cm) on its long axis. Tank design should be such that no sharp edges come in contact with the back of the man carrying the tank. The tank should have a carrying handle, back pack straps, and clips to hold the hand pump when it is not in use. Another desirable feature is a ventilated backplate designed to keep the water container clear of the user's back. All seams should be welded or otherwise secured so that they will not rupture upon sudden impact with solid objects. Care must be exercised to prevent puncturing the bottom section. Vehicle mounting brackets, with quck-release straps, will hold these pumps upright during transportation. Highly durable, corrosion-proof, rubber or plastic back pack tanks are available.

Accessories. Bag-type and rigid tanks of back pack pumps should be equipped with a rust-proof strainer and a tight-fitting filler cap. A vented cap is not necessary with bag-type containers. Shoulder straps, 1½ to 2½ in. (3.8 to 6.4 cm) in width, adjustable in length, and with appropriate snaps for attaching to rings on the water containers, should be a part of each back pack pump. Straps

should be of such weight and construction as to hold rolling and curling to a minimum. A collapsible canvas bucket or other suitable container is a desirable accessory.

Torches.

Firing Devices. There is often opportunity and need to use controlled fire in line firing, burning out to a control line, or backfiring. Various types of firing devices may be used to make this job more effective. Without these devices it is sometimes difficult to get fuels to burn when their removal by fire can be done with the least risk. Planned removal of fuels by burning, with or without the aid of any firing equipment, should be done only under the supervision of a fire control officer experienced in this specialized job. This includes backfiring.

Torch, Backfiring, Fusee. A commonly used firing device is the fusee. Fusees are complete firing units, which are ignited at the primed end by scratching lightly with the protective cap. Ordinary railroad fusees are quite satisfactory unless a larger flame is needed to kindle the fuel. These fusees burn for 10 to 20 minutes and may be held in the hand, but it is much safer if the spike in one end is attached to a stick. A variation of this type of fusee is equipped with a metal ferrule which extends about 3 in. (7.6 cm) beyond the cartridge and may be placed over the end of a stick for greater comfort and safety in firing. Directions for use are printed on each fusee. Fusees are relatively safe in use and in storage.

Drip Torch. The drip torch is a firing device employing liquid fuel. In selecting such devices, safety should be a primary consideration. Torches should be designed to prevent any leakage or flashback. Normal capacity is about 1 gal (3.8 *l*).

Hand-held Torch. A hand-held propane fire torch has been developed for backfiring. It produces a hot flame about 10 in. (25.4 cm) long and comparable to a burning fusee. A scratch igniter works effectively for relighting. When the "flame control lever" is released, the flame shortens to a pilot light inside the torch "head." It balances well in one hand while the 3-ft (0.9-m) extension wand places the torch head near ground level for work in short fuels. The complete assembly weighs 4½ lbs (2 kg). Empty cylinders are disposable and replacement containers weigh less then 2 lbs (0.9 kg) when full. Empty cylinders must be removed from the fire area and disposed of in an approved area.

Back Pack Flame Thrower.

This firing device operates under pressure and employs liquid fuel from tanks varying in capacity from 1½ to 4 U. S. gals (5.7 to 15.2 *l*). Fuel may be diesel kerosene, or a combination of fuels. Gasoline should only be used in a mixture with kerosene or diesel oil in the proportion of 1 part gasoline to 3 parts kerosene. Weights of empty flame throwers range from 15 to 25 lbs (6.8 to 11.4 kg). Since this type of firing device may operate under pressures of 100 psi (69 kPa) or more, it is extremely important that materials and workmanship be of the best. Any leakage of fuel could contaminate the operator's body or clothing, causing irritation or endangering life in fire areas. A "no-leak" vent in the cap is essential. Some types of flame thrower consume fuel at the rate of approximately ½ gal (1.9 *l*) per minute of actual operation.

Tool Conditioning.

Appropriate tool sharpeners shall be stored with edged tools and taken to the fire line. Oil, grease, or rust preventive will help keep tools in good condition.

Equipment List.

Fire fighting tools and equipment are expensive. Persons responsible for their care and availability will find a fire equipment check list a valuable aid. Such a list will be most effective when posted at the point where the equipment is stored. This type of check list is designed to help insure that tool caches are complete; it is not intended to be a substitute for accountability systems.

Housing and Care of Equipment.

Hand fire tools and powered fire suppression equipment represent a substantial investment. To protect that investment the tools and equipment should be serviced frequently so that they will be ready for use at all times. Housing should provide adequate protection and suitable work space for frequent inspection, maintenance, and orderly storage. Storage facilities should also be readily accessible during all seasons. Particular attention must be given to winterizing pumps and equipment.

Buildings. It is often necessary to use barns or small outbuildings for storage, particularly where tools are stored at residences of wardens or similar fire control officers. Whether buildings are constructed for the purpose or existing structures are utilized, an effort should be made to insure that the facilities are dry, well ventilated,

and lighted. Structures built off the ground, with provision for air circulation underneath, are preferred for housing of equipment which is affected by moisture conditions.

Adequate Work Area. There is often a tendency to store fire equipment in buildings with insufficient space. This makes it difficult to maintain neat warehousing and to do maintenance and repair work. Arrange for adequate working area. Clear the area around the building as a protection measure. Provision should be made to prevent vandalism or theft and, at the same time, make the equipment available to fire control officers when needed.

Fire Tool Storage Boxes. Hand fire tools are often stored in specially built boxes distributed according to plan throughout the area being protected. Boxes are usually wood, but sometimes are fiberglass or metal. In either case, they should be relatively weather-proof and placed off the ground to keep out moisture and prolong the life of the box as well as the tools. Provision must be made for locking or sealing tool boxes to prevent unauthorized use of tools stored at isolated locations. Most boxes are of the horizontal type, placed at a height above the ground to make maintenance, placement, and removal of tools convenient. Ordinarily, the entire top is hinged for opening, with adequate chain or other device to prevent damage to the hinges by letting the lid fall backward. Some tool boxes, usually made of metal, are of the upright type, with a door opening at the front. Boxes may be designed to store hand tools sufficient to equip crews of from 6 to 15 fire fighters.

Standard Design. Boxes of varying design have been adopted as standard. The designs have been based upon the particular types of hand tools normally used in these areas. Boxes are commonly planned to hold outfits for crews of 6 to 8, 8 to 10, or 12 to 15 fire fighters. Boxes to store tools for larger crews are also common but are usually mounted on trucks or kept in fire tool warehouses where they can be loaded easily with the aid of ramps, rollers, hoists, etc.

Size. The details of fire tool box construction are dictated by the number, size, and shape of the tools to be stored and by the ingenuity of the designer. It is often good planning for communities to use the smaller type of box, such as the 6 to 8 person size. For larger crews, the tools from two or more boxes may be employed. It is quite common in some areas for crews to load the fire tool box in a pickup or other truck and thus keep the tools safely separated from crews during transportation. Such miscellaneous items as sharpening stones, first aid kits, and wedges are more apt to reach the fire fighting scene when the entire tool outfit is taken in its box than when crew members individually select tools.

Design. A suitable box for storing tools for an 8-person crew will be about 90 in. (2.3 m) long, 16 in. (41 cm) wide, and 18 in. (46 cm) high, outside dimensions. It may be made from ¾-in. (1.9-cm) lumber or from exterior grade plywood. The box should be reinforced where necessary so it will stand the hard usage it receives when taken to fires. The bottom should have strips at the edges for its entire length to give protection to the box when it is dragged about during loading and unloading. These strips will also make handling easier. Corners should be reinforced with 18-gage iron strips or equivalent. Straps of the same material should extend across the bottom and up the sides of the box. Metal reinforcing should be riveted. There should be no sharp points or edges, and the entire box should be weatherproof and ventilated to prevent "sweating" and rust.

Carrying Handles. Handles should extend the entire width of the box at each end and should not extend much beyond the end of the box. Metal tool boxes are made of about 20-gage metal and are frequently of the upright type. In designing upright metal boxes, care should be taken to adequately reinforce the bottom of the box at the front so that the door may extend to the floor level. Otherwise, it is difficult to clean the box.

Interior. The interior of fire tool boxes will vary according to the tools to be stored. Appropriate partitions will serve to prevent damage to the tools.

Rodents. Even though an effort is made to make warehouses rodentproof, there is always the possibility that these destructive pests may gain entrance when the building is open. Therefore, rodentproof areas should be provided by setting off a portion of the storage space with partitions covered with metal or with mesh fine enough to keep out mice, squirrels, etc. Floors and ceilings of such areas should be included in this rodentproofing.

Insect Damage. Various insects may cause damage to fire equipment in storage. Powder post beetles, for example, may damage tool handles, particularly handles which have never been used. There are several treatments which may be applied as a precaution. Arrange storage so that these handles can be easily observed. Do not store them in dark, out-of-the-way places. When stored in lighted areas, off the floor, it is often possible to detect damage from insects by observing the fine dust which falls from the wood as beetles do their work. Frequent inspection of equipment will pay off.

Vehicles and Pumping Equipment.

In selecting vehicles and pumping equipment consideration should be given to a number of factors within the protection area. Among these are:

Road System. Is the area readily accessible by roads so that most fires can be reached with mobile equipment? If so, what type of water-carrying equipment will best meet the needs of the community? How much fire hose will be needed to reach areas of operation?

Fuel Type. What is the nature of the fire endangered fuel type? Is the fuel heavy, requiring considerable quantities of water to control and mop up a fire? Is the fuel of a flash type, creating fast fire spread, requiring quick initial action by hose streams or nozzles on pumpers?

Water Source. Is water readily available? What are the sources — lakes, ponds, rivers, creeks? Can portable pumps be used at such sources in the potential areas, or must water be hauled to the fire in pumpers, tankers, or by aircraft?

Property Values. Are property values such that fires must be extinguished promptly to prevent serious losses? Or can a fire be allowed to burn to the nearest road or other barrier because of low rural wildland values? What about the past fire results? Will there be serious erosion problems such as silting of reservoirs? Will rehabilitation be costly?

Pumping Equipment. What pumping equipment is presently available to handle the community fire problem? Is the equipment the right type for the intended use? In how much of the area can it operate? Can it get there fast? Should it be supplemented? Can it be converted or rebuilt to serve the needs?

Portable Pumps. In the fire service a portable pump means one that can be carried to a water source by fire fighters, sometimes over difficult terrain. When put into operation it should supply sufficient water rapidly to fill tank trucks and supply pumps and hoselines at the fire scene. Heavier pumps, trailer- or truck-mounted, or otherwise made mobile, are valuable, but used less commonly.

NFPA 1921, *Specifications for Fire Department Portable Pumping Units*, sets forth specifications to be followed when purchasing portable pumps. It classifies these pumps by capacities and operating pressures for use in the fire service as follows:

(a) **Small Volume — Relatively High Pressure.** This pumping unit shall be capable of pumping 15 to 20 gpm (57 to 76 *l*pm) at

200 psi (1.379 kPa) pressure through a 1-in. (2.5-cm) discharge outlet while taking suction through a 1½-in. (3.8-cm) suction inlet. This class of portable pump is especially useful to fire departments for forest fire fighting which frequently requires long 1½-in. (3.8-cm) hoselines and pumping uphill in rugged terrain.

(b) **Medium Volume — Medium Pressure.** This pumping unit shall be capable of discharging 60 gpm (228 *l*pm) at 90 psi (621 kPa) pressure and 125 gpm (475 *l*pm) at 60 psi (414 kPa) pressure through a 1½-in. (3.8-cm) discharge outlet while taking suction through a 2½-in. (6.4-cm) suction inlet. This class of portable pump has limited utility for small structural fires and can supply a good ½-in. (1.3-cm) stream through 250 ft (76 m) of 1½-in. (3.8-cm) hose. It can be used to fill booster tanks or be used with 2½-in. (6.4-cm) hose to move water a long distance.

(c) **Large Volume — Relatively Low Pressure.** This pumping unit shall be capable of supplying 125 gpm (475 *l*pm) at 60 psi (413 kPa) pressure and 30 gpm (114 *l*pm) at 20 psi (138 kPa) pressure through a 2½-in. (6.4-cm) discharge outlet while taking suction through a 3-in. (7.6-cm) suction inlet. This class of portable pumping unit is frequently used for tank filling when a pumper cannot get close to a source of water. It is also suitable for dewatering cellars, manholes, and other areas where water has accumulated.

Methods of Use. The problems of supplying water in rural areas can frequently be overcome through the use of the correct portable pump. Many departments, through area prefire planning, locate water sources where portable pumps can be used for filling tankers or for supplying fire fighting hoselines. It is important to evaluate the many uses that can be made of portable pumps. The fire fighter should use this knowledge to apply sound judgment decisions to the types of pumps and uses in supplying water at the fire scene.

Centrifugal pumps are usually preferred over other types because of their ability to handle dirt and abrasives with less damage and their desirable volume-pressure ratio. Similarly, four-cycle engines are considered more suitable for fire service use, although two-cycle engines may be used.

Supply Operations. Portable pumps can be used in single or multiple combinations to accomplish the following:

Supplying fire fighting hoselines.
Relaying water from a source in a variety of combinations or hook-ups.
As a means of filling truck tanks when no fire pumper is available.
Pump-and-roll operations.

Low Pressure Centrifugal Pumps.

The low pressure centrifugal portable pumps (high volume) generally are rated at 200 to 300 gpm (760 to 1140 *l*pm) and capable of discharge at pressures of 50 to 80 psi (348 to 552 kPa). Usually these pumps will not discharge rated capacities when operating with suction lift in excess of 5 ft (1.5 m).

Some of these pumps do not use running rings or seal rings and do not have close tolerance, so they may be used in dirty water where some debris or abrasives are encountered. These pumps require little maintenance.

Other brands of portable pumps in this category do not use water or seal rings which will not hold up for long when pumping water containing substantial amounts of abrasive materials.

At lower discharge pressures, this type pump may deliver larger volumes, over 400 gpm (1520 *l*pm), at very low discharge pressures and high pump rpm's (for example, relay from portable pump into fire pump on apparatus).

Operation of these pumps depends on centrifugal force to move water and they are very effective for relay operations to pumper, or for filling a booster tank or tanker. There are no special operating problems and the pump will not heat up as rapidly as others if run without water.

High Pressure Centrifugal Pumps.

High pressure portable pumps (small volume) generally have a small capacity with an average of 30 to 40 gpm (114 to 152 *l*pm) discharge and operating pressures in the 125 to 150 psi (824 to 1034 kPa) range.

Gear Pumps.

Gear pumps (high pressure, low volume) are of positive displacement type with gears having very close tolerance between gears and case. They may be used safely in clear water only. Dirty water will cause damage to gears and case. They are not very useful for tank filling or relay work as they are generally of low capacity in the lighter models.

They are very good for fire fighting where high pressures are desired. These pumps have a shorter life span than the centrifugal type, are widely used by the U. S. Forest Service, and are easily packed on the back. They should never be operated without water and must be equipped with a relief valve.

Piston Pumps.

Piston pumps (high pressure, low volume) are operated by a piston, sleeve, or cylinder with two check valves. They can be either single or double action with one or more cylinders. They are positive displacement type and must be operated with clean water. They are usually high pressure pumps. Piston-type pumps are limited to small capacities and weigh more than centrifugal or gear pumps. They are capable of very high lift.

The impeller is usually geared twice as fast as the engine to get the pressure at single stage. This type uses running rings or seal rings the same as larger fire pumpers and usually incorporates closed volutes in the impeller.

Floating Pumps.

A recent development is the floating pump which primes and pumps automatically when placed in water. This type of pump is constructed to sit inside a float which resists breakage and needs no maintenance. Some entire units weigh under 50 lbs (23 kg) including fuel and provide from 60 to 90 minutes of operating time from the 5-qt (4.71-*l*) fuel tank.

The pump serves a need for a lightweight, easy to operate, portable fire pump which may be placed in the water and does not need suction hose or strainers.

High-lift Pumps.

The high-lift pump is a small, portable pump which uses water to drive a water motor, which in turn drives an impeller and pumps water to high elevation into a fire pumper for relay into hoselines for fire fighting.

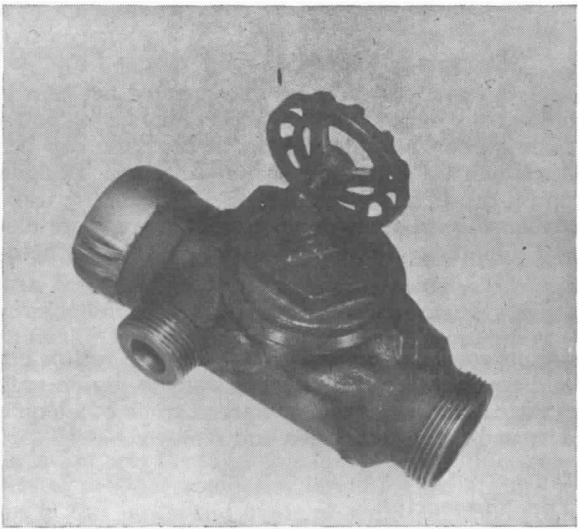
The high-lift pump is designed to obtain a water supply from a river, lake, stream, swimming pool, or other source not accessible to a pumper or conventional portable pump for drafting operations.

The water used to power the water motor of a high-lift pump is taken from the booster tank of the pumper and discharged at high pressure through the fire pump into the hose to the high-lift pump water motor. This, in turn, drives the water motor which is connected to the high-lift pump impeller, thus forcing volumes of water back into the intake side of the fire pump and into the fire fighting hoselines.

High-lift pumps may be hooked into hoselines and lowered or tossed into water sources at the lower levels without the need for fire fighting personnel to go down to set the pumps.

Setting Up a Pumper.

Pumping operations involving short hose lays on level terrain are simple. But when it is necessary to pump water up slopes, or when long hoselines are used, the problem becomes more complex. If pumping from a stream, make sure the portable pump is not too large for the available water supply; if it is, it will have to be shut down frequently.



A combination check and bleeder valve used at the pumper when vertical lift is 200 ft (61 m) or more. A check valve holds the water back when a positive displacement pumper is stopped.

Valves.

A check and bleeder valve is needed with positive displacement pumps to prevent the back flow of water on uphill hose lays. This can be located at the pump outlet or preferably at the end of the first line of hose, away from the pump. Back pressure from high lifts will make it difficult to start the pump unless some means of relieving the pressure is provided between the pump and the check valve. This can be done with a valve on a tee or by use of a standard hose siamese. Suction hoses for centrifugal pumps used in forestry work have a foot valve that prevents water from flowing back to the pump. Since the back pressure in the centrifugal pump

housing is hydraulically equalized, starting is simple and there is no danger to the engine. It is advisable to install a check valve above the pump to prevent back pressure from rupturing the suction hose.

NOTE: The weight of such valves plus the weight of charged hose along with pumper vibrations very often cause hose swivel failures. To prevent these failures, experienced pumper operators often use a short 3- or 4-ft (0.9- or 1.2-m) section of hose which permits the heavy fittings to lie on the ground. If a short hose section is not available, they can be placed at the end of the first full length.

Hoseline Tees.

Hoseline tees (water thieves) may be inserted between lengths of hose for filling back pack cans. The outlet may be ¾- or 1-in. (2- or 2.5-cm) male garden hose threads so garden hose can be used for lateral lines which are important in mop-up work. Designed specifically for grass, brush, and forest fires, these tankers are usually much less costly than the structural fire units; they are more mobile and, as a general rule, faster hitting and better adapted for field use.

Slip-on Pumps.

Slip-on units consist of a water tank, line hose reel or basket, and a pump and engine, all combined into a single slip-on tanker. The slip-on is carried on any pickup or flatbed truck of adequate length and capacity and is easily installed and removed.

Nozzles and Accessories.

Many types of nozzles are available, with discharge patterns varying from fog to spray, straight stream, and a combination of these. Delivery varies from less than one to hundreds of gpm. Fire control organizations should make certain they purchase the correct nozzles designed for the capability of the pumps with which they are to be used. A little water, properly applied, is much more effective than great volumes used in "spraying the landscape." On most fires, more water is wasted than used effectively. Water running in little rivulets down every depression is not being used wisely. When water is hauled in tank trucks, sometimes for great distances, anything less than efficient application is inexcusable.

Hose.

Improvement in hose manufacture is a continuing process. Use of synthetic fibers has resulted in increasing the bursting pressure of hose while at the same time decreasing the weight. These improvements have changed some of our concepts regarding hose and some

of the statements formerly made about linen hose are no longer applicable. The types of forestry hose in common use are cotton-jacket, rubber-lined; cotton-synthetic jacket, rubber-lined; and unlined (linen).

Cotton-jacket, Rubber-lined Hose. This hose when used in fighting forest fires is usually single-jacket as compared to the double-jacket hose used by city fire departments. Forestry specifications call for burst pressure tests up to 600 psi (4137 kPa); this is for short sections and for short periods. Working pressures of 300 psi (2069 kPa) should be expected from new hose of this type, which is manufactured in both 1- and 1½-in. (2.5- and 3.8-cm) sizes.

(a) **Favorable features.** Less friction loss than with unlined linen hose. No water loss through fabric by seepage. Thorough cleaning of outer jacket not as essential as with linen. Generally believed to withstand more hand usage than linen hose. Generally more flexible under pressure.

(b) **Unfavorable features.** More bulk than unlined linen hose and less can be carried on truck of given capacity. Cannot be kept in storage indefinitely. The rubber lining deteriorates even when hose is not used. (If not used in the field, hose should have water run through it at least twice a year to prevent hardening and cracking of rubber lining.) More subject to damage from hot embers.

Cotton-synthetic Jacket, Rubber-lined Hose. This combination single-jacket uses the favorable features of both cotton and synthetic fibers to produce a superior jacket for certain fire jobs. The fiber yarns in this jacket are made of synthetic fibers for increased burst and weight reductions. A 100-ft (31-m) roll (uncoupled) of 1½-in. (3.8-cm) cotton-synthetic hose weighs about 26 lbs (12 kg), 7 lbs (3.2 kg) lighter than all-cotton rubber-lined. Latex-lined, all-synthetic hose jackets are also available which results in additional weight savings.

Unlined Linen Hose. In the past, the main reason linen hose was favored by many field men over lined hose was because of its lighter weight and less bulk. Another primary advantage is that this hose "weeps" and when under pressure is safer from damage by hot embers and flames. Linen hose is also burst-tested to 600 psi (4137 kPa) with kink tests of 300 psi (2069 kPa).

(a) **Favorable features.** Lightweight. Costs less than rubber-lined hose. Small bulk. Unlined linen hose will roll into small compact rolls (some makes even when wet). More hose can be carried on a truck than when using rubber-lined hose. Leakage of water through fabric affords protection to hose when dragged through hot embers. When properly stored will last indefinitely.

(b) **Unfavorable features.** Larger friction loss compared with rubber-lined hose. This is particularly objectionable when large volumes of water are being pumped. Leakage of water through fabric means less water delivered at nozzle until hose is thoroughly saturated; thereafter leakage should have negligible effect. It takes time to charge a line of linen hose. One series of tests showed that as much as one-half hour was lost in charging a long line of this hose. Unlined linen hose must be thoroughly cleaned and thoroughly dried after use or it will mildew or rot. It has been the general experience that it does not ordinarily get the care that it needs with the result that it does not stand up as well as cotton rubber-lined hose. Sometimes it is difficult to find suitable storage facilities for unlined linen hose, particularly in humid climate.

Hose Coupling Screw Threads.

The type of screw threads used on the hose couplings will depend on what is standard in the area. The National Standard fire hose coupling screw thread is recommended by NFPA and has been adopted by the U. S. Forest Service, most of the states, and all but one province in Canada. It is always well to check with local fire officers so that the hose purchased can be used along with other hose available in the area. Adaptors should be carried for use with other types of couplings used in the area.

Pumping Relays.

In steep or mountainous terrain it often becomes necessary to use 2 or more pumps to relay water at an elevation above that which could be reached by 1 pump alone. The usual method is to set up 1 pump at the water source to pump water into a tank some 250 to 300 ft (76 to 92 m) vertical distance above the first pump. At this point a second pump is used to boost the water up the next leg of the relay or to the fire. Under some conditions pumps are used in service with a suitable centrifugal pump directly in the line, part way up the slope, making a relay tank unnecessary. However, the relay must be balanced to avoid cavitating the line.

Tank Trucks.

Tank trucks can also be used for relays. When this is done, the procedure is for the first or lower tanker to pump directly into the tank of the second pumper, and so on, until the water is relayed to the point where it is to be used. Portable pumps and tankers may be used together in the same relay.

Placement of Pumps.

The important factors in relays are the selection and placement of pumps. The larger volume pumps must be at the bottom of the relay. This will assure that the upper pump or pumps will not exhaust the water being furnished by the lower pumps in the relay. Pump pressures also are important since the pressure determines the practical distance between relays. Pumps capable of providing 300 psi (2069 kPa) pressure can boost water up to 400 to 500 ft (122 to 137 m) vertically, depending on the length of the hose lay. Pumps developing less pressure will have lesser relay distance capabilities. Type or age of hose is still another factor in determining relay distances, since the amount of pressure the hose will stand before bursting also determines the distance the water can be pumped.

Relays have been used, in some instances, to boost water up several thousand feet. As many as eleven tankers have been used in a single relay operation.

Portable Tanks.

Portable canvas tanks are available for relay pumping. Some tanks are made of heavy, treated, mildew-proof duck cloth, reinforced at all points of stress. Barrels and tubs, and even a piece of canvas, used to line a pit dug in the ground will serve usefully at relay stations. Polyethylene sheets lining a hole or depression make an excellent relay pump.

Gravity Water Systems.

Gravity water systems are not powered, but can take the place of a power pumper. Gravity pressure develops at the rate of 43.3 psi (2986 kPa) for each 100 ft (30.5 m) of vertical drop. If a source of water is available, such as a stream or spring, and if the terrain is such that this water can be diverted into a gravity "show," then an excellent substitute for a pump can be provided.

Gravity Intake.

A gravity intake, or "gravity sock," consists of a cone-shaped piece of canvas, 3 to 6 ft (0.9 to 1.8 m) long. The end is about 10 in. (25.4 cm) in diameter, held open by a metal ring. A 1½-in. (3.8-cm) threaded male coupling is attached to the tapered end of the cone to which the hose is attached. These socks have been used to bring water from several separated springs into one point; the total water from the springs being enough to supply a 1½-in. (3.8-cm) hoseline.

Gravity Head.

The point of water use from gravity lines must be at least 50 vertical ft (15.3 m) below the point of water intake, if there is to be sufficient pressure to use a nozzle. As the vertical distance between intake and point of use increases, the pressure builds up, sometimes to the point where care must be taken to keep the hose from bursting. When this point is reached it is well to insert a siamese connection and use two hoselines on the fire, or at least turn part of the water out of the hoseline.

Relieving Pressure.

Another method of relieving the pressure in gravity lines is to remove the hose gaskets at the connections and then connect the hose sections loosely, allowing water to escape at each connection. Or, break the line into another gravity sock if pressure buildup becomes excessive. While gravity intakes or socks facilitate the start of a gravity system, other means can be employed. A 5-gal (19-*l*) open can, with the hose secured to the bottom (like a funnel), can be used. A length of iron pipe or a section of hard rubber suction hose will also serve in an emergency.

Water Ejectors (Suction Boosters) Uses.

Water ejectors have many uses in industry and in deep well pumping operations. They are used also in connection with fire department pumpers. An ejector makes it possible for a pumping unit to take supply from water sources not otherwise available. For example, when a bridge crosses a river or stream too high above the water surface to permit drafting, an ejector may be used to lift water 80 ft (24.4 m) or more. Because of soft ground, a tanker may not be able to draft water from a swamp in the conventional manner; or a road, winding up a river drainage, may be too far back from the water source to permit conventional drafting. On the level, or slightly above the level, ejectors will make such water sources available for distances up to 200 ft (6.4 cm). The large portable pump is effective for filling tanks using a 2½-in. (6.4-cm) supply line from pump to tanker.

Technique. When using an ejector it is necessary to have enough water in the pumper to fill the hose connecting the pump with the ejector at the water source. The pump should also carry enough water to last until the supply gets back to the pumper from the ejector. Ejectors should be selected in relation to the gpm output of the pump with which they are to be used.

Advantages. In addition to permitting use of otherwise unavailable water sources, ejectors have the following advantages: Lessen the need for large suction hose. Operate even with a few leaks at hose connections. Prevent the running of a dry pump during drafting operations. Permit a small volume pump with relatively high pressure to produce a larger volume in ordinary drafting operations.

Disadvantages. Two hose lines must be laid to the water source. The crew must be trained in the use of these devices.

Tank Trucks.

Many types of tank trucks or "tankers" are available to communities. There are, also, municipal fire department pumpers of up to 1,500-gpm (5.7-k*l*) capacity and other equipment designed for fighting structural fires, but they are not the most effective for nonstructural fires. Some agriculture spray tankers can be adapted readily for fire fighting. It is desirable to keep plumbing and valves as simple as possible.

Brush and Slip-on Tankers.

Some communities have solved this problem by acquiring "brush tankers" to handle all except the structural fires.

Care of Pumps and Tankers.

The following points are to be considered in the care of portable pumps for winter or nonfire season storage: Close gas line valve at tank and operate engine until all gas is exhausted in gas line and carburetor. Drain engine of all water. Dry, and then pour ¼ pt (0.1 *l*) of oil into the engine. Turn engine backward three revolutions. Disconnect to the pressure gage and allow the water in the tube to drain out. This assures that the water in the tube will not freeze and injure the pressure gage. When pumps are in storage it is well to turn them over periodically — at least once a month to let the engine cylinders come to rest in a new position. This change in position helps to prevent etching of the cylinder walls which sometimes occurs when an engine remains idle for a long period of time. Follow manufacturer's recommendations.

Tankers.

If tankers equipped with pumps are to be used in freezing weather, they should be kept in heated storage. If they are to go out of service the following should be done: Start engine and pump water from all lines. Oil pump. Open all drains and valves, remove all caps. Disconnect batteries, clean, fill with water, and charge. Remove hose from reels and compartments, clean and store. Check tank for rust. If necessary paint and make repairs.

Maintenance.

In spite of all that may be done, metal parts of equipment may suffer from rust. Plan to use rust preventives. Preventives are inexpensive, easily applied, and cut down on maintenance costs. A light coating of oil may often be adequate to perform this job, but is not as lasting as some rust preventives. Oil film tends to gather dust on the tools. Ventilate the area.

In freezing temperatures, care must be taken to assure that water has been drained from all equipment in storage. It may be necessary to disassemble equipment such as back pack pumps, to be certain that all the water has been removed.

Excessive heat in a storage building is undesirable and a nominal amount of shade will help to hold down temperature. However, too much shade will result in making the storage area damp, and this condition is worse than having the high temperatures.

Exercise caution in the storage of kerosene, oil, and gasoline. Refer to NFPA standards for information on the storage of combustible liquids and materials.

Provide plenty of space for powered fire equipment. Make sure floors are adequate to support weight. Maintenance and repair work can be done on rainy days or on "half-work" days. Too frequently storage space does not allow free movement of personnel when the equipment is in its designated space. Provide room ahead, on both sides, and to the rear of equipment in storage. Install a workbench with adequate lighting and such simple accessories as a vise, grinding tool, drill press, and small anvil.

Make certain that adequate guards are installed on power tools. Keep safety goggles available and close to the tools which indicate their use. Make a simple rack for orderly storage of small hand maintenance tools. Keep these tools in their assigned place when not being used. When building, renting, or adapting space for equipment storage, the factor of adequate room for free movement must be given its deserved weight. If space is inadequate initially, it will continue to be that way, probably to an increasing degree.

Additional tools may be acquired and equipment may be replaced with larger types. Do not allow oil, grease, or oily rags to accumulate. Provide loading platforms or ramps and loading machinery when they will be needed to assist in loading or unloading equipment. Often one or two fire fighters may be available when this job of loading has to be done.

Keep first aid kits and fire extinguishers always at hand.

Follow manufacturer's instructions in maintenance and repair of powered equipment.