A Publication of the
National Wildfire Coordinating Group

Sponsored by
United States
Department of Agriculture

United States
Department of Interior

National Association of
State Foresters

In Cooperation with
Petawawa National
Forestry
Institute of the Canadian
Forestry Service

Volume 2, No. 2 1989

FOAM APPLICATIONS FOR WILDLAND & URBAN FIRE MANAGEMENT

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

Canadian Committee on Forest Fire Management — Comité canadien de gestion des feux de fôret

NEW PROPORTIONER SYSTEMS SUPPLY ACCURATE FOAM CONCENTRATE MIXTURES

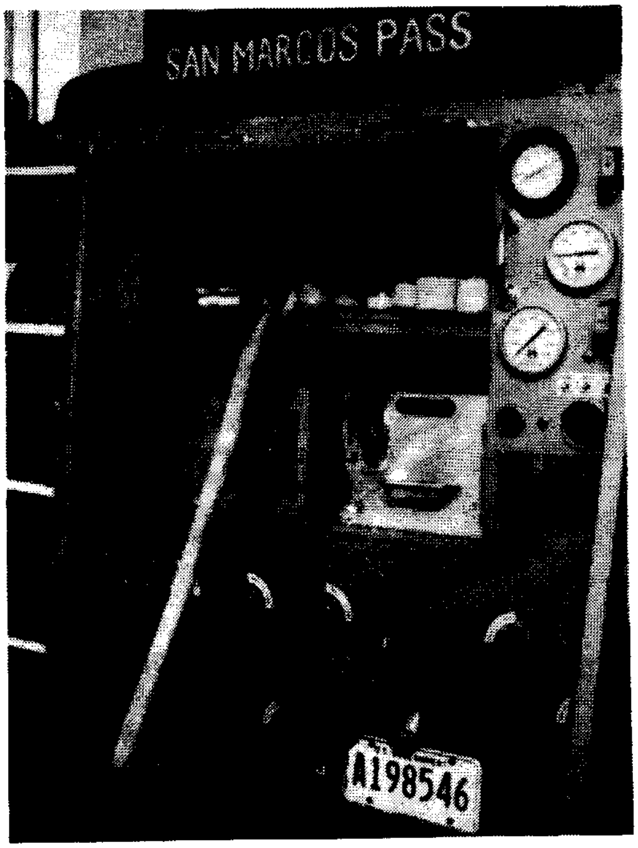
by Dan McKenzie, USDA Forest Service

Proportioner systems can alleviate some of the problems associated with adding foam concentrates (or "foaming agents" or "surfactants") directly into main water tanks. Historically, concentrates have been added into the water tanks of pump trucks. This would cause tank and pump corrosion, affect pump priming and the water-level gauge, and waste foam concentrate. An in-line proportioner system has been developed by SDTDC that injects the foaming agent directly into the high pressure (discharge) side of a pump for fighting wildland fires. The system features low flow loss (3 to 7 psi at 50 gpm), is accurate even at very low flows, can be placed anywhere in a hose line, and is not situation sensitive since it is a positive pressure system.

The San Dimas foam proportioner has evolved into a two-part portable attachment that sits in a fire engine bin or cabinet. The prototype consists of a pump (driven by a 12-volt electric motor), a pilot-operated relief valve, a filter, and a ball valve, all housed in an aluminum case. The other half of the proportioner unit is a 17-gallon aluminum tank which holds the foam concentrate. The concentrate is delivered to a venturi and is capable of proportioning up to 1 percent of foam concentrate into the hose line. Personnel from the Los Padres National Forest, Santa Barbara Ranger District, helped install the prototype proportioner on a model 60 engine from the San Marcos Pass Station.

Al West, Deputy Chief, handling foam nozzle

Phoenix Enterprises, Inc. of Monrovia, California, (Region 5's 1989 engine building contractor) is installing two prototype models of the San Dimas proportioner unit in model 61 engines. These prototype units will go in the curb side back bottom bin of the truck. The bin has been expanded 6 inches towards the frame to accommodate the electric motor and pump. The concentrate tank will be installed in front of the rear wheels, between the frame. One of these engines will be on the Shasta-Trinity National Forest engine and the other on the Angeles National Forest. Phoenix is also building a portable prototype for demonstrations at engine academies and training sessions.



Los Padres Natioanl Forest San Marcos Pass engine with foam proportioner installed.

During a visit to SDTDC Al West, Deputy Chief State and Private Forestry, showed his interest in foam technology by operating a 1-1/2 inch line with an aspirating nozzle from the Angeles National Forest's Dalton engine. The engine was equipped with the new SDTDC Foam Proportioner unit.

Hypro Corporation of Milwaukee, Wisconsin, SDTDC and the Cleveland National Forest will field test Hypro's Foam Pro system on a new model 61 that will be located at the Corona Station. This unit is similar to the one that is on BLM's engine 107, and CDF's engine 2000.

For further information, or to obtain technical details on foam concentrate delivery systems, contact Dan McKenzie, mechanical engineer, FTS 793-8000; (714)599-1267 or (818)332-6231; DG, D.MCKENZIE: W07A.

LONG-TERM FIRE RETARDANT MIXED WITH FOAM

By Bob A. Read, Regional Fire Prevention Co-ordinator, Prince George Forest Region, Province of British Columbia, (604)565-6118

The British Columbia Forest Service tested another new concept during the 1988 fire season. The Forest Service used a combination of long term fire retardant mixed with a foam concentrate to yield a "foam retardant". This concept was tested by the Cariboo and Kamloops regions. A foam injection unit was installed in a Conair Firecat, which included a foam concentrate reservoir. Approximately five minutes prior to the drop, the foam concentrate was injected into the load of liquid retardant. Initial reports were positive in that Aerial Attack Officers noted a fluorescent orange-pink colored foam, which was very easy to see from the air, and drop patterns that appeared to produce a more oval effect on the ground. It was noted during the trials that a thickening agent may no longer be required for liquid retardants when foam concentrates are added. More detailed tests will be done during 1989.

THE BLM FOAM PROJECT FIRE ENGINE 1988

By Ron R. Rochna, Bureau of Land Management, Boise Interagency Fire Center, (208) 389-2432

The BLM Foam Project has a state-of-the-art engine for wildland and urban-interface fire suppression. A 1,600 gallon water tank was mounted on a 35,000 GVW chassis powered by a 250-hp L10 Cumins diesel motor. This engine is on loan from the BLM Roseburg district.

Foam is made by the Compressed Air Foam System (CAFS). Two John Deere HPR 65 hydraulic pumps mounted off the front crank shaft of the Cumins control the speeds of the water pump and air compressor. The water pump is a CBP3 Hale capable of 260 gpm at 160 psi. The air compressor is a XR 70 Champion rated at 125 cfm at 150 psi. The volume of material produced by both allows the use of 2-1/2-inch hose.

Foam concentrate is injected by a Hypro foam injection system on the pressure side of the water pump. A microprocessor matches concentrate flow to water flow at mix ratios from 0.1 to 0.9 and water flows from 0 to 260 gpm. The concentrate is stored in two 15-gallon stainless-steel tanks.

For optimum mixing, water, foam concentrate, and air pass through a Komax motionless mixer. The mixer produces finished quality foam in 12 inches without loss of kinetic energy.

The engine has 5 discharge ports, two on each side plus a 2-1/2 inch monitor mounted mid-ship. The monitor can operate for 15 continuous minutes per truck load and is capable of reaching distances over 180 feet, flowing 125 cfm and 125 gpm at 0.3 percent mix ratio. At these rates, over 80 percent of the foam produced reaches the target.

This vehicle has full pump and roll capability without interruption of the foam stream due to shifting or changing engine rpm and production rates of this engine have been compared to a strike team of five water engines. We feel this engine is a true wildland and urban-interface engine of the future.

INJECTION FOAM SYSTEMS AND ASPIRATING NOZZLES

By David J. Day, State Forest Ranger, Fire Research Coordinator, Calif. Dept. of Forestry and Fire Protection (916) 445-9418

The California Department of Forestry and Fire Protection (CDF) has been testing and expanding the use of high-pressure discharge injection foam proportioners and aspirating nozzles. The technology has advanced tremendously in the last year and proportioners now incorporate precision controls and metering injection pumps. The nozzles now produce a wide variety of effective firefighting foam densities, while maintaining the ability to perform the streams and patterns of a regular combination plain water nozzle.

Currently, CDF has fire suppressant foam capability on the new Pilot Model Engine 2000 and 10 retrofitted proportioners on a variety of other fire engine models. Each of these engines can supply foam solution to several discharge outlets. Both 1 inch and 1-1/2 inch aspirating nozzles are supplied with the foam equipment when it is installed. This equipment will be used on all fire incidents where fire suppressant foam can be used.

The ability to use fire suppressant foam is desired by all firefighters who have seen its advantages. It is an exciting concept to demonstrate because of its acceptance among people in the fire service. There is no doubt among firefighters about the increased ability to control fires with these foam products.

CDF began to explore ways to utilize the relatively new foam products on a statewide basis in early 1987. It soon became obvious that standardized operational and training functions would be necessary for an organization the size of CDF to maximize their benefit. The equipment development process began to define CDF's foam needs. The methodology and equipment used must improve the overall firefighting ability of CDF and be cost effective.

Criteria have evolved from evaluating past CDF experience with other water enhancing products and the related equipment. The application methods for use in today's rural California structural and wildland fir protection consider many other aspects as well as fire control effectiveness. These aspects are:

1. Firefighter safety is primary in all applications.
2. Reliability of foam solution product delivery in all fire control evolutions is necessary.
3. The foam solution must be available over a wide range of pressures and flow rates from the apparatus when supplying handline operations.
4. The nozzle firestream must be adjustable so the firefighter will be able to react to any changes in the intensity of the fire being attacked, both for personal safety and effective fire extinguishment.
5. The foam solution delivery must be a stable and constant ratio through extensive hose lays and elevation changes between the apparatus and the nozzle.
6. Nozzles must be of a size and weight comparable to those in plain water application, while having both the aspirating and water pattern capabilities.
7. The proportioner system and nozzles must be uncomplicated to operate.

The CDF engines are equipped with foam equipment and nozzles that meet the above criteria. Operational training has been easy for both proportioners and nozzles. Fire suppression personnel will be asked to critique the equipment and its use after several months use. Changes and improvements to the systems and procedures will be incorporated as needs develop.

Formalization of training curriculum and application methodology will follow the general experience derived from using the fire suppressant products by firefighting agencies throughout the United States. All agencies should encourage the quantification and validation of fire suppressant foam's effect on Class A fuel materials. Standards and repeatable results of these products when compared to water are essential for them to become an accredited firefighting tool throughout the fire service.

FOAM DRAINAGE VESSEL

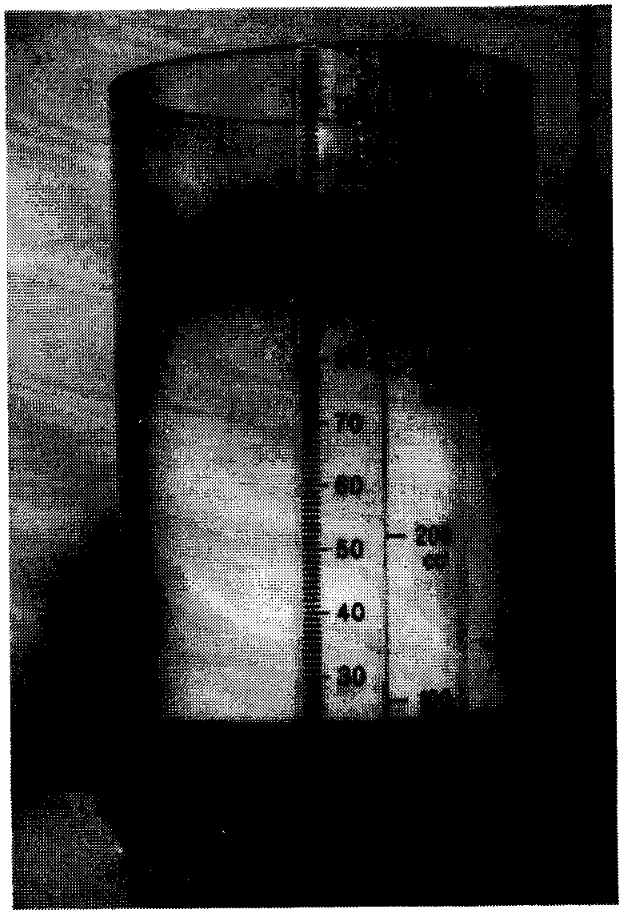
By Edward Stechishen,
Canadian Forestry Service,
Petawawa National Forestry Institute,
Chalk River, Ontario, Canada KOJ1JO,
(613) 589-2880

Containers suitable for foam drainage determination must have perfectly vertical walls, flat bottoms and a 90 degree internal wall to bottom angle. Since commercially available transparent containers, including graduated cylinders, did not meet this criteria, Canus Plastic Inc. custom built containers having a volume of 500 ml with graduations to determine the volume of foam in cc and graduations to determine the depth of liquid in mm.

Expansion is determined by dividing the volume of foam by its net mass in g (mass determined by a balance) and the drainage rate by reading the depth of the liquid in mm at given times and converting this depth reading to mass of fluid using a table or the equation: $Y = 37.3585 X$ (where X = depth and Y = mass). Since the foam solution has a specific gravity of approximately 1, the amount drained is the ratio of amount in liquid form relative to total amount in the vessel. Readings taken at two minute increments for 30 minutes give an excellent drainage/time relationship when plotted on graph paper using percent drained rather than fraction of total.

<u>Foam Vessel Specifications</u>

Wall thickness	0.35 cm
Inside diameter	6.96 cm
Wall height	13.25 cm



Foam collection beaker.

FOAM EFFECTIVENESS IN RELATION TO QUANTIFIED FIRE BEHAVIOR

By Martin E. Alexander
Fire Research Officer, Forestry Canada
Northwest Region
Northern Forestry Center
Edmonton, Alberta

Fire researchers in Western Australia (WA) recently published a report concerning fire behavior in relation to the effectiveness of foam applied from the ground on slowing the head fire spread and reducing fire intensity. A summary of their publication follows.

Three prescribed fires were started for training purposes on December 10, 1986. The fuel type consisted an unprunned, 17 year old heavily stocked (about 2,000 stems/ha or 800 stems/Ac) maritime pine plantation. The burning plots were about 1.3 ha (3.2 Ac) in size. Topographic slope was not specified in the report but was likely at least 10 percent.

A summary of fire behavior characteristics is given in the accompanying table. The associated weather conditions during the day's burning operation were:

Dry-bulb temperature:	21-25° C (70-77° F)
Relative humidity:	30-33 percent
10-m open wind:	20-24 km/h
20-ft open wind:	11-13 mi/hr

The moisture content of the surface litter and entire forest floor layer ranged from about 10-12 percent and 11-14 percent, respectively. The authors observed "short bursts of crown fire activity" and noted that "It seemed that fuel, weather and stand conditions were just below the threshold for sustaining crown fires." All three fires can probably best be categorized as intermittent crown fires.

The WA fire researchers concluded that "The foam lay were completely ineffective under the conditions of this trial. Fuel loads were too great and the energy output of the fires was more than sufficient to evaporate the foam, and ignite the fuels with no effect on fire behavior." Unfortunately, no details of the foam application such as product used, consistency, or spray width, are given in the report.

A copy of the WA report can be obtained from: N.D. Burrows, Department of Conservation & Land Management, P.O. Box 51, Wanneroo, WA 6065, Australia.

Behavior of three prescribed fires in a WA maritime pine plantation, (adapted from Burrows, Ward and Robinson 1988)

Pilot No.	Fuel consumption t/ha	Fuel consumption T/Ac	Head fire spread rate m/min	Head fire spread rate ch/hr	Frontal fire intensity kW/m	Frontal fire intensity Btu/sec /ft
1	17.9	8.0	3.0	9.0	1647	476
2	20.6	9.2	3.3	9.9	2106	609
3	19.0	8.5	2.6	7.9	1534	444

*Synonymous with Byram's fireline intensity. The estimates of fire intensity are based on a net low heat of combustion of 18,400 kJ/kg or 7915 Btu/lb.

An abstract from the USDI publication; 'A PERFORMANCE TEST OF LOW EXPANSION NOZZLE ASPIRATED SYSTEMS AND WILDLAND FOAM Dated: November 1988.

By Ronald R. Rochna and Paul Schlobohm, Fire Management Specialists, Bureau of Land Management - USDI, Boise Interagency Fire Center and Clarence Grady, Fire Protection Instructor, Chemeketa Community College, Salem, Oregon.

Nozzle aspirating systems can be quickly adapted to conventional water systems. These systems are well suited for direct attack, indirect attack, and mop-up firefighting tactics. Low expansion aspirating nozzles were tested for discharge pattern, expansion, and drainage rate according to the National Fire Protection Association Standard 412. According to the tests, expansion ratios averaged 5.6, and the 25 percent drain rate averaged 3.4 minutes. The test creates only a baseline of performance from which users and manufacturers can make judgements. Weather, topography, and fire behavior are examples of variables which were not part of the test procedure.

Wildland fire foams are characterized by relatively stable bubbles formed by a liquid of superior wetting ability.[1] Hydrocarbon surfactants or soaps are the major ingredients of foam in addition to water. Surfactants reduce the water surface tension allowing the water to form bubbles. Reduced surface tension also gives improved penetrating and spreading capabilities to water draining from a foam. Fire knockdown rates are improved over plain water. Foam acts as a vapor suppressant and as an

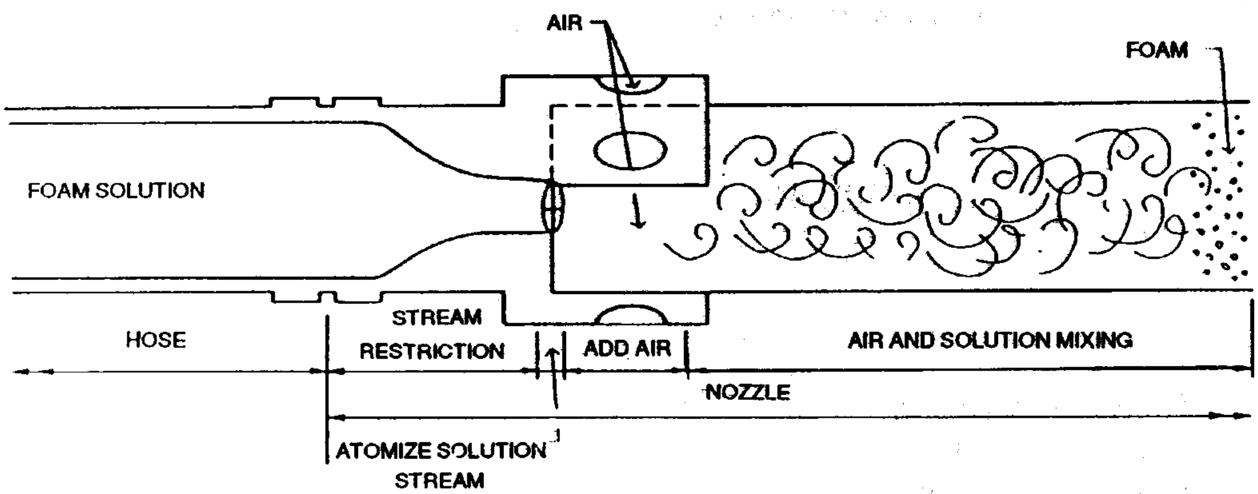


Figure 1

Schematic of the nozzle aspirated system

Figure 2

The nozzles tested are either commercially available or their simple construction design can be obtained.

Nozzle Name	Nozzle Shape Scale: 1" = 2'	Pattern Settings Tested	Contact if not Commercially Available
Rockwood SG 60 w/ FF extension		a	
Co-son Blizzard Wizard LF 5		c	
Co-son Blizzard Wizard MF 16		c	
Co-son Blizzard Wizard HF 32		c	
Co-son Blizzard Wizard HF 32M		c	
Southwest Oregon Nozzle		c	O. Eary & D. Moody Oregon State Department of Forestry 5286 Table Rock Road Central Point, OR 97502 (503) 664-3328
Pacific Airflex III		c (3)	
Pacific Airflex I		c	
Elkhart FSL w/ Model 244 Tube		a	
Elkhart SM-10F w/ Model 245 Tube		a	
Modified KK (2)		a,b	Gary Self Los Padres N.F. Los Prietos R.D. Star Route Santa Barbara, CA 93105 (805) 967-3481
Model 4100		a,b	John Machado California Department of Forestry 1968 S. Lovers Lane Visalia, CA 93277 (209) 732-5954

a: maximum distance pattern

b: maximum aeration pattern

c: optimum foam production pattern

insulative, reflective barrier, preventing or delaying ignition. These foams are considered suppressants and have limited long-term effectiveness. Use levels are between 0.1 percent and 1.0. percent. Available performance data about these foams and their generating systems are limited.[2]

Firefighting foams are mechanically generated by either low or high energy systems. The low expansion, aspirated nozzle is a low energy system.Low energy means the total amount of energy available for creating foam is supplied by the water pump. No other motive forces exist.

Nozzle aspirating systems create foam by: 1) atomizing the foam solution streams, 2) drawing air into the streams to create a froth, or, 3) mixing the froth in an expansion chamber to enlarge and strengthen the bubbles (see figure 1). Generally, nozzles which spend much energy for propulsion of foam have little energy available to make foam and therefore produce a wet, frothy foam. Conversely, nozzles which use most of their energy in foam production have short discharge distances.

The foam properties tested were discharge pattern, expansion, and drainage rate. Expansion relates to heat absorption, water use, and barrier depth characteristics. Drainage rate is an indication of foam stability and viscosity, and is commonly measured by the 25 percent drain time.

The NFPA 412 standards followed are described in section 422, Hand Line and Auxiliary Nozzles, parts a and b. Testing occurred during windless and near windless conditions. We chose as a reference point to test all aspirated systems at 100 psi., 0.5 percent solution, and as much water as the nozzle would allow under these conditions. Water temperature was 40° F. A commercially available wildland fire foam product was injected into the water line for all systems.

Each nozzle was mounted at normal hand-held operating height on a turret which was tilted 30 degrees from the horizontal. The nozzle produced foam for 30 seconds on flat pavement. Markers were set out to denote pattern width and length.

The collector was located to sample mid pattern foam properties. Each discharge pattern was sampled for expansion and drain time. The aluminum collector was a standard aqueous-film-forming-foam collector with dimensions as shown in figure 3.

Two sample containers held by the collector were one liter capacity transparent plastic graduated cylinders, 14 inches tall and 2.5 inches inside diameter. Ten ml. graduation marks were placed on the cylinders below 100 ml. to remain in the working range of the test. Each cylinder was cut off at the 1000 ml. mark to ensure that sample volume. When the sample containers became filled with foam a stop watch was started to define time zero for drain time analysis.

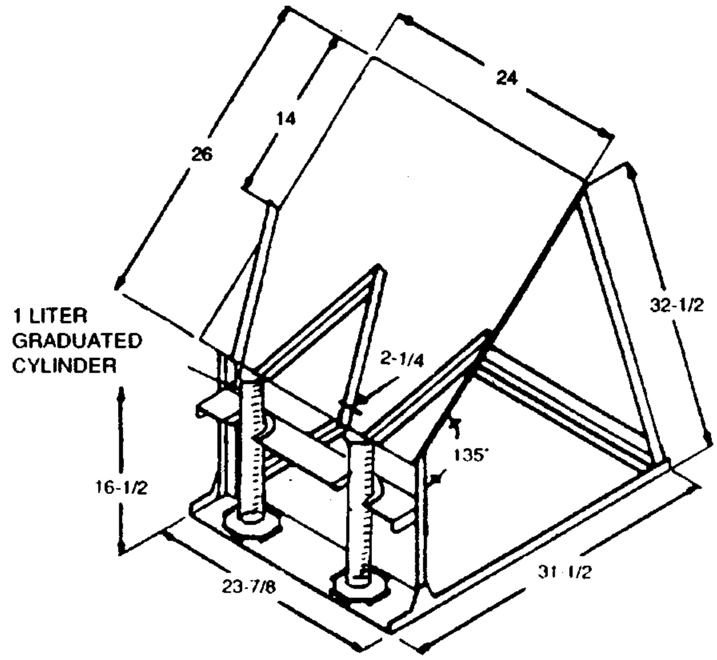


Figure 3
Low Expansion Foam Collector[3]

Each foam-filled container was weighed to the nearest gram. The expansion of the foam sample was determined by the equation:

$$\text{expansion} = \frac{\text{Volume of foam}}{\text{volume of solution}} = \frac{1000\ \text{ml.}}{(\text{full wt.}) - (\text{empty wt.})}$$

The drainage rate was conducted on the same samples measured for expansion. The time in minutes for one quarter of the liquid in the foam to drain from the foam is called the "25 percent drain time." The 25 percent volume was determined by dividing the net weight of the foam sample by four. Beginning with the time established when collection was complete, the draining volume was measured every minute until it reached or surpassed the 25 percent volume. If necessary, interpolation was used to estimate exact time. For example, if the 25 percent volume occurred between the 4 and 5 minute marks, then the increment to be added to 4 minutes was found by:

$$\frac{\text{25 percent volume - 4 min. volume}}{\text{5 min. volume - 4 min. volume}}$$

Figure 4

Discharge patterns and water flow rates of low expansion nozzle aspirated systems. Foam was produced at 100 psi and projected 30 degrees from the horizontal.

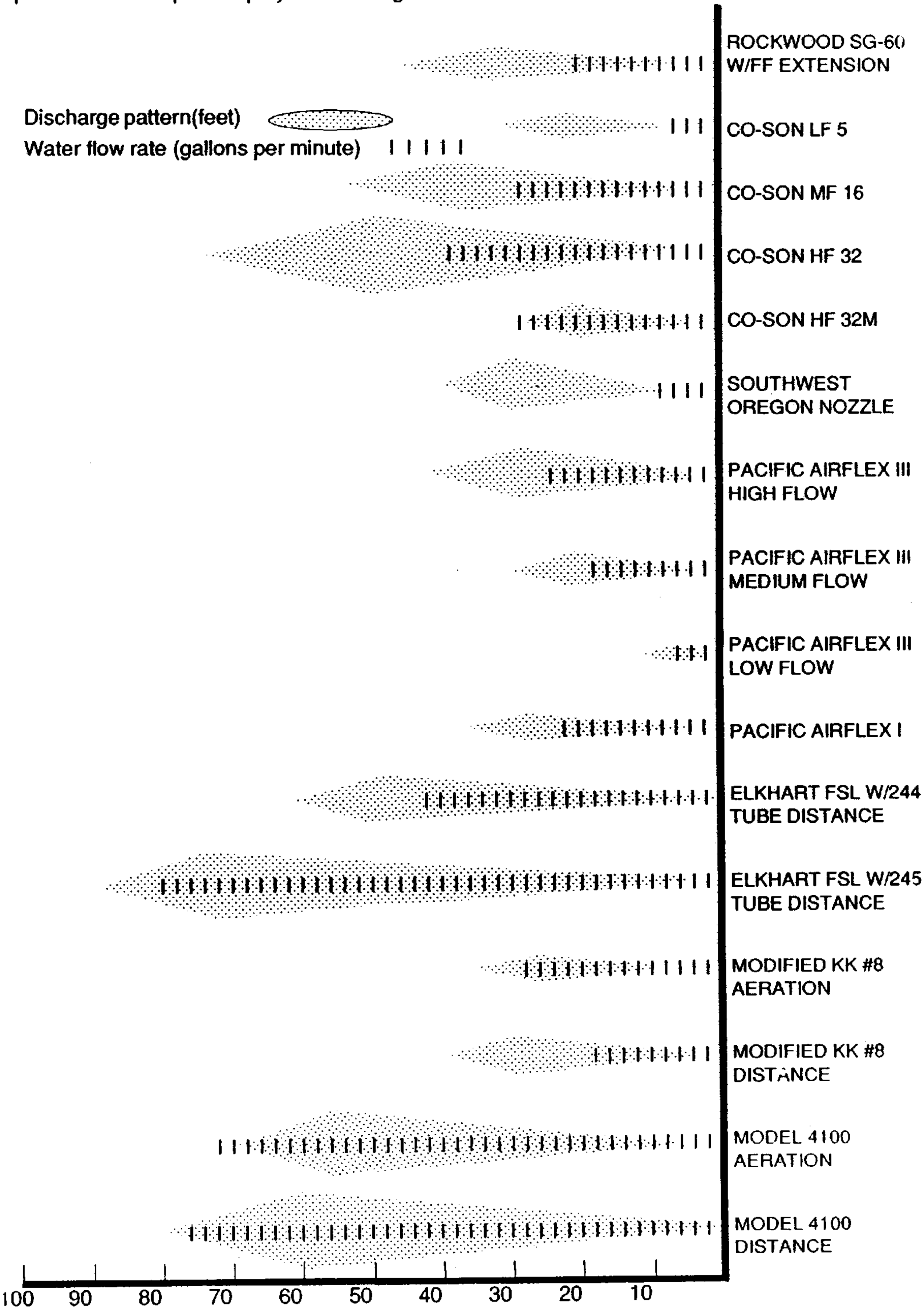
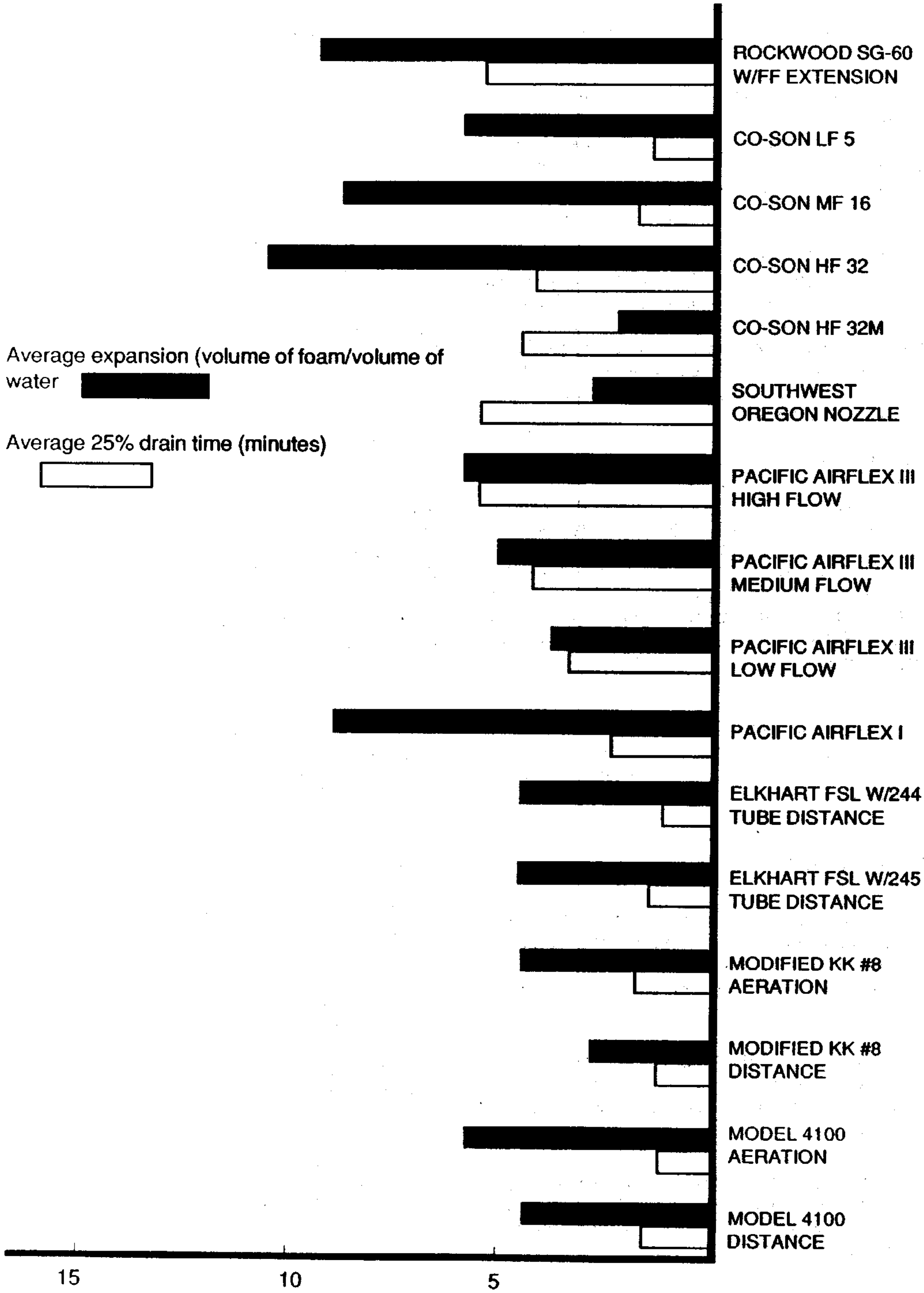


Figure 5

Expansion and 25 percent drain rates of low expansion nozzle aspirated systems. Foam was produced at 100 psi with 0.5 percent and 0.3 percent solutions, respectively.



Discharge patterns and water flow rates are shown in figure 4. Results for expansion and 25 percent drainage time were averaged between the two sample containers and plotted in Figure 5.

Four large water flow nozzles reached over 70 feet. Over two thirds of the discharge patterns were less than 60 feet long and 6 feet wide. Expansion ratios ranged from 2.9 to 10.8 with an average of 5.6. The 25 percent drain rate averaged 3.4 minutes, ranging from 1.9 to 5.4 minutes.

The foam collecting device has an inherent drain time error for two reasons. First, the collector is designed to capture wet foams. Dry, low expansion foam did not readily slide into the containers. Second, the device requires that two sample containers be filled. When one container becomes filled well before the second, the drainage rates of the two containers can be significantly different.

In general, low expansion aspirated nozzle systems have limited discharge distance and produce rapidly draining foams. Increased discharge distance requires either an increase in system energy such as pump pressure or less energy spent creating foam. These characteristics suggest aspirated systems are well designed for 1) direct applications to fire fronts, 2) creating defensive foam barriers, and 3) surface fire mop-up. Aspirated systems with Multiple pattern settings offer the most versatility for these applications.

The advantage of the low expansion aspirated nozzle systems is that they offer a simple, introductory method of foam production with low initial costs and improved water efficiency.

REFERENCES

[1]Madrykowski, Dan. 1988. Wildland foam testing at the National Bureau of Standards. Presented at: The International Workshop on Foam Applications for Wildland and Urban Fire Management. Denver, Colorado.

[2]NFPA 298. 1988. Draft Standard on fire suppressant foam chemicals for wildland fire control. Quincy, Massachusetts: National Fire Protection Association.

[3]NFPA 412. 1974. Standard for evaluating foam firefighting equipment on aircraft rescue and firefighting vehicles. Quincy, Massachusetts: National Fire Protection Association.

SUGGESTED READING

The Foam Task Group compiled a list of over 30 references that contain valuable information on the world of fire foams. The following articles, papers, and reports on foam technology are for your suggested reading:

1. Anonymous. New liquid foam to fight forest fires in France. Fire Intl. p. 81; 1972.

2. Aubert, J. H., Kraynik, A. M., and Rand, P. B. Aqueous foams. Scientific Amer. (5):74; 1986.

3. Hoffman, V. B., and Jung, S. EXPYROL W1, ein neues Schaumloschmittel fur die Bekampfung von Waldbranden. 36: 1093; 1982; Allgemeine Forst Zeitschrift; Munich, W. Germ.

4. Insurance Services Office. Fire suppression rating schedule. New York: Insur. Serv. Off.; 1980.

5. Lorberbaum, V. G., and Smirnova, K. V. The application of high intensity foam in fighting forest fires. In: Bull. 19, Forest fires and the technical means of combatting them. Leningrad, USSR: Leningrad Sci. Res. Inst. of For.; 1974.

6. Lorberbaum, V. G., and Smirnova, K. V. Foam for forest fire control. LesnoeKhozyaistvo (6): 74-75; 1972. [Edited Engl. transl. avail. from Library Environment, Canada.]

7. McKinnon, G., ed. Foam extinguishing agents and systems. 15th ed. Sect. 18, chapter. 4. Quincy, MA: Natl. Fire Protect. Assoc.; 1981.

8. Metzner, A. B., and Brown, L. F. Mass transfer in foams. Indstrl. & Engrg. Chem. 48(11): 2040-2045; 1956.

9. National Fire Protection Association. Mobile foam apparatus. Quincy, MA: NFPA; 1986.

10. Rivkind, L. E., and Myerson, I. Foams for industrial fire protection. Indstrl. & Engrg. Chem. 48 (11): 2017-2020; 1956.

11. Bryan, John L. Fire suppression and detection systems. 2d. ed. New York: MacMillan Publishing Co., Inc.; 1982. 518 p.

12. Chang, R. C., Schoen H. M., and Grove, C. S., Jr. Bubble size and bubble size determination. Indstrl. & Engrg. Chem. 48(11):2035-2039; 1956.

TEXAS FOREST SERVICE CAFS STRIKE TEAM TRAINING PROGRAM

by Mark Stanford, Texas Forest Service, P.O. Box 310, Lufkin, TX. 75901, (409) 639-8100

CAFS strike teams were first used by the Texas Forest Service during the 1987 west coast fire siege. Although they proved effective, strike team personnel reported the need for specialized training beyond the standard water handling courses. Some of the training needs which were identified included CAFS troubleshooting and maintenance, the role of CAFS in extended attack, and structural and aircraft applications.

A 40 hour training course was developed under the direction of strike team leader David Abernathy. David's involvement in the CAFS program dates back to it's inception both as an agency employee and fire chief in Pittsburg, Texas. The training was designed to prepare firefighters to safely deploy and maintain CAFS engines within a strike team framework. Since strike team members are expected to be experienced in water handling, the training is considered an advanced course specializing in CAFS applications.

The training course includes the following topics:

1. CAFS STRIKE TEAM CONCEPT. This introductory section will offer a brief review of the strike team responsibilities and the agency's mobilization and travel procedures.

2. PERSONNEL SAFETY. Personal survival techniques along with fire apparatus safety and environmental hazards will be included in this section.

3. CAFS OPERATION. Reviews the history of the system, components of the module, and applications.

4. TROUBLESHOOTING AND MAINTENANCE. An overview of problems that can be encountered with foaming agents and components of the air and water systems, along with repair and maintenance, and problem solving will be discussed.

5. DEPLOYMENT AND TACTICS. This section will include strike team deployment, direct and indirect attack, and mop-up.

6. FIRE APPARATUS OPERATION. Included in this section will be equipment, relay pumping, water supply, nozzle and hose evolutions, and pump-and-roll.

7. STRUCTURAL APPLICATIONS. Exposure protection, direct and indirect attack from outside structures, attic/roof fires and mop-up will be presented.

8. AIRCRAFT APPLICATIONS. This section will cover terminology, safety, fixed-wing design, helicopter design, fire protection, and evacuation.

In addition to the training program, the Texas Forest Service is initiating the development of CAFS strike teams from volunteer fire departments through their county fire associations. These strike teams will be trained and certified by the Texas Forest Service for use on incidents requiring state-wide response. Hopefully this program will bring us closer to our goal of shared-resources and total mobility by further involving the volunteer firemen that work within the state of Texas.

<u>NOTICE</u>: WATER HANDLING EQUIPMENT GUIDE

The third edition, June 1988, of the Water Handling Guide is available from Boise Interagency Fire Center, BLM Warehouse, 3905 Vista Avenue, Boise, Idaho 83705. The price is $1.52; order NFES 1275.