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# *FOAM APPLICATIONS FOR WILDLAND & URBAN FIRE MANAGEMENT*

***Prepared by:*** **NWCG Fire Equipment Working Team's Task Group for International/Interagency Foams and Applications Systems**

## NEW FIREFIGHTING FOAM APPROVED FOR HELICOPTER USE

*by Chris Button, Los Angeles County Fire Department*

In mid-February 1989, the Los Angeles County Fire Department conducted a demonstration of Monsanto Company's newly developed wildland firefighting foam Phos-Chek WD 881. Witnessing the demonstration plus a presentation by Monsanto were representatives from the California Department of Forestry and Fire Protection (CDF), USDA Forest Service, Los Angeles City Fire Department, Ventura County Fire Department, and Kern County Fire Department—as well as the local news media.

The demonstration consisted of three different helicopter applications of the foam concentrate product. The first (a salvo drop) showed a single, condensed application of a full 360-gallon payload (see fig. 1). The second (a 500-foot-long trail drop) dramatically showed how application of a 0.3 percent solution reduces the surface tension of water and provides a penetrating action that is suitable for use in deep duff and litter. The third (also a trail drop) clearly showed how a 0.6 percent solution keeps water runoff to a minimum, as desired for use in heavy fuels or canopy fires.

Phos-Chex WD 881 is unique because it is the only foam concentrate (foaming agent) certified for use in helicopters equipped with attached tanks (see fig 2). Previously, concentrates could not be used in this application due to corrosion problems with helicopter parts. Representatives from several agencies, including the Los Angeles County Fire Department, mentioned that they were planning to use this new product during the 1989 fire season.


*Figure 1. Los Angeles County helicopter No. 14 making a salvo drop of 0.3 percent foam concentrate.*

For further information on helicopter use of Phos-Chex WD 881 with helicopters, contact Inspector Chris Button, Community Relations, Los Angeles County Fire Department; 213/267-2413.

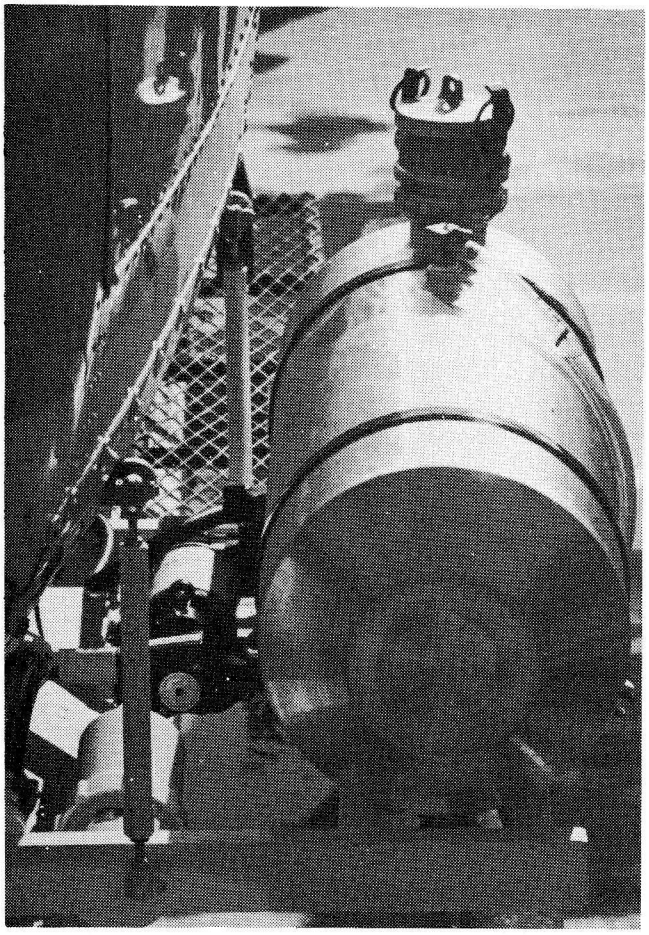

*Figure 2. Tank, filter, and pump of a Simplex system used to inject the foam concentrate into helicopter fixed drop tank.*

## CHAIRPERSON'S CORNER

*by Doc Smith, USDA Forest Service*

It is interesting to hear about all of the new developments in foam. The British Columbia Forest Service is using a combination of foam and retardant; USDA Forest Service San Dimas Technology and Development Center (SDTDC) has developed a new foam proportional system—there was a huge tactical application of this system during the Greater Yellowstone Area firefighting episode; new apparatus has been worked out to add concentrate to helicopter buckets. It just goes on and on! We need to share with each other the things that work. This is the prime objective of this multi-issue informational publication, so please take the time to write a short description of YOUR foam experience to share with the wildland and urban fire community.

The Foam Task Group recently met in Phoenix, AZ, to continue with the great direction from the Denver, CO, International Foam Applications Workshop of the summer of 1988. Lack of funds continues as a problem, but the enthusiasm of participants in the group just about overcomes the deficit. SDTDC recently added Steve Raybould as a program assistant to Paul Hill, who serves as an advisor to the Foam Task Group. Steve will help in the foam area, as well as related areas of the Center's extensive fire management program; he will give a big boost to this foam applications publication by providing coordination between authors and the SDTDC publications personnel.

The interest in foam is high and the payoff from applications is now recognized as "real." Keep up the good field work and let us know WHAT, when, where, how, and why you are doing what you are doing in the way of foam concentrate efforts.

## TEXAS FOREST SERVICE FOAM PROGRAM UPDATE

*by Pat Ebarb, Texas Forest Service*

The Texas Forest Service (TFS) recently had an opportunity to review its foam program with Senator Phil Gramm (R-TX). He was provided an exhibition of the small, static tractor-operator protection system (TOPS) and a large compressed air foam systems (CAFS) unit on a 3-ton 4x4 chassis. The Senator expressed active interest in CAFS technology as he operated the business end of a 1-1/2-inch foam line (see fig. 3).

The TFS is also busily putting the finishing touches on six CAFS engines to be used for strike team response both in and out of the State of Texas. These engines consist of a 1-1/2-ton 4x4 chassis with a fiberglass tank containing 300 gallons of water with "Fire Quench," a low-cost

*Figure 3. Senator Phil Gramm handling a 1-1/2-inch foam line from a CAFS-equipped engine.*

foam concentrate (foaming agent) manufactured by the Texas Department of Corrections. This concentrate costs $3.00 per gallon, fob, Sugar Land, TX.

"Fire Quench" works well on class A materials at a mixture of 0.2 of 1 percent. The Aurora, CO, Fire Department has tested "Fire Quench" in a series of six tests on hydrocarbon (diesel) fires. The concentrate appeared to work fairly well. However, these tests were limited, and the manufacturer does not make any claims for the product's use on anything except class A materials. For more information, contact Captain C. L. Bennett, Battalion Training Office, Fire Dept., 1470 S. Havana St., Aurora, CO 80012; 303/695-7110.

A water expansion systems (WES) field report summary (see tables 1 to 3) was recently put together by Staff Forester III Mark Stanford, a recent addition to the TFS fire control staff. The summary was derived from 385 separate incident reports submitted by 63 volunteer fire departments from 51 counties in Texas. The 344 direct attacks reported had a 97 percent success rate using WES. Of ten failures reported, one was attributed to equipment breakdown and only one failure was due to the foam not being effective. Interestingly, 70 percent of these incidents were wildland (ground cover) fires, with single-story residential fire accounting for 8 percent, and vehicle fires 7 percent. For more information on the WES field report summary, contact Mark Stanford, Texas Forest Service, P. O. Box 310, Lufkin, TX 75901; 409/639-8100.

***Table 1—WES use/value loss by fire location.***

| *Fire location* | *No. of incidents* | *Percent* | *Ave. qty used (gal)* | *Ave. area (acres)* | *Total loss value ($)* | *Ave.loss/ fire ($)* |
|---|---|---|---|---|---|---|
| Single-story structure | 30 | 8 | 385 | | 232,375 | 7,745 |
| Two-story structure | 2 | 1 | 400 | | 65,000 | 32,500 |
| Mobile home | 7 | 2 | 234 | | 66,500 | 9,500 |
| Vehicle | 28 | 7 | 124 | | 48,450 | 1,730 |
| Ground cover | 270 | 70 | 220 | 38 | | |
| Miscellaneous | 48 | 12 | 283 | | | |

***Table 2—Successful fire attacks by type.***

| *Type of attack* | *Number* | *No. successful* | *Percent successful* |
|---|---|---|---|
| Direct attack | 344 | 334 | 97 |
| Indirect attack | 7 | 6 | 86 |
| Exposure protection | 6 | 5 | 83 |

***Table 3—Failed fire attacks by type.***

| *Type of attack* | *Number* | *Failure reason* |
|---|---|---|
| Direct attack | 10 | 2-late alarm/1-lack of wtr/1-foam not effective/1-eqpmt failure/1-weather/4-other |
| Indirect attack | 1 | Lack of water |
| Exposure protection | 1 | Late alarm |

## YOU NEED TO KNOW A FOAM'S DRAINAGE RATE

*by Ed Stechishen, Canadian Forestry Service*

Foam, an aqueous agglomeration of bubbles separated from each other by a liquid film, undergoes structural rearrangements from spheres to polyhedrons as it attempts to balance the energy forces within it. The binding forces that give foam much of its stability are due to the presence of surface-active agents (surfactants) that are also responsible for the liquid's ability to foam in the first place. The stability of the bubble mass is measured by the rate at which the foam releases the solution from within its structure; i.e., the rate of the drainage. The rate of drainage is a measure of the foam's effective life expectancy, since it is a time-related reference to the disposition of the solution that was originally transformed to the bubble state.

Fuels are wetted by free liquid; therefore, a regulated release rate from foam to liquid is desirable. In defining the optimum solution release rate, it is necessary to consider where the foam comes to rest and what should happen to it as time goes on. Slow-draining foam works well if it comes to rest on the fuels that are to be protected or if the fuels' combustion is suppressed. However, in a multistoried fuel structure, drainage must be accelerated if adequate wetting is essential at the lower level (below a canopy) to stop the spread of a surface fire. This can be achieved by reducing the mix ratio, provided some basic drainage characteristics are known.

Drainage essentially tells whether the foam (1) remains where it lands and slowly wets the fuel on which it rests or (2) releases the solution faster than it can be absorbed by the fuel and the free liquid filters through to lower levels. To determine the mix ratio that should be used in a given foam generating system, the user's specific need should be known, since each system produces a unique foam for a given mix percentage. If the need is to protect tree crowns or to pre-treat the perimeter of a prescribed burn area, then a slow-draining foam is required; otherwise, the drainage should be fast enough to provide general wetting.

Drainage information should be a key consideration when comparing product brands with the objective being to purchase the most cost-effective brand. By comparing drainages and determining mix ratio requirements of each brand, the most economical purchase can be identified in terms of cost per volume of concentrate. Above all, the person who benefits most from knowledge about drainage characteristics is the Birddog Officer who directs aerial suppression. If this officer knows the fuels and can read the fire's activity from an aerial vantage point, the most efficient use of each measure of foam that is delivered by the airtankers will be made. This will be achieved by specifying the mix ratio that yield a foam draining at a rate that is most beneficial in terms of timely wetting of the fuels at the best place.

For further information on this subject, or if you have any questions, contact Ed Stechishen, Canadian Forestry Service Research Forester, Petawawa National Forestry Institute, Chalk River, Ontario, Canada KOJ 1JO; 613/589-2880.

## NEW IN-LINE PROPORTIONER SYSTEM SUPPLIES ACCURATE MIXTURE OF SURFACTANTS

*by Keith Adamson, Robwen Inc., Los Angeles, CA*

A proportioner alleviates the problem of adding foam concentrates (foaming agents) directly to a main water tank. Historically, concentrates have been added into the water tanks of pump trucks; this could waste foam concentrate and cause corrosion. The new Flo-Mix 500 foam system is a outgrowth of a "Wet Water Proportioner," invented by two Los Angeles City firefighters, which has been in use for over 10 years by many municipalities. The Flow-Mix 500 (see fig. 4) is designed to be attached to any point in a hose line. The standard model is available either in a portable or a built-in configuration and has a capacity of 5 gallons. It is currently being tested at the USDA Forest Service San Dimas Technology and Development Center (SDTDC). SDTDC will coordinate field testing with Pacific Southwest Region units during the 1989 fire season.

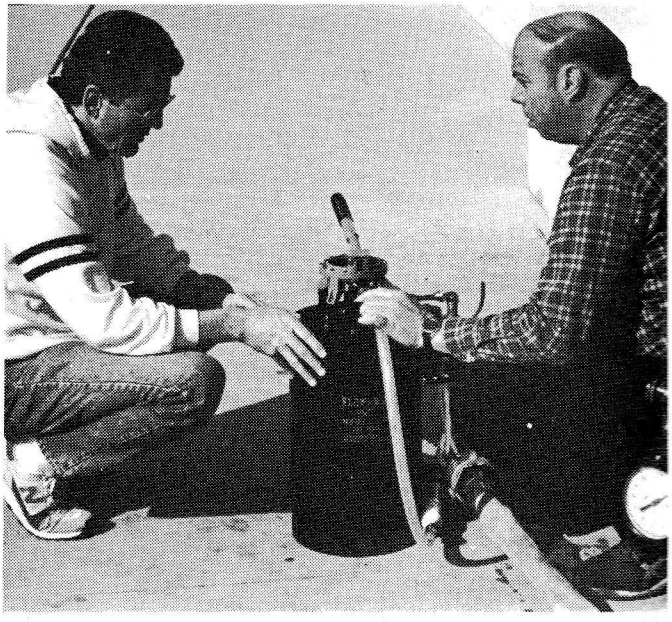

*Figure 4. Paul Hill (left), SDTDC fire program leader, and Keith Adamson reviewing new Flow-Mix in-line foam proportioner that Robwen Inc. is producing.*

The unit operates by variable pressure being exerted on a bladder filled with foam concentrate. This pressure is created by the flow of incoming water from the hose line. The concentrate is forced through a metered orfice, down a feed line to the discharge side of a differential valve and venturi. With the development of a highly accurate valve, the system can be set for proportioning from 0.1 to 1 percent, calibrated in settings of 0.2 percent. When water flow through the differential valve stops, pressures in the main body becomes static and the foaming agent flow stops.

A modified hand pump, with newly developed built-in check valves refills the system in less than 2 minutes and can be refilled at any time without shutting down the hose line. It virtually can be mounted anywhere on the engine with servicing being done on the complete system in approximately 45 minutes. The unit is self powered, wires and electricity are not needed; nor are plumbing, flowmeters, or switches.

For additional information on the Flow-Mix 500 in-line proportioner, call Robwen Inc., 1945 Blake Ave., Los Angeles, CA 90039; 213/665-5633.

## FOAM USE IN FLORIDA EVERGLADES REGION

*by J. P. Greene, Florida Division of Forestry*

South Florida presents unique challenges to wildland firefighters. It is a region that, for the most part, was originally inundated for several months each year. Drainage and development has changed all that, with a resulting change in fuels and fire regime. Fuels now range from the original wetlands sawgrass, tropical hardwood islands, and pine "ridges" to dense stands of the imported Melaleuca tree; all increasingly interspersed with homes. As South Florida has developed, residents are more often personally threatened both by fire and by the effects of smoke.

The Florida Division of Forestry is charged with the responsibility of fire control in all non-Federal unincorporated areas of the State, including the Everglades area. Traditional methods of fire suppression have included extensive use of counterfire ignited from airboats, aircraft, and the ground; direct suppression using water from engines and all-terrain vehicles (such as the Bombardier Muskeg); and limited use of fire plows and bulldozers.

A typical suppression operation might consist of two or more Division of Forestry Bombardiers in direct attack, nursed by a Metropolitan Dade County engine. As the distances from the nurse truck to the fires increase, attack efficiency and effectiveness decrease. Thus, the water expansion and enhancement possibilities of foam become increasingly attractive to our firefighters. Further, as water becomes more effective, the need for environmentally damaging plow and dozer lines decreases.

Since the fall of 1988, the Division has had a 20-cfm, 20-gpm CAFS unit in service on a Bombardier Muskg tractor carrying 300 gallons of water. Using both Fire-Trol FireFoam 103 and Silv-ex, it has proven its effectiveness, and shown greater efficiency than plain water, in a variety of fuels—including sawgrass and southern rough. Through the use of foam, the amount of time spent shuttling water to fires is reduced through greater extinguishing efficiency and the ability of foam to prevent re-ignition.

In general, a "sloppy" foam capable of immediately penetrating the often dense and matted litter is found to work better than a dry, fluffy foam. The water expansion appears to be approximately threefold, as currently employed. While not as numerically impressive as in some other applications, it does mean that the effectiveness of the unit is tripled. Not bad! The new K-K "Bubble Cup" D1024BC aspirating nozzle has also been tested, and shows definite promise as a dual-purpose appliance. Purchase of three new Bombardier units is programmed for 1989. The plan is to equip them with CAFS units. This is an indication of the confidence Division of Forestry personnel in the Everglades region have in the emerging technology of controlling wildland fires with foam. For further information, contact J.P. Greene, Fire Resource Manager, Florida Division of Forestry, 3125 Conner Blvd., Tallahassee, FL 32399-1650; 904/488-6107.

## COMPRESSED AIR FOAM SYSTEMS (CAFS) WORKSHOP

*by Jim Page, USDA Forest Service*

The Plumas National Forest sponsored a 3-day CAFS workshop in December 1988 at the Plumas County Fairgrounds, Quincy, CA. Instructors were Paul Schlobohm and Ron Rochna from the USDI Bureau of Land Management (BLM) Salem (OR) District Office. (Editor's note: See their article " An Evaluation of Foam as a Fire Suppressant is Available," p. 6-7, Vol. 1, No. 2 of this publication.) They made presentations and demonstrated the state-of-the art in foam technology and appliances. Topics included: History of foams; foam chemicals; foam generating systems; applications—wildland and prescribed fires, structure fires, hydrocarbon fires; hazardous materials; environmental concerns; and safety.

The 73 workshop attendees represented a cross-section of Federal and State agencies, local fire departments, and manufacturers representatives who came from as far away as Minnesota, Indiana, and Canada. They included personnel from six National Forests, the San Dimas

Technology and Development Center (SDTDC), USDI National Park Service, the California Department of Forestry and Fire Protection (CDF), the Department of Defense, eight volunteer fire departments, and 11 manufacturing and distribution companies.

The attendees, using off-the-shelf components, got to assemble some CAFS systems, and the industry representatives demonstrated the latest in CAFS foams, components and systems. The fairground setting (and cooperative weather) provided a great opportunity to evaluate the operational characteristics of foam generating systems. At the end of the second day the grounds, adjacent buildings, and trees looked like a major snow storm has just passed through.

To cap off the workshop, the local Sierra Pacific mill provided a huge pile (75-ft long x 12-ft high x 25-ft wide) of wood waste products for a demonstration burn. The appropriate permits were acquired and the pile was ignited on the last day. Using various foam systems and appliances, BLM, Forest Service, and fire department personnel made initial attacks on the fire. BLM demonstrated their latest CAFS engine with a foam monitor nozzle, which impressed everyone by foaming the entire butt end of Sierra Pacific's largest mill deck during a running attack demonstration.

Incidentally, this same BLM engine made quite an impression on fire personnel during last year's Greater Yellowstone Area fire complex operations. Ron Rochna and his crew demonstrated the value of foam and foam generating systems not only for structure protection but also in pretreating areas in advance of the fires making major runs on control lines. News from other agencies includes the following items: CDF has taken an active interest in foam systems. Their mobile equipment division is pursuing the retrofit of foam injection proportioners on 10 engines in the 1989 fire season. New apparatus will be equipped with foam proportioners and nozzles as they are built. SDTDC is leading the development, cooperation, and exchange of CAFS information within the Forest Service.

## FIREFIGHTING FOAM FOR GROUND APPLICATION

*by Paul Blankenship, California Department of Forestry & Fire Protection*

Wildland fire suppressant foam products were being offered to California Department of Forestry and Fire Protection (CDF) in 1986. (Editor's note: See "California Department of Forestry & Fire Protection Foam Studies," p. 10, Vol. 1, No. 1, this publication.) Very little information was available to use as a determining factor, other than undocumented dissertations from Canada and reports of soap skim usage in Texas. There appeared to be advantages for their use in a variety of applications on class A type fuels (wood products fibers and other cellulose compositions). Compressed air foam systems (CAFS) had been promoted in Texas for over a decade and, when properly operated, could produce almost any consistency of foam-lather coverage desired. Application of these devices were deemed too complicated and unreliable to be utilized by CDF because of the complex operation adjustments and fire flow limitations.

Low ratio fire suppressant foam chemicals have become available from commercial manufacturers in recent years. We began studying how CDF might be able to benefit from these more recent improved products. A list of critical items that must be met was established:

1. Firefighter safety had to be primary.
2. A quality foam product had to be dispensed repeatedly under all conditions.
3. The equipment had to be extremely reliable and compact.
4. The nozzle person had to be able to immediately adjust to the intensity and reaction of the fire being attacked; i.e. water curtain, fog, straight stream, heavy liquid, lather, etc.
5. The nozzle flow volume must be adjustable (at will)—from a dribble to full open—while maintaining a constant concentrate ratio.
6. A wide range of pressures and flows must be available at the nozzle.
7. The foam system must operate accurately in extreme elevation changes and hose lay lengths.
8. It must be uncomplicated to operate.

These items meant that a very sensitive flow monitoring proportioner had to be used that would inject concentrate into discharge flows ranging from 5 to 200 gpm up to 400 psi.

A number of organizations held discussions and symposiums to exchange information and learn the progress being made by other agencies and manufacturers. A CDF market search was begun in 1987 to find a manufacturer of equipment that could do this work. Two things had to be accomplished. One, the proportioner components had to be improved to be more active and user friendly, and two, aspirating nozzle technology had to be improved drastically. Manufacturers of those products were given these criteria to work with toward product development.

Two manufacturers began serious development work in late 1987. The Hypro Corporation began work on the proportioning equipment. K-K Products, Inc., assigned a design engineer to develop an improved nozzle that could do all of the operations. By March 1988 the first experi-

mental models of both components were in the operational trial stages. In September 1988 the first ever computerized fire apparatus foam proportioner was delivered and installed by Hypro Corporation. Full-range nozzles for 1- and 1-1/2-inch hard lines were provided by K-K Products, Inc., to begin field evaluation.

The proportioner consists of a flow sensor in the discharge piping; a 12-volt, variable-speed motor driving a variable displacement metering pump; a computer in a small case; and a discharge injection fitting installed downstream from the flow sensor. The computer calculates the concentrate demand from the flow reading and adjusts the pump speed to inject the required amount. It is extremely accurate throughout the variable flow requirements of hand-line fire operations.

The nozzles utilize a tube that can be moved (a) forward to aspirate foam or (b) back to provide all the patterns available from a combination nozzle. They are produced in all configurations: Pistol grip, basic straight, ball shutoff, and come in various gallon ratings for both hose sizes. They can produce "juicy" foam, with very effective fuel penetration, to a product with a frothy, sudsy lather. The ranges of foam types is very suitable for all types of direct attack on cellulose fuel fires.

An 8-gallon concentrate tank is being installed on CDF fire engines. A ratio of 0.5 percent is being used that will make 1,600 gallons of foam solution from the 8 gallons of concentrate. Given a conservative estimate of 5-to-1 aspiration expansion rate, we can produce 8,000 gallons of foam. Simply stated, three 500-gallon tanks of water are easily increased to equal 15. The proportioner is operated by operating a toggle switch and opening the hose nozzle. The nozzle is adjusted to suit the demands of the particular fire incident. Continued fire attack can be maintained until extinguishment is accomplished. Maintenance consists of keeping the concentrate tank filled and an occasional visual inspection of the pump and filter.

The busy 1988 fire season across the country provided many opportunities to study the foam effects in attack, mop-up, and pretreatment. Many agencies participated in the operations. In all cases, the general consensus was positive and that motivated us to proceed toward more widespread application of the fire suppressant products. CDF and many other agencies have applied the wildland fire suppressant foams to class B fires. These concentrates have been found to be safe and effective in accomplishing extinguishment. It is extremely important that all users know that these particular products do not provide the annealing quality of AFFF and other class B foam chemicals. We emphasize this fact at every opportunity.

The CDF fire apparatus fleet will begin using ten retrofit injection proportioners in the 1989 fire season. New apparatus will be equipped with foam proportioners and nozzles as they are built. A major portion of the fleet is expected to have foam capability within 3 to 5 years. Training and application procedures will be developed as the fire apparatus becomes capable of producing foam solution. Work has been started toward this objective.

The electronically controlled, discharge injected foam system—along with versatile aspirating nozzles—are going to provide CDF with many advancements in fire suppression. Many efficiencies will be realized in control time, injury reduction, fire losses and equipment maintenance. The mechanical aspects of installation are minor and flexible. Firefighter safety is improved in many ways; less heat and smoke exposure, more variables for protection by adjusting the nozzles, less time spent controlling the fire, greater capability with less water, reduction of exposure to hazards of overhaul and mop up. We in CDF anticipate improving our overall fire protection service with these products.

## TRAINING AND SAFETY NOTES

*by Ron Rochna, USDI Bureau of Land Management*

Editor's note: With this article, a new feature is introduced. While the first three issues of this publication in 1988, Vol. 1, ended with a suggested reading list, we now plan to end each issue with "Training and Safety Notes."

### Safe Operation of Compressed Air Foam Systems (CAFS)

Safe CAFS operation can be deceiving. As the hose is filled with water and air, it is very light relative to a hose filled only with water. However, the compressed air within the hose is ready to expand when released from the end of the hose. This energy release is the reason that there are long discharge distances with compressed air foam. The energy from the compressed air also exerts a great force against the nozzle person and can cause serious injury if not properly controlled.

Nozzles used with CAFS must be opened SLOWLY. The nozzle person should stand as if he/she was about to absorb the force of a sudden collision and yet wished to remain standing. One hand should be firmly on the shutoff valve; the other on the hose or nozzle—hold the hose up from the ground at a 45-degree angle.

Special care should be taken with tools (such as the mop-up wand), which change the direction of the stream flow. The torque created is strong. To avoid losing control, hold the wand approximately half way between the shaft and the nozzle shutoff. As with nozzles, open all gated wyes and valves SLOWLY. Rapid openings create a violent

surge through the hose that is difficult for a nozzle person to control (unless the nozzle is shut).

Hose and all appliances should meet standard pressure guidelines. Avoid using rotting, frayed, or otherwise weakened hose. Personnel should wear proper safety gear when operating CAFS. Skin and eye protection are essential for the nozzle person during all applications. CAFS can be operated safely and effectively if its potential energy is understood and respected through proper preparation.



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