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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

GEORGE K. SCHAEFFER

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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HISTORY OF SMOKE JUMPING, 1939–49 [1]

DIVISION OF FIRE CONTROL

U. S. Forest Service, Washington, D. C.

"Elapsed time" is the essence of good fire control. Study of time records of forest fires has shown that travel time, that part of elapsed time from report of the fire until attack is made, is a major factor affecting the final area of a fire. The final area of many a fire has given rise to the wish "If one man could only have got there early enough!"

Forest officers have given much thought to the problem of reducing the travel time to inaccessible or back country fires. As early as 1931 T. V. Pearson, United States Forest Service employee now retired, thought of using airplanes and parachutes to overcome this time handicap. However, it was felt that the time was not ripe to experiment with this novel idea. Parachuting in those days was not considered as something to be planned, but rather as a "last chance" to be used by a man in an airplane just before a crash.

The idea of using airplanes and parachutes to overcome the elapsed-time handicaps was almost "still born." Nothing was done to keep it alive until 1939 when David P. Godwin, then Assistant Chief, Division of Fire Control, took up the idea. Quoting from his article in the April 1940 issue of the Aero Digest: "Since the beginnings of systematic forest fire control, about 30 years ago, men have bent their thoughts and energies toward the extension of forest ways and to faster means of traveling over them. In our National Forests a vast network of transportation routes is now maintained. Along those forest ways, by foot, by horse and by motor, go the men dispatched to suppress fires. On the 23,000 miles of roads, and 137,000 miles of trails, there are 20,000 motor vehicles in use by the Forest Service and more are rented in time of need.

"Gradually the extension of roads and the addition of vehicles are slowing down as the point of diminishing returns approaches. What then? Will current travel-time achievements become static? There will be some continuing extension of ground routes and improvement in ground vehicles, but the results of this in further reduction of travel time will become comparatively unimportant.

"On the other hand, if we can intelligently adapt transportation by air to our ends, it may open up an era of time-cutting which our present forest fire organization plans have hardly glimpsed. For some years aircraft have been used in the delivery of fire fighters and fire control overhead from distant centers to nearer centers, and this has been a great advantage in assembling men for large going fires. We have developed 76 landing fields, but this is pitifully scant distribution

[1] Condensed from Regional reports.

over the great area of all of the national forests. More can be constructed, but topography will soon limit such extension. Here again, the curve of progress will begin to flatten out, rising again sharply with the advent of a heavy pay load carrying craft capable of hovering, and of vertical descent and ascent. We then may be able to land aircraft in thousands of small clearings, on beaches, bottoms, and ridge tops.

"So for the present, at least, comes the question 'What can be done to land men without landing planes?' The question is not new. For years fire control men have mused and argued about the possibilities of parachute jumping of individual trained fire fighters near small fires in back country and thus catch 'em early. Is such a travel-time reducing method mechanically practicable, and is the risk to life and limb a responsibility sane forest officers would care to assume?

"Professional parachute stunt jumping has been confined mostly to airports. The Russian and German armies in maneuvers and in actual warfare have made mass jumps of armed men, but always over open, flat, or rolling country. So far as known, however, there have been no premeditated jumps over rough and timbered terrain such as that found in the high back country of our western forests. It looked too fearful from the air. But as often happens, things are not as bad as they look."

These remarks by the late Mr. Godwin are ample evidence that he was among the first to press for the application of parachute jumping to overcome the travel-time headaches of potentially disastrous back country or inaccessible fires. It was through his efforts that experiments in smoke jumping were undertaken by the United States Forest Service in 1939. As far as is known, these were the first experiments designed to determine whether or not delivery of men to inaccessible fires via airplane and parachute was feasible.

Until 1938 all Forest Service flying in the West had been done by army planes or by private contract fliers. In 1938 the Forest Service purchased a Stinson SR-10 fitted out especially for fire control experimental work. This five-place plane was powered with a 450-horsepower P&W Wasp motor. Rear seats and the door on the starboard side were removed and the interior arranged for cargo. This plane was assigned to Region 5 (California) of the Forest Service and used in fire bombing experiments in that area.

Early in 1939 the bombing experiment was transferred to Region 6 (North Pacific Region). David P. Godwin was in charge of the project. He was assisted by Lige Wernstedt representing the regional division of operation and Harold King, Forest Service pilot. During the summer of 1939, the decision was made to abandon the aerial fire bombing project and to devote efforts for the remainder of the fire season, October 5 to November 15, to experimenting in the delivery of fighters to fires via airplane and parachute.

The location selected for the experiment was an airport near the Winthrop Ranger Station, Chelan National Forest, Wash. C. Otto Lindh, Chief of Fire Control, Region 6, had charge of the field work. Other immediate personnel were Beach Gill, collaborator; David P. Godwin, Assistant Chief of Fire Control, W. O.; T. Albert Davies, technician (later project leader, forest officer); Harold C. King, Forest Service engineer pilot; Walter Anderson, fire assistant, Chelan

National Forest; Frank Derry, head parachute rigger and jumper; Chester Derry, jumper. The Eagle Parachute Co. was the successful bidder for a contract to provide parachutes, protective clothing, and the services of professional riggers and jumpers.

After a number of dummy tests, about 60 live jumps were made largely by professional parachute jumpers employed by the contractor. During the concluding days of the experiment several Forest Service employees were allowed to jump into open fields and timbered areas. There were no injuries of consequence. Here on the Chelan a special handle was bolted to the right-hand strut of the plane to enable the smoke jumpers to steady themselves while standing on the step outside the door.

The selected training outfit, consisting of the Eagle 30-foot back-pack and 27-foot emergency chest-pack canopies with quick detachable harnesses, proved satisfactory. A two-piece, felt-padded suit, football helmet with wire-mesh face mask, athletic supporter, ankle braces, combined back and abdominal braces and heavy logger boots completed the attire of the jumpers and provided protection from the hitherto unknown hazards of timber jumping.

There is no record of any fire jumps during 1939.

Conclusions drawn from the experiment were:

1. Smoke jumpers could land safely in all kinds of green timber cover common to the Chelan National Forest. Its major timber types—subalpine, lodgepole (mature and immature), mixed north slope Douglas-fir and wastern larch, ponderosa pine and hardwoods—are common to many areas in the western national forests. The experiment thereby proved that jumping could be done successfully in most of the green timber areas, except those of the tall west coast Douglas-fir and redwood types, providing terrain was satisfactory.

2. Successful jumps could be expected in mountain meadows, open ridges, and steep open slopes if boulders were not too close together. Elevations under 7,000 feet above sea level offered no obstacles.

3. Snag areas, areas of down timber, lodgepole deadenings, extremely steep slopes, deep canyons, and areas of rock cliffs or ledges should be avoided.

4. Jumpers experienced less fatigue in jumping than would result from a short hike up a steep hill.

5. The denser the stand of timber the easier the landings and the less shock experienced by the jumpers. Landings in thickets of young trees and reproduction were termed "feather bed" landings because of the manner in which the vertical descent of the smoke jumper was checked.

6. Retrieving a parachute canopy from the crown of a tree or trees is a problem.

7. The ability to steer the type of parachute used contributed greatly to accuracy in hitting the ground target even when ground wind was stronger than 10 miles an hour. Gusty winds are much more troublesome than stronger steady winds in that the unexpectedness will cause a 200- to 300-foot drift before the jumper can maneuver to compensate.

8. The type of parachute used had a natural forward glide in still air of from 5 to 8 miles per hour; this could be used to advantage by facing into the wind, thereby reducing the drift over the ground by a like amount.

9. There was no evidence of fear or panicky state of mind even in first-time jumpers.

The primary conclusion of the experiment was that delivery of fire fighters to fires via airplanes and parachutes could be done and without injury to the men engaged in such work. This conclusion led to the next phase of the smoke-jumping program; namely, the development of plans for actual operations to be undertaken in 1940. The dreams of many firemen were at last to be realized.

Reports and cost estimates were made, equipment and personnel specification written, equipment and supplies purchased during the winter months. Since this was a new project specifications had to be developed and firms found that would be interested in furnishing much of the nonstandard pieces of equipment. Administration, training, and operation plans were also prepared.

The thoroughness of the preliminary planning by Region 6 personnel was a vital contributing factor to the success and safety record of the experiment. The safety measures then devised have been followed with success as history in following years shows.

1940

Region 1 (Northern Region) and Region 6 each organized a small squad of smoke jumpers for the 1940 fire season through recruitment of the younger men from among their most experienced firemen. Region 6 was fortunate in having two professional jumpers who had gained some experience through the 1939 experiments. The Region 1 squad had no previous training in this type of work.

Frank M. Derry of the Eagle Parachute Co. was retained by the Forest Service to serve both regions during the training season. Region 6's squad of seven men was trained at the Winthrop base in Washington. The project leader from Region 1 also received his orientation there. He then returned to his region to supervise the training of its squad at Seeley Lake about 35 miles from Missoula.

After training the Region 6 squad was stationed at the Winthrop base and the Region 1 squad at Moose Creek Ranger Station, Bitterroot National Forest. The Region 6 squad jumped to only two fires during the season. The small squad at Moose Creek saw action on nine jumper fires.

The first actual fire jump in the history of smoke jumping was made by Rufus Robinson at 3:57 p. m., July 12, 1940, in connection with initial attack operations on the Martin Creek fire, Nezperce National Forest (Region 1). Earl Cooley is credited with making the second actual fire jump on the same fire. They were the only two to jump to that fire. Control was established by 10 a. m., July 13. Of historic note also is the first successful "rescue jump" made by smoke jumper Chester N. Derry 3 days later to an airplane crash on the Bitterroot National Forest.

According to Region 1 estimates the total cost of the smoke-jumping operation during 1940—including personnel, depreciation on equipment, and flying—was $9,047. They estimated that the nine fires controlled by smoke jumpers would have cost $32,270 if ground crews alone had been employed.

On the Chelan in Region 6 a fire at the head of Little Bridge Creek was jumped by Lufkin September 10; a second fire was jumped on Twenty Mile Creek, September 11. These two could have been very serious fires costing a lot of money to control except for smoke-jumper action.

An interesting side light—and one of far-reaching effect—pertains to the visit of four United States military staff officers to the smoke-jumper training camp in June. One of them, Maj. William Cory Lee, later employed Forest Service techniques and ideas in organizing the first paratroop training at Fort Benning, Ga. Major Lee subsequently commanded the 101st Airborne Division which he took to England and trained for the Normandy invasion. He became first chief of the Airborne Command and is regarded as the unquestioned father of United States airborne doctrine.

High lights of the 1940 season:

1. Smoke-jumping operations were successfully applied to 11 fires.
2. No incapacitating injuries resulted from the 1940 operations.
3. Project Leader Lundregan of Region 1 believed that delivery of skilled and well-trained fire fighters by parachute could be done successfully in rough timber terrain in winds up to 30 miles per hour and at altitudes up to 8,000 feet above sea level. (NOTE.—Later indicators pointed to maximum velocities of more nearly 20 to 25 miles per hour with presence or absence of gustiness being probably more important than velocities.)

It was concluded that—

4. Parachuting as an aid to forest fire control would probably not prove economic in forest areas where the road system provides ready access for ground forces.
5. Smoke jumpers should be between 20 to 35 years of age and not over 190 pounds in weight.
6. Smoke-jumping operations should continue in 1941.

1941

All smoke-jumping operations were confined to Region 1. Increased funds allowed expansion to a 4-squad outfit of 26 men, including all of the jumpers who had served the previous year. One squad was located at Moose Creek on the Bitterroot, one at Big Prairie on the Flathead, and one at Nine Mile Camp a short distance from Missoula. Thirty-four jumps were made on nine fires—three on the Chelan, two on the Bitterroot, one on the Lolo, and three on the Flathead. Some of the jumps on the Chelan National Forest were several hundred miles from the operating base.

Region 1 stated in its report, "An impartial reviewer of the season's fire control activities would have to admit evidence shows that we 'missed the boat' in a few cases." Supervisor Harris of the Chelan wrote: "Conditions seemed too favorable to justify smoke jumpers at the outset on the Route Creek Fire. 'Back sight' now points out clearly that smoke jumpers would have saved $12,000 in suppression costs. With our 'easy season' in Region 1, we cannot point to any net probable savings, but it appears that we may have been a little slow in ordering out the jumpers on at least one fire which eventually ran into money."

Estimates for the season indicated that the ratio of benefits to costs was about 10:1 or about $33,875 to $3,410 on nine fires. This estimate indicated the need for a system of selection that would assure the use of smoke jumpers on fires that have major conflagration potentialities.

Important developments of the season:

1. A static line adapted to the Eagle back-pack and used throughout the season. This device, which eliminates the manually controlled rip cord, appeared to have a remarkable effect on the trainees; it reduced the intensity of nervous reactions that generally precede first fire jumps.

2. Dr. L. P. Martin of Missoula, locally known as the jumping doctor, continued his jumper training and expressed his willingness to make parachute jumps to injured or helpless individuals in the back country. This resulted in a plan for a jumping squad to be available to render first aid in inaccessible areas.

3. The Ford Tri-motor and Curtis Travelair type airplanes proved admirably suited to smoke-jumping operations.

4. For the first time an organized force was jumped to a threatening fire that had escaped from the initial attack forces and had reached an area of 15 acres in very bad fuels. The jumpers were able to hold the fire in check until additional ground forces arrived.

5. Accidents due to jumping can be held within an acceptable tolerance ratio.

6. It was demonstrated that smoke jumping is a practical possibility.

1942

The project continued in Region 1, and location of the squads was the same as in 1941—Moose Creek, Big Prairie, and Nine Mile Camp. A further expansion led to a 4-squad unit and only the impact of World War II prevented greater development. Because of the war, age limits and experience requirements had to be liberalized though physical standards were not lowered. Training was undertaken with but 5 experienced men. Of the 33 recruits to be trained only a few were experienced smokechasers. This necessitated a greatly intensified program of fire control training in addition to the jumper training.

The equipment situation was very critical. Occasionally a few chutes not acceptable to the Armed Services were obtained and converted. Experimentation resulted in an outstanding development in aerial fire control—the Derry slotted chute. This chute is easily opened and maneuverable, and provides a slow descent and better oscillation. It was found that any standard, flat-type parachute could be converted by adding slots and guide lines.

Thirty-one fires were jumped by smoke jumpers during 1942. The savings in suppression costs were estimated to be $66,000 because the fires selected for the jumpers were potentially bad ones. As in previous years, accidents were few and were therefore not considered to be a bar to the future of the program.

1943

The manpower shortage had reached a very critical stage, and only five experienced jumpers returned to the project. Inquiries were received from 4–E draftees (conscientious objector) in Civilian Public

Service (C. P. S.) camps who wished to secure noncombat work of the nature afforded by smoke jumping. Sixty candidates were selected, a majority of whom were from the "peace churches"—Mennonite, Brethren, and Friends.

Regions 4 and 6 reentered the project with Region 1, each sending fire control men to Missoula to be trained as squad leaders and riggers to serve as overhead for C. P. S. squads that would be assigned later. Facilities for training were enlarged at Seeley Lake by the addition of an obstacle course, a plane mock-up, and some lesser improvements in equipment. About 70 new men were trained during the 1943 season and again there were no failures. However, a few received minor injuries in training which prevented them from jumping to fires during the summer.

The smoke-jumper program for the summer involved 4 squads or 48 men for Region 1, 1 squad or 11 men for Region 6, and a 5-man squad for Region 4 (Intermountain)—a total of 64 men. The Region 6 squad, under the direction of Jack Heintzelman, was located at the Redwood Ranger Station, Siskiyou National Forest, Oreg.; the Region 4 squad was stationed at McCall, Idaho, Payette National Forest; final distribution for Region 1 was 12 men each at Seeley Lake, Big Prairie, Moose Creek, and Nine Mile Camp.

Thirty-one fires, involving 94 individual jumps, were recorded for Region 1 squads, 6 fires for Region 6, and a few fires for Region 4, for a season's total of about 40 fires.

An indicated savings of more than $75,000 is attributed to the use of smoke jumpers on fires in 1943.

High lights of the 1943 season:

1. Training of parachute rescue units involving 25 men from the United States Coast Guard, Canadian Air Observer Schools, and United States Air Forces. About half of the men trained were flight surgeons.
2. The Derry slotted chute proved successful and popular with the jumpers.
3. Conscientious objectors were used to advantage as jumpers.
4. Again, accidents did not prove a bar to continuance of the program.

1944

C. P. S. men continued to be the reservoir of manpower for the project, with nearly 60 percent of 1943's group returning. Distribution of the men was about the same as in 1943 but with changes in the numbers of jumpers assigned the 3 regions. Approximately 120 men took part in the program. Training of the new men continued to be confined to Region 1, as was most of the refresher training of the experienced men.

A further centralization of smoke-jumper use in Region 1 led to a changed arrangement of forces at the various bases. A stand-by unit was held at Missoula; the number of the men in the squad could be raised according to potentialities of use by drawing from outlying feeder bases where 40 to 50 jumpers were kept, many on work of project nature.

There was a considerable increase in smoke-jumper use in 1944. Nearly 100 fires were handled—about 75 percent from the Missoula base. Jumpers were used on larger fires than previously and in larger groups. Substantial suppression savings were made.

Important developments in 1944:

1. Smoke jumping was no longer on an experimental basis; it was considered as a routine operational feature of the over-all fire control job in Regions 1, 4, and 6.

2. Smoke jumpers were used in Region 5 for the first time. They jumped to one fire on the Happy Camp District of the Klamath National Forest.

3. A method of guideline attachment allowing faster and easier manipulation of the canopy was developed, tried out, and pronounced successful.

4. A new simplified technique in let-down from trees was perfected.

5. Perhaps the most significant change was in Region 1 where parachute jumpers were included in the regular organization. Previously, the smoke-jumper unit was organized as a special force—an adjunct to the ground forces, financed from special funds. Some national forests for the first time reduced the number of back country smokechasers, thus becoming wholly dependent on smoke jumpers over considerable areas.

6. Nineteen hundred and forty-four was the first year in which considerable use was made of military aircraft for smoke jumping in Region 6. In Regions 1 and 4 Ford Tri-Motor and Curtis Travelairs continued to be the mainstay for smoke-jumper transportation.

7. Continued low-accident rate in smoke-jumping operations proved the safety measures observed and intensive training of smoke jumpers were successful and that the program could be expanded, if necessary, without particular worry concerning accidents.

1945

Nineteen hundred and forty-five was the last of the war years. Continued expansion of the C. P. S. program and the return of war veterans permitted an increase in the total number of smoke jumpers in the 3 regions to about 220 men, of which nearly 100 were seasoned smoke jumpers. Training of new men and most of the refresher training of the returnees was conducted under the direction of Region 1 at the Nine Mile Camp out of Missoula.

Distribution for the season resulted in increased quotas of jumpers: Missoula, Mont., 153; McCall, Idaho, 36; Twisp, Wash., 15; and Cave Junction, Oreg., 15. The 153 men were not actually located in Missoula. Missoula was used as a base of operation to which smoke jumpers could be brought as the need developed.

Use of smoke jumpers was very high during the period July 11 through the first week in September. In the 3 regions smoke jumpers were used on 265 fires involving 1,236 individual jumps. These jumps were to potentially serious fires on 23 national forests in Montana, Idaho, Washington, Oregon, and California, and to fires in Yellowstone and Glacier National Parks, United States Indian Service lands, and private timber association lands. Also, the first jump by smoke jumpers over the international boundary in Canada was made.

A partial analysis of suppression costs indicated a savings of $347,000 for the season's operations.

Most significant events in 1945:

1. First experimental "Air Control Area"[2] involving 2 million acres of roadless wilderness. This area included parts of the Flathead, Lewis and Clark, Lolo, and Helena Forests in Region 1, and became known as the Continental Unit. Aerial detection and smoke jumping almost to the exclusion of ground forces work were used.

2. Additional training of military men in parachute work pointed at aerial rescue operations.

3. First active collaboration of smoke jumpers and army paradoctors on rescue missions. Air-rescue jumps for the season were 55.

4. Training of the 555th Battalion of Negro paratroops in timber jumping and fire fighting to combat Japanese balloon fires. Ninety-seven Negro paratroops were jumped on the Bunker Hill fire and 28 on the Heather Creek fire, both on the Chelan. Regular smoke jumpers were used as overhead. In addition, 6 made jumps on the Rattle Snake fire, 10 on the Lemon Butte fire and 4 on the Copeland Creek fire, all on the Umpqua National Forest.

5. The loan of two UC–64 Noorduyn Norseman airplanes from Army for use in Region 6.

6. Standardization of (1) qualifications of men selected as smoke jumpers, (2) training technique, (3) jumping gear, such as parachutes, suits and other rigging, and (4) jumping technique.

7. Air transportation demonstrated as a quick and effective means of placing skilled, hard-hitting crews on fires that might otherwise prove serious, and also for placing additional forces on fires escaping initial attack crews.

8. The testing of quick-release type harness. This harness had advantages over the old type since it simplified "tree let downs" and was designed to fit any size man. Regions changed over to this type of harness in 1948.

1946

With the end of the war, the C. P. S. program was liquidated. Only a small group of trained smoke jumpers remained, and it was necessary for the regions to recruit large numbers of civilians to be trained.

The over-all number of jumpers and their distribution to operating bases remained about the same as in 1945. Of Region 1's group of about 160 jumpers, 84 percent were ex-service men and about 40 percent were college students, many taking up forestry as a career. The Yellowstone and Glacier National Parks and the California Region participated financially for the first time in the program.

A C–47 airplane was added to the contractor's fleet making it possible to transport larger crews at greater speed.

Three hundred and twenty fires involving 1,111 individual fire jumps resulted from the 1946 operation. This was an increase of 51 fires over the previous year.

Savings attributed to the Region 1 part of the operation (202) fires was $376,000.

[2] For further information see FIRE CONTROL NOTES 1947, vol. 8, No. 1, pp. 28–32.

1947

There was no radical change in the operational features of the program or in the number of jumpers employed. Of interest, however, was the degree of turn-over; about 50 percent of the previous year's men returned. This helped to reduce the job of training. The season was less severe than that of either 1945 or 1946. Consequently fewer fires were attacked from the air. A total of 932 individual jumps were made on 192 fires.

High lights of the 1947 season:

1. Regions 4 and 6 developed their own training centers and conducted their own parachute training.

2. A foreman and eight jumpers from Region 1, with a Noorduyn Norseman plane and pilot from Region 6 were detailed to the Gila National Forest in Region 3 (Southwestern) for the period May 25 to June 25.

3. The use of helicopters to retrieve smoke jumpers and return them to interior airfields or other locations of immediate access was considered seriously for the first time. With this plan in view, experiments were conducted in Region 5 during the season.

4. David P. Godwin, who fathered the smoke-jumping operation during its initial phases and throughout the following years, died in a commercial airline crash in the Virginia mountains on June 13.

5. Smoke jumpers from the Missoula base participated in combined attacks on two fires that were bombed from the air as a part of the Forest Service-U. S. Army cooperative fire-bombing project.

6. Two groups of Air Rescue Service were trained as jumpers at the Missoula base.

1948

The number of smoke jumpers increased from 225 in 1947 to 244 in 1948, mainly because more jumpers were employed in Regions 4 and 6. The groups at Cave Junction, Oreg., and at the Inter City Airport (near Twisp, Wash.) on the Chelan National Forest each employed 28 men. A new unit of 10 men was added to the Region 4 set-up and stationed at Idaho City, Idaho, on the Boise National Forest. Region 5 entered the program by financing a leader and 3 jumpers, who were stationed on the Siskiyou National Forest and supervised by Region 6.

The 1948 fire season in the West was the lightest in many years, except in Region 3 where a severe season was experienced. One hundred fires involved but 402 individual fire jumps during the season's operations.

High lights of the 1948 season:

1. Helicopters were used for the first time to return smoke jumpers from back-country areas to places of immediate access. The first use of a heliocopter for this purpose was on July 30 and involved the Cedar Camp fire on the Klamath National Forest in California. All six jumpers with their equipment were moved out after being replaced. Two other fires jumped in Region 5 involved transportation out by helicopter. Nine smoke jumpers and gear were retrieved in this manner for the first time on the Chelan on August 4.

2. Special lengthy reports were eliminated because smoke-jumping operations had become generally accepted as routine.

Helicopters were used for the first time by Region 6 for initial attack on the Snoqualmie National Forest.

1949

There was very little increase in the number of smoke jumpers employed in 1949, and operational procedure remained about the same. Region 1 had 150 jumpers with the primary base of operations at Missoula, Mont.; Region 4 had 11 jumpers at Idaho City, Idaho, and 35 at McCall, Idaho; Region 6, 28 at Cave Junction, Oreg., and the same number at Inter City Airport, Wash.—a total of 252 men. The 8-man unit from Region 1 was again detailed to the Gila National Forest in Region 3 during May and June. Region 5 financed 8 men from the Siskiyou, Region 6, to serve the needs of 5 northern California forests.

There were 354 fires jumped in 1949, involving 1,335 individual jumps. This was the largest number of fires and the greatest number of jumps since initiation of the program in 1940. The estimated savings in suppression costs exceeded $900,000 for the season.

Helicopters were used on more fires to return smoke jumpers to points of immediate access than during 1948, principally in Region 5 where four fires were involved. Initial attack was made by helicopter on fires in Region 1 and the Wallowa in Region 6—a small beginning, but a gain in experience in the use of this craft.

Summary of Smoke-Jumping Activity 1940–49

Year	Smoke jumpers	Fires jumped	Average fires jumped per crew	Individual fire jumps	Average men per fire	Average fire jumps per man
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
1940	14	9	0.64	[1] 27	3.00	1.93
1941	26	9	.34	[1] 30	3.33	1.15
1942	32	31	.99	[1] 100	3.22	3.12
1943	64	40	.62	[1] 130	3.25	2.03
1944	120	100	.83	[1] 350	3.50	2.91
1945	219	269	1.23	1,236	4.60	5.64
1946	229	320	1.40	1,111	3.47	4.84
1947	225	192	.86	932	4.85	4.14
1948	244	100	.41	402	4.02	1.64
1949	252	354	1.39	1,335	3.77	5.29
	1,425	1,424	1.00	5,653	3.96	3.97

[1] Estimated.

RANGER DISTRICT ORGANIZATION ON HIGH DANGER DAYS

Paul M. Kihlmire

District Ranger, Clark National Forest

The fire presuppression job which makes large demands on the ranger's time is the preparedness and organizational planning on high fire danger days. This planning supplements the annual fire plan and all the other guides used in fire control. It concerns the day-by-day and hour-by-hour maneuvering as fire danger builds up and continues high over several days.

The planning starts the afternoon and night before anticipated high danger days and is a continuous action over sustained high danger periods. Initial plans are made by the ranger during early afternoon, expanded and fully developed as soon as possible the same night by the ranger and his staff. These plans include:

- Weather reports.
- Follow-through action.
- Regular personnel.
- Lookouts.
- Fire crews.
- Equipment (mobile and special).
- Fire tools.
- Food and supplies.
- Overnight watch and fatigue plans.
- The situation.

Weather reports.—Assemble all weather reports received by dispatcher during the day and correlate with special weather information relayed from the supervisor. Check these reports against local radio and newspaper forecasts. This data will give a trend and is used to calculate probable fire dangers. The anticipated danger becomes the basis for adjustments in the fire control organization to meet the change in conditions.

Follow-through action.—Secure data on all reportable fires, false alarms, and nonstatistical fires for the period. Estimate the mop-up and patrol job as carry-over suppression work to be dovetailed into the plans for fire inspections and fire investigation. This information gives the pattern for assignment of regular personnel and the need for supplementing this personnel with outside help.

Regular personnel.—Each of the regular personnel is given an assignment for the following day. His geographical location is definitely determined and his means of communication with the dispatcher established. Each man is assigned a piece of equipment and has a specific fire job to perform. On large fires each man has a special assignment to best utilize his abilities in the large fire organization. This is also true in the high danger day organization where the placement of personnel is determined by fire occurrence, fire mop-up and inspection, fire investigation, and the distribution of fire tools, food, and supplies.

Lookouts.—The tower-manning requirements are reviewed in line with expected weather, visibility, and period of time the towers have been manned. Secondary towers may be needed and the personnel to man them mobilized. Alternates for the regular lookouts are necessary to rest the regular towermen. The normal morning check-in time and the night check hour may be changed to meet local conditions during high fire danger. (Experience has proved a 10 p. m. night check may be much more effective than an 8 p. m. check the night of a pie supper or revival.) Windy nights require all-night detection and dispatching.

Fire crews.—Determine number of fire wardens and fire fighters needed for the anticipated danger for the following day. Request for approval on needs beyond authorization. Send orders to wardens on size of crew wanted, where to report, and work assignment upon reporting. Consider the current day's work by fire crews to keep initial attack force fresh and effective mop-up jobs completed early. An additional task on these days is expansion of mobilization to include seldom-used wardens and the hire of additional equipment.

Equipment (mobile and special).—This phase of the planning includes the placement of equipment and personnel assigned. Tankers and plows are located for initial attack determined by terrain, fuel type, risk, and accessibility. Follow through on operating condition and readiness for call.

Fire tools.—Needs of fire crews and means of delivery scheduled. Warehouse fire-tool replacements are requisitioned currently to maintain the authorized fire-tool complement. Inspection of fire-tool maintenance and distribution assigned.

Food and supplies.—The dispatcher keeps a want list for food, rations, and miscellaneous supplies needed by wardens, lookouts, and field crews. Purchase and distribution is scheduled and assigned to regular personnel, except on large fires where a separate service of supply is set up.

Overnight watch and fatigue plans.—Plans are made for alternate dispatcher or at least telephone operator to take night calls when towers are manned all night. One of the regular personnel is assigned to be called when action is needed. Both days and hours are staggered as much as possible to keep fatigue at a minimum.

The situation.—The planning action is summarized and a report telephoned to the forest supervisor. Approvals are secured and any changes for forest-wide fire-control needs are incorporated into the organization for the district.

Briefs for newspapers and press releases in outline form are made ready since all information is available.

This check-list planning gives the administrator the pulse of his organization. The staff conference, informal and short, enables the regular personnel to report on the effectiveness of the various wardens, how the fire crews performed, elimination of "goldbricks," and the ever-present job fire possibility. The total work load can be equalized; above all it is an ideal time to break down the tension of high fire danger.

FIRE FIGHTING ORGANIZATION AND WARDEN SYSTEM

GIFFORD B. ADAMS

District Ranger, Clark National Forest

[Following is the district organization with emphasis on the fire-warden system to effect economical fire control.—Ed.]

District ranger (full time).—Free to carry on other field duties, either fire or project, except when a fire situation develops, or on days of high fire danger. In touch with dispatcher or tower by radio at regular call times. Takes initial action when feasible. Usually takes charge of first large fire, and worst fire when several serious fires are going. In touch with dispatcher by radio to correlate over-all fire picture. Is accompanied by five- to six-man fire crew during high danger days.

Forestry aide (full time).—This employee is dispatcher approximately 90 percent of the time. He does most of the dispatching on high danger days and during bad fire situations. He is assigned to enough fires each year, as fire boss, to keep in touch with actual fire fighting and to keep oriented on crew capabilities, communications, and other field conditions indispensable to efficient dispatching.

Fire control aide (fire season only).—Handles initial attack on majority of fires occurring within his reach on bad fire danger days. Usually has "hot shot" crew of well-trained men on four-wheel-drive jeep pickup and pumper. Acts as dispatcher on occasion. Capable of handling large fires. Usually first reinforcement when a warden and crew has taken initial action.

Strawboss (fire season only).—Handles some initial attack on low hazard days. Usually reinforcement. Will be capable of handling large fires with additional experience and training.

Primary warden system.—The primary wardens are the backbone of the fire fighting organization. Each warden, who is well-trained and experienced, has a crew of 3 to 10 dependable local men and a truck equipped with fire tools, rations, radio or, in some cases, a portable telephone. These self-contained warden units are used to a large extent for initial attack in their local zones where they are most familiar with the roads and trails, and local conditions. In bad fire situations they are used extensively as reinforcements and so gain experience in other areas.

Many considerations are involved in the organization of a good warden system. The value of a warden depends on his availability when needed, skill at finding and controlling fires, leadership, local acceptance (which is extremely important), need of employment, interest in the fire control job and ability to exert fire prevention influence among his neighbors.

The warden should be properly located as to fire risk and means of communication. He must own or have access to a motor vehicle and must be able to arrange his farm or other work to permit availability for fire work. It is very seldom that a prospective warden meets all the above qualifications. A compromise on one or more points is usually necessary.

The warden organization must be maintained throughout the year. Probably the most important factor in such maintenance is the casual contacts of the year-long personnel with the wardens from time to time. At these frequent contacts a warm personal interest in the warden, outside of fire problems, and a sharing with him of new developments in the Service go far to maintain morale and improve future value of the warden. A 1-day training session is held each year in February, at which time teamwork is stressed as well as individual items of fire prevention and fire control work. At this time a special effort is made to make these men feel that they are a valuable and necessary part of the Forest Service organization.

Every opportunity must be taken to give the warden on-the-job training, and under Clark fire conditions it is not difficult to find such opportunities. It is also possible to give additional training and responsibility to promising wardens so that they will be capable of handling larger problems in the future.

One difficult task is to balance employment of wardens with forest fire fund standby authorizations, problems of risk and danger, and desire of the wardens for employment. The morale of the warden organization hangs on a delicate day-to-day manipulation and balance of these factors. Some wardens want all the employment they can get, while others wish to be called only when absolutely necessary. Limitations of funds holds the number of primary wardens within the number that can be employed to a sufficient extent to maintain their active interest.

The importance of communications with wardens can hardly be overemphasized. Their value in quick fire control depends on prompt communication. Whenever possible, connections are made with Forest Service telephone. Some more important wardens, off the telephone lines, are given radios, and in some cases they must be reached by messenger from the towerman, or by taxi or other means.

In all cases an effort is made to secure some degree of fire prevention by the wardens. The effectiveness in this field varies considerably by individuals. When the warden is a leader in the community we get good returns. In any case the warden must be respected by his neighbors or much damage to the prevention effort becomes evident. As a general rule, the warden has limited value as an enforcement agent. As long as respected neighbors sincerely believe in the value of woods burning, any active participation by the warden in enforcement endangers his value as a prevention and control agent.

Secondary warden system.—The secondary warden may be described as a man strategically located from a fire control standpoint and who is actively interested in keeping the fire out of the woods, but who does not meet the requirements of a primary warden. Lack of communication due to isolated location usually makes the difference. This type of warden is supplied with tools and takes independent control action when a fire occurs in his immediate locality. This type

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of warden has limited value except in rare cases, such as a blow-up situation. His greatest value is probably in the field of local fire prevention.

High school crews.—Two high schools on the district are often called on for fire crews. One of the seniors with leadership ability and experience is set up as a warden and fire crews are arranged through him. One good 10-man crew can be depended on from each school, and an additional 20 men from each in an emergency. Other high schools on the district can furnish untrained crews in emergencies. The high yearly turn-over of trained men from schools limits the value of this source, although this same factor increases the fire prevention potential as these young, trained men become distributed throughout the district.

Industrial crews.—A cooperative agreement is held with the local lead mining company which has extensive land holdings adjacent to the district. This agreement calls for mutual aid. The Forest Service furnishes fire tools and trains key mine foremen. It also spots fires on or adjacent to mine lands and reports them to the company. The mining company agrees to furnish men up to their full complement in case of fires threatening both Forest Service and mine lands.

Cooperators.—This includes a miscellaneous group of people interested in fire prevention and fire control who do not wish to be called for routine fire control activities because of their extensive private interests, but who will respond in a serious situation in any way they can help. These may be ex-Forest Service personnel, business men, or large farmers.

Fire control handbook.—All basic material necessary to the functioning of the fire control organization is maintained in a fire control handbook on the dispatcher's desk. For quick and economical revision all changeable information is recorded in pencil longhand. This basic material is given a major revision just before the spring fire season, and then is revised currently throughout the year as changes occur in the organization.

LET'S CHANGE OUR HEADLIGHT CIRCUIT

ALVA G. NEUNS

California Forest & Range Experiment Station

One thing, they say, leads to another. In this case a search for a throw-away headlight outfit for use on fires led to the discovery that we aren't getting the most for our money out the the present model. In fact, the lamp and battery circuit used by the Forest Service is the least efficient of three tested by C. C. Buck and W. L. Fons at the California Forest and Range Experiment Station.

On the assumption that the current drain on the batteries may be too heavy in the headlight circuit now in use, two other circuits were suggested. All three were set up for comparative measurement. Figure 1 shows diagrammatically the kinds of lamps and batteries used

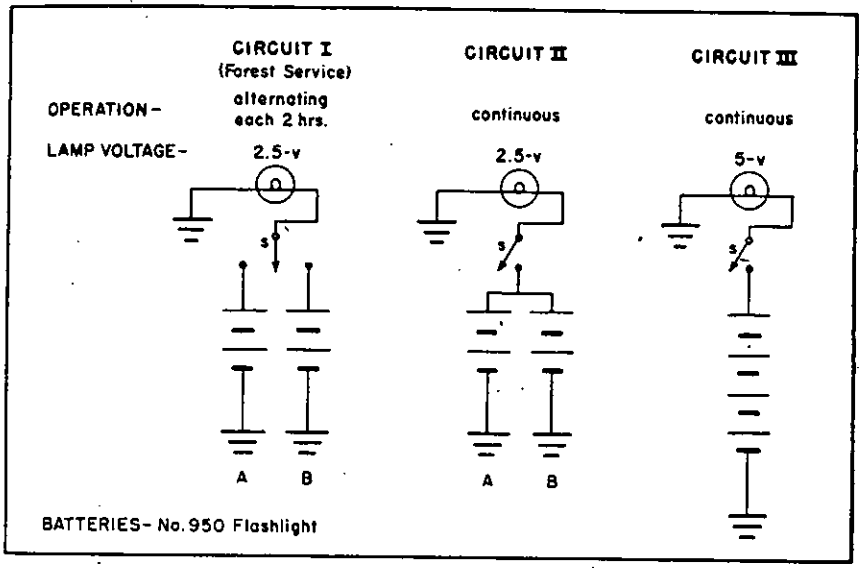


FIGURE 1.—Wiring diagram for three electric headlight circuits.

and the hook-up and operation of the lamp and battery circuits. There are four batteries in each circuit. In circuit I (Forest Service) and circuit II they are arranged in two parallel pairs, A and B. Circuit I draws current from battery pair A or battery pair B. Circuit II draw simultaneously from both pairs and circuit III uses current from all four batteries in series.

An 8-hour period of good light was considered to be a minimum requirement, so the study was set up to cover this period. Circuit I operation is based on the fact that batteries will recuperate if allowed a rest period. Therefore, contact is alternated between battery pair A and B every 2 hours. Circuit II relies on continuous operation of both pairs and circuit III on continuous operation of all four batteries in series.

In order to stabilize fluctuations in light output, usual in bulbs at the beginning of use, each new bulb was allowed to burn 20 minutes prior to measurement. Battery performance was checked by duplicating the observations using the batteries of a different manufacturer. Results were identical in both tests.

Current flow of each circuit during the 8-hour period was measured continuously with a recording milliammeter. Comparative light output of the three bulbs was also measured with a University of California Department of Engineering photoelectric cell photometer for a number of values within the ranges of current flow through the lamps recorded in the individual tests. From both these measurements the light output values were computed for each circuit during the eight hours (fig. 2).

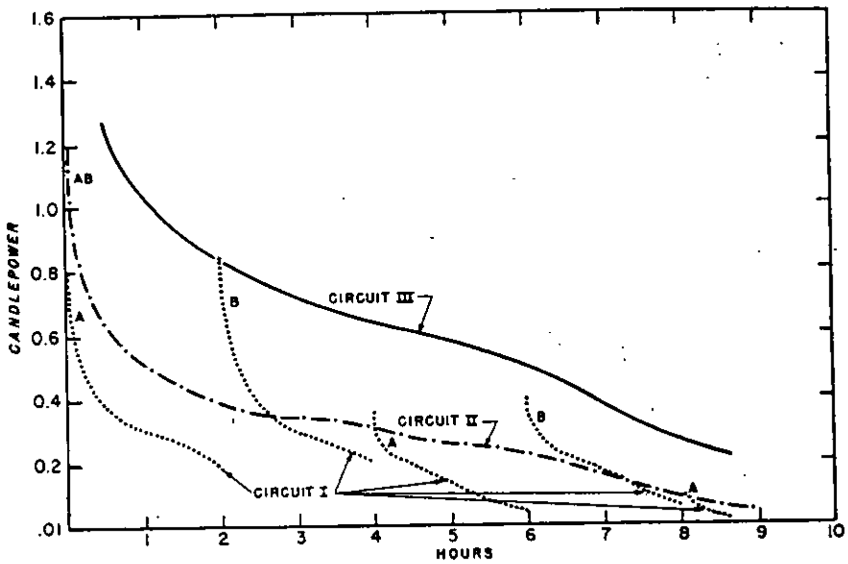


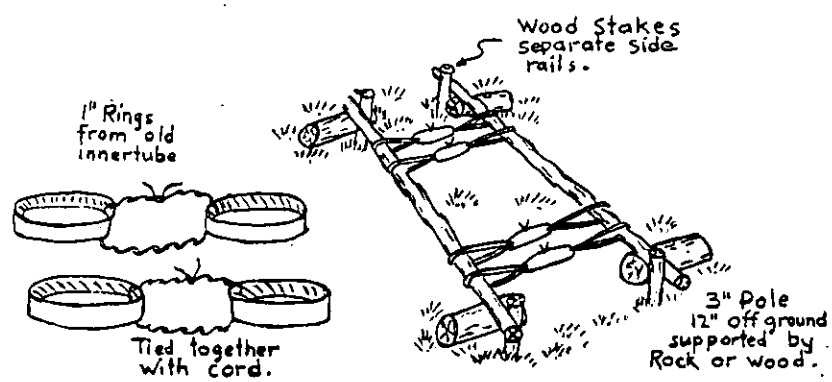
FIGURE 2.—Light output of three electric headlight circuits over an 8-hour period of operation.

Study of figure 2 will show circuit III to be superior throughout 8 hours of use. At the end of 2 hours it was equal in strength to the initial output of circuit I operating on battery pair A or B; after 3 hours it was still equal to A or B after only 10 minutes use. At no point was it as low as circuit II or circuit I. Note the immediate fall in output and the relatively small recovery after the rest period observable in the alternated pairs of circuit I. Circuit II is a little better than circuit I in that its light output remains more constant. It not fall as low at any hour as circuit I does at the end of each hour-use period. Both circuits I and II fall off more rapidly than circuit III.

Besides being least efficient the present Forest Service headlight has an added practical disadvantage. The user must remember to switch from one pair of batteries to the other in order to provide them with occasional rest periods. Ideally, this should result in a usable light continuously for 8 hours. Actually, this is seldom the case. A man on a fire or any other job cannot be expected to spend time or thought on how to operate a flashlight.

Even though circuit III is obviously the best of the three, it presents a problem in that it uses a 5-volt bulb instead of a 2.5-volt one. This would require changes in the present headlight assembly. A new reflector has already been designed but expense of cutting the die necessitates the creation of an adequate market before the cost can be justified and manufacture begun. The same holds true to a lesser extent for a new throw-away battery case. The throw-away unit would be ideal for fire use and will eventually be made for that purpose. For general use, however, it should pay to develop the new reflector and modify the present case in order to take advantage of the strong adequate light provided by circuit III during the entire use period.

Portable Bedsprings.—How many foresters and firefighters have laid their hips on a bed of rocks or hard ground night after night in an effort to get a good night's rest after a tough day? How can this be avoided without too much cost or effort in pruning all the boughs from young thrifty trees? I think I found the answers in a logging camp visited in northern Maine last summer. (This statement is qualified because I have not tried the device.)



Here it is: Cut about a dozen strips an inch or so in width from an old auto inner tube. Hook six on either side of a 6-foot pole. Spread the poles far enough apart for a comfortable width bed, tie the pieces opposite each other together with cord, elevate the poles or frame about a foot off the ground and lay bed on top. The illustration gives a pretty good idea of design. Strips may be placed as close together as necessary, depending on weight of individual.

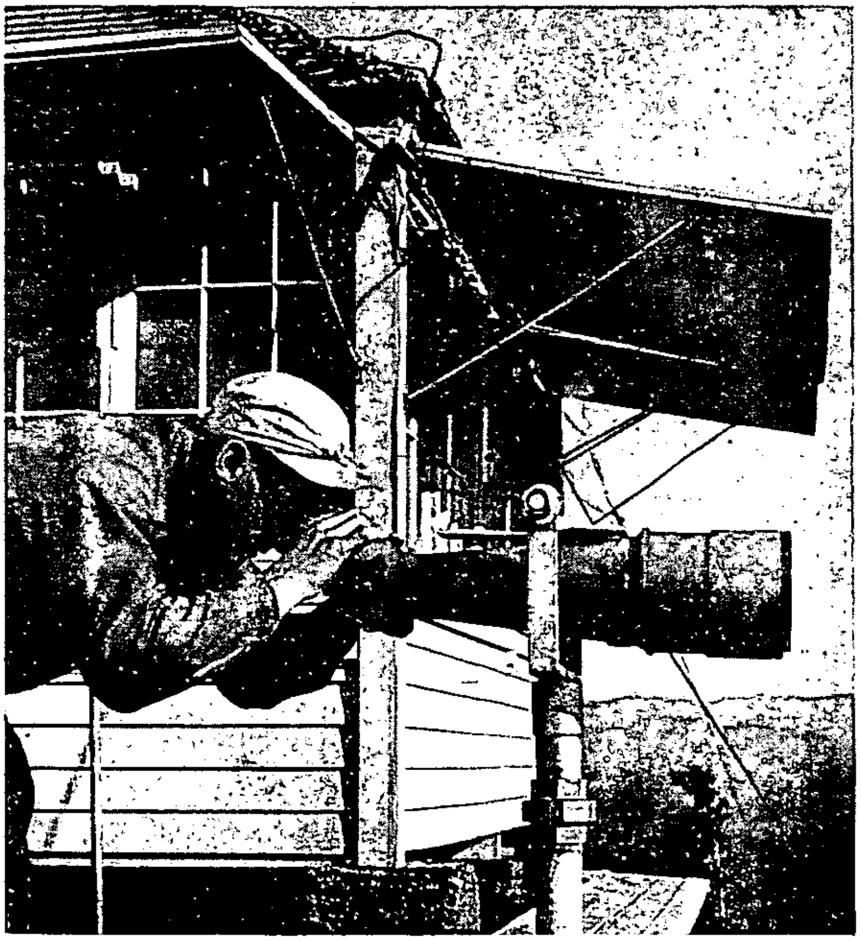
An alternate suggestion is to use three loops of inner tube, tying together with square knots, eliminating the string.—Ed Ritter, *Forester, Region 7, U. S. Forest Service.*

SPOT FINDER BOARD AND BINOCULARS ON LAVA BUTTE

E. J. Parker

District Ranger, Deschutes National Forest

A spot finder board and heavy Japanese binoculars were set up on Lava Butte in 1947 for the use of the public visiting the lookout. The finder board was constructed by tracing the outstanding features from a standard one-half-inch forest map on a piece of plywood that had

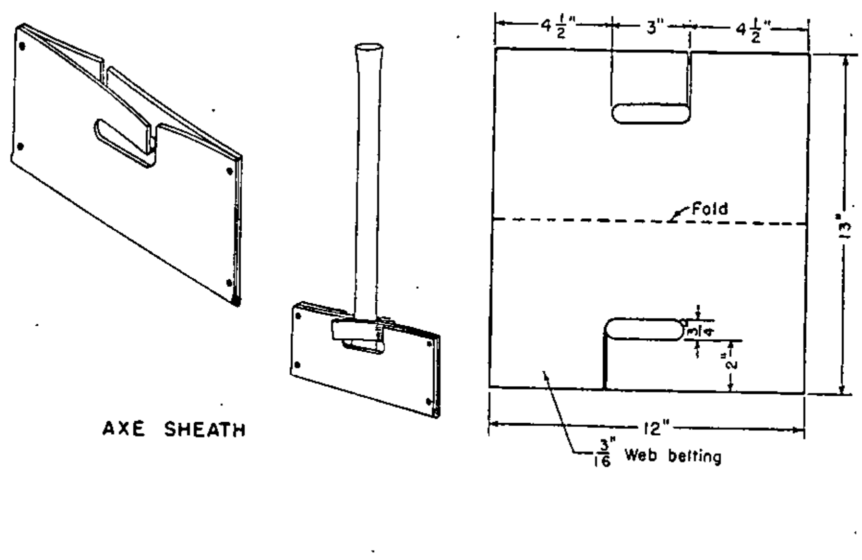


Heavy Japanese binoculars on Lava Butte, Deschutes National Forest, Oreg. The spot finder board is mounted off to the left.

been painted silver gray. The summit of the Cascades, peaks, lakes, and rivers were inscribed in black or dark blue india ink. Holes were drilled in the board for mounting upright pegs over the summit of each visible peak. The key peg for Lava Butte was painted red, and the others silver. The air-line distance from Lava Butte and the elevation of each peak was inscribed on the map. After the board was oriented on the ground and fastened to four vertical pipes, it was possible for the public to determine the various peaks by simply stooping over and lining up the red peg with any one of the silver pegs. Though no lakes were visible from Lava Butte, their location in reference to the outstanding peaks was of interest. Instructions for use were printed in one corner of the board. The board was protected by giving it two coats of spar varnish before mounting.

The mount for the heavy Japanese binoculars was constructed by Mr. Westcoatt of the Departmental Shop. The binoculars were hung by means of a vertical tilt spring and friction bolt and the assembly pivoted on a threadless pipe cap. The public seems to enjoy using these fine glasses, and 10,000 people annually make Lava Butte one of the most visited lookouts in the Pacific Northwest Region.

Inexpensive Ax Sheath.—Ax sheaths or other protectors for ax blades have long been recognized as essential from both a safety standpoint and to protect the blade. The loss of sheaths on going fires is unusually high and in recent years the cost of replacement excessive. In an effort to solve the problem at minimum cost, Ranger Cleo J. Anderson began experimenting with different materials and methods. The best solution seemed a sheath of scrap webbing ⅜ inch thick. This was split to give a better thickness to work. The $\frac{3}{16}$-inch webbing is still more durable than leather and only slightly heavier. The material is cut to a pattern with grooves to fit over handle and joined by two rivets on each end. Straps, buckles, and carrying ring can be added if desired.—PERL CHARLES, *Assistant Supervisor, Tonto National Forest, Ariz.*



AXE SHEATH

THE MOUNTING DOUGLAS-FIR SLASH PROBLEM IN WESTERN OREGON AND WASHINGTON—WHAT CAN WE DO ABOUT IT?

KERMIT W. LINSTEDT

Chief of Fire Control, Region 6, U. S. Forest Service

Currently there are about 25,000 acres of national-forest lands being cut over in western Oregon and Washington each year.

When areas on which disposal by broadcast burning is not planned have been set aside and we add those planned for burning but not burned, we find that areas of unburned slash are developing at the rate of some 10,000 acres a year.

I presume the experience on national-forest lands to be little different from that on State and private lands. A problem of what to do to meet this increasing hazard becomes evident.

There are several approaches to the solution of the problem. Probably the best long-time solution lies in closer utilization. The production of plastics, alcohol, fiber board, and other comparatively new developments gives promise in assisting with the problem in a manner that certainly should not be overlooked. To the practical man who is confronted with the problem as it is today, these possibilities, which will undoubtedly be developed by science to a continuing degree, are only something in the dream stage and are not at all a solution of the immediate problem.

In Rhode Island the Soil Conservation Service has made a trial in grinding up the woods waste resulting from logging and putting it back as litter on the forest floor to enrich the soil. This is a commendable start, but like the utilization suggestion, it has not developed to the point where it offers any real solution of the slash problem at the moment.

Another approach to the problem is to leave the slash on the ground to decay by natural means and give it an additional standard of protection in that interim. This complements the first suggestion in that it permits salvage of some of the material for a good number of years after the original logging.

Experience in protecting slash areas on the ponderosa pine type adds promise to this proposal as a means of hazard abatement. Undoubtedly, there are areas and situations in the Douglas-fir region where the same is true. In all too many cases, however, accumulated slashings in western Oregon and Washington have set the stage for disastrous fires. Even with good additional protection, there exists considerable question as to whether it is reasonable to expect that we can protect these areas from fire for the time necessary to abate the hazard normally.

Under present economic conditions the major approach to the slash problem then lies in the much-debated practice of burning.

Successful disposal of slash by burning calls for complete consideration of the problem from the time the first work is done toward laying out the logging plan until the disposal fire is extinguished.

For best success in slash disposal, more effort must be expended in applying known techniques of fire fighting to this all important job. The same basic principles hold good whether they are used to suppress a wild fire or to purposely burn an accumulation of logging waste.

Many of our problems in burning slash have stemmed from a failure to recognize this clean-up after the harvest as a legitimate cost of operation chargeable to logging.

We must start with a recognition of the job to be done and the need for doing it. From there on, it becomes a matter of planning, adequate financing, and the application of the best-known techniques to the accomplishment of the job.

The staggered-setting system of cutting has probably done more than any single recent development to aid us in the solution of the mounting slash problem. This system allows a better selection of time to burn because of the limited acreage to be burned in any one unit.

In this system of cutting as in any other, strong emphasis should be placed on planning the slash disposal at the time the first cutting area is considered. There are a number of important considerations that follow on through the cutting operation and until the time of actual disposal. I will review briefly the most important of these.

1. The cutting unit should be established on the ground so that full advantage is taken of all natural topographic breaks. It is particularly important to have a topographic break at the top of a cutting unit. Minor ridges can frequently be used to form the sides of cutting units.

2. Roads can frequently be so located as to form a break at the top of the cutting area which has no natural topographic break.

3. The cutting area should be kept to a maximum of 40 to 50 acres in size if practicable.

4. All trees possible should be felled into the cutting area.

5. All trees and snags within the cutting area should be felled.

6. All dangerous snags should be removed for a distance of 200 feet around the exterior boundaries of the cutting area.

7. Fires should be set in a drying-out period after a rain.

8. The best possible weather information should be obtained prior to burning. This applies especially to winds and east winds in particular.

9. Adequate manpower should be on hand to set the fires and insure control.

10. Slopes should be burned from the top down. Level areas should be fired first on the inside and then around the edges of the cutting area.

11. When the decision has been made to burn, burning should be accomplished in the shortest possible time. Mop-up of the fire edges should be started as soon as the burning of fine fuels has been accomplished.

In conclusion, it is my opinion that we must first do all we can in utilizing what is now waste material in the woods. Secondly, when better means are not available, we must aggressively plan and execute disposal by burning most of our slash currently if we are to avoid catastrophe and accomplish the best possible management of our forest lands. We must recognize, of course, that the effect of burning on site, watersheds, and similar factors must be considered and disposal of slash through burning adjusted to meet the primary needs of these factors.

Blazing the Road to a Fire.—The first attacking crew enroute to a fire does not always find it practicable to stop and erect signs indicating the proper road to that fire. If there are numerous roads the job actually becomes time consuming. The signs placed in a hurry often blow over or get knocked down. They are difficult to see and in some cases give wrong information.

During the fire season of 1949, the following method was employed on the Saugus District of the Angeles National Forest and found to be very practical.

About a quart of flour was placed in a paper bag. The opening of the bag was folded down and taped shut. About six of these bags were placed in an easy to get to location in each fire-going vehicle on the district.

At each road fork where there might be a question as to which road to take to the fire, the flour in these bags was used to indicate the correct one. A crewman merely broke one of the flour bags, got out of the truck, and walked alongside the tanker as it went through the intersection. In this manner a line of white flour about 10 feet long was deposited on the road indicating the direction traveled by the tanker. Equipment following can easily spot this white line and take the direction indicated.

It is not intended that this method wholly replace the "Fire Camp" sign, as the flour streak becomes obliterated in a short while if there is much traffic. If the fire lasts any time at all regular signs should be erected.

The main advantage of this system over the signing method is that it gets done. Members of a suppression crew seem to be anxious to leave this mark. It has an appeal that the signs seem to lack. Other advantages are that it is quickly done and much easier to see than a sign.—Charles T. Smith, *Suppression Crew Foreman, Angeles National Forest.*

LIGHT DUTY POLE DOLLY

KEITH C. EULER

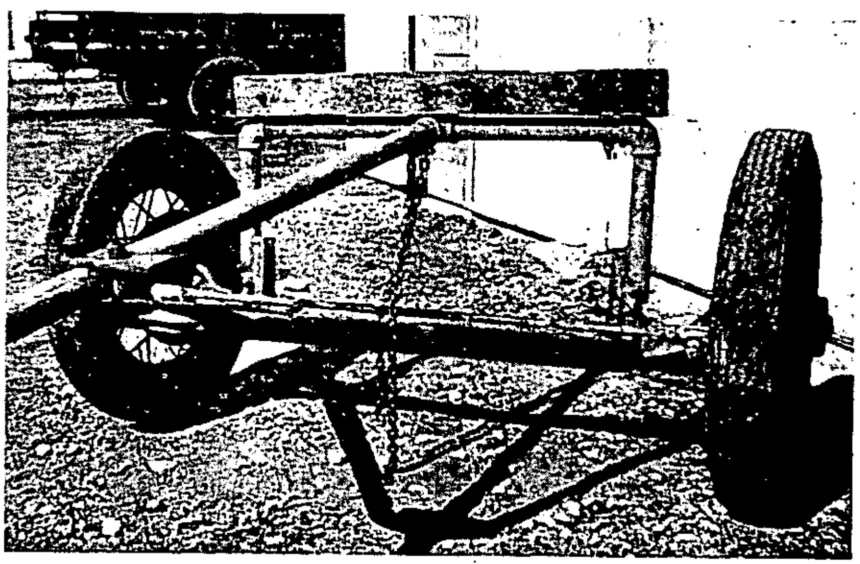
Engineering Aide, Modoc National Forest

Too often stake-side trucks have been uneconomically used to distribute one to three telephone poles on minor telephone line repair jobs. This has been overcome by constructing a light duty pole dolly for use behind a pickup.

The light duty pole dolly was constructed locally from a Ford front axle and wheel assembly and a few pieces of salvaged 1½-inch water pipe and fittings. The total cost of materials was less than $50. With this unit, the butts of up to six poles may be placed in the bed of a pickup and the dolly, fastened to a standard hitch, carries the remainder of the load.

The use of this dolly has not only made the job easier but has cut the transportation cost in half.

Details of construction are shown in the photograph.



DEATH ON THE FIRE LINE

SETH JACKSON

Administrative Officer, U. S. Forest Service, Washington, D. C.

A review of fire fatalities through the years focuses our attention on four major problems.

The greatest man-killer, of course, is the blow-up fire which almost yearly takes its toll. Hundreds have died from this source, if one considers the historic fires of the past, such as Peshtigo. Losses of life are becoming fewer because of organized fire-suppression efforts. Fast initial action with machine-age equipment such as planes, trucks, and tractors, a better understanding of fire behavior, more thorough planning of control strategy, more foremen trained in handling men on fires, has had much to do with the reduction in the number of fire fatalities in recent years. But blow-up fires still constitute the worst potential killer. Much yet remains to be done before the problem is solved.

The second major problem is closely related to my first point. Under extreme emergency conditions, such as occur during blow-up fires, oftentimes men fail to carry out instructions. In trying to work out their own salvation, they become trapped. To overcome this, stressing of crew discipline is a must!

Training to foresee potential events will help. Instructions can then be given before it is necessary to think under pressure. A top foreman gives clear, concise instructions. He tells and demonstrates to his men. He stresses the need of following orders. He checks his men by direct questioning to be sure they understand. He knows them by name; gains their confidence. He follows up to assure compliance. He emphasizes obedience. If and when an emergency comes, he will then be able to control his men and guide them to a previously selected safe location, thus avoiding the crisis.

The third problem crops up almost yearly. Often during fire emergencies, large numbers of men are recruited in a hurry. In the stress of filling the orders for manpower frequently not enough thought is given to their physical condition for the arduous duties ahead. This puts on the fire lines physical incompetents who are actually detrimental to fire suppression. They do not pay their way. They are a drag on the entire organization. All too often, one of these men dies from overexertion.

The remedy is careful screening at the point of hire and again during transportation to the job, in fire camp, and on the fire line itself. The more obvious misfits can be easily screened during the first contact. They may not be properly clothed or shod. They might be in obviously poor physical condition. Direct questioning about such things as hernia, heart, lung trouble, or previous debilitating injuries will weed out many. This process should continue right on out to the line, where in spite of the best intentions, an occasional misfit will arrive.

The fourth problem, tree felling, is common to all forestry or construction work. Last year it was highlighted in fire suppression when four men were killed on national-forest fires alone. Tree felling is a dangerous, unpredictable business. Trees fall or are blown in unexpected directions so often that this possibility should not be overlooked during the best conditions. Wearing hard hats is one safeguard which could well be applied more universally. In addition, it will pay even the most experienced woodsman to plan ahead for the unexpected occurrence. Tricky air currents on fires, and rotten snags with dropping branches or more or less holding wood than anticipated, can cause misfortunes in a few seconds. Injuries can come from lack of a planned escape route, too many men working within the radius of fall of a tree, or simple carelessness.

Probably the thing which is needed most of all in tree felling is lumberjack training which stresses key safety points at each step in the operation.

Looking into the future, we can expect continuing serious injuries and fatalities, accidents from trucks and tractors and mechanical line builders, injuries from plane or helicopter use. Here again, careful training in the use of such equipment and in how to spot hazards will help reduce the number of injuries and fatalities.

At best, fire fighting is hazardous. But it is a job which must be done. We do not want to develop the feeling that because fires are dangerous, we should back away from them without good reason. We must, however, assess the aggravated hazards in fire control and do our best to control them. At the same time, we can instill confidence in our men by letting them know that their welfare is our first consideration when laying out our fire-suppression plans.

WARNING SIGNS FOR FIRE FIGHTERS

A. A. Brown

Chief, Division of Fire Research, U. S. Forest Service

In 1949, 32 men died as a direct result of forest fires on national-forest, State, and private lands. Most of them lost their lives because of extreme fire conditions which resulted in blow-ups. These comments will be confined to these special situations.

Probably it is expecting too much to make fire behavior experts of all fire bosses. Nevertheless, we should go as far as we can in the interest of safety and sound fire strategy.

We need to study the large fire from the point of view of a local weather phenomenon. As soon as sufficient heat and sufficient area, from which heat is rising, have crossed a particular threshold, the fire takes on new potentials in behavior beyond those to be expected by simply extending the dimensions of a small fire. Sometimes we say "it begins to write its own ticket." This is because of the air turbulence which is set up. Similarly, there is good evidence that local atmospheric conditions, beyond the already known effects of humidity and wind, play a big part. This relates to the stability of the air at the location of a fire. It seems reasonable, when an existing atmospheric inversion or ceiling gives way under pressure of a mass of hot air and gases from below, that there is a sudden acceleration in both the rising and descending air currents and a corresponding acceleration in the surface air circulation with effects similar to those of blowing fresh oxygen on a smoldering fire.

In other situations unburned gases seem to accumulate, then explode.

Full analysis of such factors will require the help of competent meteorologists and active participation and close cooperation by both research and administrative groups. This will be essential if we are to make significant new progress in foreseeing blow-up behavior. It can be done.

In the meantime, here are some warning signs to consider when critical situations arise:

Manpower placement and safety

1. Every fire crew boss needs to have a good knowledge of fire behavior if he is to be left on his own responsibility. The alternative is close supervision and explicit safety instructions by an experienced supervising officer.

2. There is always danger in placing men above a large fire and in fighting it from the head down in steep country. Wherever such strategy is necessary, lines of retreat and places of refuge become a critical part of the responsibility of the fire boss.

3. Closely related to No. 2 is the fact that it is always hazardous to attempt to outrun a fire uphill when there is danger of being

trapped. Nearly always there are safer alternatives.

4. Special precautions are needed in assigning men to special duties when they are detached from the main crews or will otherwise be isolated for a time from direct supervision and guidance by an experienced fireman.

5. The danger of being asphyxiated is often overlooked in selecting places of refuge. The bottom of a gulch in the direction of spread may become a chimney flue even though it has no fuel to burn, and most low places directly in the path of the head of the fire have such hazards.

Effects of ground cover

The fire front moves much more rapidly through grass and open cover than through heavy timber. All experienced fire fighters realize this but they often underestimate the contrast in the rate of spread. The fire perimeter can be expected to change from 2 to 10 times as rapidly on the sectors of a fire in that kind of cover. These two—cheatgrass and dry bunchgrass—have extremely high rates of speed in steep country, even if the cover is sparse. It is well to recheck the known ratios between contrasting but intermingled fuel types and to impress them on trainees.

Influence of weather and topography

1. Prevailing wind direction, particularly if the wind is of low velocity, will be modified a great deal by rugged topography.

2. Extremely rugged country is apt to produce erratic behavior in any fire that has gained momentum because of the conflicting air currents that are set up.

3. The mouth of a canyon in rough country is always affected by conflicting air currents. Any fire in its close vicinity is likely to reflect these air currents in its behavior. The head of the fire in such cases may not be the most threatening.

4. To an experienced fire fighter, dust devils—those local whirlwinds of dust—are an ominous sign. Such whirls account for many blow-ups.

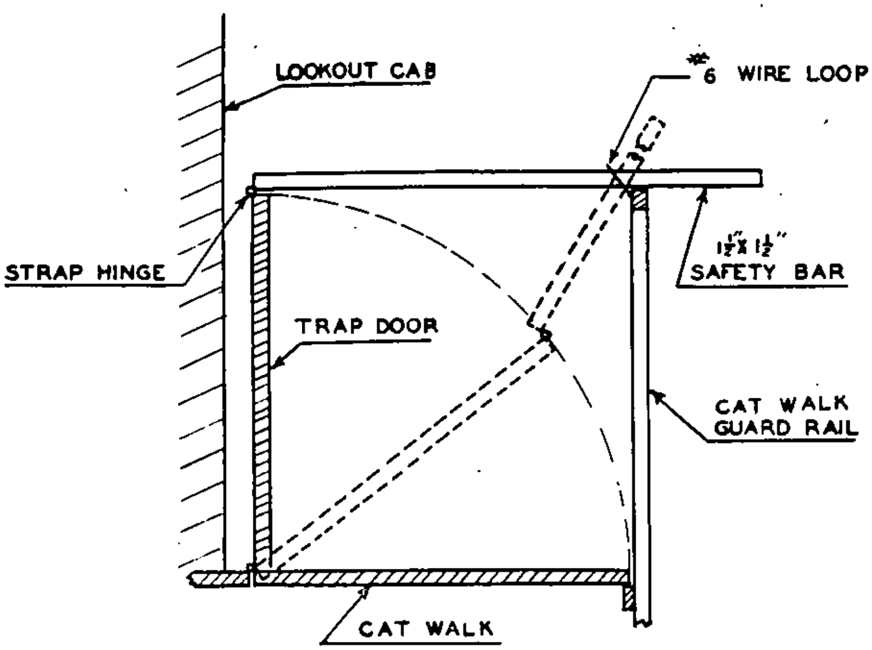
CATWALK SAFETY BAR

H. E. Branagh

District Ranger, Los Padres National Forest

Many of the lookout tower trap doors in California are equipped with safety bars that the lookout man can only hook in place by walking all the way around the catwalk from where the stairs enter it. For that reason, lookout men are prone not to bother putting the safety bar in place when the trap door is open.

The drawing illustrates how a simple, yet effective, automatic safety bar operates. When the door is closed, the piece of lumber 1½ by 1½ by 40 inches, is out of the way by being adjacent to the guardrail. In this position it protrudes 4 inches above the top of the railing, and is held in place by a loop of No. 6 galvanized wire which is bolted to the angle-iron railing.



The lower end of the safety bar is connected to the outer edge of the trap door, and is held in place by means of a strap hinge 1½ inches in width.

Installation of this simple device is positive assurance that the safety bars on lookout towers will always be in their proper place when the trap door is open.

HIGH LIGHTS OF FIRE CONTROL EQUIPMENT DEVELOPMENT PROGRESS IN REGION 1 [1]

DIVISION OF FIRE CONTROL

U. S. Forest Service, Washington, D. C.

REGION 1 FIRE LINE TRENCHER

A trial model incorporating information gained from earlier experiments was completed during the winter of 1948–49. This was given a fairly complete test during the spring of 1949. Objectives governing the present project and results obtained from previous pilot model are as follows:

1. Size and weight should be suitable for aerial delivery. The test model weighs 175 pounds and may be packed for aerial delivery in a box approximately 20 by 24 by 36 inches.
2. Units should be self-propelled for ease of operation and to reduce manpower required for suppression use. The test model is powered by 6-horsepower, 4-cycle, air-cooled motor. The arrangement of power drive is such that the machine is powered both forward and reverse through a quick-acting clutch.
3. Performance should be such that a substantial saving in line production may be accomplished. The previous test model has not been used enough to obtain performance in all types of ground conditions. In open types of slope 0 to 30 percent and little or no rock, the machine built 19 chains of acceptable trench in a 15-minute run or 76 chains per working hour. On the most difficult area tried with side slope up to 70 percent and with considerable heavy rock, the trencher built 8 chains of trench in a 15-minute run or 32 chains per working hour. This is about the limit of operation and is very tiring for operator working the machine alone.
4. Climbing ability should be such that the machine will trench up slopes of 60 percent where ground conditions are suitable. The test machine has built trench up a 50 percent slope. In this test there was no rock but considerable light brush. Short runs have been made up 60 percent slope.
5. The machine should operate on steep slide slope. This indicated that the limit for side hill operation is around 70 percent. For the 1950 fiscal year the following was planned: (a) Make final design for production; (b) prepare specifications and shop drawings for production of three units; (c) construct three test units for field service and breakdown testing.

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[1] Extracted from reports to the Chief, U. S. Forest Service.

Progress through January 1.—Drawings are nearly complete and any questionable mechanical application not used in the first model has been tested on a wooden mock-up. Detail drawings of frame, drive arrangement, and handle control have been analyzed for strength by outside engineers. The frame has been shown to a manufacturer for refinement to permit accurate fabrication. Construction of several items such as sprockets and wheels has already been done. It is expected that the three units will be completed in May, and the tests completed in June 1950.

PARACHUTE TEST INSTRUMENT

Since costs prohibit the use of instruments developed by the military an attempt is being made to develop simple low cost instruments for this purpose. To date one instrument has been constructed which appears to have some promise for recording opening and landing shocks. Calibrations have been made with good results. The instruments consist of two large cylinders with pistons having approximately 10 square inches surface. Air from these cylinders is forced into a small one of approximately 1 square inch area. The piston in the small cylinder acts upon a spring which controls the length of line on the recorder measuring opening and landing shock. The test instrument may be weighted for various types of parachute to give load from 50 to 200 pounds.

AIR-CUSHIONED CARGO CONTAINERS

This container is constructed for aerial delivery of miscellaneous cargo. It contains an air chamber to absorb landing shock. Cargo is placed inside a cardboard carton of standard size which is in turn placed in a box. The inner container is allowed to slide inside the box but is cushioned by the air which must escape past the cardboard carton or through escape holes.

LONG-TAILED PARACHUTE

A long-tailed parachute is essentially a standard chute, except that the loading is attached to the chute with a rope approximately 75 feet long. Test drops have indicated near perfect operation in tall timber and the long line has always let the load down to the ground very easily. The chute acts as a brake as the cargo drops to the ground between the trees. Tests indicate that it is much easier to retrieve the chute—many of them without climbing or felling the trees. Too many failures due to breaking the long rope have shown the need for nylon or other high-strength rope. Tests with new high-strength rope should bring successful completion of this item.

PLATFORM FOR DISCHARGING HEAVY CARGO

In order to speed up dropping operations and save flying costs when large planes are used in cargo dropping, an aluminum platform with ball bearing rollers for discharging heavy or bulky cargo or for dumping several small bundles simultaneously is being developed. The present arrangement locks the rollers against the floor of the aircraft while cargo is placed on the ramp. When ready for discharging bundles over the dropping spot, the rear of the platform is raised to free the rollers and slide the cargo out the door. The pilot model is being constructed for use in a C-47 airplane. No tests have been conducted on this item.

FIRE MESS OUTFITS

Changes by manufacturers and developments during World War II have made many items in Forest Service mess outfits obsolete. The 1950 fiscal year project includes:

1. Canvass regions for ideas and suggestions and for information regarding types and sizes of fire mess outfits needed.
2. Develop new methods of packaging suitable for all types of carriers. Investigate new types of lightweight plywood containers.
3. Explore fully paper or other disposable products or other new material which may be suitable.
4. Analyze contents of mess outfits and bring up to date.

Progress to date.—Questionnaires completed by regions have been received and are being analyzed. Information upon available equipment is being catalogued and many samples are being tested and compared. Several sample outfits will be made up for experimental use during the summer of 1950.

Disposable Headlights.—Because of the claim of several western regions that headlight losses on large fires were quite high, it appeared desirable to investigate the possibility of developing an expendable headlight that could be produced at a very low cost. Region 4, United States Forest Service, made up an experimental unit as follows:

The lamp used was of the fixed focus penlite type globe which eliminates the necessity for both a reflector and glass cover. The lamp socket and headpiece assembly was made from tin-plate material with a rubber pad clipped on in a similar manner to that used on the standard Forest Service headlight. A light piece of metal was used to support the socket and to project from the headpiece, allowing for adjusting the angle of the light by simply bending this arm to the angle desired. The head strap was taken from the Forest Service standard headlight. The wire used to make cord was a multistrand plastic covered wire which is soft and pliable. One end of this cord was soldered to the lamp socket, the other end has a two-pronged plug. The battery pack was made of two ordinary flashlight cells connected together in series by piece of wire and wrapped in paper or tape to form a two-cell pack with a socket for two-pronged plug. The connection was made by simply inserting the two-pronged plug into the battery pack socket, thus eliminating the cost of a switch.

This experimental headlight gave a satisfactory light. The total estimated cost of all parts used is approximately $1.54, including one battery pack or $1.24 without battery. A simple economic study made by Region 4 shows that if expendable headlights at $1.24 each were adopted, the annual cost to the Region would be approximately $1,200 more than the present cost with the standard Forest Service light. From this it appears that the cost of the disposable type headlight cannot be more than 60 cents each, if they are to pay their way.

The results of this project show that without a radically new design there is little hope of obtaining a disposable headlight cheap enough to compete with the present Forest Service standard unit. Therefore, our next step should be toward improving and reducing the cost of the standard headlight.—DIVISION OF FIRE CONTROL, *U. S. Forest Service, Washington, D. C.*

LETTER TO A PROFESSOR IN FOREST PROTECTION

[This excellent letter was written in December 1949 by Arthur W. Hartman, assistant regional forester, Division of Fire Control, Region 8, in response to a request from a Professor at a midwestern university who was preparing a course in fire control. Headings have been inserted for the convenience of the reader.—Ed.]

"* * * Forest management in all its phases is a developing, progressive matter. Professional foresters, and the teaching of them, dare not be static. One located at a vantage point for observations must conclude that generally speaking, portions of university training are outdated. Too often new graduates come to work indoctrinated with about the same ideas as were given to me some 35 years ago and which have been passed along with little adjustment to the revelations of experience. * * *

"Fire control is still seen by many at a level of vocational performance or craftsmanship. Our profession is relatively young. So much so that thinking has not emerged generally to where the different levels are defined. For illustration purposes we shall borrow from older professions:

"In construction work we all are familiar with the differences between an architect and the pipe fitter, stone mason and carpenter, and the different levels of training, viewpoints, and thinking each must follow. We are familiar with the variations between a mechanic and a mechanical engineer, the builders of power lines and the electrical engineer. * * *

"A good mechanical engineer should in his early days be given a vocational ground work. He should learn the feel and use of tools, acquire some personal skill in the shaping of metals and gain a working knowledge of shop practices. Thereafter, he moves to the fields of intensive design and applied engineering.

"Any professional forester, if he is going to progress to where he can successfully meet responsibilities for developing and protecting a major high value forest property, must sooner or later learn to see things and think along the same lines as an industrial engineer. As a student, this fact of life should be made plain to him.

"If you will check back over your own school days, field training camps you have attended, and much of the protection literature, I am sure you will find that a pretty good job was done in making you familiar with the working tools. You learned of the tools of fire detection; towers and lookout men; communications and reporting; transportation; project fire camps, how to equip them and feed the help. You no doubt swung a Pulaski tool and built fire lines to acceptable specifications; actually felled dangerous snags, gained an idea of shop practices. * * * At that point one must be classified as learning a trade, developing into a pretty good skilled laborer, or a competent foreman of labor, something of a technician.

"It is above that level where stress and development is needed if young professionals are to gain a concept and understanding of a professional approach to the protection of our timberland resources from fire. Rather than thinking of each function or subject as a thing by itself, good fire control engineering requires an evaluation and blending of economics, silviculture, human relations, laws of nature, logic, soils, and related sciences.

"Proper evaluations, anticipating probable changes, transitions, or events, and planning to be ready to meet most of such things before they are on you—by these, and the quality of their application, is determined whether the battle is won or lost. Of course, no one can be brought to that stage in the classroom. Much experience and many hard knocks are required before the individual comes to a realization of the meaning, value, and place of the many things he is taught.

"Were I to attempt to teach fire control, I think I would first start at the top, give them a professional goal or objective to work toward, outline the finished structure, then of the component members, their places and functions in the whole. Later, as they are led through the subject of working tools and shop practices, as they come up through silviculture, economics or other of the courses, students would be better able to relate them and see them in perspective.

"Certainly they would not be misled into believing that fire control was a matter of just finding fires and extinguishing them. They would gain an understanding that fire is to forestry as diseases are to the human frame. The competence of the medical examiner and diagnostician, the skill of the surgeon or doctor in treatments, eliminates, limits or greatly extends the usefulness of persons. You already know that however ideal the theories of resource management and however good the plans, the results are very much at the mercy of the degree of protection attained.

PRESCRIBED BURNING

"It is good to learn that you are going to give the students an insight into the usable qualities of fire. The woods are full of inhibited men. Southern foresters are more and more adopting the wholesome and, shall we say, scientific approach, segregating facts for what they are and laying them out in the open for nonemotional assessment.

"Unfortunately, you have cited the available literature on prescribed burning. Yes, the use of fire has spread greatly across the South. Quite a few things have been learned or refined. Perhaps it is not as yet timely, but for one reason or another the subject has not been brought up to date in print.

"The Region 8 national forest prescribed burning program for the coming winter will encompass about 200,000 acres. That will include some 25,000 acres of loblolly located both on the Francis Marion in South Carolina and in Texas. The region for a few years had more critical longleaf burning to do than could be handled financially. Loblolly burning was carried on experimentally but on administrative sized blocks. * * *

"Several State forestry organizations have trained their district men to where they now give technical advice to landowners on whether or not to burn and how to burn. Some of the major industrial landowners are using fire when and as they believe such operations are called for.

"Following are some of the things you may not find in print:

"People are like pendulums—they tend to swing from one extreme to the other. One finds the pure fire exclusionist; after learning just enough to know fire can produce some marked benefits (but not enough to appreciate its complexities), this type tends to swing too far over, get 'match happy' and overdo it. That is why students should be let in on the facts and become ingrained with the idea that to burn or not to burn is a matter of cold-blooded analysis and calculation.

"We are not burning in the upland or Piedmont topographic types. We know pretty well the direct physical effects of fire on the various commercial tree species and on the low-grade brush which is encroaching. What the profession has yet to determine are: measures of fire effects on biological content of soils; on water absorbing qualities of soils; and definition of that zone when pine, hardwoods, and brush species are in satisfactory balance.

"Foresters in position to observe wild fire and its effects on loblolly have known for many years that the backing portion of a fire produced no important damage among 4-inch diameter and larger trees at certain seasons and when soils are moist. That observation is being well confirmed by large-scale tests.

"A fairly widespread concept has been that prescribed burning is a form of 'light' burning, done to keep an area from being burned by wildfire. Such a primary use of fire is rare and occurs mainly for the purpose of breaking up or partially insulating major areas having lethal fuel accumulations.

"Most fire use is primarily for silvicultural effects, and on a given area will be accompanied by a considerable spread of years between burns.

"Seedbed preparation and brown-spot control burning have secondary effects of reducing fuel and keeping shrub species controllable.

"Slash and loblolly pine areas in the South have been undergoing a major transition during the last decade. As protection progressed and wildfire burning became less frequent, the various understory species have taken ascendancy over commercial species. Where there have been no fires, such a dense ground cover has developed that reproduction cannot succeed. If that situation is not treated, rather than practicing sustained yield, it will be a matter of gradually harvesting the established stems, then presenting to the public extensive brush fields as the product of professional management.

"Industrial foresters in such areas are plenty scared. They hired out to produce a sustained flow of raw materials for the mills. Cold-eyed directors are beginning to look around and ask questions as to the whereabouts of the future crop. It is a problem that has to be solved, and solved on a business-dollar basis, if the profession is to maintain claims of being expert timberland managers.

"Fire is not the only tool that can be used toward modifying the war between pine and brush for control of an area. One can use bulldozers, poisons, or an ax. In areas of lush growth, the present day costs of such treatments are economically prohibitive. Fire treatments can be effected at around 20 cents per acre.

"This same problem—what species will dominate—is present all the way across this region, and it is gaining momentum. A forestry graduate who goes to this or similar areas, can, if warned of conditions and trained to view the problem with an open mind, be in line to figure out successful performance. The others will be handicapped and less attractive buys to a business wanting results. * * *

RATE OF SPREAD

"There are two types of rate of spread: One deals with increases in fire perimeter; it reflects the size of the line-building job. The other is the rate at which the head or heads of fires travel. It reflects the strategy to be employed to head off the fire. * * * As wind velocity increases, spread rate increases more than proportionately due to spotting well ahead of the flames.

"Because of terrain, or for lack of proper equipment, it is necessary to suppress many fires with manpower. That method is costly, both in direct cash outlay and in producing larger burns on the average with higher fire damage.

FIRE LINE EQUIPMENT

"Various types of motorized fire line equipment have been developed and the spread of their use is rapid. Tractor-plows, bulldozers, motor vehicles with plows, etc. When properly designed for terrain, soil and cover, and used by experienced men, such units can build more and better fire line in an hour than can 25 men. Because a tractor does not tire as a line worker will, their relative advantage over men increases as time passes. A given fire is handled at a lesser over-all cost and the burned acreage is considerably less.

"Students should become aware of powered equipment suppression potentials and be given sufficient insight to realize that present-day developments are only milestones, that they are the ones who will have to devise and adapt to their advantage even better equipment as industrial advances make opportune. * * *

HUMAN RELATIONS

"It would be difficult to overstress to forestry students the decisiveness of human relations over their future success. They may graduate highly polished on scientific theories and facts, but it will be the effectiveness with which they apply and operate them that will be the measure of their value. Important generally, but they should appreciate that in fire control human relations exert at least half of the total influence on results.

"For most timber growing areas the fire problem (both prevention and control) is pretty much a human problem. It is tied into the understanding, thinking, actions, and reactions of great numbers of people from all walks of life, with varied degrees of education, and with different backgrounds and traditions. People cannot be treated as a mass. Properly influencing them will require development of the desire and ability to make penetrating and understanding analysis of them. The forester will have to live among them and work with them. A crucial necessity is that he first succeed in selling himself to a point where he can break through firmly established barriers of clannishness, provincialism, and some prejudice. Only then will he gradually become accepted. Many a young forester seems unaware that he is constantly under observant eyes that measure and weigh his every act. Once he is weighed, for good or bad, people fix and freeze his level of prestige and leadership among them.

"It is more what some might call the little things that count: the sincerity and workmanlike manner with which he goes about each task; the interest in and little considerations he gives to the ordinary fellow he encounters; the willingness to go to a little extra effort to be helpful; retaining his proper position but still being warm and friendly.

"I have seen quite a lot of young foresters make their starts, observed their accomplishments, and noted the influence of various factors over their progress. Far too many have limited their usefulness or broken their careers because of a lack of appreciation and sensitivity to the human side of their jobs. * * *"

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.