United States
Department of
Agriculture

Forest Service

Volume 49, No. 2
1988

Fire Management Notes

Fire Management Notes An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

Forest Service

Volume 49, No. 2
1988

Contents

Fire Management Notes is published by the Forest Service of the United States Department of Agriculture, Washington, D.C. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Subscriptions may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Send suggestions and articles to Chief, Forest Service (Attn: Fire Management Notes), P.O. Box 96090, U.S. Department of Agriculture, Washington, DC 20090-6090.

Cover: Gene Benedict, Branch Chief, Fire Management and Recreation, stands before McCall Smokejumper Base, on Payette National Forest, ID. See story on **p. 33.** (Photo courtesy of Eric Bechtel, *Central Idaho Star News.*)

Artificial Intelligence Applications to Fire

Don J. Latham

Meteorologist/physicist, Intermountain Fire Sciences Laboratory, USDA Forest Service, Missoula, MT

Just what is artificial intelligence (AI), and what could it possibly do for (or to) fire science and management? Before getting into uses that, as we shall see, will be manifold and pervasive, let's dig into some of the characteristics and definitions of artificial intelligence.

Many potential or actual users of AI will insist that the term is an oxymoron. That is, anything artificial cannot be intelligent, and vice versa. There is a simple operational definition that gets us around this difficulty: the Turing test, named after its inventor, Allan Turing. If you are communicating with someone or something, and you can't tell whether the someone or something is human or machine, then it is intelligent. We can expand this test just a little to include more behavior than communication, and we have a pretty good working definition of artificial intelligence, along the lines of: if it walks like a duck, quacks like a duck, and looks like a duck, then it is probably a duck.

I don't think there is any question that we can replicate human thinking processes in machinery and use machinery to expand those processes. We've already done this. We will build machinery that thinks to match the job to be done. Imagine coming to work one morning and turning on your desktop thinking machine, only to have it announce that it was calling in sick. So, we'd probably want our desktop machines to be rather subservient. On the other hand, suppose we send a machine to explore the surface of Jupiter. We would want this machine to have a great deal of intelligence, including the capability of refusing to carry out a self-destructive action (see Asimov's laws of robotics).

Where are we now in the realm of AI? Currently, the field is broken into several overlapping categories. The most common divisions are: environmental sensing (vision, hearing), including pattern matching and recognition of things; computer learning and analysis; "natural" language and linguistics; and reasoning, or knowledge-based systems ("expert systems"). Does this sound familiar? It should, because it is just what people do: input data from the senses (or from internal sources such as a dream), filter and think about the data, apply known processes and remembered data to the result, and act on the result. Some of our actions are "hard-wired," like reflexes, some "background" or meta-programs, like driving a car, and some call for much active thought, like reading this paper.

Each of these divisions of AI is in its embryonic stage. Every step forward seems to generate more questions than answers. Robotics, for example, a sort of melding of these arbitrary divisions of AI, is moving fast. Both military and commercial interests want robots to work for them: robots don't talk back, they obey orders, are dispensable, and cannot sue you. At present, however, robots are limited in capability. A robot van has successfully negotiated a road, on its own, at about 3 miles per hour. Remotely piloted helicopters, using infrared scanners and knowledge-based systems, are being

developed to recognize tanks. Does that sound like something desirable for fire application?

At present, the most useful AI technology is the "expert system" or knowledge-based system. These computer programs use knowledge bases (composed of facts and rules), interpreters of the facts and rules (called inference engines), input and output routines, and explanation routines. Most of these programs follow long and sometimes tortuous reasoning chains through to a conclusion. They are good at this, whereas people are not; it is not a survival characteristic. Engaging in long reasoning chains when threatened by a saber-tooth tiger probably would get you eaten.

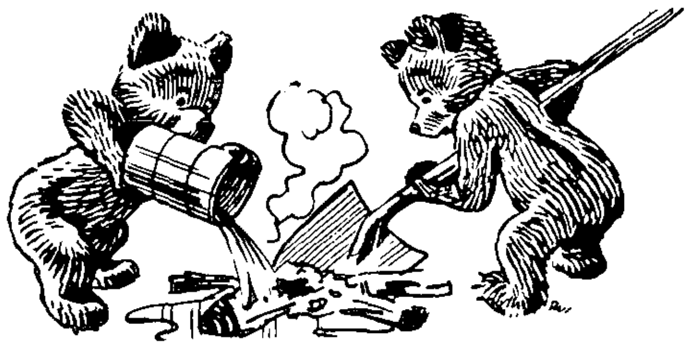
An expert at something has created a domain of knowledge about the something. Within that domain, the expert has formed heuristics, or rules-of-thumb, to guide activities within the domain. If the expert can, with the aid of a knowledge engineer, or without, codify his or her knowledge, an expert system can be constructed to mimic the behavior of the expert in the domain. The codification and the knowledge base that result are knowledge representation, one of the major problems in expert systems. This process is, of course, putting the expert's knowledge into machine-understandable format.

Why not just teach the machine to accept the knowledge and codify it, thus replacing the knowledge engineer with a program? Attempts to do just that are ongoing. It is one of the current hot topics in artificial intelligence.

Of course, the program, unlike the expert, is not able to extend the knowledge base in other than an elementary deductive way. Once we have started the program going and it has deduced all the consequences of the knowledge it has in its knowledge base, it stops. We have not told the program how to extend its knowledge. The machine's extension of its knowledge is, as you might expect, one aspect of machine learning. The program has to know not only how to learn, or store data, but also to form and test new hypotheses about new input. To do that, the program has to know how to think about thinking. And so on.

If our understanding of how to build effective machines is so infantile, then what good, in a practical sense, are the simple programs that are available to us? Right now we can computerize any repetitive process or any closed operation for which a knowledge representation can be found. We can also generate programs that add facts within the representation to their knowledge bases, and reason, using those new facts. We can construct intelligent databases and inventory systems. If we had started work 5 years ago, in a serious way, we could right now be using:

- An expert system that is the Forest Service Manual.
- A semi-automated land-use planning system.
- An elementary, reasoning fire dispatch system.
- Prescribed burning plans that learn.
- Interactive, self-correcting, geographic information systems.



Many of these would have been available this year or during the next couple of years on cheap mass storage and running on advanced work stations, large desktop computers. We are, then at least 5 years behind.

If we run like heck to get caught up, how far could we get by the year 2000? We could be testing or have:

- The first crude robots for forest use.
- Completely automated fire dispatch machinery that would be able to use the forest robots as smokechasers and forest plans for broad guidance.
- Interactive teaching tools with highly realistic simulations.

A robot for a forest or rangeland would be programmed to roam a given geographic area, monitoring for fire and bug activity, and keeping track of wildlife and the like. It could be programmed to do elementary thinking about its environment and would call for help if needed. Of course, it would know where it is and communicate by satellite.

Fire dispatch machinery such as I describe is already beginning to be used, except for the robotics, in Ontario and Quebec. The package and concept were developed by Peter Kourtz at Petawawa. The machine dispatcher keeps track of fuels by satellite, rainfall by radar, and weather and lightning occurrence by land-based sensors. It is at present dependent on human input, but will become more and more intelligent as time goes on.

Do such machines and programs replace people? Yes, of course. They replace people who are doing mundane, repetitive tasks, tasks that almost all people dislike and perform poorly. They free people to do what they do better than machines—think creatively and with common sense. The machinery must be looked at as a tool, as an extension of the mind and body. Look—did the bulldozer replace the Pulaski? Sure, for some uses, but each still has its place.

Aside from cost, which is a matter of commitment to a course of action, the things that hold us back from implementation of this or other new technology are simple human inertia, a reluctance to change, and a management system firmly rooted in the 19th century.

Resistance to change is, however, a survival trait. New things must be tested to assess their value. What I am doing is proposing that application of new technology is more than just a better way of putting out a fire or even better planning tools. It now includes change in a chain of command, with information and policy implementation passing through many layers, to a system two or three layers deep and with far more automated information passing. We are seeing the beginnings of this with implementation of the Forest Service-wide computer system. It is starting as an aid within the old management structure, but will sooner or later enable a far more efficient structure, releasing managers from much of the paper shuffling necessary for passing information through a vertical structure. Geographic Information Systems will tie information to the land, and make it available without being manually handled. Administrative information can be quickly dispersed without the need for many differing interpretations as it passes through a chain of people. And artificial intelligence programming techniques will be helping us all the way. ■

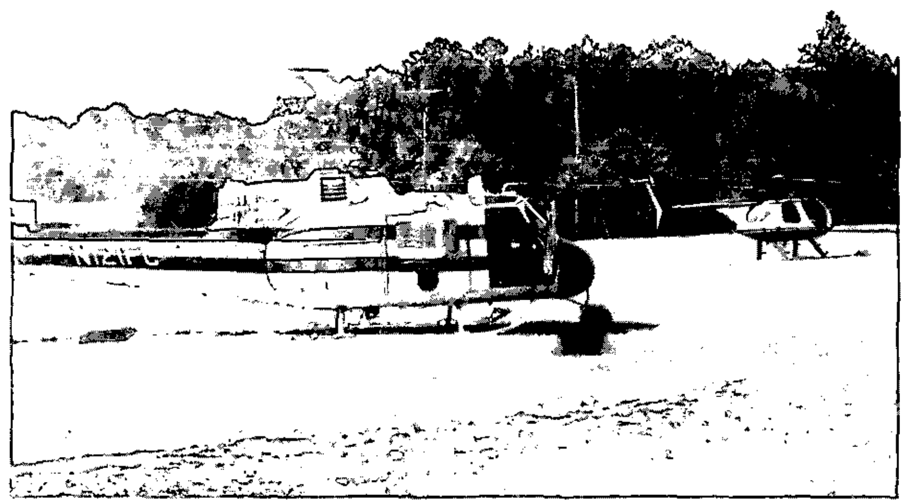
The Florida Division of Forestry Helicopter Program

John Mason Glen

State of Florida aviation safety officer, Tallahassee, FL

The 1985 fire season was the worst in recent history for the State of Florida. One Division of Forestry firefighter and one local forest products industry firefighter were burned to death battling a wildfire; over 200 homes were destroyed and in excess of 400,000 acres of timber management area was ruined.

This conflagration did provide the impetus for a concentrated effort on the part of the Division of Forestry, in concert with the industry, Senator Paula Hawkins' office, and the Florida Forestry Association, to acquire helicopter assets to assist in fire management. These efforts were rewarded by the U.S. Navy's releasing two Bell UH-1E helicopters into the USDA Forest Service Excess Property Program for loan to the Florida Division of Forestry. The helicopters are operated within the strict guidelines of a cooperative agreement with the Forest Service requiring 90 percent of the flight time to be on fire-related activities.



In foreground, Bell UH-1E helicopter on loan to Florida Division of Forestry; in rear, newly purchased Hughes 500D.

The 1966 UH-1E models, with roughly 4,000 hours of flight time each, underwent comprehensive maintenance inspections following their arrival from the storage depot at Davis-Monthan Air Force Base near Tucson, AZ. All inspection panels were opened; corroded areas repaired; new rivets, tail rotor cables and guides, drive shafts, thick-walled masts, dynamic bearings, stabilizer bars and other miscellaneous items installed; and an engine "hot-end" inspection completed by factory technicians. Main and tail rotor blades were ordered to replace some that are high time and will be installed once these components' hour requirements expire. King intercom, Nav-com, transponder, and Wulfsberg 9600 channel radios replaced the 20-year-old military radio equipment. One "Huey" was painted Division green and white and had new soundproof interior installed. The other paint job will be accomplished in fiscal year 1988. Three "Huey" fuselages for nondynamic parts replacement were also acquired, as well as an entire rebuilt spare Lycoming T-53-11 engine.

Additionally, the Florida State legislature appropriated $200,000 for the Division to purchase outright a smaller helicopter for seed orchard and nursery spraying, aerial ignition, fire management, and other forestry duties. Out of a list of 30 possible candidates, six helicopters were looked at. A 1979 Hughes 500D with 1,600 hours on it seemed to be the best choice, and came on-line in February 1987.

Interagency cooperation and assistance has been highly visible since the inception of the program. The U.S. Navy provided Division aircraft mechanics with training as well as some specialized tools. The Division is able to order helicopter parts from the Army on the same priority code as a frontline military unit.

All three helicopters and pilots are based in Tallahassee. Current management objectives call for repositioning of a helicopter into the Southern Region of the State when the weather build-up index reaches very high or extreme, or fires have occurred, or a combination of the two. During our fire season, roughly February through June, an aircraft will remain in the Southern Region, with the pilots rotating on a weekly basis. A portable auxiliary power unit, 240 gallon Bambi bucket, cargo net and lead line, tool box and helmets, and Nomex flight suits and gloves accompany the deployment of a helicopter.

Aircraft maintenance is accomplished by the Division aircraft mechanic staff, which also maintains 19 single-engine fixed wing and 3 multi-engine fixed wing airplanes. The single-engine airplanes, used for fire patrol and some personnel transport, are not instrument flight rule-equipped nor do they fly at night. The multi-engine airplanes, used almost exclusively for administrative fire protection and travel, are for all-weather, day or night usage. Parts, Airworthiness Directives, and information are tracked through a microfiche system, while all time components are on a computer spread sheet updated monthly that alerts maintenance to components with less than 25 hours useful life remaining. Although the three pilots fly any of the helicopters, each aircraft is assigned to one pilot who is responsible for ensuring that it is cosmetically maintained and that the maintenance staff is aware of write-ups or discrepancies. Personal protective equipment, required for Division helicopter pilots during fire-related activities, but optional for administrative flights, has been provided through the USDA Forest Service excess property program.

The Division taught a helicopter managers course to familiarize our own people with the capabilities of these new tools, and I-374, the Incident Command System (ICS) Helicopter Coordinator course, which included Division personnel as well as participation by the National Park Service, Florida Fire College, and the USDA Forest Service. Additionally, the Division will host the USFS/OAS (USDI Office of Aircraft Services) Southeast Regional Helicopter Manager workshop this year, the second week in February. A Division UH-1E recently assisted at the Florida Fire College in Ocala by rappelling firefighters onto a high-rise building at the end of their training session. Ten Division employees are also carded as Premo Mark III aerial ignition machines operators after having had instruction from either the USDA Forest Service or the National Park Service. The Division completed nearly 10,000 acres of prescribed burns during calendar year 1987, in cooperation with USFS and the Florida Freshwater Fish and Game Commission, and has plans to do at least 15,000 together with the Freshwater Fish and Game Commission, USFS, and the U.S. Fish and Game Commission. All three helicopter pilots are USDA/USDI Interagency carded. One of the pilots was recently sent as Air Operations Director for an Interagency Incident Command Team to east Tennessee during its extreme fire problem period. The Hughes 500D is interagency authorized for any sort of fire management duties, while the UH-1E's are carded for water dropping only.

The pilots take proficiency check rides on a 6-month renewal basis and are required to keep current and proficient at their unique type of flying, such as aerial delivery of water or retardant, aerial ignition, and nursery spraying. One pilot divides his time between maintenance and flight duties, another handles both fixed wing trips and helicopter missions, while the third administers the helicopter program and acts as the Division flight instructor and Safety Officer. We comply with the 7 flight-hour and 10 hours of uninterrupted rest requirements, as well as no night flights nor Instrument Flight Rules.

Although the National Guard has provided valuable aviation assistance in the past, they could only be committed in life threatening or fire disaster situations. The Division hopes to utilize its helicopters to prevent these types of situations from occurring. Further, the Fire Control Bureau has felt for some time that Division helicopters could arrive more quickly and do more in fire management simply because they were schooled in fire-related activities. Now, with our own helicopters, fire management objectives such as increased seedling production and decreased fuel loading through aerial ignition can be better achieved. Also, the Division now has one more tool available during lightning busts and peak fire periods, when most other assets are committed. ■

Prescribed Burning for Cultural Resources

John E. Hunter

Forestry technician, Orleans Ranger District, Six Rivers National Forest, USDA Forest Service, Orleans, CA

Gathering plants by Native Americans on public lands is a widespread practice in some areas. Land managers concerned with fair multiple use on these lands should facilitate this legitimate resource use particularly when the administration of those lands has hampered traditional practices in the past. Fire suppression and prevention programs, for example, have limited the ability of Native Americans to burn vegetation in conjunction with collecting and other activities. As a result, some special resources collected only in burned areas are not readily available. Fire managers thus find themselves in a unique position to utilize their expertise in the development of important cultural resources.

The Orleans Ranger District of the Six Rivers National Forest has a long history of gathering by Native Americans and a more recent history of fire exclusion by the Forest Service. Located in northwestern California, the District is still frequently used by members of the Karuk, Yurok, and Hupa tribes to collect plants for a variety of subsistence, ceremonial, and native arts purposes. Both bear grass *(Xerophyllum tenax)* and hazel *(Corylus cornuta* var. *californica)* are preferentially collected in burned areas around Orleans and are used in constructing baskets and other items. Hazel sticks are collected early in the second or third spring following fire when the new shoots are straighter and more flexible. But the majority of requests for information on burned areas for plant procurement in the Orleans area concern bear grass rather than hazel. This may be because hand pruning is an alternate treatment that produces good results in hazel. Also, willow (*Salix* spp.) can be used as a substitute when good hazel is not available. With bear grass, however, fire is the only effective treatment and no other plant is considered a good substitute. Bear grass is collected during the spring and summer of the first post-fire year. The new bear grass leaves are superior to older leaves since they are stronger, thinner, and more pliable.

To obtain information on correct burning procedures in order to provide for bear grass users, three experimental burns and numerous interviews with local collectors were conducted on the Orleans District during the 1987 field season. The information gathered during this period was used to assemble the following burning guidelines. These guidelines can be used in planning fire use on units interested in burning to enhance cultural resources.

Prescribed Fire Guidelines

Treatment Area Specifications. The two most important specifications to consider when selecting burn sites are accessibility and shading. Sites adjacent to maintained roads are more accessible to collectors, many of whom are elderly. Bear grass stands beneath a canopy are preferred since plants in the shade remain pliable for a longer period of time.

Site selection criteria such as size of the burn, elevation, and fuel continuity are less important. Burn acreage will depend on local resource needs, the number of planned burns, and size of bear grass stands in the area. Burning higher elevation stands may be preferred since bear grass growing there produces longer and stronger leaves *(1)*. The continuity within bear grass stands will vary from site to site, and deciding whether or not the fire can carry will be the responsibility of the individual burn planner. Other treatment area specifications such as soil type and aspect are of no apparent importance as far as the quality of the bear grass is concerned.

Specific Burn Objectives and Desired Results. By consuming between 90 and 100 percent of the dead bear grass foliage and about 75 to 95 percent of the live bear grass foliage, the burn stimulates new growth and the young shoots will provide the preferred basket construction material.

Seasonal Timing. Various publications summarized by Lewis *(2)* indicate that burning to improve basketry materials traditionally took place in the summer and early fall in northwestern California. Burning later in the fall is acceptable if conditions are within the prescription. Summer burning during periods of low or normal wildfire occurrence will produce good results at a time when fire management personnel are available.

Desired Fire Behavior. Flame lengths between ¾ of a foot and 3 feet and a rate of spread between 1 and 4 feet per minute have produced acceptable results. A specific fire behavior is not necessary to produce good results in bear grass as long as the desired consumption is obtained and the fire is held within control lines. But very high temperatures and long residence times associated with heavy fuel concentrations will cause unwanted plant mortality.

Fire Behavior Prescription. Since a highly specific fire behavior is not required to obtain good results, the following fire behavior prescription is not restrictive.

Item	*Maximum*	*Minimum*
Dry bulb (°F)	85	40
Relative humidity (%)	25	70
1-hr fuel moisture (%)	6	11
10-hr fuel moisture (%)	8	17
Midflame windspeed (mph)	10	0
Live fuel moisture (%)	75	150

On the Orleans District, live fuel moistures for bear grass in July and August were consistently about 115 percent, and this value was adequate for fire behavior computations.

Firing Techniques and Equipment. Bear grass is similar to many other live fuels in that burning will be vigorous as long as enough heat is applied initially. Hand-held drip torches easily supply the required heat. Any strip burning method is acceptable, although the minimum number of strips necessary to control the fire and to meet objectives is recommended so as to simulate fire behavior as it must have been for the original practitioners. Unlike broadcast burning, spot burning of individual plants with gelled gasoline or pressurized torches during periods of high moisture does not produce good results.

Other Considerations. Experience has shown that a five-person engine module can successfully line, burn, and mop-up small bear grass plots during a normal work day. With the possible exception of mileage, costs are minimal. Bear grass fuels present no special mop-up problems and spotting is rare since very few fire brands are put up during combustion. The only smoke management strategy used at Orleans was to burn only on a specified "burn day." But surprisingly heavy smoke on even small burns warrants the usual notification of other agencies and the public. If fuel accumulation is sufficient, biennial burning of a particular site is acceptable.

Current Burning Program

The favorable public response and the success in meeting burn objectives during the first season of burning prompted the Orleans Ranger District to plan a modest target of 2 acres per year for cultural burning. The burns will be conducted during the regular fire season on 1/10 to 1/4 acre plots. At least one burn will also be conducted to enhance hazel.

Site preparation burns are commonly utilized for gathering bear grass *(1)*. Prior to any planned burning for bear grass, these burns were the only areas available. These locations are not optimal however, since they are usually unshaded and are often difficult to access. But some site preparation burns are good for collecting. Those that are acceptable are identified on maps along with suitable wildfires and the planned burns. These maps are available to interested persons during the spring and summer gathering season. In addition to the maps, a small sign designating each planned burn site as a "Cultural Burn Area" will improve access and increase public visibility of the program. The combined acreage of planned and unplanned burns should meet the needs of local collectors, although obtaining data on exactly what those needs are is difficult.

A burning program to enhance cultural resources offers an excellent opportunity to improve relations with members of the community who play an important role in managing public lands. By allowing collectors to participate in the program by identifying potential burn sites, the ranger district may obtain additional good will and cooperation. Seldom do resource managers have such a good opportunity to provide resources and improve public relations at the same time. ■

Literature Cited

1. Heffner, Kathy. Following the smoke: Contemporary plant procurement by the Indians of Northwest California. Unpublished manuscript on file. Six Rivers National Forest, Eureka, CA: 1984. 94 p.
2. Lewis, Henry. Patterns of Indian burning in California: Ecology and ethnohistory. Ramona, CA: Ballena Press: 1973. 101 p.

"So, Ya Wanna Make a Movie?"

Frank Carroll

Public affairs officer, Coconino National Forest, USDA Forest Service, Flagstaff, AZ

Firefighters are used to new technology on the fireline. The two firefighters punching line near the head of the Deardorff Fire on the Malheur National Forest near John Day looked us over, decided who we were, then went back to work. As we walked by I heard one tell the other that we were an infrared unit looking for hot spots.

Close. We were looking for hot spots. And we were also looking for numerous other dramatic or technically correct scenes that would eventually translate our storyboard into the video movie called "Wildfire: Hand Tools," a training video supplement to S–130, "Basic Firefighter."

It's a phenomenon that has become more common as technology becomes more accessible—video cameras on the fireline, at the very head of the fire, intermingled with the leading elements of crack hand crews, camera lenses inches from the bright glow of fusees. Nor are these VHS ½-inch camcorders. We're talking *television*, low-end industrial cameras, state-of-the-art chip cameras, *network* quality cameras!

What We Wanted

When Neil Paulson, Forest Supervisor and Chairperson for the National Wildfire Coordinating Group's Training Working Team, came into my office in May of 1986 and asked me if I thought we could make a national movie on using hand tools, I said, "Yes!" And then I started to figure out how.

Video is an important and useful tool that, when used in conjunction with hands-on training and actual experience, can give a trainee a more thorough feel for how to accomplish some objective such as how to use a shovel properly.

The NWCG had certified the skills course S–130 in 1983. The Training Working Team identified a need for new audio-visual materials to complete the course. Most of our training films were too old or not up to current standards.

The team decided it needed to begin to get into producing nationally certifiable training videos cost-effectively. They assigned the project a budget of $15,000. Neil volunteered to make the video using National Forest resources which, in this case, consisted of one fledgling videographer with a minimum of equipment, a maximum of enthusiasm and ideas, and lots of fireline experience. Oh . . . and a lot of help from many interested firefighting friends.

How We Did It

The techniques of firefighting with hand tools have not changed appreciably over the years. We decided to make the video along the lines of its most recent predecessor, "Handtools for Wildfire," and in a format that would complement the new course.

We prepared a script and sent it out to members and advisors of the Training Working Team for comment. "Great," they said. "Where's the storyboard?" I contacted the video experts at Northern Arizona University. They told me that a storyboard is a visualization of the project in the form of drawings or photos that tell the camera people what to shoot and show everyone else what you're trying to portray. I hired a local artist at $10 an hour to draw the storyboard based on video I already had, pictures from textbooks, and from real life modeling provided by myself. It took her 2 days to draw over 90 frames and complete the storyboard.

Next I added video instructions that I learned about by reading three or four pages of a university textbook—such things as "medium shot" and "extreme close up," audio instructions in the form of what narrative goes where, and, finally, transition instructions, how to get from one shot to another by "fading to black" or using a "cut."

Then we sent the whole package back to the team and advisors and they said, "Great. Now shoot it."

We wrapped the video equipment in high impact foam and packed it in standard Forest Service red fire bags to transport it. Then we waited. As the fire season progressed, I followed hand crews to fires in various parts of the country taking pictures to match the storyboard. We tried to use footage from as many different parts of the country as possible to assure that it would be a national video.

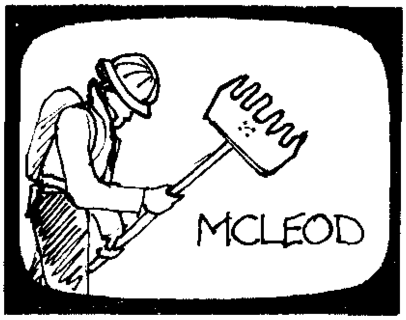
When we finally got all the pictures we needed, I took the raw tape to Bureau of Land Management editing bays in Santa Fe, NM, and to the Forest Service bay in Albuquerque, NM, and edited the movie together according to the instructions provided in the storyboard. I ended up with a movie that had pictures, sound effects, and narration.

STORYBOARD 11

Date: 6/19/86

Project: FIREFIGHTING HAND TOOLS

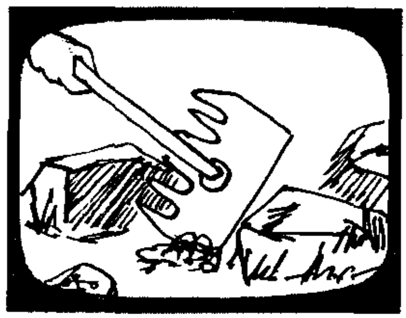
Frank Carroll



Video:
MCU of McLeod scraping fireline. The tool is turned to show the rakers raking needles. The scraper edge is shown cutting grass and brush. Freeze frame and title.

Audio:
VO: The shovel is sometimes followed by the McLeod or kortick tool. The kortick has a detachable head for easy packing. The McLeod is used to clean and improve the fireline. The teeth easily rake debris. The scraping edge cuts grass and brush.

Transition

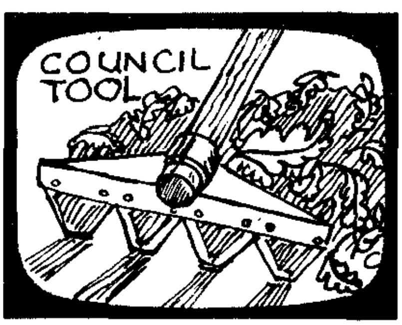


CU of side of McLeod overscraping between rocks.

VO: The sides are useful in tight places.

MS of McLeods building line.

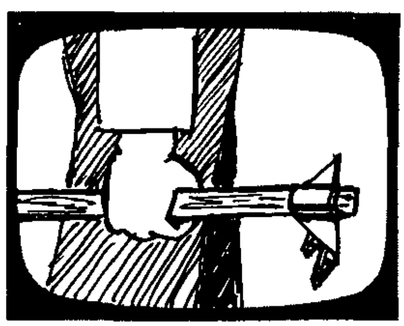
VO: In fuel types where the McLeod can be used, it is one of the fastest line building tools available.



Video:
MCU of council tool building fireline in leaves. Freeze frame and title.

Audio:
VO: The council rake is highly efficient for fireline building in deciduous leaves.

Transition



MS/MCU of council tool being carried and its uses in mop-up.

VO: It should be carried with the cutters pointed down. The council tool is used during mop-up to scrape burning embers off trees and stumps, pull hot logs and stumps from the fire edge, and shovel soil onto hot materials.

MS of McLeod and council tool building fireline.

VO: The McLeod is preferred over the council rake in open pine areas of the west.

Portion of storyboard used to guide shooting of video.

Next, I took the "master composite," as it is called, to a production studio in Albuquerque to have "final production" done. The studio put the titles, special effects, and final credits into the movie. Next, I presented the movie, now officially titled "Wildfire: Hand Tools," to the NWCG Training Working Team at a meeting in Riverside, CA.

They recommended several changes in pictures and narrative, and agreed to certify the movie for national use when the changes were complete. I made the changes and sent the final 17-minute-long master to the Boise Interagency Fire Center where the Publications Management System folks had it copied and put on the shelf, where it is available today for $9.95 in VHS.

What We Learned

We started in mid-May and finished in September. We could produce the same movie today in less than 2 months. It took much longer because we needed to learn as we did the video. Here is some other advice:

- A Forest Service or Bureau of Land Management District Office or National Park or State Forester can make national training videos. The equipment is available or can be bought for $12 to $15,000.
- Half-inch VHS camcorders will not do the job. They are fine for internal project-oriented work, but they do not produce a quality image for extensive internal or external use.
- Do not pick up a camera without a completed storyboard in your hand. Make sure that the people who are ultimately responsible for the production have signed their name or names to the storyboard.

- It is usually cheaper to use outside talent to draw the storyboard than to pay wages and travel to talented people in the organization.
- For safety reasons when making fire-oriented video, provide the camera person with an experienced firefighter to help see that the camera crew doesn't get caught and to help haul equipment, which is a bit bulky.
- The more people involved in making the movie, the more popular it will be, and the more useful. Invite those you want to use the film to help make it. If it's a national film, be sure it has a national perspective.
- Try not to show vehicle cabs and other things that will prematurely date the movie.
- Do not use simple computers to generate titles for your movie. It costs only a few hundred dollars to put professional looking titles and credits on the tape. "Homemade" titles look homemade.
- Do final production in a production studio but use a friend's and cooperator's editing bays to do most of the work.
- Whenever possible, use actual situations rather than staged situations. Combat photography looks real because it is real.
- Hire a quality narrator, and make sure his or her voice fits the project.

You can do it! There are lots of good people who can help with advice and equipment. Video is not the wave of the future. It is the here and now, and land managers can thoughtfully and purposefully take advantage of this powerful communications tool to help care for the land and serve the people.

For more information, contact: Frank Carroll, Public Affairs Officer, Boise National Forest, Boise, ID 83702, 208-334-1854.

Neil R. Paulson, Forest Supervisor, Coconino National Forest, 2323 East Greenlaw Lane, Flagstaff, AZ 86004, 602-527-7400. ■

Building a Command Post That is Mobile

Bill Terry

Head, Training Section Fire Control Department, Texas Forest Service, Lufkin, TX

It was a typical cold front passing through Central Texas, which Texans like to call a "norther." This one was more severe with high winds, rain, and scattered tornados. Although November was a bit late for this type of weather, it was not unprecedented. By mid-afternoon a series of tornados had ravaged several small communities and rural areas across Central Texas.

The tornados hit south of Palestine, moved into the Jacksonville area, and passed south of Tyler before dissipating. Within a few minutes telephone service and power were disrupted across a wide area, and extensive damage was inflicted on mobile home parks, scattered commercial properties, and about 15,000 acres of timberland.

Texas Forest Service (TFS) personnel helped set up an emergency command post in the sheriff's dispatch station in Jacksonville and helped to set up search and rescue teams. Emergency standby power generators were set up at the TFS Area II Headquarters in the Henderson Dispatch Center to ensure communications for the TFS units on the scene as well as cross-channel communications with other emergency crews. Within a few hours additional personnel brought up a Mobile Command Post from Lufkin to set up a similar operations center in Palestine.

The Texas Forest Service provided local maps, portable radios, and resource locators for emergency crews involved in search and rescue. The TFS crews cleared roadways to provide access and later assisted timber owners with salvage operations.

The same TFS personnel had responded a few months earlier to help when a plastics factory in Jacksonville caught fire. When any type of disaster strikes, communications is the first priority. Without it, it is impossible to get anything done. But how do you put together a functional, relatively inexpensive and totally self-contained communications base that can go anywhere at a moment's notice? The answer is not simple, but the TFS has developed several units that can help others to design a mobile communications center.

The first step was to put it on wheels. TFS did it by using Federal excess property travel trailers, which had previously been used for temporary housing (see fig. 1). These were 22-foot or 24-foot trailers equipped with kitchens and baths. The trailers were modified to provide room for dispatchers, storage, communications gear, and a work area. While trailers have been used in Texas, a large step van or motor home could be converted.

The unit was made self-contained by using only 12-volt equipment. In addition to a heavy storage battery, a special 12-volt generator was built from a small gas engine and an automobile 60-amp alternator. With a small amount of fuel, the unit can run uninterrupted for days.

The layout of the communications center, which we call a mobile command post, is shown in figures 2, 3, and 4. This concept has been both functional and relatively inexpensive—$15,000 total cost, including communications equipment (see fig. 2). We hope that others can adapt this idea to their needs.

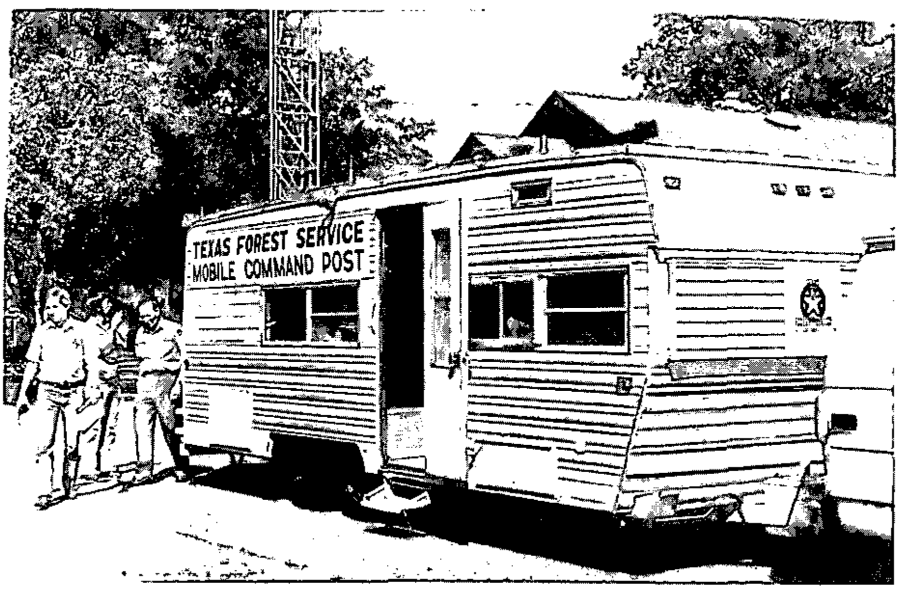


Figure 1—*Mobile command post with tower, a telescoping 50-foot antenna that contains a mount for a high-band antenna and a mobile-phone antenna. Other antennas can be mounted as needed. Tower can be raised and antennas connected and be operational within 10 minutes.*

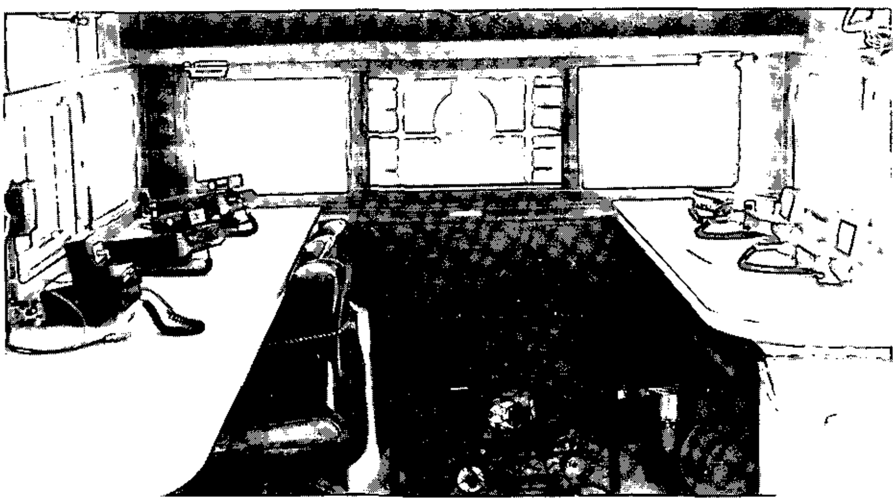


Figure 2—*Interior of mobile command post. Low-band radios on the right, high-band radios on the left, 12-volt generator in the center. The generator is set outside for operation.*

For more information contact Charles Barbier, Head, Communications Section, Fire Control Department, Texas Forest Service, P.O. Box 310, Lufkin, TX 75902-0130, (409) 639-8100. ■

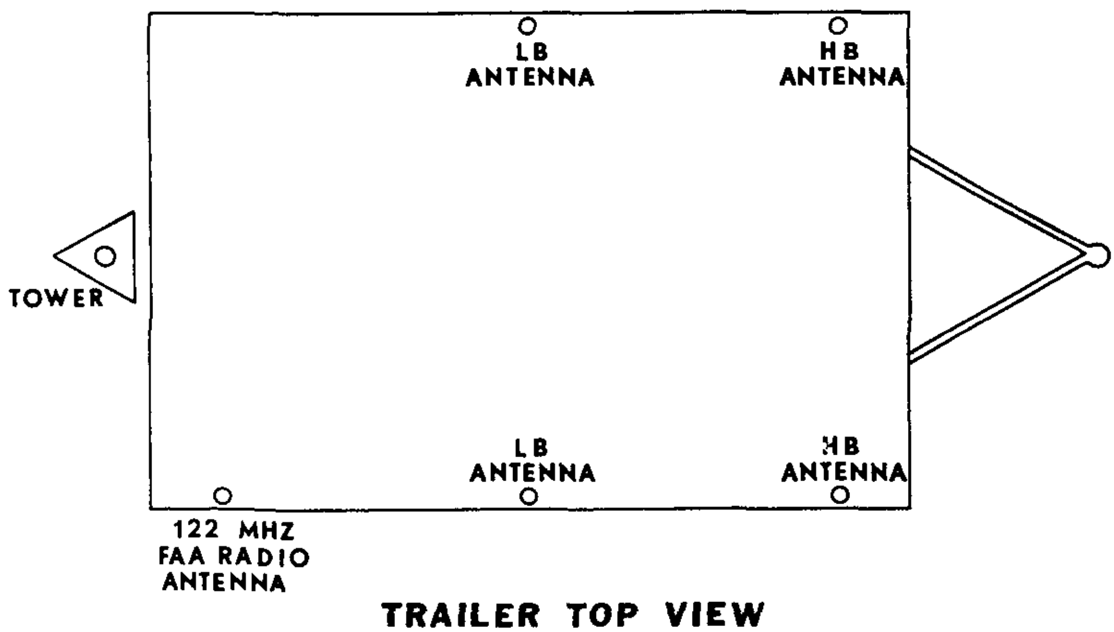
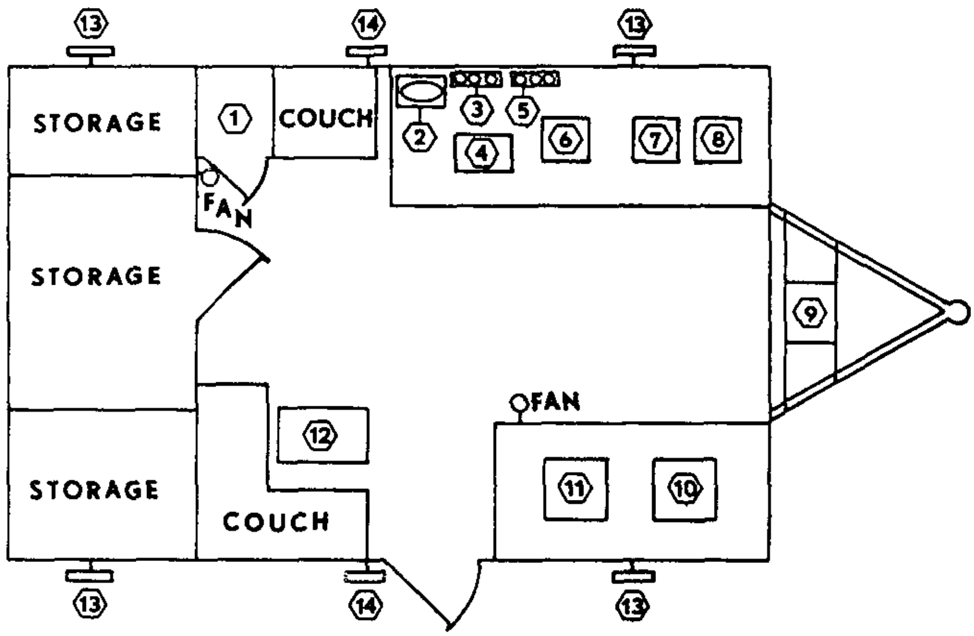


Figure 3—*Trailer top view, showing arrangement of the low-band and high-band antennas. Also, included is a 122 MHZ FAA radio for talking with aircraft. All antennas are mounted for transport on an aluminum catwalk frame that allows technicians to work on the roof of the unit without damaging it. This was designed by the Texas Forest Service to prevent roof damage and to serve as a cradle to carry the tower.*



FLOOR PLAN

1. Mobile-phone transmitter, DC to 120 VAC inverter—500-watt public address amplifier.
2. Mobile-phone control head.
3. 120 VAC from inverter.
4. Small copy machine—should use less than 400 watts.
5. 120 VAC from external electrical hookup.
6. Midland high-band 80 channel radio.
7. Midland high-band 80 channel radio.
8. Midland high-band 80 channel radio—mounted on slide-out brackets.
9. 12-volt heavy duty storage battery. Can be connected to 12-volt generator to maintain charge.
10. Midland low-band radio.
11. Midland low-band radio.
12. Conference table.
13. Outside 12-volt flood lamps to shine over exterior removable canopies.
14. Outside 12-volt flood lamps to shine under exterior removable canopies.

Note: All radios can be programmed by a technician. All lights and fans are 12 volt.

Figure 4—*Floor plan of the Texas Forest Service mobile command post.*

An Evaluation of Foam as a Fire Suppressant[1]

Paul Schlobohm and Ron Rochna

Fire management specialists, Boise Interagency Fire Center, Bureau of Land Management, U.S. Department of Interior, Salem, OR

The Bureau of Land Management (BLM) is evaluating the effectiveness of foam as a means of controlling fire. The impetus for this study can be described by the reality of current ground-applied fire control efforts. Wildfire suppression capability is limited where water is scarce and real property values are threatened. Prescribed fires are often difficult to contain. Time-consuming mop-up reduces further burning opportunities.

The Concept of Foam

The concept of foam is not new, but the limited use of foam in wildlands warrants a review of its capabilities. Foam extends the life and effectiveness of its water. Foam reduces the surface tension of water molecules, enabling greater penetration of the water. Soap-based foam dissolves the waxy coating of green vegetation, further enhancing wetting ability. Foam inhibits water evaporation, allowing more of the water applied to be used for cooling and penetration. As foam, water becomes a reflective, insulating blanket *(1, 2)*.

Foaming Agents

As recently as 1985, foam systems relied on foam-making substances not specifically designed for fire suppression. Pine soap or soap skim, popularized by the Texas Snow Job, is a derivative of the paper-making process. Household dish soap was also used because of its availability *(3)*.

Since 1985, foaming agents designed for wildland fire suppression have been available. These products combine relatively stable bubble structure, improved wetting ability, and vapor suppressants. They provide the capability of instantaneous extinguishment, construction of an impenetrable barrier to fire, and reduced mop-up time.

Foam Generating Systems

Foaming agents can be utilized by a variety of means. Synthetic foaming agents have sparked new interest in the foam generating systems made popular by pine soap. Compressed air foam systems (CAFS) have been modified with centrifugal pumps and metering devices and enlarged with 40 or more cubic-feet-per-minute air compressors. Air-aspirating and conventional water systems also have applications for foam.

Foam is produced in the CAFS by mixing compressed air and solution at equal or nearly equal pressures and pumping the mixture through one of three forms of agitation. Hoselays longer than 50 feet (1-inch diameter) provide enough space for air and water to mix into foam. Scrub chambers, tubes filled with obstructions, force air and water into foam in 1 to 2 feet. Specialized nozzles combine compressed air and atomized solution as they leave the nozzle. Hoselays are the most common agitation method; this discussion will concentrate on their features.

Compressed air systems that pump foam through the hose flow water at less than normal rates. A 1-inch nozzle may flow 12 gallons per minute (gpm) of water as foam at 150 pounds per square inch (psi), with a discharge distance of 85 feet. Water is expanded about 10 times at agent/water ratios of 0.2–0.3 percent. CAFS has the unique ability to change foam consistency by changing water flow rather than mix ratio.

Extra equipment required for the CAFS include an air compressor and full flow ball valves. Compressor size is dependent on need. Generally, 2 cubic feet of air is necessary for every gallon of water to create quality CAFS foam. The ball valves are used as nozzles to shut off the foam flow.

Foaming agents have also initiated the production of a wide range of air-aspirating or expansion nozzles. Low- and medium-expansion nozzles produce quality foam. Low-expansion nozzles are most common. They flow 10 to 30 gpm at 150 psi, discharging 30 to 70 feet. The air-aspirating system pumps solution through the hose and creates foam at the nozzle. Air is drawn into the nozzle when the solution is atomized and passed through a pressure gradient. Water is expanded 5 to 10 times with agent mix ratios between 0.3–0.4 percent.

The third system in which foam agents can be used is as a wetting, extinguishing solute in conventional water systems. Through all apparatus from turbo jet to sprinklers to bladder bags, bubbles will form froth due to low agitation. With the surfactant in the water, wetting and extinguishing will be greater than with straight water.

Technology offers improvements over conventional equipment for mix

[1]Presented at the Symposium on Wildland Fire 2000, April 27–30, 1987, South Lake Tahoe, CA.

methods, hose types, hoselays, and nozzles. The inefficiencies of batch mixing concentrate and water are overcome with eductors or proportioners. Eductors also make possible the use of foam when the sole motive force is a water pump. A portable pump, for example, can draw concentrate into the hose as it pulls water out of a stream. Proportioners, which pump concentrate as desired into the water line, have the accuracy and dependability necessary to be integral engine components.

Hose types are important when foam is pumped through the hose (CAFS). Durable woven rubber hose is used to avoid kinking. Any restriction in a hoselay will break down bubbles, thus significantly reducing foam quality and discharge capability. Hose that is porous or has an irregular lining will disrupt foam flow and reduce discharge performance (table 1).

Hoselays can be different for the CAFS, depending on application. Usually, foam barriers are applied with one or two nozzles. Since foam is compressible, hoses are easily clamped and extended. Hoses filled with foam do not exhibit all characteristics of hydraulics. Greatly reduced head pressure enables foam to be pumped significantly farther above the pump than water *(4)*.

Nozzles vary in performance for aspirated and compressed air systems. Low-expansion air-aspirated nozzles range in performance for 1½-inch hose at 150 psi from 7 gpm and 25-foot discharge to 26 gpm and 70-foot discharge. At 35 gpm and 150 psi, a 1-inch CAFS nozzle has a maximum discharge of 70 feet, a sustained discharge of 55 feet; a 1⅜-inch nozzle: 90 and 70 feet, respectively.

Table 1—*Hose characteristics important to foam flow*

Hose type	Resistance to kinks	Resistance to fire	Porosity with foam	Resistance to flow
Synthetic	Poor	Poor	High	High
Cotton	Fair	Fair	Low	Medium
Rubber	Excellent	Excellent	None	Low

Applications

The applications phase of the project directly evaluated fire control potential of foam in the field. Where possible, comparisons were made with water performance. Evaluations occurred on prescribed fires and wildfires throughout the West.

Direct Attack. Visual evaluations of foam's extinguishing capability were made. Flames burning in light, flashy ground fuels, tall snags, pitchy stumps, red slash concentrations, and desert sage were treated. Extinguishment was instantaneous. For example, two light engines worked the flank of a range fire. The engine using air-aspirated foam never had to turn around for rekindled flame. This engine's pumping time was one-third greater than the water engine's. The engine using water found some of its flank had started burning again *(5)*.

The compressed air foam system has great extinguishing capability in part because foam can be indefinitely compressed in the hose. The ball valve can be shut off without risk of bursting hose. This creates back pressure in the hose which, when released, produces a fine-bubbled mist and long discharge distances (fig. 1). The fine-bubbled mist is unique to the CAFS. When released, the mist puts on a cooling, suffocating performance that has been compared to halon gas. Together with initial discharge distances of up to 85 feet with 1-inch hose, the mist gives the firefighter a deluge initial attack capability. Many prescribed burn spot fires have been extinguished by merely opening and closing the ball valve.

After the initial, fine-bubbled surge, the foam produced becomes thicker. It forms large masses of bubbles that cling together. This clinging property is also an important extinguishing feature. Foam can be lofted onto flames, the clinging bubbles forming a vapor suppressing blanket that also separates oxygen from flame. Because it exhibits low head pressures, foam can be injected into the bottom of a burning snag to extinguish fire burning within. The foam will fill any accessible cavity, suffocating fire.

Protective Barrier. Applications of foam for protection include prescribed burn boundaries, fuelwood piles, snags (fig. 2), wildlife trees, fragile sites, and backfire wetlines. Twenty firelines adjacent to prescribed fire units have been pretreated with foam. The foam-

Figure 1—*Fine-bubbled mist during initial discharge from the compressed air foam system.*

treated areas adjacent to firelines ranged from 300 to 1,500 feet in length. Width (25 to 100 feet) and depth (0.25 to 2 inches) depended on the foam generation system and site conditions. The time between application and ignition ranged from 0 to 45 minutes. Spotting beyond the foam lines occurred on occasion, but no foam line was crossed by moving fire.

Two examples of foam as a barrier to fire occurred on the Toad Creek unit in western Montana. Fuel loading was 100-tons per acre of fuel model 13 lodgepole pine/subalpine fir (*Pinus contorta var. murrayana* Engelm/*Abies lasiocarpa*) logging slash. The prescription of 40-percent relative humidity, 70 °F temperature, and light (1 to 4 miles per hour), favorable winds was met at 2000 hours. Nevertheless, running flame lengths were 3 to 20 feet high and the fire crowned to 60 feet.

In the first example, a 150-foot by 10-foot by 1-inch foam line was placed across one ½-acre corner of the unit. No tools were used, no fuel was removed to construct this line. The unit's test fire was lit in the corner. The fire ran quickly to the poles standing adjacent to the line, crowning and producing firewhirls. When the fire reached the foam line, flames leaned over the line, but the fire's forward progress stopped. Time elapsed from foaming to fire contact was 2 minutes.

Lighting of the rest of the unit continued across the foam line. The line was exposed to heating on both flanks for about 5 hours. Inspection the following day showed the line intact, with green vegetation and fine fuels throughout. Two logs greater than 8 inches in diameter which had burned through the line from both ends were the exceptions.

In the second example, a 1,400-foot foam line was placed outside a cut fire trail in an adjacent timber stand. Foam was applied 100 feet wide, 75 feet into the canopy, and 1 to 2 inches thick. Application was 5 to 15 minutes prior to ignition of the adjacent portion of the unit. Two people created this line with one 1-inch hose. Application time was

Figure 2—*Snag protection capability of the compressed air foam system.*

5½- hours. Fire behavior remained extreme, with long duration, high flamelength fire tossing firebrands into the treated stand. Personnel familiar with burning under these conditions expected the fire to escape. The width of the line prevented most firebrands from starting spot fires. One spot that did occur was extinguished with foam from 60 feet away.

Mop-up. Direct foam versus water performance and cost comparisons were made during mop-up operations. Personnel involved were not informed of the comparison to avoid any changes from standard instructed procedure. In each case, the foam crew was mopping up with foam for the first time.

The first comparison occurred during mop-up of a wildfire in felled and bucked douglas fir (*Pseudotsuga menziesii*) timber. A 4-person crew using 2 nozzles completed 100-percent mop-up of 5 acres in 3 hours with 7,700 gallons of water. Nearby, on 5 acres of the same fire, this productivity was equaled by two 20-person crews employing 24 nozzles and approximately 55,000 gallons of water.

The foam crew used 15 gallons, or $225, of foaming agent based on 0.2 percent mixture and a price of $15 per gallon. Assuming the average salaries for the foam and water crews are $7 and $5.50 per hour, respectively, the foam operation cost $309 for labor and foaming agent; the water operation cost $660 for labor.

The second comparison occurred during mop-up of the Toad Creek unit. A 5-person foam crew mopped up 100,000 square feet in 4 hours. A 25-person water crew mopped up 25,000 square feet in the same time. Both crews had an unlimited water supply. Total water flow for the foam crew was 30 gallons per minute.

Again, 15 gallons of foaming agent was mixed. Using the same wage assumption in the first comparison, the foam operation cost $365; the water operation cost $550.

Foam application technique for both comparisons was designed to let the foam do the work. Foam applied was wetter than the protective foam type. Foam was spread out so that it penetrated and cooled, while the operator moved on. Extra attention to hot spots was given only when heat was well below the surface.

Discussion

Foaming Agents. Of all the types of foaming agents presented, the relatively new synthetic products made specifically for Class A fuels are preferred. The 3.0 percent mix ratios of pine soap are 10 times greater than synthetic. Preliminary laboratory tests have shown pine soap to be an inferior wetting agent. Common dish-soap lacks vapor suppressants and durability. The price of the new agents has continued to drop as the demand for them has increased. Some users have experienced 25-percent reductions in suppression costs despite the $12- to $15-per-gallon prices *(6, 7)*.

The notion that water is free is a fallacy. The Bureau of Land Management fights most of its fires where water sources are miles away. Twelve dollars can make 500 gallons of water into 5,000 gallons of effective water as foam.

Foam-generating Systems. Purchasing requirements vary significantly with the three generating systems presented. Foaming agent alone will give one an improved wetting agent with conventional apparatus.

As the minimum initial equipment investment, air-aspirating nozzles will assure quality foam production, especially for protection and mop-up. Long-term use of this system is appropriate only if the consistent high use of foam is more tolerable than a high initial investment for the compressed air system.

The CAFS generally requires the greatest initial capital outlay, primarily the air compressor, as well as a retrofitting or new engine package. However, CAFS can be assembled on-site from inexpensive components such as rented trailer air compressors, readily available plumbing, and an existing water pump. The high initial cost is quickly returned by increased capability and performance and reduced volume of foaming agent required.

Applications. The success of foam in the examples given of performance can be attributed to two factors. First, the combination of synthetic foaming agents and the compressed air foam system creates a powerful tool for fire suppression.

Second, proper training is necessary to ensure success. Foam can fail and if its properties and uses are not understood, it will. Foam should not be considered a cure for every fire situation. It is simply a very useful tool.

Foam must be of the appropriate consistency: wet, dripping, or dry. It must be applied for the appropriate effect: lofted for intact, clinging, and smothering bubbles; pressure-impacted for broken, wetting bubbles.

Foam is a short-term suppressant when applied as a barrier. Its effective lifetime varies with fuel, weather, and fire conditions. Applications must be adjusted accordingly.

Safety precautions should be followed when using foam. Foaming agents are mildly corrosive to skin and eyes. Protective gear is recommended. The high-pressure lines of the CAFS should be operated with caution. Valves must be opened slowly to prevent nozzle kickback and hose whiplash.

The Future

Over the past 2 years foam has developed into a tool for the future. The full potential of foam has yet to be realized. In fact, the technology of Class A foam firefighting is expanding beyond Class A fires. Cost-effective, successful applications have been demonstrated with hydrocarbon fires, vehicle fires, and structure fires. Methods of delivery are also expanding to fit different needs and resources.

The wildland-urban interface fire protection program may have the most to gain from foam development. Research must increase our understanding of foam processes. Training of application techniques must begin. The days of fighting fire with unrefined water are numbered. Water has served well in fire suppression over the years. As we move toward the 21st century, water will serve fire managers even better as foam. ■

Literature Cited

1. Godwin, D.P. Aerial and chemical aids. Fire Control Notes. 1(1): 5–10; 1936.
2. Everts, A.B. A dual purpose hazard reduction burner and foam unit. Fire Control Notes. 8(2, 3): 10–12; 1947.
3. Ebarb, P. Texas snow job. Fire Management Notes. 39(3): 3–5; 1978.
4. U.S. Department of Interior, Bureau of Land Management, Boise Interagency Fire Center. Data on file. Boise, ID.
5. Carriere, Al. Fire Management Officer. U.S. Department of Interior, Bureau of Land Management, Lakeview District. Personal communication with Ron Rochna. July 20, 1986.
6. Moinber, Jerry. Forester, Simpson Timber Company, Eureka, CA. Personal communication with Ron Rochna. May 5, 1987.
7. U.S. Department of Interior, Bureau of Land Management, Salem District. Data on file. Salem, OR.

New Accident/Injury Reporting Form

Boise Interagency Fire Center (BIFC) has a new form for reporting burn-related accidents or injuries and fire entrapments. If your unit experienced a fire entrapment or burn accident this summer, follow up to ensure that this form was completed.

The Missoula Technology and Development Center (MTDC), formerly the Equipment Development Center, played a major role in designing this form for the National Wildlife Coordinating Group's Fire Equipment Working Team. The form will help identify where to concentrate efforts to improve personal protective equipment and training. All NWCG member units (State and Federal agencies) should order copies from the BIFC Warehouse and become familiar with the reporting instructions and information. The form's PMS number is 405-1; NFES catalog number is 0869.

South Dakota Strike Teams Help Fight California Fires

Ken Terrill and Greg Krumbach

Respectively, fire management specialist and public information officer, Division of Forestry, South Dakota Department of Agriculture, Pierre, SD

South Dakota
Department of Agriculture
Division of Forestry

Firefighters from South Dakota helped battle the fires that raged in California during the month of September. After receiving a request for assistance from the USDA Forest Service in Denver, the State resource center in Rapid City made sure South Dakota could spare the personnel and equipment. Assured it would not impair the local firefighting capabilities, 5 fire trucks and 12 firefighters were sent to do battle.

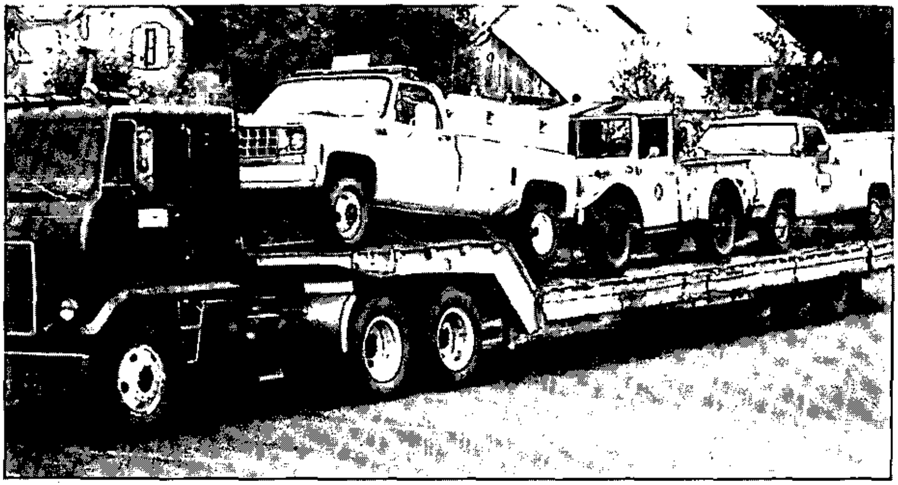
Of the five fire trucks—engines if you prefer—that went to California, two were from the State Division of Forestry, one from the Black Hawk volunteer fire department, and one each from the Piedmont and Nemo volunteer fire departments.

Ken Terrill, fire management specialist for the South Dakota Department of Agriculture's Division of Forestry, said two of the engines were rather unusual because at one time they had been Federal military trucks that became Federal excess property before being converted to fire engines similar to engines built by the State Division of Forestry's fire equipment shop. Suppressing the California fires gave the refurbished engines, one a ¾-ton Dodge and the other a 1¼-ton Jeep, the chance to again help the Federal government.

Terrill said two semi-tractors and low-boy transports hauled the engines to the West Coast.

The firefighting crew left Rapid City September 4 and, after traveling practically nonstop, arrived in California 2½ days later.

Their first assignment was the Mendenhall fire near Willows, California, in the northern part of the State. After a week battling the Mendenhall blaze, the strike team was demobilized and reassigned to what was called the Salmon Complex near Yreka, CA, a 1-day trip further north.



South Dakota engines loaded for transport to California.

Dale Deuter, a mechanic, semi-driver, firefighter, and full-time employee for the South Dakota Division of Forestry's Rapid City office, said they battled fires for 2 weeks in the Yreka area, working mostly at night. He said there was a total of 16 separate fires to contend with. "Our fire camp was almost completely surrounded," Deuter said. "You could see fire in almost every direction."

Deuter, who first started fighting fires as an 18-year-old volunteer, said the sight of all the fires was "spectacular." He also had words of praise for how well firefighters from 38 States, including State employees and volunteers, and the USDA Forest Service, worked together.

"You couldn't have asked for a better, hard working crew," Deuter said. "Everyone was working together. If they need to send us again, I'd be ready to go."

Terry Chaplin, district ranger for the USDA Forest Service in Spearfish and also the South Dakota strike team leader, said there were some minor problems, but overall things went smoothly. "There is frequently a coordination problem when you get 2,500 people in a fire camp," Chaplin said. "But you just have to take it with a grain of salt and do the best you can."

Dave Fieroh, Nemo, South Dakota fire chief, said that as if fighting fires wasn't enough, they also had two other obstacles to contend with. One of those was the threat of bears, who Fieroh said "enjoyed very much our second choice of sandwich meat—slab turkey on wheat bread!"

The second obstacle they encountered was running into illegal marijuana fields that were protected by mines and shotguns wired as booby traps. "You just didn't walk up and down with a backpack on without looking twice," Fieroh said.

Nevertheless, those obstacles didn't deter Fieroh or any of the firefighters. "Our Black Hills engine strike team performed with a professional attitude and I believe we will go again if the situation arises. We all learned a lot." ■

Ivy Block Status

United Catalysts, Inc., has recalled Ivy Block. The recall concerns a difference in interpretation over product classification with the Food and Drug Administration (FDA), not Ivy Block's safety or effectiveness in preventing dermatitis from poison oak, ivy, and sumac. University of California at San Francisco lab tests showed Ivy Block to be highly effective in preventing dermatitis from the poison plants. The Missoula Technology and Development Center had asked field units to evaluate Ivy Block during the 1986 season. To help United Catalysts comply with the FDA recall order, Forest Service units should send unused Ivy Block to the company COD for a $4.80 refund per can. The address is United Catalysts, Inc., 1240 South 13th Street, Louisville, KY 40210. If you used Ivy Block, please complete and return your evaluation form to MTDC.

A spokesman for United Catalysts, Inc., has said that the firm is negotiating with a major company to market Ivy Block once FDA approvals are obtained.

A Quick Method To Determine Northeastern Woody Fuel Weights

Cary Rouse and Donna Paananen

Respectively, research forester and technical writer, North Central Forest Experiment Station, USDA Forest Service, East Lansing, MI

Results of prescribed burns depend upon the quantity and arrangement of the materials that burn. When fire managers know the weights of downed, woody fuels of different diameters, they can use this information to predict the behavior of their planned fires. After the prescribed burns, they can compare preburn and postburn fuel weights to assess how successful the fire was, particularly when one of the main objectives is fuel reduction.

Currently, fire managers in the Northeast make a visual "guésstimate" of the amount of fuel loadings, or they spend long hours sampling and making calculations using the planar intersect method *(3)*.

The planar intersect method is a sampling technique that permits accurate estimation of downed, woody fuel weights. The method requires relatively simple field procedures: the estimator tallies different-sized twigs, branches, and boles of a species or species group that intersect an imaginary vertical sampling plane. (In the Northeast, downed, woody fuels with diameters of 3 inches or less are generally tallied because these are the ones that burn during a prescribed fire.) Once the tallies are made, the estimator either uses a graph *(1)* to convert the tallies to fuel weights or returns to the office and mathematically computes the fuel weights using multi-variable formulas. Both graph conversions and mathematical computations can require complex analysis and a great deal of time.

We propose a method that allows the fire manager to make quick, accurate estimates in the field by using the planar intersect technique and a "simplifying factor."

The usual formula for estimating fuel weights (modified from reference *6*) is:

$$FW = 11.65 \times I \times S \times D$$

where:
- FW = fuel weight (tons per acre),
- 11.65 = is a constant to convert specific gravity (in pounds per cubic feet) and fuel diameters (in square inches) to FW (in tons per acre),
- I = average number of intersections per foot in each species/size-class category,
- S = representative specific gravity of fuels in each species/size-class category in pounds per cubic feet, and
- D = representative squared diameter (square inches) for fuels in each size-class category.

To simplify computation by field personnel, Brown *(3)* multiplied the constant 11.65 by the other fuel characteristics (S and D) to obtain composite factors (CF) for several western fuels. In this report, we obtained CF's for three size classes of four hardwoods and six conifers found in the Northeast (table 1). (Values for S and D are extrapolated from reference *5*.)

To use table 1, proceed through the following steps:

1. Sum the total number (N) of intersects tallied for each size class and species,
2. Sum the total length (L) of lines sampled in feet,
3. Divide N by L to obtain the average number of intersects per foot (I): $N \div L = I$, and
4. Multiply I by the appropriate composite factor (CF) in table 1 to obtain the fuel weight: $I \times CF = FW$.

(When slopes exceed 30 percent, consult Brown *(3)* for slope correction factors.)

For example, suppose you have just completed a planar intersect line of 200 feet on a jack pine clearcut site and have the tallies shown in table 2. Divide each tally (N) by 200 to yield the average number of intersects per foot (I). Then multiply each I by its corresponding composite factor (CF) for jack pine in table 1 to get fuel weights (FW).

Using this method can help fire managers determine light, medium, and heavily loaded plots at the site, shorten the time it takes to input information into fire behavior prediction models such as BEHAVE *(2, 4)*, and enhance the ability of these models to reflect true prescribed fire behavior in the Northeast.

Historical methods to determine fuel weights range from a quick, but inaccurate, method ("eyeballing") to time-consuming ones (using a graphical aid or multi-variable formulas). The method suggested here is a compromise in that it involves an easy-to-use formula that requires only the knowledge of the northeastern species, the average number of

Table 1—*Composite factor (CF) for each of three size classes of downed, woody fuels of selected northeastern species*

Species	Size class I (0–¼ in)	Size class II (¼–1 in)	Size class III (1–3 in)
Hardwoods			
Aspen	2.584	6.613	20.122
Birch	2.572	6.500	27.668
Maple	3.211	6.798	27.364
Other	3.211	7.910	27.341
Conifers			
Balsam fir	1.477	5.275	16.512
Black spruce	1.594	9.384	21.280
Jack pine	2.377	9.011	25.968
Northern white cedar	1.324	6.830	18.787
Red pine	3.198	7.704	23.010
White pine	1.780	6.327	23.199

Table 2—*Fuel weight calculations for jack pine slash*

Size class	Total number	Intersections per foot	Composite factor	Fuel weight (tons per acre)
I (0–¼ in)	734	3.67	2.377	8.72
II (¼–1 in)	412	2.06	9.011	18.56
III (1–3 in)	50	.25	25.968	6.49
			Total	33.77

intersections per foot in each species/size-class category, and a necessary composite factor. ■

Literature Cited

1. Anderson, Hal E. Graphic aids for field calculation of dead, down forest fuels. Gen. Tech. Rep. INT-45. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1978. 21 p.
2. Andrews, Patricia L. BEHAVE: Fire behavior prediction and fuel modeling system—BURN subsystem, Part I. Gen. Tech. Rep. INT-194. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1986. 130 p.
3. Brown, James K. Handbook for inventorying downed woody material. Gen. Tech. Rep. INT-16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1974. 24 p.
4. Burgan, Robert E.; Rothermel, Richard C. BEHAVE: Fire behavior prediction and fuel modeling system—FUEL subsystem. Gen. Tech. Rep. INT-167. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1984. 126 p.
5. Roussopoulos, Peter J. An appraisal of upland forest fuels and potential fire behavior for a portion of the Boundary Waters Canoe Area. East Lansing: Michigan State University; 1978. 166 p. Dissertation.
6. Roussopoulos, Peter J.; Johnson, Von J. Estimating slash fuel loading for several Lake States tree species. Res. Pap. NC-88. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1973. 8 p.

Conference Announcement

The 1988 Interior West Fire Council (IWFC) Annual Meeting and Workshop will be held October 24–27 at the C.P. Mountain Resort Alpine Village in Kananaskis Valley, Alberta, Canada. The theme of the meeting/workshop is "The Art and Science of Fire Management" and will feature four ½-day technical sessions (fire management problems and opportunities; fire research programs in support of fire management decisions and solutions; role of new technologies, analytical systems, and support services in fire management activities; and fire management actions and practices), luncheon and banquet with distinguished speakers, and a ½-day field trip in Kananaskis country or Banff National Park.

The IWFC represents an amalgamation of the former Intermountain and Rocky Mountain Fire Councils.

For more information contact: Gordon Bisgrove, Alberta Forest Service, Forest Protection Branch, P.O. Box 7040, Edmonton, Alberta, Canada (Telephone: 403-427-6807) or Marty Alexander, Canadian Forestry Service, Northern Forestry Centre, 5320-122 Street, Edmonton, Alberta, Canada (Telephone: 403-435-7210).

Celebrating Research Accomplishments at the Forest Fire Laboratory

Roberta M. Burzynski

Public affairs officer, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA

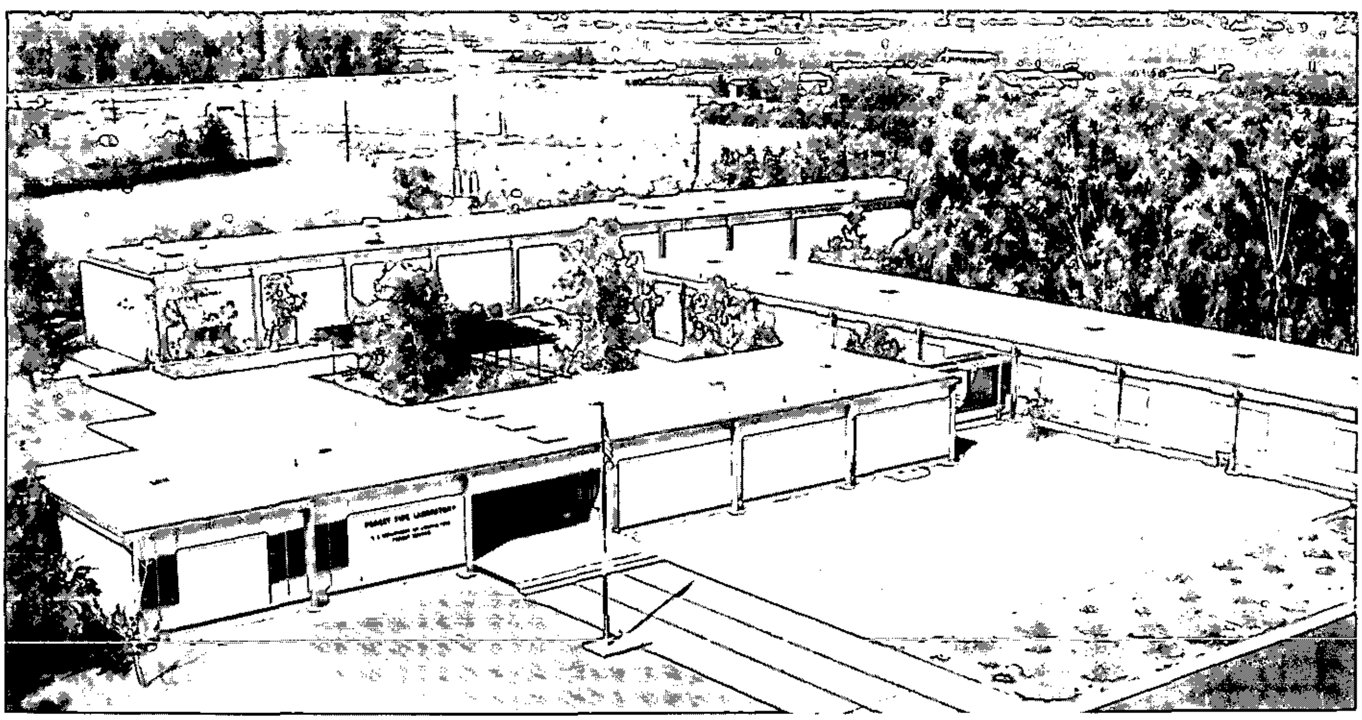
This year marks the 25th anniversary of the Forest Fire Laboratory in Riverside, CA. It is a field facility of the USDA Forest Service's Pacific Southwest Forest and Range Experiment Station, headquartered in Berkeley, CA. The laboratory will host an anniversary celebration, including an open house, on June 16 and 17. Scientists at the laboratory, with the cooperation of government agencies, universities, and fire organizations, have made major contributions to various aspects of fire management.

What would fire management be like today without research conducted at the Forest Fire Laboratory? To answer this question, you would have to imagine that operation FIRESTOP may not have been as successful as it was; that FIRESCOPE and the Incident Command System may not have been developed or used to benefit disaster victims worldwide; that fire suppression methods and equipment—especially air attack, helitack, and use of chemical fire retardants—might not exist at their current level; that prescribed fire might not be used with increasing precision as it is today.

Although the laboratory was dedicated in 1963, Station scientists began studying hydrologic effects of fire as early as 1930. Recent research emphasis has been on integrating fire management with other resource management problems: economic assessment of fire management alternatives among multiple resource uses, effect of meteorology on forest and brushland management practices, and the special problems caused by people moving into the wildlands and creating a wildland-urban interface.

The research program is still expanding to include other topics of regional, national, and international importance. Because of its location in the Los Angeles Basin, it is a prime site for studies underway on atmospheric deposition and impacts of heavy recreational use in nearby National Forests.

For more information, contact Earl B. Anderson, Forest Fire Laboratory, Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507. ■



USDA Forest Service Forest Fire Laboratory, Riverside, CA.

An Overview of the 1987 Wallace Lake Fire, Manitoba

Canadian Forestry Service — Service canadien des forêts

Kelvin G. Hirsch

Fire research officer, Canadian Forestry Service, Manitoba District Office, Winnepeg, Manitoba

Wallace Lake is located in eastern Manitoba approximately 160 kilometers (100 mi) northeast of Winnipeg. The surrounding area is comprised mainly of mature jack pine and black spruce stands and is a popular location for summer cottage developments. Spring fires in this area are not uncommon, but the 1987 Wallace Lake Fire was one of the most devastating wildfires in modern times. It also has special significance for two main reasons. First, it was the first campaign fire in Manitoba during which the Canadian Forest Fire Behavior Prediction (FBP) System *(1)* was used operationally to forecast probable fire behavior on a near real-time basis. Second, the fire produced one of the worst wildland/urban interface incidents in the province's recent history.

The Wallace Lake Fire started on Tuesday, May 5, and by May 13 reached its final size of 20,850 hectares (51,520 acres). The winter of 1986–87 was unusually warm and much of the fire area experienced below normal precipitation. Snowmelt occurred rather rapidly in early April due to a strong and persistent upper ridge pattern over the area that produced record maximum temperatures on numerous days. Total precipitation following snow free cover was minimal. Four weather stations in the general area reported an average of only 3.4 millimeters (0.13 in) of rain. The combination of these factors contributed significantly to the low moisture content of the dead forest fuels and in part to the extreme fire behavior that occurred during the first half of May 1987.

The majority of the area burned by the Wallace Lake Fire was the result of three separate runs, which took place on May 5, 8 and 12 (fig. 1). The primary cause of these major fire runs was the strong surface winds associated with the passage of three successive cold fronts. Average wind speeds were in excess of 30 kilometers per hour (19 mph) on each of these days, with gusts up to 60 kilometers per hour (38 mph) being reported. Minimum relative humidities ranged from the high teens to low thirties, and maximum air temperature varied from 23 °C (73 °F) to 32 °C (90 °F).

The FBP System was used to predict potential fire behavior (e.g., spread rate and type of fire) and proved to be a valuable asset to the overhead team assigned to the fire. The fire spread projections were sufficiently accurate and reliable to be a major factor in determining evacuation requirements. For example, on May 8 the fire jumped the established control line and raced eastward towards the subdivision on the west shore of Wallace Lake at a rate of 3.9 kilometers per hour (2.4 mph). A lodge, campground, and 54 of 69 cottages were either damaged or destroyed by this fire (fig. 2). However, no lives were lost, because of the precautions taken by the overhead team.

The extensive property losses at Wallace Lake coupled with the $2.26 million fire suppression costs made the Wallace Lake Fire one of the most expensive wildfires to be fought in Manitoba. This fire did, however, illustrate the value and usefulness of

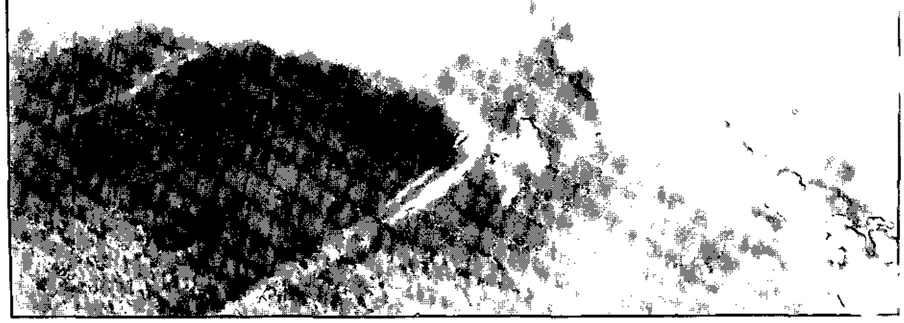
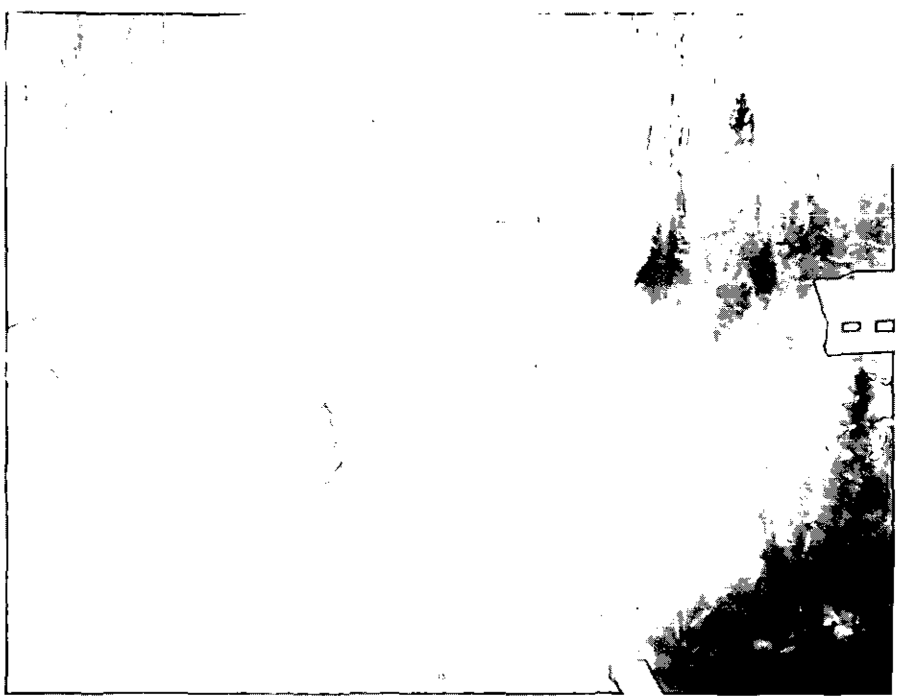


Figure 1—*The Wallace Lake Fire during the initial stages (around 1500 CDT) of its major run on May 8, 1987 (photo courtesy of Manitoba Natural Resources).*

the FBP System on a going fire and showed the potential consequences that many of the other cottage subdivisions in this general area could possibly face in the future. ■



Literature Cited

1. Lawson, B.D.; Stocks, B.J.; Alexander, M.E.; Van Wagner, C.E. A system for predicting fire behavior in Canadian forests. In: Donoghue, Linda R.; Martin, R.E., eds. Proceedings of the Eighth Conference on Fire and Forest Meteorology; 1985 April 29–May 2; Detroit, MI. Society of American Foresters Publication 85–04: 6–16 Bethesda, MD: Society of American Foresters; 1985.

Figure 2—*Aftermath of the Wallace Lake Fire at the shoreline cottage subdivision on May 8, 1987 around 1800 CDT (photo courtesy of Manitoba Natural Resources).*

Mapping Fires With the FIRE MOUSE TRAP

Duane Dipert and John R. Warren

With USDA Forest Service, respectively, soil scientist, Colville National Forest, Pacific Northwest Region, Colville, WA; and electronics engineer, Fire and Aviation Management, State and Private Forestry, Boise, ID

Introduction

The FIRE MOUSE TRAP[1] (FMT) method of mapping wildland fires was conceived in 1984 *(1)*. It was first tried experimentally on wildfires by the State of Alaska in 1985, using a T-28 fixed-wing aircraft *(2, 3)*. Alaska calls it the TROLL[1] and also used it in 1986 and 1987. The Alaska conditions and TROLL development and use are described in detail in the doctoral dissertation of Ronald G. Hanks *(4)*. The FMT was briefly tried, experimentally, in USDA Forest Service Region 6 (R-6) in 1986. In 1987, R-6 crews were trained, and the FMT was used in field trials on forest fires in both R-5 and R-6. The plotting capability was not used extensively by the R-6 crews because of some Loran equipment problems. The balance of the system performed very successfully. In addition to the system developed for R-6, a similar system was developed for R-5. The R-5 system, including the plotting capability, was used successfully. Both systems were used in contractor-supplied Bell 206 helicopters with FLIR, Inc., Model 2000, forward looking infrared (FLIR) units installed. The Forest Service provided the balance of the FMT system. The experience of one of the R-6 crews on an R-5 fire is described, followed by a brief description of the FMT concept.

[1]Flying InfraRed Enhanced Maneuverable Operational User Simple Electronic Tactical Reconnaissance And Patrol. Alaska calls it TROLL for Thermal Recorded Observation and Loran Locating.

Bell 206 with attached FLIR unit.

FIRE MOUSE TRAP Use on the Yellow Fire

The Yellow Fire in California was an "ideal" situation for the use of the FMT. This fire was located adjacent to the Marble Mountain Wilderness on the Klamath National Forest in northern California.

During October 1987, a dense layer of smoke blanketed the Yellow Fire to an altitude of about 4,000 feet in the morning, rising to about 8,000 feet in the afternoon. The high altitude infrared line scanner had been making nightly flights of this and other fires for at least a month prior to our arrival with the FMT. The infrared interpreter was located in Yreka, at least a 3-hour drive from fire camp at Forks of the Salmon.

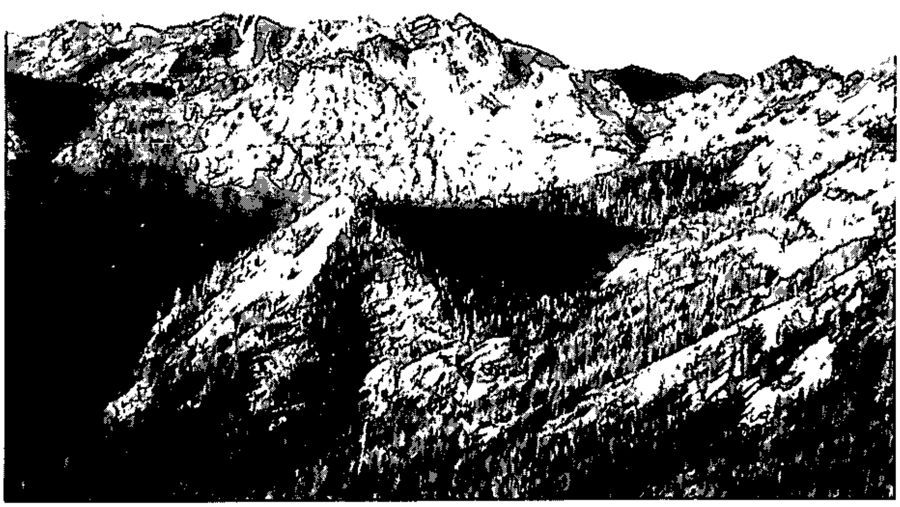
Because of the dense smoke, no visual aerial reconnaissance could be done, and even the people on the ground had difficulty locating the fire from hour to hour. The turnaround time on the line scanner information could be 10 hours or more from the time of the flight to the time it was delivered on site.

We did not use the FMT's plotter system on the Yellow Fire, but, instead, relied on the FLIR video imagery and VCR tapes to map the fire. Several well-defined drainages served as landmarks. The helicopter could follow the fireline or hover several hundred feet from the fire, panning the terrain to get a good view of the terrain and the fire edge.

In spite of a complete smoke cover, the FMT's infrared system confirmed that the fire had not crossed the northern control line, Wooley Creek. On several occasions, the infrared camera zoomed in on questionable hot spots adjacent to Wooley Creek to determine if they were on the right side of the creek or not.

One planned control line was Hancock Creek, a tributary to Wooley Creek, on the northeast part of the fire. In the second week in October, the high altitude infrared line scanner spotted a "possible" spot on the opposite side of Hancock Creek. The FMT independently located the spot and confirmed that it was on the opposite side of the creek and that it was a burning log that had fallen across the creek. After the first one or two FMT flights, the overhead team cancelled the line scanner and requested two flights per day with the FMT instead.

The next planned control line and burnout was along Big Meadows Creek, another tributary to Wooley Creek. Using both infrared and color



Marble Mountain Wilderness, Klamath National Forest, showing terrain typical of that encountered on the Yellow Fire.

video equipment, the FMT flew beyond the smoke to give the overhead team information about terrain features, fuel types, and possible fireline locations. During the next week or so, FMT flew two flights per day—one in the morning and one in the afternoon. The helicopter landed at the fire camp after each flight. Using the infrared VCR tape, we could accurately map the fire about ½ hour after the flight—truly up-to-date, immediate information.

As the time for the planned burnout along Big Meadows Creek grew closer, the dense smoke layer still prohibited any visual aerial reconnaissance, and the FMT was scheduled to make four flights during the burnout to monitor the progress. Fortunately, rains during the night squelched the fire, and the planned burnout was cancelled.

Other Uses of the FIRE MOUSE TRAP

Another use of the FMT developed while it was attached to the Salmon Complex (Yellow Fire). Apparently, local residents along the Salmon and North Fork Salmon Rivers were concerned that the USDA Forest Service was not adequately protecting their homes. Even though smoke filled many of the canyons, the FMT, in 1- to 2-hours flying time, recorded each house on video tape and confirmed with the infrared system that there were no hot spots near the houses. In one case where a reburn occurred near residences, the FMT monitored the progress of the fire twice per day, until it was controlled.

The infrared VCR tapes from the FMT were used by the overhead team to map the fire, and they were shown to fire fighters and news reporters to provide updated information about the progress and intensity of the fire.

A common use of the FMT during the 1987 fire season was to fly along the firelines to map hot spots within 300 feet of the fire perimeter. Hand lines may have been difficult to follow along a cold fireline edge, but tractor lines, roads, and streams were usually easy to follow. On several fires where crews had been removed because the fire was essentially out, the FMT located hot spots adjacent to the fireline. The overhead team could then determine if additional actions were necessary.

The FMT was also used in a nonfire application earlier in the year for "mapping" bug-kill areas. The pilot flew the helicopter visually around the damaged area while the latitude and longitude position points were stored in a lap-sized personal computer (PC). The position points were subsequently plotted on a map to show the total perimeter and other points of interest or damage.

Since the infrared unit can detect heat sources as low as body temperatures, another possible use of the system that has been used but not tested extensively is making wildlife inventories. Cows in a pasture or deer in brush show up as hot spots on a cool or cold background. As long as the animals are not obscured by trees or a dense canopy, they can be seen by the infrared system and recorded on video tape for review in the office. Search and rescue operations can also be conducted using infrared to detect campfires, other heat sources, or people.

FIRE MOUSE TRAP Description

The FMT approach to fire mapping uses a small, forward-looking infrared unit mounted on a helicopter or small fixed-wing aircraft. A color video camera can be mounted beside the FLIR. The color or FLIR video is selected for display on the monitors in the aircraft and for recording on a common VHS portable VCR. The pilot flies around the fire perimeter using the FLIR where needed to see through smoke or to identify the hot fire perimeter. A LORAN-C navigation unit with an RS-232C output provides an update of the aircraft position every 2 seconds. These position points are stored in a lap-sized PC. Upon completion of the flight, the PC is connected to a plotter, and the fire perimeter and any hot spots are plotted directly and to scale on a map or transparent overlay up to the size of a quad sheet. The plot is available within a few minutes of the start of the plotting operation. The video is also available for playback and a good look at any area of special concern or interest. When color video and high resolution FLIR units are used, the amount of detail is enough to see even an individual fallen log as described in the Yellow Fire narrative above. Trained and experienced crews for the FMT are invaluable in the use of the FMT and selection of best viewing angles, heights, and type of video.

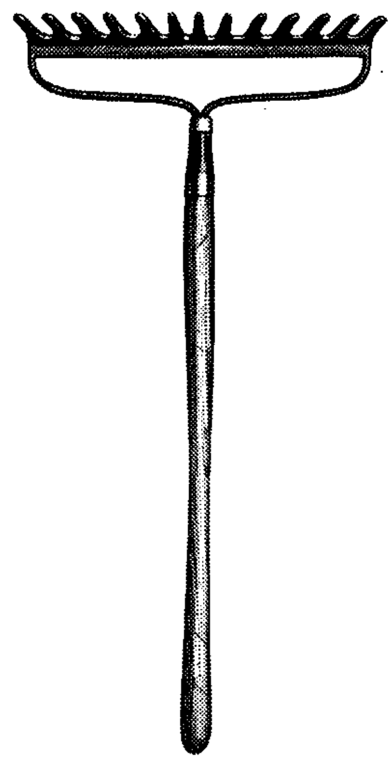
Conclusion

The FMT has proven its value as an operational tool for fire management. It is adaptable to a variety of fire sizes and conditions as well as many nonfire uses. It is a quick and readily available means under the control of the fire staff to gather fire information around the total fire perimeter or in selected critical areas in a timely manner.

For more information on costs, availability, training, and capabilities of the FMT, contact John Warren, FTS 554-1439. ■

References

1. Warren, John R. FIRE MOUSE TRAP. Boise, ID: U.S. Department of Agriculture, Forest Service; unnumbered report; Oct. 1984.
2. Warren, John R.; Hanks, Ronald G. FIRE MOUSE TRAP/TROLL Prototype Test and Operations Report. U.S. Department of Agriculture, Forest Service; unnumbered report; Jan. 1986.
3. Hanks, Ronald G.; Warren, John R.; Pendleton, Dennis. Alaska Division of Forestry goes TROLLing. Fire Management Notes. 47(1): 32–36; 1986.
4. Hanks, Ronald G. The TROLL system. Columbia University. Ph.D. dissertation; 1986.



Correcting an Error in the HP-71B Fire Behavior CROM

Robert E. Burgan and Ronald A. Susott

Research forester and research chemist, respectively, Intermountain Fire Sciences Laboratory, USDA Forest Service, Missoula, MT

The difficulty of writing an error-free computer program has been demonstrated once again. An error has been found in the program used to produce the fire behavior custom-read-only memory (CROM) for the HP-71B. Fortunately, this error can readily be remedied.

The problem occurs when using a dynamic fuel model. The fuel load is not being transferred between live herbaceous and 1-hour fuel classes. In other words, dynamic fuel models are erroneously being treated as static fuel models. The problem can be fixed by entering the program given later in this paper. Once this program is typed in, the fire behavior program is run in routine fashion. But if the calculator suffers a memory loss from dead batteries or any other cause, you must enter the program again.

The following exercise will demonstrate the problem. Once you have entered the program, you can repeat this exercise as a means of checking that you have correctly fixed the problem.

1. Turn on the HP-71B and type in RUN BEHAVIOR.
2. Go to the fuel model (FM) module and get fuel model 2 by typing G2.
3. Change the fuel model number to 22 by typing I for input, 22 for model number, and just press the ENDLINE key when a model name is requested. Then type 114 and, when STATIC-DYNAMIC (0–1) appears, type a 1. Just press ENDLINE when the wind factor is requested.
4. Save the model by typing S.
5. Quit the fuel model module by typing Q and go to the direct (DI) module.
6. Type I, then input the following data:

MODEL	22
1H	10
10H	10
100H	10
HERB	80
MFWS	10
SLP	40
WDIR	0
PREDICT AT MAX (Y/N)	Y

7. Type R to get the following results:

ROS	113
H/A	431
FLI	890
FL	10.2
RI	3127
EWS	10.4
MAXD	0

To enter the program:

1. Type in EDIT LOADFIX and press the ENDLINE key to get into the editor. The display will show LOADFIX BASIC Ø.
2. Type in AUTO to get automatic line numbering. Press ENDLINE. A 1Ø will be displayed.
3. Type in the program given below **exactly,** including spaces. The calculator will give you the line numbers. The characters will appear in the display as you type them. Press the ENDLINE key as you complete each line. After you type in the last line (120) the calculator will display line number 130 and wait for you to input something. Just hit the ENDLINE key without entering anything. That will get you out of the editor.

Some of the characters in the program might give you trouble:

- The single quotation mark is obtained by pressing the blue g key, then the number 7.
- The : character is obtained by pressing the g key, then the *.
- Push the SPC key for a space.
- Note the zero is slashed (Ø) but the letter O is not.
- There are no spaces between the left and right parentheses that have no characters between them.

Here is the actual program. Please remember the instructions in number 3, above.

```
1Ø  SUB RDIRECT(M(),E(),
      O(),Z9(,))
2Ø  L1=M(1) @ L4=M(4)
3Ø  IF M(12)=Ø THEN GOTO
      'STATIC' ELSE GOTO
      'DYNAM'
4Ø  'DYNAM':
5Ø  F= -.Ø111*E(5)+1.33
6Ø  F=MAX(MIN(1,F),Ø)
7Ø  O1=F*M(4)
8Ø  M(1)=M(1)+O1 @
      M(4)=M(4)= -O1
9Ø  'STATIC':
1ØØ CALL RDIRECT(M(),E(),
      O(),Z9(,)) IN RUNALL7
11Ø M(4)=L4 @ M(1)=L1
12Ø END
```

You can check the program by typing EDIT LOADFIX again and using the ▼ and ▲ keys to look at each line. Hit ENDLINE to get out of the editor. If you have trouble fixing an incorrect line, use the ▲ and ▼ keys to scroll to the erroneous line, position the cursor over the first character in the line, type the whole line in again, and then press the ENDLINE key.

To check that your program gives correct results, type in RUN BEHAVIOR, go to the Direct or (DI) module and input the data provided in step 6 of the previous exercise.

Run the direct module and you should get the following results:

ROS	128
H/A	414
FLI	971
FL	10.6
RI	3088
EWS	10.4
MAXD	0

The difference between the two runs reflects the fact that herbaceous fuel load was not being transferred to the 1-hour fuel class in the first run, but was being transferred in the second run.

We hope that no more errors will be found. We are fortunate this one can be repaired so easily. ■

New McCall Smokejumper Base Dedication Planned

Gene Benedict

Branch chief, Fire Management and Recreation, Payette National Forest, USDA Forest Service, McCall, ID

Planning is underway for a dedication ceremony for the new McCall Smokejumper Complex. The complex is located in the Intermountain Region (R-4) on the Payette National Forest in McCall, ID. The dedication is planned for June 25–26, 1988. During the last 2 years, construction has been underway for the $2.9 million dollar facility. Included in the complex is a new paraloft, airtanker base and off-site housing with barracks for 40 single jumpers, and married jumper facilities for 10 families. The new paraloft has the normal loft features: warehouse/storage and fire pack assembly area, large drying tower, sewing room, packing room, ready room, first-aid/whirlpool room, weight room, 80-person classroom, conference room and administrative offices. Also located in the paraloft is the Payette Forest Dispatch Office. The facility is located on the west side of the McCall City Airport and has a large ramp area for smokejumper, airtanker and leadplane aircraft parking and a training unit area to be completed by 1989. A mixmaster office, tanker pilots readyroom, aircraft maintenance building, and helibase round out the other features. The complex has its own parallel taxiway for access to the runway.

The dedication ceremony will begin at 1:00 p.m. (mdt) on Saturday, June 25 and will last for approximately 2 hours. It will include speeches, special recognitions, and both aerial demonstrations and static displays. Following the ceremony, there will be an open house with tours until 7:00 p.m. The open house and tours will continue on Sunday from 9:00 a.m. through 4:00 p.m. Invitations and specifics concerning the dedication ceremony will be mailed by May 1.

This is the newest such facility in the National Forest System and is an extremely impressive structure. It has an aesthetically pleasing appearance, with its mixture of cedar siding, shake roof, and native rock from the Salmon River.

We hope to see you all in June! ■

ONLY YOU

United States
Department of Agriculture

Washington, D.C.
20250

OFFICIAL BUSINESS
Penalty for Private Use, $300

Superintendent of Documents Subscriptions Order Form

Order Processing Code:
*

Charge your order. It's easy! MasterCard VISA CHOICE

☐ **YES,** please send me the following indicated subscriptions:

_____ subscription(s) to **FIRE MANAGEMENT NOTES** for $8.00 each per year domestic, $10.00 per year foreign

☐ **New** ☐ **Renewal**

1. The total cost of my order is $_____ . All prices include regular domestic postage and handling and are subject to change. International customers please add 25%.

Please Type or Print

2. ____________________
(Company or personal name)

____
(Additional address/attention line)

____
(Street address)

____
(City, State, ZIP Code)

( )____________________
(Daytime phone including area code)

3. Please choose method of payment:

☐ Check payable to the Superintendent of Documents

☐ GPO Deposit Account ☐☐☐☐☐☐☐ - ☐

☐ VISA, CHOICE or MasterCard Account

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

____
(Credit card expiration date)

Thank you for your order!

____
(Signature)

4. Mail To: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402-9371