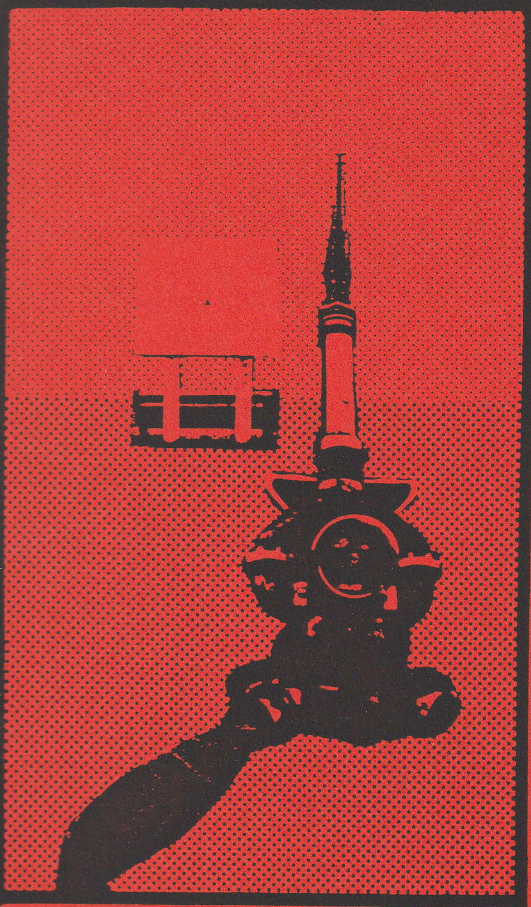

A PERFORMANCE TEST OF LOW EXPANSION NOZZLE ASPIRATED SYSTEMS AND WILDLAND FOAM

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A PERFORMANCE TEST OF

LOW EXPANSION

NOZZLE ASPIRATED SYSTEMS AND

WILDLAND FOAM

The first in a series of reports on foam-generating systems for Class A fuel application. The series will continue with reports on compressed air foam systems (CAFS), medium expansion aspirated nozzle systems, and how to use each of the three systems to its advantage.

by

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ABSTRACT

Performance information for wildland foam equipment is in high demand. Nozzle aspirating systems can be quickly adapted to conventional water systems. Low expansion aspirating systems were tested for discharge pattern, expansion, and drainage rate according to the National Fire Protection Association Standard 412. Expansion ratios averaged 5.6. The 25 percent drain rate averaged 3.4 minutes. Nozzle aspirated systems are well suited for direct attack, indirect attack, and mop-up firefighting tactics.

INTRODUCTION

The Bureau of Land Management and Chemeketa Community College conducted the Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles (NFPA 412) as part of a continuing cooperative evaluation of wildland foam technology. The purpose of the test was to start meeting the demand for performance information on aspirated nozzles.

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

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

ASPIRATED NOZZLE SYSTEMS

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, 3) mixing the froth in an expansion chamber to enlarge and strengthen the bubbles (see Figure 1). In general, nozzles which spend much energy for propulsion of foam have little 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.

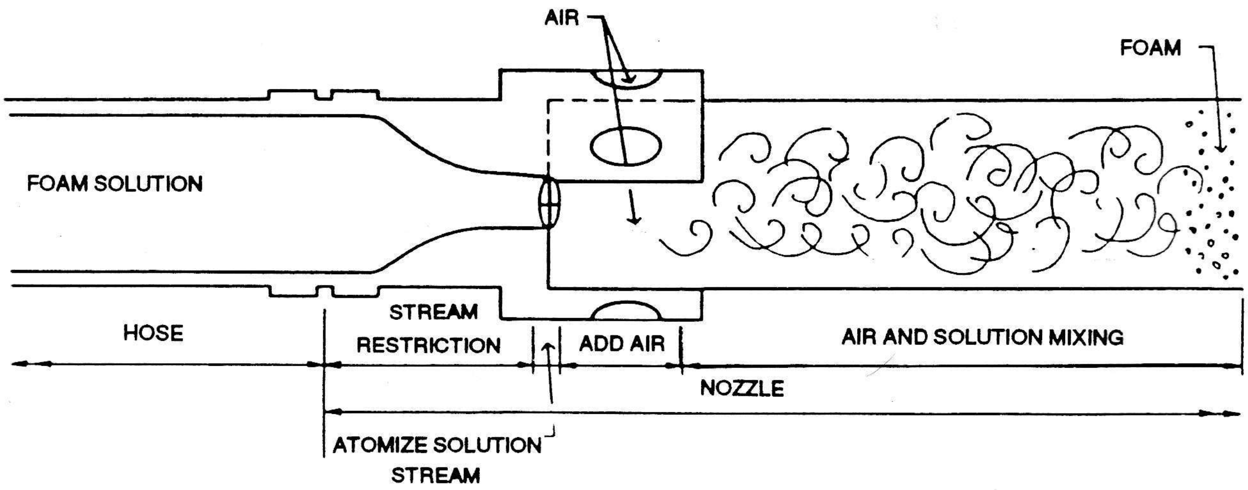


Figure 1

Schematic of the nozzle aspirated system

THE TEST

We hope this test can be a benchmark for others who wish to test currently available or soon-to-be available systems. As many aspirating systems as possible were tested and they are listed in figure 2. Many are commercially available, some are not.

The foam properties tested were discharge pattern, expansion, and drainage rate. Direct attack will not be safe or effective beyond the length of a nozzle's discharge pattern. The capability of a nozzle to form a fire resistant ground and canopy barrier is also a function of discharge pattern. 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.

TEST PROCEDURES

The NFPA 412 standard contains many related tests for foam equipment. The procedures followed are described in section 422, Hand Line and Auxiliary Nozzles, parts a and b.

Testing occurred during windless and near windless conditions. When wind would have been a factor, tests were conducted within a sheltered area.

Every aspirated system has a range of recommended values for water pressure, water flow, and concentrate ratio. 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.

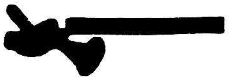
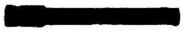
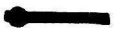
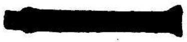
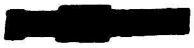
Water temperature was 40°F. Foam concentrate was injected into the water supply. A commercially available wildland fire foam product was used for all systems.

GROUND PATTERN

To determine the discharge pattern, 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.

Each pattern setting for a given system was established and measured.

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

FOAM SAMPLING

After the pattern markers had been set, the nozzle was pivoted to the side to project onto the foam collector. The collector was located to sample midpattern 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 in height and 2.5 inches in 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 the stream was directed away and a stop watch started to define time zero for drain time analysis. The containers were removed from the collector and cleaned of excess foam.

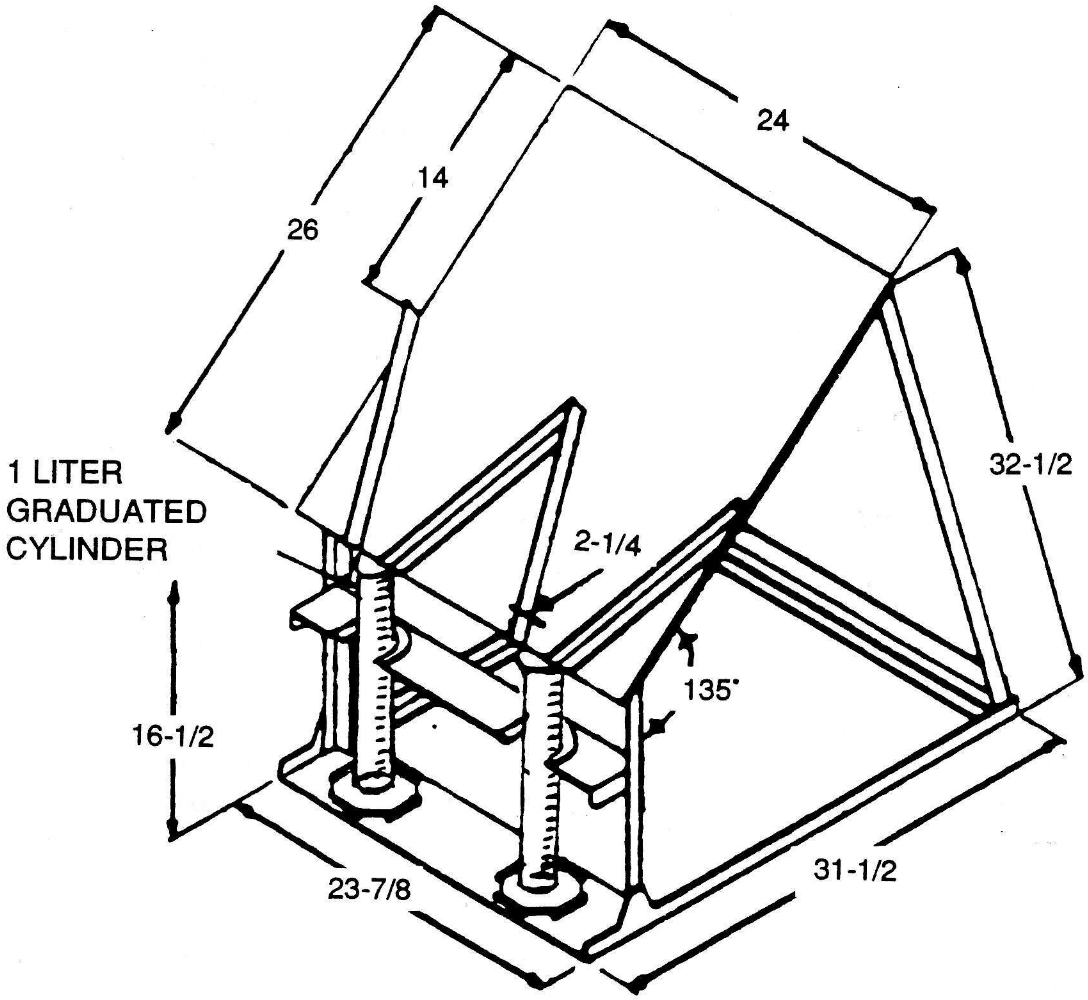


Figure 3

Low Expansion Foam Collector[3]

Expansion

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

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

Drainage Rate

The analysis for 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:

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

RESULTS/DISCUSSION

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.

Although the NFPA 412 guidelines for procedure were followed as closely as possible, we chose not to measure pattern depth. It was understood that the rationale for depth measurement came from two dimensional liquid fuel applications. We felt the expansion and drainage data would adequately measure the ability of foam to form layers on three dimensional wildland fuels. The measured foam pattern was defined by the limits of material dropping from the projected stream. At times, wind made pattern measurement difficult.

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 becomes filled well before the second, drainage rates of the two containers can be significantly different.

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.

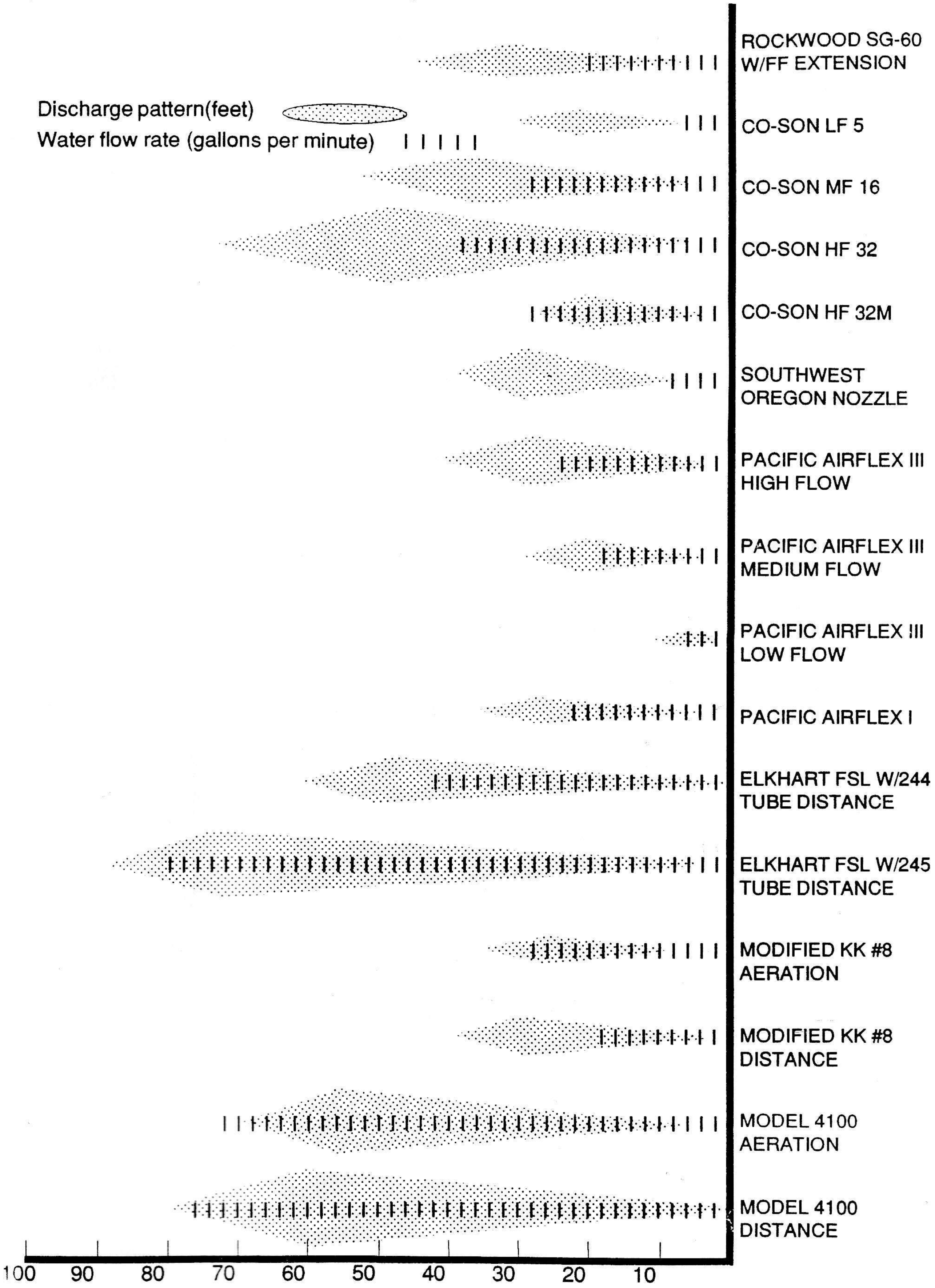
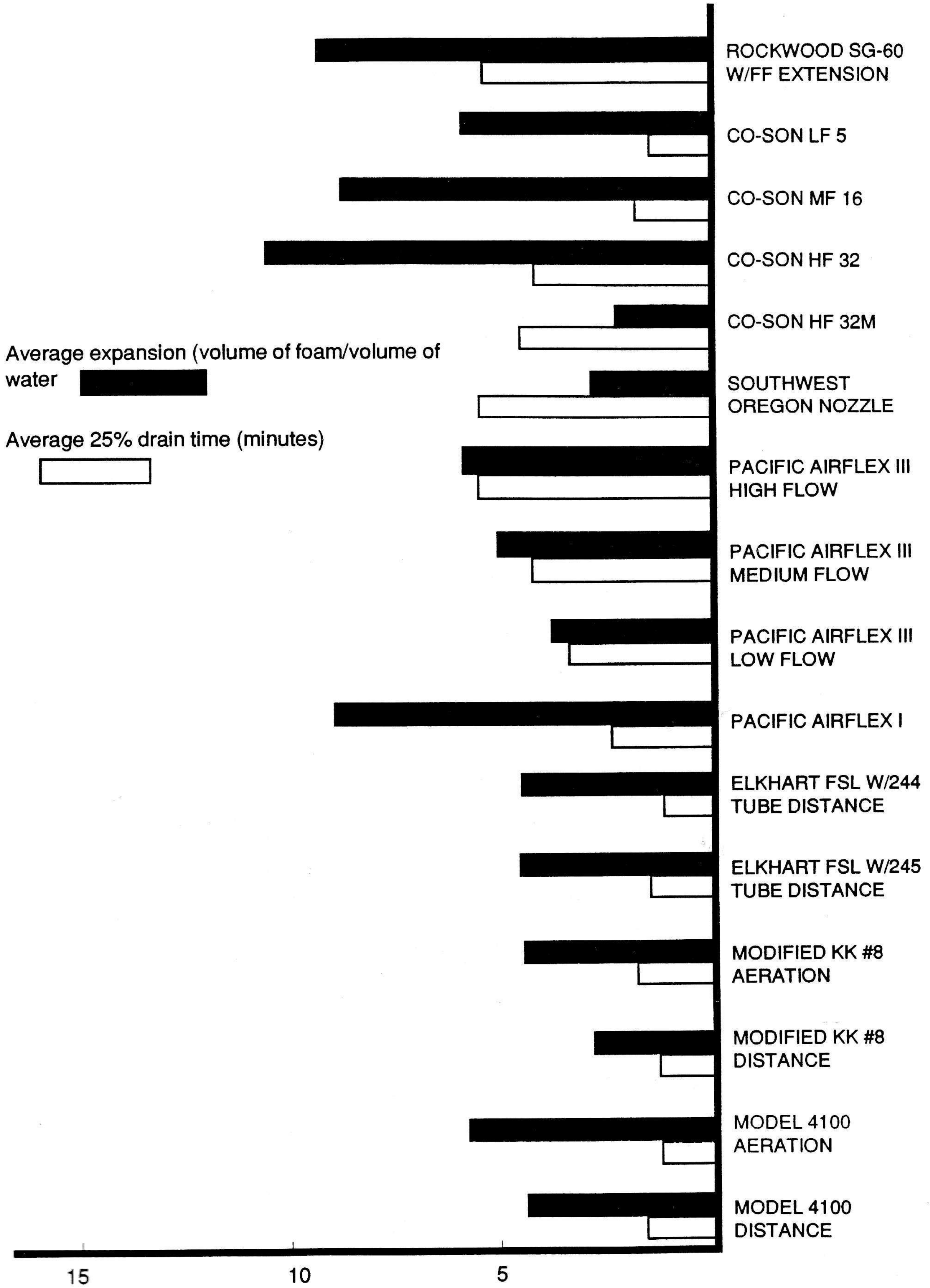


Figure 5

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



CONCLUSION

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 fire fighting equipment on aircraft rescue and fire fighting vehicles. Quincy, Massachusetts: National Fire Protection Association.