NFPA No.

295

WILDFIRE CONTROL BY VOLUNTEER FIRE DEPARTMENTS 1973

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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

Standard for

Wildfire Control by Volunteer Fire Departments

NFPA No. 295— 1973

1973 Edition of No. 295

The recommendations in this guide were prepared by the NFPA Forest Committee and adopted by the Association during the Annual Meeting in St. Louis, Missouri in May, 1973. This edition 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 No. 295, Community Forest Fire Equipment, adopted by NFPA in 1934.

Explanation of Intent of No. 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.

Forest Committee

Merle S. Lowden, *Chairman,*
4616 SW 25th Ave., Portland, OR 97201

Paul R. Lyons,† *Secretary,*
National Fire Protection Assn., 470 Atlantic Avenue, Boston, MA. 02210

W. G. Cleaveley, Dept. Lands & Environmental Protection, Ontario, Canada
James Corlett, Oregon Forest Protection Association
Henry W. DeBruin, Forest Service, U.S. Dept. of Agriculture
John Hastings, California Division of Forestry
H. J. Irving, Societe de Conservation de l'Outaouais, Quebec, Canada
Wm. H. Larson, Washington Forest Protection Assn.
William A. Penttila, State Fire Marshal
James Richardson, U.S. Dept. of the Interior, Bureau of Land Management
Milton C. Stocking, Northeastern Forest Fire Protection Commission
Ross A. W. Switzer, Dept. of Public Works, Ottawa, Canada
Willard R. Tikkala, Forest Service, U.S. Dept. of Agriculture
James C. Turner, Jr., Georgia Forestry Commission
D. S. Watts, MacMillan Bloedel Ltd.

†Nonvoting.

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.

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Standard for
Wildfire Control by Volunteer Fire Departments

Introduction

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. 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 these mandatory requirements by formal action, perhaps using this format: **The**.....
Name
Fire Department of the.....
County, Town, City, Province
of.....**accepts the mandatory requirements of NFPA No. 295 as a working charter providing reasonable guidance to reduce, as far as practicable, hazards to life and property from fire.**

Preface

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 evaulation 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.

This standard describes the fundamentals to be considered in such organization, 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.

Standard for

Wildfire Control by Volunteer Fire Departments

NFPA No. 295 — 1973

A. Organization and Management[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.

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

3. Prospective members of the fire department shall undergo and pass physical examination before selection.

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

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

6. Members shall be familiar with the entire area protected by the department.

7. Members shall be trained to achieve safe and effective response to alarms.

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

9. Mutual aid agreements with adjacent fire departments and other agencies shall be prepared and followed.

10. A fire prevention program shall be planned and carried out for the entire year.

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

12. The first responsible fire authority at the fire shall be the fire boss in command until someone with higher authority relieves him.

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[1]Ref. 1, page 66.

13. Personnel safety shall be the first consideration in all fire suppression operations and decisions.

B. Protection and Safety

14. The fire chief shall require that protective clothing and head gear be worn by fire fighting personnel.

15. First aid kits shall be available on all emergency responses, especially for fireline use.

16. The organization shall have sufficient hand tools for outdoor fire control.

17. Fire tools and equipment shall be for fire emergencies only and shall be marked distinctly.

18. The organization shall consult with local forest fire protection agencies for advice on selection of tools and equipment.

19. The cutting edges of all tools shall be covered with guards.

20. Power saws shall have adequate spark arrestors.

21. All tractors (dozers) shall have protective canopies and shall be equipped with effective spark arrestors.

22. Care shall be exercised in the use of all chemicals in fire protection.

23. The safety principles recommended in this standard, and in the publications of Federal, provincial and state forest fire control agencies shall apply in training and fire fighting.

Appendix

CHAPTER 1. ORGANIZATION AND PLANNING

110. Organization. To protect itself against forest, grass, and brush fires, a community should establish the following:

1101. An officially designated organization headed by a fire chief or fire warden charged with the responsibility of preventing and suppressing fires.[1]

1102. A well-organized, equipped and trained crew which will operate under the authority of the fire chief, fire warden or subordinate officers.

1103. A communications system by which fires may be reported to this 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.[2]

120. 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.

1201. Persons selected as active members of the fire department shall undergo a physical examination by a physician and medical files shall be established to keep a history of any accidents or disability that the fire fighter receives in his 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.

130. Fire Station. A building shall 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. (*See page 295–49.*)

[1]Ref. 1, page 66.
[2]Ref. 2, page 66.

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 will be giving part of his 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.....
Wife, near relative, parent or guardian

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

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

Shown above and on the next page are typical forms which can be used for enrolling new members in volunteer fire departments. (From a booklet of the Firemanship Training Division Engineering Extension, Iowa State College.)

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 he hernia or enlarged inguinal rings?.....
.....

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

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

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

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

I believe this man (not to be) (to be) physically qualified to be a fireman .....

Signed .....M.D.

Form for physical examination of volunteer firemen, developed by Dr. Leonard F. Roblee, for the Lockport, Illinois, Township Fire Department.

140. 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 shall be familiar with the entire area protected by the organization and, for each emergency, shall report to the fire chief or other officer in charge.

The organization shall include training to achieve safe and effective response to alarm. A small well-trained group with up-to-date equipment often can accomplish more than a much larger group which is inadequately equipped and poorly trained.

150. Plans for Operations. Written fire control 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 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 plans should be updated at least annually.

1501. Sample Fire Plan

A. Fire Chief — Name — how to contact
Alternate " " " "

B. Manpower — " " " "

C. Other facilities — " " " "

D. Cooperating Agencies " " " "

E. Equipment Type and location

(1) List available reserve manpower, 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.

151. Training Program. Another important step in organizing for community fire protection is to establish a long-range training program. This will cover use of tools and equipment (see Section 2), apparatus and fire control tactics (see Section 3). 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 Forest Service, USDA, Washington, DC 20250.

160. Outside Assistance. Forest, grass, and brush fires which appear to be spreading beyond control require action by large well-trained groups. County, state, forest and agricultural agencies, municipal fire departments, and similar organizations need to be contacted promptly. Good organization for outdoor fire control calls for close cooperation between property owners and all private, state, provincial and federal agencies whose help may be needed in emergencies.

161. Written Cooperative Agreements. Small communities which are beyond the corporate limits of larger communities may arrange to receive fire protection service on a contract basis. This is generally termed "outside aid" by the larger municipalities, but legal agreements must be completed to specify the type of fire response and any financial arrangements. These eliminate confusion and avoid conflicts in jurisdiction during an emergency. Many communities are not allowed to participate in these contracts. In the absence of such an arrangement some communities form a "fire district" under the provisions of State or Provincial legislation. Advice and assistance for organizing and developing small fire organizations can be obtained from forestry agencies, State or Provincial fire marshals and directors of fire service training. In addition, associations of fire chiefs, firemen and insurance rating bureaus may provide some guidance.

162. Mutual Aid. In each stage of its development, the fire control organization has to be certain of receiving outside assistance for large fires or emergencies which are beyond its capability. This usually means establishing agreements with surrounding communities or with forest fire control agencies so that each community can play an effective roll in a major emergency. State, Provincial, and Federal agencies can advise on the methods of establishing mutual aid arrangements within the framework of existing legislation.[1]

[1]Ref. 2, page 66.

163. 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 area or other wild land 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.

170. Fire Prevention.

1701. 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 prevention 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.

1702. 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.[1,2]

171. Burning Permit. The community should establish an ordinance to give the local fire chief or fire warden authority to enforce fire prevention.[3] Included in this would be his authority to issue permits for outdoor burning or to refuse permission for such burning

[1]Ref. 3, page 66.
[2]Ref. 4, page 66.
[3]Ref. 5, page 66.

in dangerous weather and dangerous locations. Such a system must conform to existing law. Most organized communities have such regulations which are relatively easy to enforce as long as the public is informed of the need for fire prevention. Sometimes it is necessary to establish a system of fines for violators of these regulations.

172. Other Fire Regulations. States and Provinces have adopted a number of nationally recognized fire codes to assure safe practices of fire prevention and fire protection.[1] The community fire organization must learn what codes have been adopted for its own State or Province, and, if necessary, adopt other fire codes or standards which may not be covered by state or provincial legislation. The assistance of a local attorney or legal organization should be obtained so that the community can develop its best fire protection within the framework of its legal rights. State and Provincial Fire Marshals and Foresters should also be consulted.

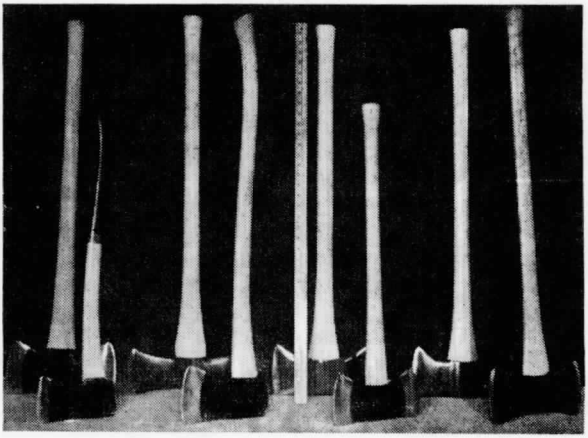
173. Outdoor Fire Prevention. Campers, hunters, and other persons who use the woods frequently need to be instructed on how to prevent fires and how to control campfires and other types of burning which may be necessary for their particular activities in the wooded areas. Folders, booklets, and other literature describing fire prevention and basic fire safety can be passed to these individuals as they enter the wooded areas.[2] They should receive advice on the local fire danger rating and should also be instructed on how to report a fire problem. They should also be advised on the location of fire trails and other open areas which may offer them safety, if a large fire starts in the woods. Personnel of private industrial concerns, such as those which engage in timber cutting, may need special instruction on fire prevention and control practices. Such instruction would stress the need for regulation of smoking and the use of power tools and equipment whose fuel or exhausts may be sources of ignition. Most states have laws covering this. The need for fire prevention is continual and the fire control organization must be consistent in maintaining control of its fire prevention program throughout the year.

[1]Ref. 6, page 66.
[2]Ref. 6, page 66.

CHAPTER 2. HAND TOOLS

210. Location. Communities shall have sufficient hand tools to equip a crew of at least ten men. These tools shall be for fire emergencies only, and shall 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 en route to a fire.

220. Selection. Tools needed will vary by sections of the country, due to difference in vegetation, soil, and topography. All equipment selected for fire control must 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.[1] 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.

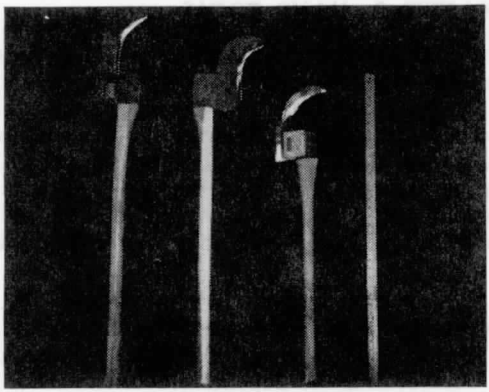


(Right) Axes: single and double bit.

230. Chopping, Felling, and Clearing Tools

2301. 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

[1]Refs. 7 to 19, page 66.



(Left) Brush hooks: single and double-edged.

axe is usually preferred in a 3½-pound weight. The over-all length of head is about 10 inches and the width of bit about 4⅝ inches.[1]

2302. Single Bit Axe. The single bit axe, or pole axe, commonly weighs about 3½ pounds, has a bit width of 4⅞ inches and a head, or flat hammer-like surface, about 3½ inches by 1 inch. It is particularly useful in mop-up work, where the head serves well in knocking stumps, logs, and other heavy fuels apart. A 30-inch handle is a commonly preferred length. In the hands of unskilled men, the single bit axe may offer an added feature of safety.[2]

2303. 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 pounds.[3]

2304. 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

[1]Ref. 6, page 66.
[2]Ref. 6, page 66.
[3]Ref. 6, page 66.

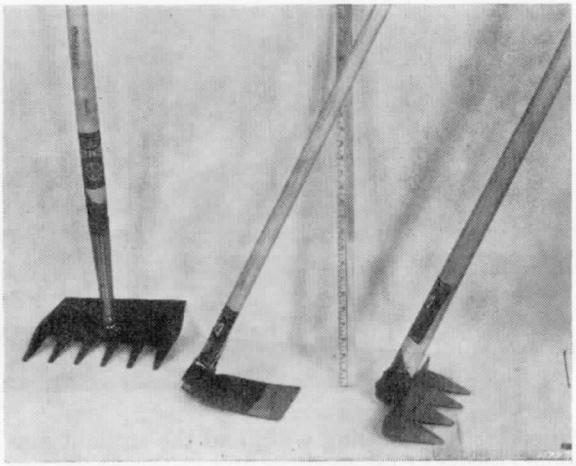
(Right) Pulaski tool.

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 inches and overall handled tool length is 36 inches. The double-edge brush hook may also be fitted with either a straight or curved handle. Weight is 4 pounds 10 ounces, 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.

2305. 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 pounds 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 inches long and the hoe is 3⅜ inches 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.[1]

2306. 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.[2]

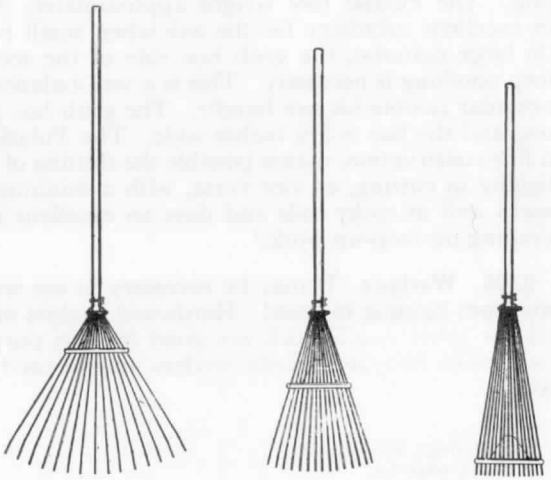
[1]Ref. 9, page 66.
[2]Ref. 10, page 66.



(Left) (Left to right) McLeod tool, Hazel hoe and Council or Rich tool.

2307. Hammers. In fire suppression work, hammers should be used for driving wedges. Axes should not be substituted for striking hammers, particularly 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.[1]

[1]Ref. 11, page 66.



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

240. Raking, Hoeing and Trenching Tools

2401. 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-inch angle iron which has a planter's hoe eye for the accommodation of a 60-inch 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 pounds.

2402. 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 inches. The tool is equipped with a 48-inch straight handle and weighs approximately 5 pounds.[1]

2403. Leaf Rake (or Rake, Broom or Lawn Comb). Various types of leaf or broom rakes are used in fireline 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.

2404. 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 inches wide and 11⅜ inches long, with a 48-inch handle and an overall weight of about 5½ pounds. The No. 0 size has a blade 8 by 10 inches in size, equipped with a 37½-inch handle; overall weight is approximately 3½ pounds. 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

[1]Ref. 12, page 66.

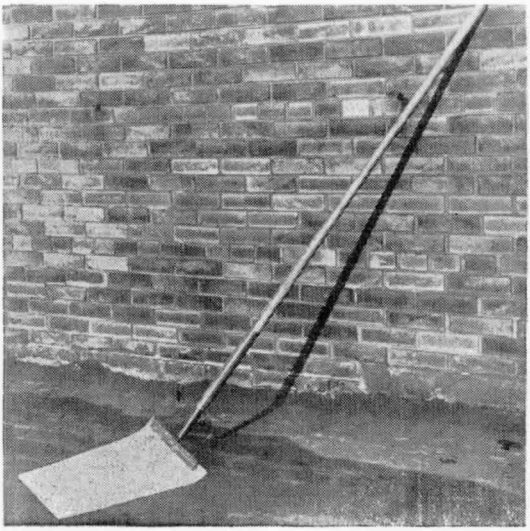
both edges of the blade to use the shovel as a scraping tool in creating a clean fire line to mineral soil. Whenonly one side is sharpened, it is usually the left side and the sharpening extends along the blade from the point to within about one inch of the top. This last inch or so is preferably left 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.[1]

2405. 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 fireline 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 Number 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 inches longer than that of the Number 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 Number 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.[2]

250. Swatting Tools

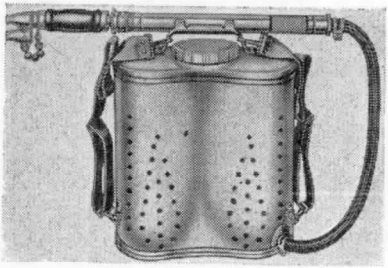
2501. Fire Swatter (or Fire Flail). The fire swatter or flail is used mainly to smother fire in light grass or grain field fuels. Usually, it is laid on the fire edge and moved progressively along the line. Hard swatting, especially in a vertical manner, should be avoided since it tends to spread the 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 inches. This

[1]Ref. 13, page 66.
[2]Ref. 14, page 66.



(Left) Typical swatter or flail has a wooden handle at least 60 inches long and weighs between 5 and 7 pounds.

(Right) Typical back-pack pump with "sliding pump."



flap is attached to a wooden handle at least 60 inches long, bringing the total weight of the swatter to between 5 and 7 pounds. The swatter has replaced such makeshift tools as the tree bough, the gunny sack, the green cowhide and articles of clothing.

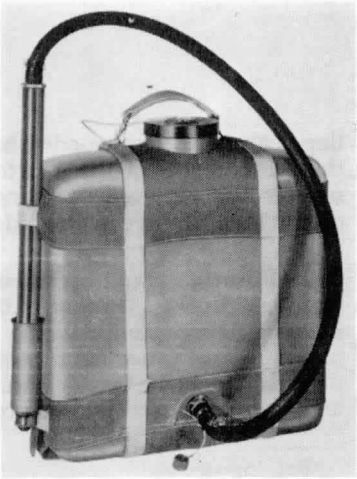
260. Pumps. Hand-operated pumps can be used in brush, grass, or forested areas. Probably the most common is the back-pack or knapsack type pump, which is very effective when used in conjunction with other hand tools. Each organized crew of 10 or 12 men should have two or three of these pumps.[1] Be careful to lift and transport filled pumps properly to prevent back injury.

[1]Ref. 15, page 66.

2601. Containers. Back-pack pumps with capacities of 4 or 5 gallons 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.

2602. 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

Bag-type back-pack pump. Capacity, 5 U.S. gallons; weight, 5 pounds.



Typical plastic back-pack tank with single action pump. Straight stream can be changed to spray by depressing thumb plate at nozzle. Capacity, 5 U.S. gallons; weight, 8½ pounds.

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 feet above the nozzle at ¼ to ½ pound 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.

2603. 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 inches 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 back-plate 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 quick-release straps, will hold these pumps upright during transportation. Highly durable, corrosion proof, rubber or plastic back-pack tanks are available.

2604. 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 inches 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.

270. Firing Devices. There is often opportunity and need to use controlled fire in line-firing, burning-out to a control line, or back-firing. 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.

2701. 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 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 inches 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.[1]

Drip-torch.

2702. 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 one gallon.

2703. Hand-held Torch. A hand-held propane fire torch has been developed for backfiring. It produces a hot flame about 10 inches 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-foot extension wand places the torch head near ground level for work in short fuels. The complete assembly weighs 4½ pounds. Empty cylinders are disposable and replacement containers weigh less than 2 pounds when full. Empty cylinders must be removed from the fire area and disposed of in an approved area.

[1]Ref. 17, page 66.

2704. 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. gallons. 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 pounds. Since this type of firing device may operate under pressures of 100 psi 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 gallon per minute of actual operation.

280. Miscellaneous

2801. First-Aid Kits. First-aid kits shall 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.

2802. Safety Hard Hats. Hard hats greatly reduce the number of serious accidents, particularly where dead trees are prevalent. They shall 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.

2803. Tool Conditioning. Appropriate tool sharpeners should be stored with edged tools and taken to the fireline. Oil, grease, or rust preventive will help keep tools in good condition.

2804. Tool Guards. Guards shall be used on all tools with cutting edges. These provide for safe carrying of tools to and from the fireline, 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.[1]

2805. Lights. During fire fighting, or travel, adequate lights are necessary. A wide variety of electric flashlights and lanterns are readily available. Minor repair parts and extra batteries should be available.

[1]Ref. 18, page 66.

2806. 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.

CHAPTER 3. POWER-OPERATED EQUIPMENT

310. Selection of Equipment. Communities can get good advice from a number of agencies and individuals to make comparisons of cost and performance of equipment. Federal, State, and Provincial forest service agencies have valuable experience data. Neighboring communities, private contractors and fire departments will also be of help. However, before a community buys power equipment a broad analysis should be made to determine what is most suitable for the long-range use. The following basic considerations should be taken into account.

3101. Specific Needs. There are no all-purpose units. Different localities and types require different equipment. When studying equipment needs, limit consideration to areas which feature reasonably uniform soil, fuel, accessibility, and fire behavior factors.

3102. Mobility. Estimate elapsed time required to get equipment in strategic position on likely future fire locations and compare with probable rate of fire spread.

3103. Fire Line Construction. Calculate the rate at which equipment will construct a fire line under the conditions normally found in the area to be protected. Remember that power in a machine is only one factor. Weight and size, ability to function on steep slopes or sharp pitches, stability when unseen logs, rocks, or other obstacles are encountered, and safety features in general — all these should be carefully evaluated. As equipment becomes increasingly heavy, the problem of getting it on the fire line where it is needed also increases.

3104. Machine Output. Be sure to evaluate machines in terms of comparable output by crews using hand tools. Consider such factors as cost, time, area burned, possibility of quick control, presence or absence of nearby manpower or machinery. Check past experience with hand tools. Was it satisfactory? Will machinery give an improvement over this past performance? Will this expected improvement increase costs too much?

3105. Men versus Machines. Has past experience shown that, in the area under study, the time of greatest danger for "run-away" fires to develop is in the first few minutes or in a later period? Which type of attack will be most apt to offset this? Which can be mobilized faster: men or machines? Are fires generally of long duration? (Men tire faster than machines.)

3106. Analysis. If an analysis covering the above and similar items indicates the desirability of powered equipment in a com-

munity, then more detailed study can be given to specific makes and models. The comments which follow may serve as a guide in the selection of powered tools which will do particular jobs in fire suppression, although the tools may have been originally designed for some purpose other than fire control.

320. Felling and Clearing Equipment

3201. 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 firefighting 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.

(Right) One-man power chain saw.

3202. One-Man Chain Saw. The one-man chain saw is preferred if the size of timber in the area will permit its use. Some one-man units weigh less than 20 pounds. The operator of a one-man lightweight chain saw can clear a line through thick growth at a rapid rate, provided he is backed up by an organized crew to do notching, limbing, and swamping with the appropriate equipment discussed earlier under "hand tools." For sustained work in fire line construction or in the removal of snags or other mop-up work, a helper is desirable. This man can alternate as saw operator and assist in pushing small timber so it will fall as intended. In thick

growth, two or three men work as trimmers and throwout men so that the chain saw can continue with the job it is best adapted to perform.

3203. Safety and Servicing. Properly used, the power saw can be a big factor in fire suppression. It has its disadvantages, however, as it needs careful servicing, can cause accidents, and is subject to sudden breakdown or damage. Safety is of vital importance in chain saw operation. A power saw operator must be vigilant at all times to make sure that other fire fighters are well clear of the felling area. The wearing of hard hats shall be required. Suggested items to be included in the chain saw kit (often carried lashed to a pack-board) are:

1 can of mixed fuel
1 can of chain oil mixture
1 wrench to adjust chain
1 screwdriver
1 shovel
1 extra spark plug
1 spark plug wrench
2 chain files
2 wedges with hammer, wiping rags
1 fire extinguisher, approved type (at place of refueling for ready use).

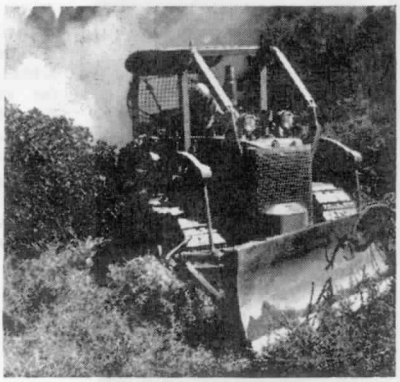
3204. Fire Protection. There is always danger of fire starting around power saw work. Each saw shall be equipped with an effective spark arrestor. A fire extinguisher, back-pack pump filled with water, or a shovel should be kept on hand. Do not start the engine of the power saw in the area where the gas tank is filled; gasoline may have spilled on the ground and be ignited by a spark. (See NFPA brochure on firesafe chain saw use.)

3205. Brush and Sapling Cutter. Lightweight power tools

(Left) Typical shoulder-carried brush cutter which is useful for clearing fire line. These clearing machines are powered by two-cycle gasoline engines rated from 1½ to about 3 horsepower.

have been developed for cutting heavy weeds, brush, and small trees up to 4 inches in diameter. The tool consists of a power unit, a drive shaft, and a cutting head. Overall weight may be as low as 26 pounds. This equipment is designed so that the operator can stand in a normal position as he works. The cutting head may be a 20-inch oscillating mower blade type designed to handle weeds and light brush stems up to about ½ inch in diameter; a rotating weed blade which is interchangeable with a circular saw; a 10-inch diameter circular saw; or a small chain saw designed for material up to approximately 6 inches in diameter depending on engine horsepower. (See par. 3202.) This power tool is useful in fire line clearing for cutting material at ground level, pruning branches and cutting logs and snags less than 18 inches in diameter. In brush areas, this tool permits fewer men to do advance line clearing and, at the same time, to keep ahead of the line trenching crew. A study of typical fuel conditions encountered during fires will help communities to arrive at a decision as to whether or not this type of suppression equipment will improve their fire control work. Cost of these powered brush and sapling cutters is low enough to enable many communities to own this equipment. For a concentration of heavy fuels, the conventional power saw is probably more effective.

3206. Powered Mower. Power mowers can cut grass, heavy weeds or light brush. A cut of 5 or 6 feet in width may be made by this equipment at one passage. The cut material will have to be removed from the line before or during the progress of trenching. This width of swath gives added safety in flashy fuels. The actual trenched line need not occupy the entire mowed strip. Power mowers can be moved rapidly over level terrain and loaded on light trucks for fast transportation.

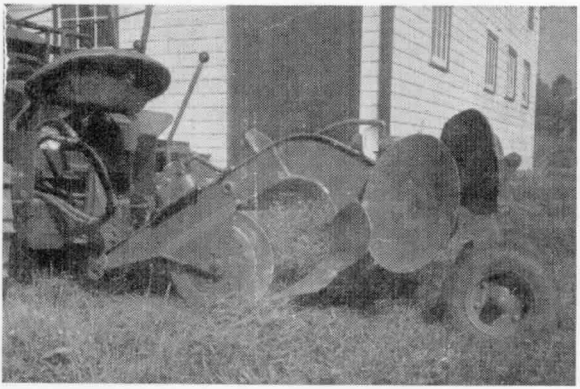


Tractor, angle dozer equipped and cable operated. Angle dozers may be positioned to operate as straight dozers. Brush guards are recommended for tractors which are to be used in the woods. All tractors shall be equipped with effective spark arrestors and protective canopies.

330. Trenching and Clearing Equipment

3301. 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 operations 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.

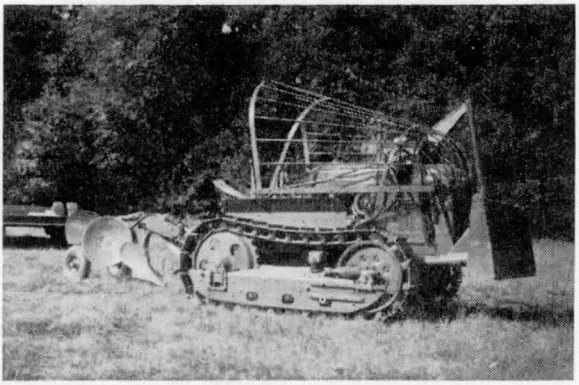
3302. Fire Line Plows. The function of plows in fire suppression is fire line construction, but three things have to be considered: Is the line construction method of fire control to be used? Does the work load justify use of fire line plows? Will existing conditions permit effective plow work? Plows designed for fire suppression work are not usually available on a rental basis. Thus it will be necessary for communities to own this special type of plow, plus specialized equipment needed to transport the plow to the fire if a study reveals this equipment to be desirable.[1]



(Left) Lightweight plow can be transported quickly to a fire and has ability to build fire line at flanks and rear of a fire. Rolling coulter slices sod; plow severs dirt furrow; and discs cast loosened dirt aside.

3303. Planning. Careful planning for the use of fire line plows in new areas is as necessary as planning for any other new procedure. Planners should have a conception of the elements of forest conditions and of organization that will determine the success or failure of fire line plow use. An understanding of the capabilities and limits of various plow units can be obtained from demonstrations and trials of proven units handled by experienced operators.

[1]Ref. 19, page 66.



(Right) Trailer-type disc fire line plow pulled by light tractor, with dozer blade and brush guard.

3304. Farm Tractors (with Bucket and/or Scraper Blade). Farm tractors, mainly wheel type, are frequently equipped with a front-end bucket or shovel used in excavation work and as a loading device. Where fuels are light, such as in abandoned fields, this lowered bucket or shovel can produce a satisfactory fire line at a reasonably rapid rate. Some of these tractors also have a scraper blade, mounted on the front or the rear, which will function quite well in light soils and fuels.

This type of equipment is not recommended for use on steep slopes or for line building machinery, but its presence in a community area should not be overlooked in the overall planning for suppression.

3305. Power-Operated Graders. The power grader, commonly used in road construction and maintenance work, is suitable in light soils and in light fuels as a line building machine. It is commonly available from town, county, state, and provincial highway departments. Memoranda of agreement should be executed so that this tool will be considered in community suppression planning.

3306. Trenchers. There is a need for powered equipment which will operate beyond areas where tractors or other heavy equipment can be used. Several types of powered fire-line trenchers have been developed and are still being worked upon in an effort to improve performance. What is required is a lightweight machine (75–100 pounds) which will work on grades of 50 to 60 per cent and on side slopes up to 60 per cent. Trenchers are very special equipment and communities probably will not be able to use them on a rental basis.[1]

[1]Ref. 20, page 66.

CHAPTER 4. PUMPING EQUIPMENT

410. General. In selecting pumping equipment, consideration should be given to a number of factors within the protection area. Among them are:

(a) *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 far will the hose need to reach from the road?

(b) *Fuel Type.* What is the nature of the fire-involved 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, fast spreading, requiring fast initial action?

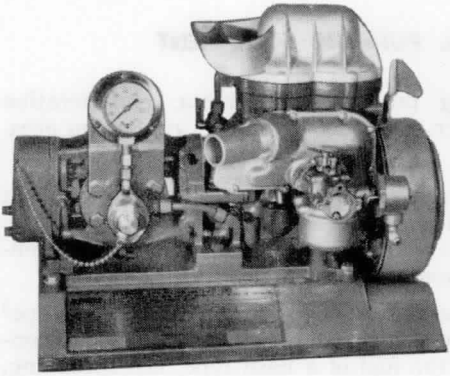
(c) *Water Sources.* Is water readily available? What are the sources — lakes, ponds, rivers, creeks? Can portable pumps be used to such sources in the potential areas, or must water be hauled to the fire in tankers or by aircraft?

(d) *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?

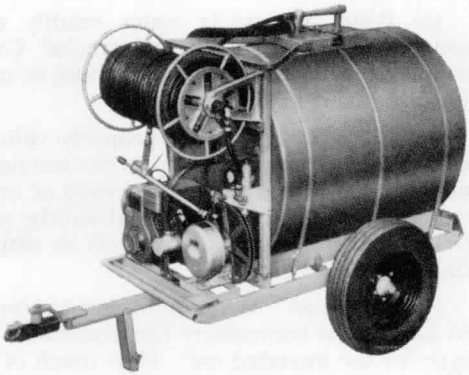
(e) *Equipment.* What pumping equipment is presently available to handle the community fire problem? Is the equipment the right type for the intended use? How much of the area can it operate in? Can it get there fast? Should it be supplemented? Can it be converted or rebuilt to better serve the needs? The following items will need to be considered in preparing an equipment plan for any community fire area.

420. Portable Pumps. Portable pumps can be carried by one to four men and set up at a water source so that water can be pumped through hose lines or into a tank truck or portable tank.[1] Portable pumps used in forest fire fighting should be lightweight and capable of providing small flow at relatively high pressure. They also are required to operate at high lift. Pumps used in communities primarily for structural fire fighting are chosen for their capability of providing large volumes at relatively low pressure. These pumps usually are much heavier than the type preferred for forest fire fighting. (See paragraph 4301.)

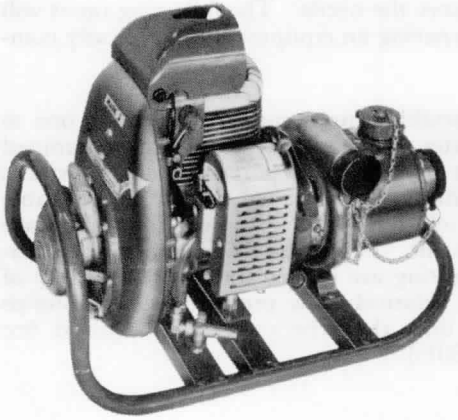
[1]Ref. 21, page 66.



Typical positive-action gear pump in the 70-pound class. The pump is rated at 40 U.S. (33.5 Imp.) gpm at 200 psi.



Trailer tanker, equipped with rotary, positive pump capable of pressures to 450 psi at delivery of 12 U.S. (10 Imp.) gpm. Tank holds 300 U.S. (250 Imp.) gallons and is fitted with live hose reel and filling ejector.



Four-stage centrifugal pump in the 55-pound class. The pump is rated at 43 U.S. (36 Imp.) gpm at 200 psi.

4201. Engines. Portable pumps are powered by two-cycle and four-cycle engines. Oil is mixed with the gasoline in the two-cycle engines, in accordance with the manufacturer's recommendation, contrasted with crankcase lubrication in the four-cycle engine. The two-cycle engine is lighter in weight than the four-cycle engine in relation to the horsepower developed.

4202. Classes of Portable Pumps. The two common types of portable pumps are the rotary and the centrifugal.

NOTE: The use of piston-type portable pumps is limited due to low water output in relation to the unit weight and will not be covered here.

(a) *Rotary Type Pumps.* Several types of pumps fall into the rotary classification: the vane, roller, and gear. Gear pumps, commonly used for forest fire fighting, consist of two intermeshing close-fitting gears mounted in a case or housing. These are positive displacement pumps, which means that a definite measured quantity of water is forced through the pump with each revolution of the rotors.

(1) *Pressure and Flow.* Portable rotary gear pumps now available will give pressures up to 350 pounds per square inch, or water volumes up to 60 U.S. (48 Imp.) gallons per minute. Gpm flow of a rotary gear pump will vary inversely with the pressure. Pump output depends upon the size and speed of the pump rotors, size of the discharge orifice and power of the pump engine.

The following is the water delivery rate of a commonly used gear pump operated at different pressures:

100 psi	50 U.S. (42 Imp.) gpm
150 psi	45 U.S. (37.5 Imp.) gpm
200 psi	42 U.S. (35 Imp.) gpm
250 psi	40 U.S. (33 Imp.) gpm
300 psi	37 U.S. (30.7 Imp.) gpm

(2) *Suction Screening.* In a rotary gear pump there is a close tolerance (about .002 inch) between the rotors and the pump housing. Even a small amount of sand will "cut out" a pump in a relatively short while. Place the suction strainer in the water source so that only clean water will reach the pump.

(3) *Specifications.* Here are the general specifications of two gear pumps:

Pump A:
Type: Gear — positive type
Output: 20 U.S. (17 Imp.) gpm at 250 psi at 2,600 rpm at sea level
Test: $^{3}/_{16}$-inch nozzle — 250 psi at 2,600 rpm at sea level
Engine: 2-cylinder air-cooled, 10 HP at 2,600 rpm
Weight: 130 pounds.

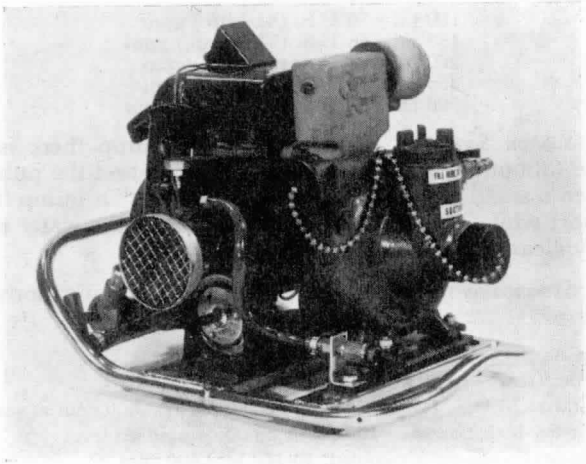
Pump B:

Type: Gear — positive type
Output: 18 U.S. (15 Imp.) gpm at 250 psi at 2,700 rpm at sea level
Test: 3/16-inch nozzle — 250 psi at 2,700 rpm at sea level
Engine: Single cylinder air-cooled. 6 HP at 2,700 rpm
Weight· 85 pounds.

(b) *Centrifugal Pumps.* Centrifugal pumps, unlike rotary gear pumps, are not positive displacement. Water is pumped by rotating impellers, with the velocity of water movement varying with the speed of the impellers. There are "single stage" and "multiple stage" centrifugal pumps, depending on the number of impellers. In the multiple stage pump, water goes through the impellers in "series" or "parallel" flow to provide maximum pressure or maximum gpm flow respectively. If the area includes steep terrain, then consideration should be given to purchasing a high pressure pump, such as one of those noted below. On the other hand, a pump of the following general specifications may be all that is desired.

Type: Single-stage centrifugal
Output: 20 U.S. (16½ Imp) gpm @ 175 psi
Engine: Two cycle, air-cooled
Weight: 29.5 pounds

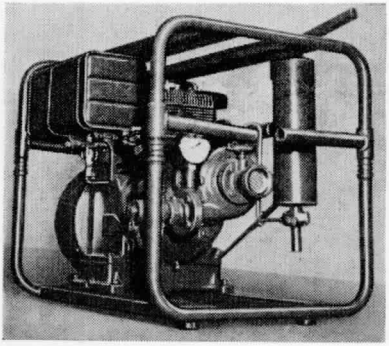
(1) *Pressure and Flow.* Lightweight centrifugal pumps now available give pressures up to 310 pounds per square inch and volumes up to 90 U.S. (75 Imp.) gallons per minute.



Single-stage centrifugal pump.

The following is the water delivery rate of a commonly used centrifugal pump operated at different pressures:

Free flow	92 U.S. (76 Imp.) gpm
100 psi	77 U.S. (64 Imp.) gpm
150 psi	62 U.S. (52 Imp.) gpm
200 psi	43 U.S. (36 Imp.) gpm
250 psi	23 U.S. (19 Imp.) gpm



Single stage centrifugal pump in the 175-pound class. The pump is rated at 15 U.S. (12.5 Imp.) gpm at 200 psi.

(2) *Suction Screening.* Centrifugal pumps have impellers or vanes turning inside the pump housing. Since clearances between the impeller and housing are not as close as for positive displacement pumps, dirty water, or water in which foreign material is suspended, does much less damage than would be the case with gear pumps. However, foreign matter in the water will eventually clog or damage a centrifugal pump. Clean, well-screened water is always best for use in any pump.

(3) *Specifications.* Here are the specifications of two centrifugal portable pumps:

Pump A:

Type: Centrifugal — can pump dirty water
Output: 25 U.S. (21 Imp) gpm @ 250 psi
Engine: Single cylinder, 2-cycle, air-cooled
Pump: 4 stage
Weight: 55 pounds.

Pump B:

Type: Centrifugal — can pump dirty water
Output: 20 U.S. (16½ Imp) gpm @ 175 psi
Engine: Single cylinder, 2-cycle, air-cooled
Pump: Single stage
Weight: 29.5 pounds.

SPECIFICATIONS FOR PORTABLE PUMPS — From NFPA Standard No. 191

Type	*Volume*	*Pressure*	*Connections*	*Size*	*Maximum Weight*	*Recommended Accessories*
Small volume, relatively high pressure (Paragraph 101)	15 to 20 gpm at	200 psi	1-inch discharge outlet 1½-inch suction inlet	Max. Height 25 inches Max. Width 25 inches Max. Length 25 inches	175 lbs.	
Medium volume, medium pressure (Paragraph 102)	50 gpm at... 100 gpm at...	90 psi 60 psi	1½- or 2½-inch discharge outlet 2½-inch suction inlet	Max. Height 25 inches Max. Width 25 inches Max. Length 25 inches	150 lbs.	A gated wye with two 1½-inch outlets
Large volume, relatively low pressure (Paragraph 103)	100 gpm at... 250 gpm at...	50 psi 20 psi	2½-inch discharge outlet 3-inch suction inlet	Max. Height 25 inches Max. Width 25 inches Max. Length 25 inches	150 lbs.	A gated wye with two 1½-inch outlets
Medium volume, relatively high pressure (Paragraph 104)	90 gpm at... 160 gpm at...	250 psi 90 psi	Two 1½-inch or one 2½-inch discharge outlets, one 2½-inch or one 3-inch suction inlet	Max. Height 30 inches Max. Width 22 inches Max. Length 56 inches	200 lbs.	A gated wye with two 1½-inch outlets
Extra large volume, medium pressure (Paragraph 105)	500 gpm at....	100 psi	Two 2½-inch discharge outlets One 4½-inch suction inlet	Max. Height 25 inches (fuel tanks not included) Max. Width 33 inches Max. Length 38 inches	200 lbs.	

Paragraph references in this table are to NFPA Standard No. 191.

430. Portable Pump Specifications. Specification information which describes portable pumper options and advice on contract purchase are available from your State Foresters Office or the Forest Service. Ask for:

Specification 5100–273a, Engine Driven Pumpers
Specification 5100–274, Lightweight Portable Pumpers

4301. The following chart lists some of the NFPA's recommendations on portable pumps designed primarily for use in municipal fire fighting. Note that these are much heavier and have larger output than the forestry pumps. Many rural fire departments use these pumps for relay operations and filling tank trucks.[1]

440. Setting Up a Pumper.[2] Pumping operations involving short hose lays on level terrain are simple. But when it is necessary to pump water up slopes, or when long hose lines 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. or more. A check valve holds the water back when a positive displacement pumper is stopped.

[1]Ref. 21, page 66.
[2]Ref. 23, page 66.

4401. Valves. A check and bleeder valve is needed with positive displacement pumps to prevent the back flow of water on uphill hoselays. 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-foot section of hose which permits the heavy fittings to lay on the ground. If a short hose section is not available they can be placed at the end of the first full length.

4402. Hose Line Tees. Hose line tees (water thieves) may be inserted between lengths of hose for filling back-pack cans. The outlet may be ¾- or 1-inch male garden hose threads, so garden hose can be used for lateral lines which are important in mop-up work.

450. 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 capacity and other equipment designed for fighting structural fires, but they are not the most effective for nonstructural fires.[1] Some agriculture spray tankers can be adapted readily for fire fighting. It is desirable to keep plumbing and valves as simple as possible.

451. Brush and Slip-On Tankers. Some communities have solved this problem by acquiring "brush tankers" to handle all except the structural fires. 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 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.

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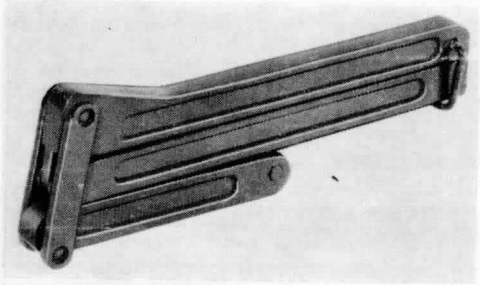
[1]Ref. 23, page 66.

460. Nozzles and Accessories. Many types of nozzles are available, with discharge patterns varying from fog to spray, to straight stream, and combinations of these. Delivery varies from less than one to hundreds of gallons per minute. 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.*[1, 2]

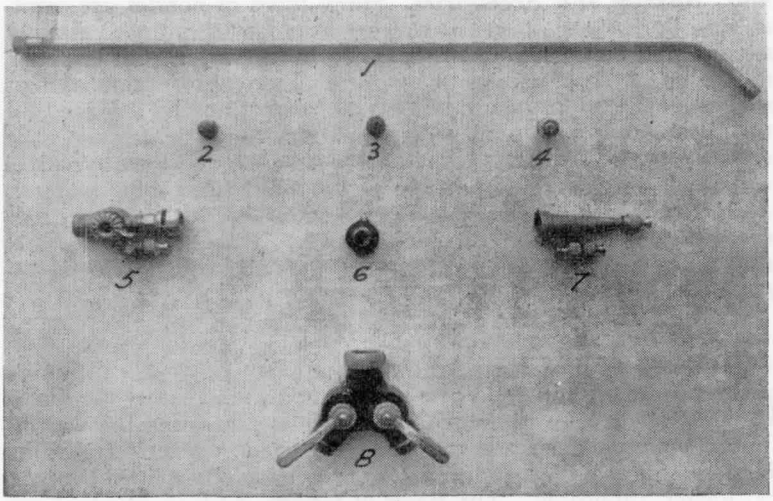
461. Hose. Improvement in hose manufacture is a continuing process. Use of synthetic fibers has resulted in increasing the bursting pressure of hose while at the same time decreasing the weight. These improvements have changed some of our concepts regarding hose and some of the statements formerly made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

4611. 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; this is for short sections and for short periods. Working pressures of 300 psi should be expected from new hose of this type, which is manufactured in both 1- and 1½-inch sizes.[3]

[1]Ref. 2, page 66.
[2]Ref. 26, page 66.
[3]Ref. 23, page 66.



Hose clamp can be used to shut off flow in lines for adding or removing lengths of hose and changing nozzles.



Standard accessories now used by one public protection agency. Numbered items are: (1) Four-foot aluminum applicator (or extension nozzle). The applicator has ¾-inch garden hose threads, a swivel female coupling on the end that is attached to the basic nozzle, a male thread on the curved end that receives the various tips. The fittings are brass. No. 2 is a 3 gpm spray tip. No. 3 is a 15 gpm spray tip. No. 4 is a 30 gpm "fog" tip. No. 6 is a 1½- to 1-inch reducer. The applicator will fit on a shut-off nozzle (5) or the 1½-inch nozzle (7) and may be used with fog or straight stream tips.

(a) Favorable features of rubber-lined hose:

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 hard 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.

4612. Cotton-Synthetic, Rubber-Lined. This combination single jacket uses the favorable feature 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-foot roll (uncoupled) of 1½-inch cotton-synthetic hose weighs about 26 pounds, 7 pounds lighter than all-cotton rubber-lined. Latex-lined, all-synthetic hose jackets are also available which results in additional weight savings.

4613. Unlined Linen Hose. In the past, the main reason linen hose was favored by many field men over crl 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, with kink tests of 300 psi.[1]

(a) Favorable features of unlined linen hose are:

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.

462. 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.[1] Adaptors should be carried for use with other types of couplings used in the area.

[1]Ref. 27, page 66.

470. Relays. In steep or mountainous terrain it often becomes necessary to use two or more pumps to relay water at an elevation above that which could be reached by one pump alone. The usual method is to set up one pump at the water source to pump water into a tank some 250–300 feet 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 series, with a suitable centrifugal pump directly in the line part way up the slope, making a relay tank unnecessary.[1] However, the relay must be balanced to avoid cavitating the line.

4701. 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.

4702. 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 pressure can boost water up to 400–450 feet 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.

4703. Relay Tanks. Portable canvas tanks are available for relay pumping. Some tanks are made of heavy, treated, mildew-proof duck, 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 sump.

480. 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 pounds for each 100 feet 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

[1]Ref. 22, page 66.

gravity "show," then an excellent substitute for a pump can be provided.

4801. Gravity Intake. A gravity intake, or "gravity sock" consists of a cone-shaped piece of canvas, 3 to 6 feet long. The end is about 10 inches in diameter, held open by a metal ring. A 1½-inch 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-inch hose line.

4802. Gravity "Head." The point of water use from gravity lines must be at least 50 vertical feet 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 hose lines on the fire, or at least turn part of the water out of the hose line.

4803. 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-gallon 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.

490. Water Ejectors (Suction Boosters)

4901. 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 feet or more.[1]

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 feet. The large portable pump is effective for filling tanks using a 2½-inch supply line from pump to tanker.

[1]Ref. 30, page 66.

4902. 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.

4903. 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 of using ejectors are: Two hose lines must be laid to the water source; and the crew must be trained in the use of these devices.

CHAPTER 5. CHEMICALS

510. General. 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 controlling flammable vegetation, such as killing grass and brush on firebreaks and rights-of-way.[1]

520. Wetting Agents. A wetting agent is "a chemical compound which, when added to water in proper quantities, materially reduces its surface tension, increases its penetrating and spreading abilities and may also provide emulsification and foaming characteristics." "Wet water" is "any water to which a compatible wetting agent has been added."[2]

A wetting agent may be added to water in back-pack cans and is frequently used in tank trucks. Automatic pickup in the proper porportion of stock solution in pumper hose lines can be accomplished by use of a venturi tube, or by special proportioners. This allows wet water to be reserved for the situations where it has definite superiority.

530. Fire Retardants. A fire retardant is a chemical that reduces the flammability of combustibles. It is also referred to as a flame retardant, this term being more properly used to designate the chemicals used to flameproof fabrics and paper products in hotels, night clubs, theaters, etc. A large number of chemicals have fire-retardant properties. Studies of mass fire build-up and behavior indicate the following general results of retardant use:[3]

Forest fuels, sprayed with a solution of retardant chemicals in water solution, will increase the effectiveness of the water and extend the time that pre-wetting of those fuels is effective. Viscous water (water with a "thickening" agent) provides similar protection.

The flanks and rear of a fire, and sometimes even the head, can be stopped by chemical fire lines. Chemicals are increasingly being used for direct suppression and for mop-up operations.

A hot crown fire in heavy brush will often drop out of the crowns when it hits chemically treated fuels, and its rate of spread may thus be reduced by as much as 50 per cent.

Backfires can be started from chemical lines that are established faster than adequate fire lines can be cleared.

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[1]Ref. 2, page 66.
[2]Ref. 32, page 66.
[3]Ref. 31, page 66.

5301. The disadvantages of such fire retardants are: they may be comparatively expensive; they should be applied at rates varying from 4 to 10 pounds per 100 square feet of fuels to be treated and the necessary quantities of chemicals are not readily available in many areas. Retardants may be corrosive to some metals.

540. Foam. Foam used for fire fighting is a chemical fire-extinguishing mixture. When applied it forms bubbles which greatly increases the mixture volume. Foam adheres to the fuel, and reduces combustion by cooling, moistening and excluding oxygen.[1]

5401. Types. The two principal types of foam are chemical and mechanical. Chemical foam is produced by a powder introduced into the hose line by means of a "hopper" or generator approximately 100 feet back of the nozzle. Mechanical foam is made by adding a liquid with a soybean base and other ingredients. It is introduced into the hose lines with pick-up tubes and proportioners.

High expansion foam is also used as an extinguishing agent for confined fires in structures.

550. Chemical Control of Vegetation. Control of grass, weeds and brush is one method used to safeguard buildings and lumber yards or to control vegetation on firebreaks and fire lines. Such breaks need to be kept clean to mineral soil for best results. Periodic maintenance is necessary.

Selective herbicides can be used successfully to control perennial weed and brush growth in specific areas. Respray of treated areas may be necessary, but how often will depend upon results of the initial chemical treatment and the degree of control desirable to maintain. Chemical soil sterilants are also available for controlling annual grasses and weeds that become flammable on curing. Some are more or less long-term soil sterilants; others will check grass and weed growth for periods of one to two years.

The chemicals available may be highly toxic and injurious to non-target vegetation and to man and animal life. Thus, proper formulation, mixing and application is of utmost importance so that the desired degree of control are achieved without any adverse impact on man or his environment. Use of some chemicals may be prohibited in certain areas. Communities wishing to consider chemical methods of protecting selected areas should consult their county agent, local protection agencies, highway departments, or power companies for advice.

[1]Ref. 34, page 66.

CHAPTER 6. HOUSING AND CARE OF EQUIPMENT

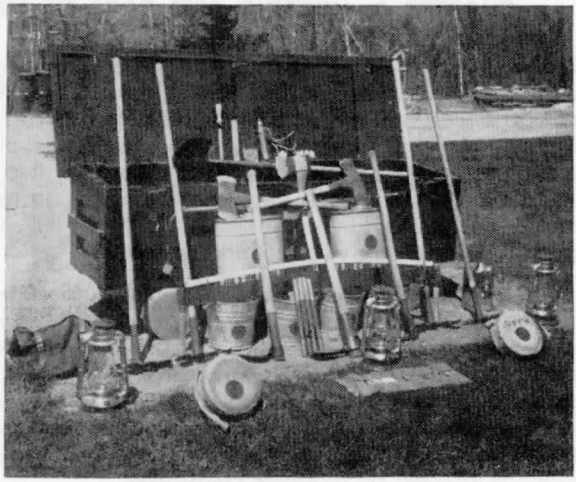
610. General. Hand fire tools and powered fire suppression equipment represent a substantial investment. To protect that investment the tools and equipment should be serviced frequently so that they will be ready for use at all times. Housing should provide adequate protection and suitable work space 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.

6101. Basic Requirements. It is often necessary to use barns or small outbuildings, particularly where tools are stored at residences of wardens or similar fire control officers. Whether buildings are newly constructed 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.

6102. 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.

6103. 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.

620. 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 fiber glass or metal. In either case, they should be relatively weatherproof 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



(Right) 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.

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 men.

6201. 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 6–8, 8–10, 12 or 15 men. 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.

6202. 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 6–8-man 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 the men 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 men individually select tools.

6203. Design. A suitable box for storing tools for an 8-man crew will be about 90 inches long, 16 inches wide, and 18 inches high, outside dimensions. It may be made from ¾-inch 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.

6204. 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.

6205. 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. Special care must be exercised in the cases of lanterns and back-pack pumps to make certain they are not damaged by other fire tools or by the design of the box itself.

6206. Safety. It is common practice to store and haul edged tools such as axes, brush hooks and saws in boxes designed for these individual tools only. This system serves to protect the tools and adds to the safety of the men. Special tool boxes of this type are frequently designed to hold either 6 or 12 tools.

630. Care of Pumps and Tankers

6301. Pumps. 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 pint of oil into the engine. Turn engine backward three revolutions.

Disconnect the connection 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.

6302. 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.

640. General Factors to be Considered in Planning Storage Facilities. 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.