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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**

NATIONAL WILDFIRE COORDINATING GROUP

Canadian Committee on Forest Fire Management

Comité canadien de gestion des feux de forêt

FOAM PROPORTIONING SYSTEM PLACED ON FLORIDA DIVISION OF FORESTRY 6000 GALLON WATER TENDER

By Dan W. McKenzie, Mechanical Engineer, USDA Forest Service, San Dimas Technology & Development Center and J. P. Greene, Fire Resource Manager, Florida Division of Forestry

The USDA Forest Service, San Dimas Technology & Development Center, San Dimas, CA assisted the Florida Division of Forestry in equipping one of their 6000 gallon water tenders with a pump discharge, automatic regulating, balanced pressure, venturi, pump proportioning system. This system was designed to operate at 400 gpm and up to 200 psi. There are plans to equip up to six more water tenders with this proportioning device.

These tenders are dual-use, stainless steel, semi-trailers constructed to dairy industry standards. They serve both as firefighting apparatus and as emergency potable water supply transports. In the drinking water supply mode, they saw extensive service in the aftermath of Hurricane Andrew in south Florida. While batch mixing foam solution in the water tank is a marginally acceptable method of foam employment in most wildland fire applications, the difficulty of sanitizing the tenders for subsequent potable water use encouraged the Florida Division of Forestry to search for a low-cost, easily operated, high-volume foam proportioner.

Figure 1.—Florida Division of Forestry 6000 gallon water tender in operation. ▶

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Figure 2.—Foam proportioning system and Florida Division of Forestry 6000 gallon water tender.

The proportioning system was specially designed to operate with the 45FP-VW53 centrifugal water pump mounted on the water tenders. The Hale 45FP-VW53 pump is rated to operate at 400 gpm and 125 psi. In normal operation the water tenders will pump overboard at 400 gpm through a 1 1/4-inch bore nozzle mounted on a water cannon. The proportioner will add foam concentrate up to 1 percent at 400 gpm water flow.

In the design of the proportioning system a large throat venturi, 1.3-inch diameter, was used in order to limit pressure loss when placing a venturi in the water flow stream. The use of this 1.3-inch venturi throat results in a pressure loss of only about 6 to 13 psi when operating at 400 gpm, which is the flow rate the system is operated at most of the time.

On the next units, a 1.5-inch diameter venturi will be used to reduce the pressure loss still further to about 4 to 8 psi when flowing 400 gpm. A positive displacement vane pump, rated to 200 psi and driven by a 3/4 hp 12-volt DC motor, was used to supply the foam concentrate at water pressure to the venturi. This pump could be driven by the centrifugal water pump engine if a suitable driving arrangement is available. The 12-volt motor does work well and in normal operation draws about 40 ampere and at maximum pressure (200 psi) draws 58 ampere.

The system tested well even at flows below 400 gpm. This system is estimated to work well down to 100 gpm and can be made to work lower by placing a 1/2 psi cracking pressure check valve just ahead of the venturi.

The first water tender equipped with this system is currently undergoing operational testing in the Division of Forestry's Myakka River District in southwest Florida. In the firefighting mode, the tender will be employed in both the direct attack and exposure protection roles in the wildland/urban intermix where heavy fuels and subdivisions come together.

Following (page 4) is a schematic drawing and (page 5) a major item material list used in the system described in this article.

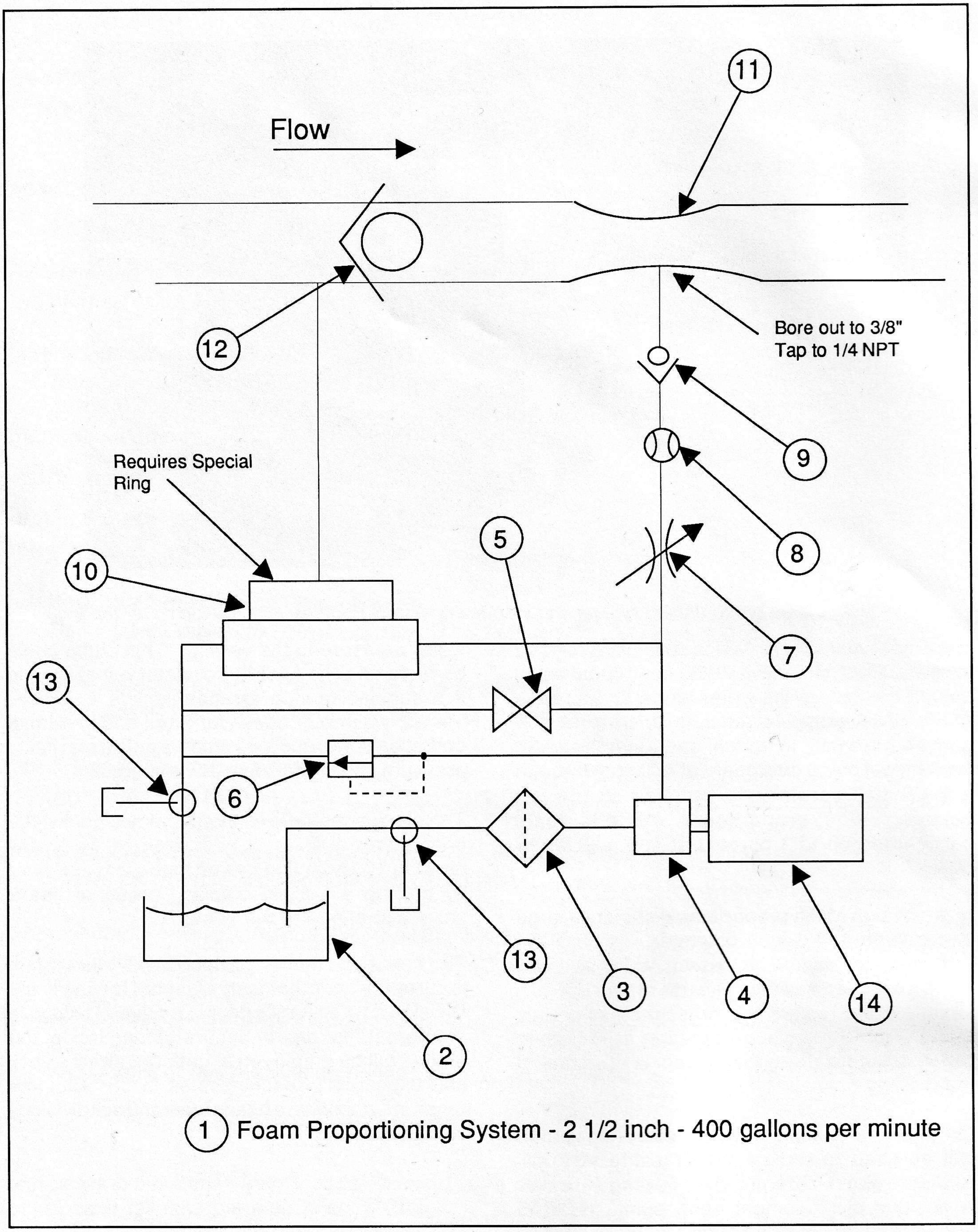


Figure 3.—Schematic drawing of foam proportioning system.

Material List

Foam Proportioning System - 2 1/2 inch - 400 gpm

Item	Qty	Description
1.	1	Foam proportioning system, 2 1/2 inch, 400 gpm
2.	1	Tank, foam concentrate, with level gauge, size to suit
3 .	1	Strainer, 3/4 inch size, Grainger 2P133
4.	1	Pump, 3.8 gpm @ 1750 rpm maximum rpm, Procon 2507 XM (set relief valve at 200 psi) (maximum pressure 200 psi) with NEMA 58C motor mount
5.	1	Valve, ball, 3/4 inch size, Apollo 70-104
6.	1	Valve, relief, 3/4 inch, set at 180 psi, Grainger 2P072
7	1	Valve, ball, angle, brass, 3/8 inch size, Whitey B-44F6-A
8.	1	Flowmeter, foam concentrate, brass, 3/4 inch size, .5 to 5 gpm, Lake B4B-6WC-05 (use foam concentrate scale)
9.	1	Valve, check, brass, 3/4 inch size, Grainger 5 X 783
	or 1	Valve, check, brass, 3/4 inch size, Apollo 61-504
10.	1	Relief valve, pilot operated, 3/4 inch size, Norgren 16002-008 with modified ring
11.	1	Venturi, brass, 2 1/2 inch size, with 1.49 throat, Barco 2 1/2 inch - 607
	or	Gerand 2 1/2 inch - 628
12.	1	Valve, check, brass, swing type with composition disc, 2 1/2 inch size, Crane No. 137
13.	2	Valve, 3 way, 3/4 inch size, brass, Apollo 70-604
14.	1	Motor, 12-volt DC, 3/4 hp, Leeson 108048

Notes:

a. Install proportioner system so, if foam is spilled, it will fall to the ground and will not run down the truck body.

b. Foam concentrate lines to be 3/4-inch inside diameter or larger.

c. Foam concentrate lines, piping, and fittings to be brass, aluminum, stainless steel, or plastic. Plain steel, galvanized steel, copper, or cadmium plated steel shall not be used.

d. Install water pressure sense line from pilot operated relief valve in front of check valve (item 13) and at the top of the water line.

e. Bore out venturi (item 11) throat to 3/8 inch and tap to 1/4 NPT.

f. May need more than one item 9.

g. Item 10 needs special modified new ring, see USDA Forest Service, San Dimas Technology & Development Center for detail.

FOAM TASK FORCE
STANISLAUS NATIONAL FOREST

by Tom Lane, U.S. Forest Service, Stanislaus National Forest, Sonora, CA

In its second year, a little more refined, a Foam Task Group is available on the Stanislaus NF and C.D.F. Tuolumne/Calaveras Ranger unit, in cooperation with C.D.F., Tuolumne County Fire, U.S. Forest Service and MI-Wok/Sugarpine Fire Department. In our first year the Foam Group was utilized on three large fires. The Moccasin Fire, on state lands near Moccasin, CA started on August 1, 1992.

Our Foam Task Force was dispatched and on arrival it was very apparent that the fire was going to be large, as flame lengths were observed at 200 to 300 feet. The main front was heading for the town of Big Oak Flat and we were assigned to structure protection for that area. Most of the structures were between the fire and the main town. We foamed structures at 1.0 percent using 80 gpm Flameco nozzles and then coated 30 feet around the structures. The Stanislaus Hotshot Crew started burning out from our foam line. These tactics worked extremely well and no structures were lost.

We also foamed a restaurant and five residences in a draw above the fire, and again, never lost a structure as the fire passed by. The next day we were moved to another part of the fire for holding line and mop-up. The guesstimate is, that by using foam, the mop-up time was cut in half. Stump holes and deep seated material were quickly put out.

After the fire, a Groveland fireman came up to us and thanked us for saving his house. He stated that he had written off his house to the fire and was amazed how the foam had protected his structure and out buildings. Even the fine fuels in his yard that had foam on them would not burn, so his entire yard area was also spared.

Although this was our first assignment as a Foam Task Force and we still had some tactical organizing to do, the question was asked, "Were we a cost effective group?"

After analyzing what was saved in public and private resources (we figured over two million dollars), the conclusion was, "fairly effective" for three foam engines, two watertenders, a utility vehicle, and a Task Force Leader! The Moccasin Fire consumed 8000 acres and was controlled in five days.

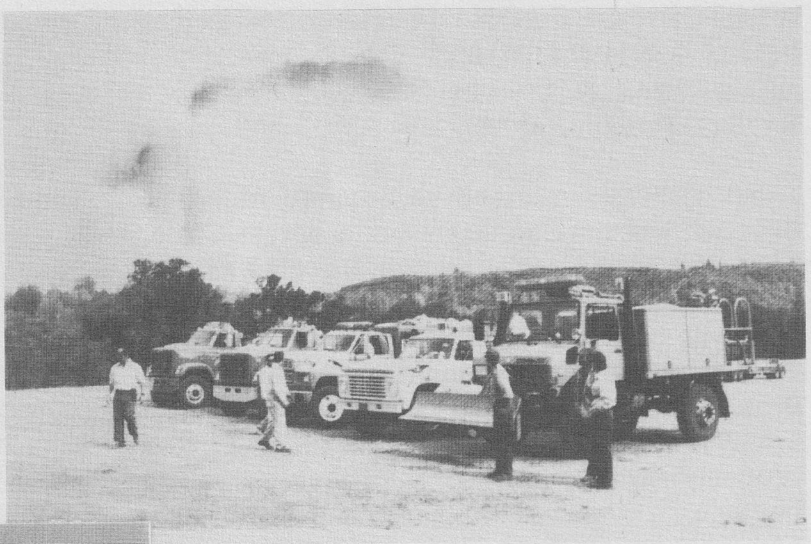
Our second fire was the Gulch Fire on August 9, 1992. We became involved four days after the fire started and had already reached 18,000 acres. Our assignment was from the U.S. Forest Service, as two agencies were involved. We were to burn out the east flank of the fire and keep it from reaching the town of Arnold, CA.

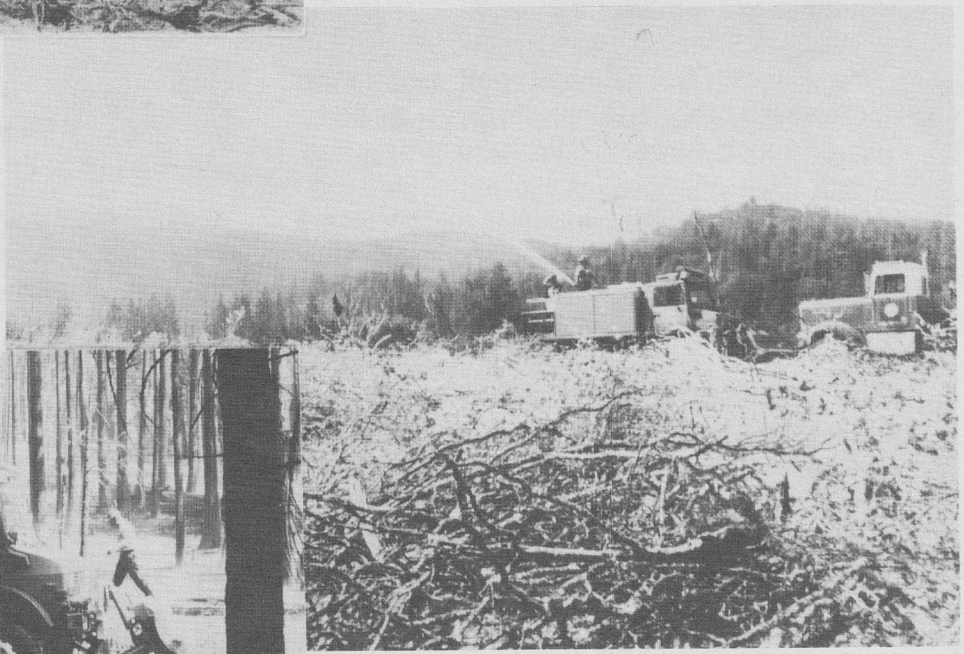
The burn-out started late in the night and as quickly as fire was put to the ground, trees would start crowning out. One of the Foam Units, STF Eng. 13, a 2150 Unimog off of the Stanislaus NF was equipped with a forester monitor and a 125 Elkhart foam nozzle. This was extremely useful in coating the crowns and knocking down the flare-ups on the line. Engine 13 was shooting foam as far as 150 feet up and out. The foam coated areas were no longer a threat. The burn-out was successful, and again, foam was a key player.

Our third fire was the Ruby Fire on September 7, 1992. The Foam Task Force was dispatched for a burn-out along a road that was to be fired. The burn-out was at night, but the fire intensity was still high. The Foam Group lined-out on the road and started foaming the opposite side of the road as the burners fired the low side. A 0.05 percent mix was used with 80 and 90 gpm. Flameco nozzles were in service. One engine got so hot that the paint was scorched on one door and the red lights melted. The foam lines held and spot fires were very minimal. The areas that foam was not used on had many spots. The fire was contained at 3400 acres by the next day. The Foam Group then went into mop-up for the rest of the fire.

Again, foam mixed at about 0.01 to 0.03 was extremely efficient for stump holes and most mop-up situations.

The Foam Task Group comprised of firefighters from the U.S. Forest Service, Stanislaus National Forest, the California Department of Forestry & Fire Protection, Tuolumne County Fire Department, and the MI-Wok/Sugarpine Fire Department in action.





WESTERN OREGON INTERAGENCY FOAM GROUP UPDATE

Merrill Tester, BLM, 1992-93 Board Chairman
WOIFG, Roseburg, OR

The WOIFG, comprised of engines from two BLM Districts, the Umpqua National Forest, Crater Lake National Park, and the Douglas Forest Protective Association, was assigned to nine incidents during the second year of operation. Two stand out as the most significant—Lone Pine (Winema NF) and Fountain (CDF-Shasta Trinity Unit). Both incidents had high private property values and exhibited extreme fire behavior. On both incidents the group used compressed air foam to successfully protect structures, burn-out and hold critical control lines. These actions clearly demonstrated the effectiveness of a highly organized, self contained and well managed suppression resource that utilizes state-of-the-art technology and apparatus.

The primary tactical missions of the Group are:

- Highly effective initial and extended attack. This includes hoselay support as well as roaded attack. The Group can provide an IA Group for almost any fire situation and can be split into two or three task forces for multiple fire situations.

- The Foam Group, combined with hand crews and other engines, has proven to be an effective force in structure protection.

- Most of the engines within the group were built for prescribed burning, so the Group can serve as an effective holding resource for wildfire firing situations.

- The Group carries a large amount of hose, fittings, and portable tanks, so it can assist the incident's water handling operation. The Group has three trucks that can function as Type II tenders, if needed, and all members are experienced in complex water handling operations.

Dispatches were to Region 5 including ABC Misc., incidents on the Klamath NF, the Fountain Incident on the Shasta Ranger Unit, CDF, and the Cleveland Incident on the El Dorado NF. The Group was also assigned to fires on the Winema and Fremont National Forests in Region 6. Major tactical assignments included structure protection and planning, firing support, water handling, water tender support, in addition to overhead and logistical support.

In early August 1992 the Group was dispatched to the Lone Pine Incident on the Shasta Ranger Unit, CDF. This fire proved to be a very sobering experience for the Group. This fire moved the Group to respond to the needs of the people of the small communities that were destroyed by the incident. Before the Group was demobilized, it took up a collection to help rebuild a community clinic. The practice of giving something back to the community effected by an incident served by the Group is now an on-going tradition.

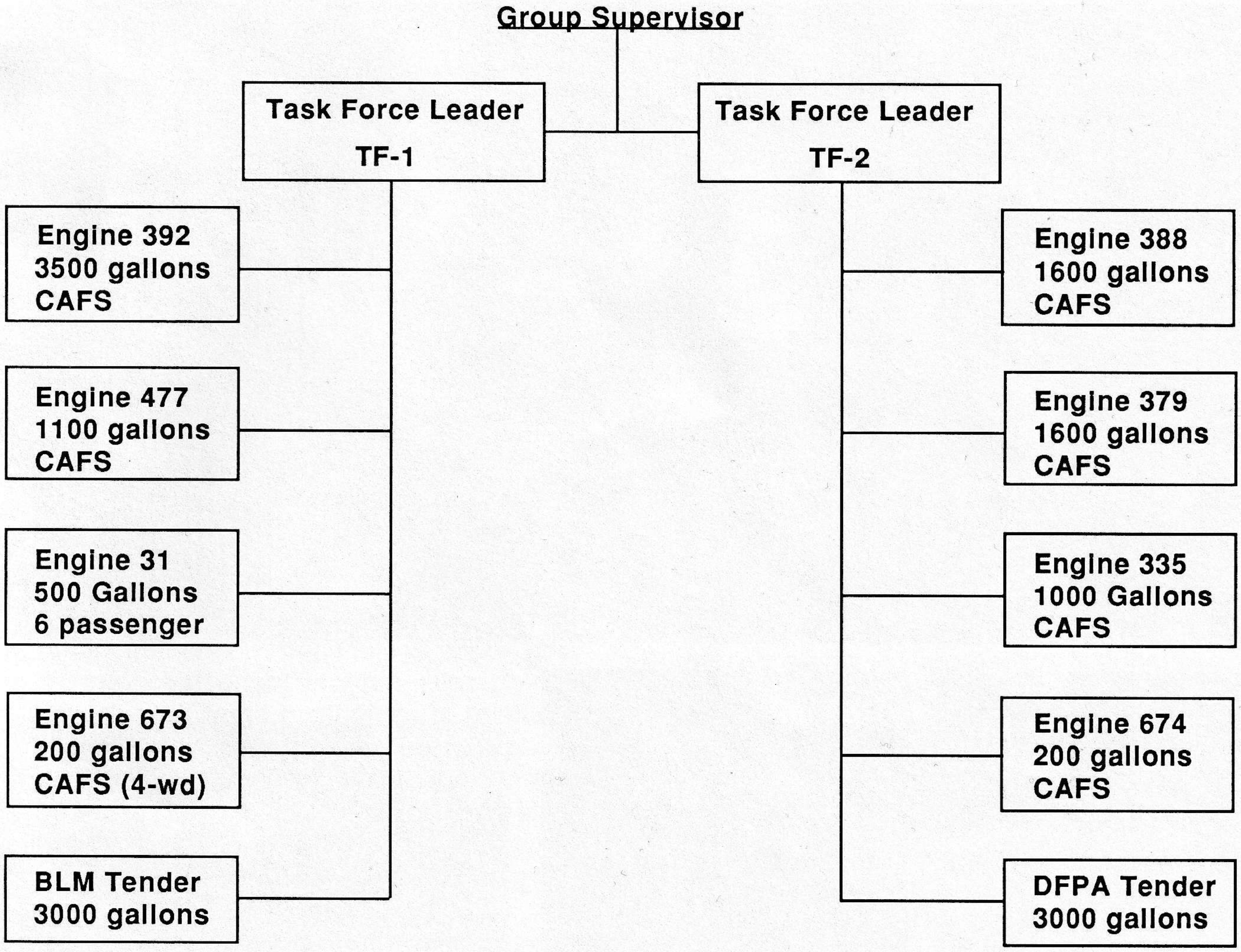
Operational Capability

One of the Group's objectives is to make all ordering units aware of just what is available within the Group and what tactical capabilities the Group offers. High-performance CAFS engines are the backbone of the organization. However, in addition to the described foam capabilities, the concept of pre-identified resources—organized and readily available—allows for rapid response when ordered. The Group is committed to having all resources enroute to an incident within two hours after receiving an order. The unit travels with enough equipment and supplies to operate for 48 hours without logistical support, so it is especially effective during initial and extended actions.

Group Components

The Group is mobilized as a single crew/shift resource, although it can be ordered with double-shift capability. There are 30 people in the outfit when single shifted and approximately 50 when double shifted. All engines are minimum 120 cfm capability, except for two 200-gallon engines which produce 45 cfm, and the Crater Lake engine, which is a model 61 engine with proportioned NAFS (nozzle aspirated foam system) capability.

The Group is self-contained with radios, batteries, bulk Silv-ex to operate for up to 48 hours without additional support. The Group carries 10,000 feet of 1 1/2-inch hose, 7000 feet of 1-inch hose, several quick-attack lays/packs, three portable



volume pumps, three portable pressure pumps, five 1200-2500 gallon portable tanks (pumpkins).

Summary

The 1992 fire season was a real learning experience and growing time for WOIFG. As with all new concepts and ideas, it took time and experience to work the "bugs" out. The number and quality of 1992 assignments provided an acid test for the Group.

In September 1992, the Foam Group hosted BLM Director Cy Jamison who started his government career as a GS-2 firefighter in the sixties. In October key members attended the Region 5 Equipment Conference in Reno, NV.

Plans for 1993 included implementation of a memorandum of understanding between all participants. Individuals wishing to serve as overhead were requested to apply through a formal application process. The Group functioned under a formal operating plan approved by the Board of Directors. WOIFG will field test a new "Durable, organic" foam agent for BIFC during 1993. This agent has long-term durability characteristics and is approved by both the FDA and EPA. Formal drills are to be held during the 1993 season.

The WOIFG 1992 Board of Directors included Board Chairman, Merrill Tester, District Fire Management Staff, Roseburg BLM; Robert Cunningham, District Fire Management Officer, Diamond Lake Ranger District, Umpqua NF; Lonnie Williams, Structure Protection Specialist, Prospect Ranger District, Rogue River NF; Larry Matthews, District Fire Management Staff, Coos Bay BLM; Allyn Wiley, Assistant Fire Staff, Umpqua NF; Al Augustine, Fire Management Officer, Crater Lake National Park; & Ron Rochna, Fire Foam Specialist, BIFC-Branch of Technical Support.

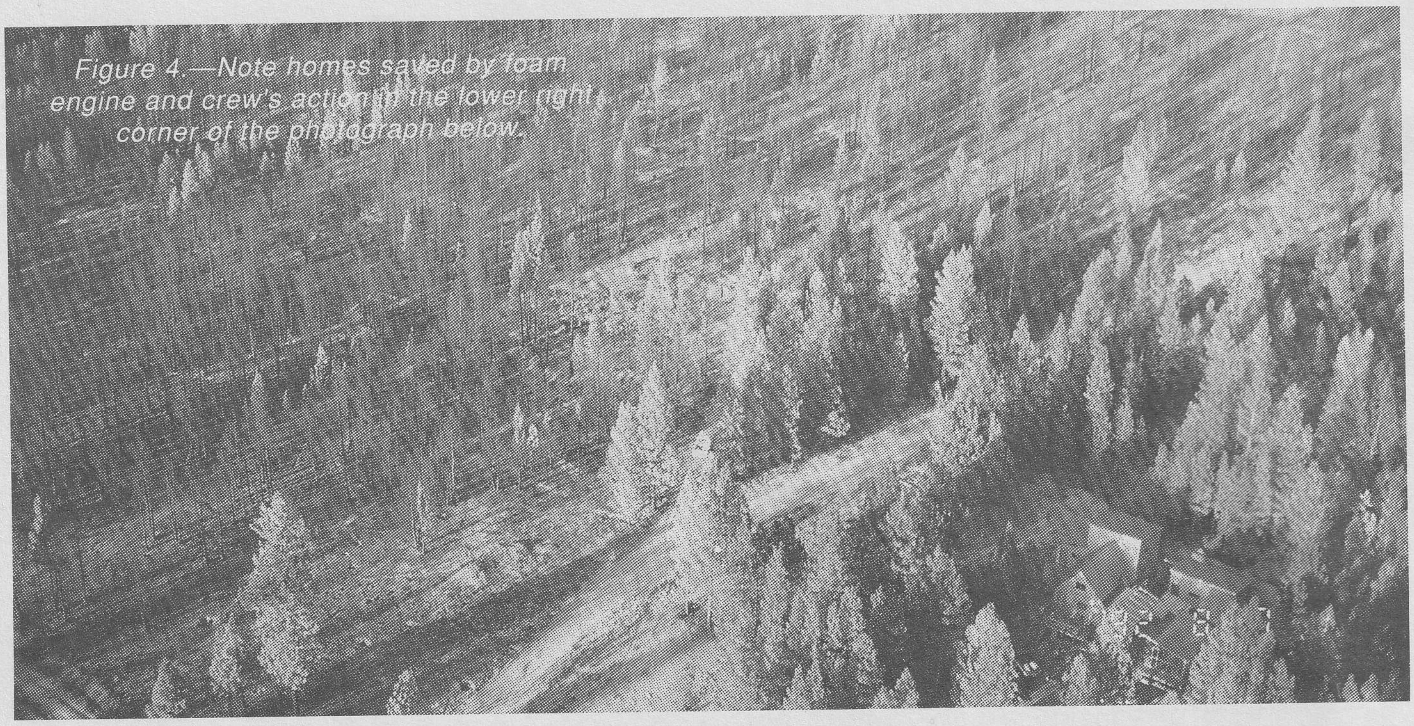


Figure 4.—Note homes saved by foam engine and crew's action in the lower right corner of the photograph below.

Figrue 5.—Chiloquin F.D. engine applying foam in conjunction with firing operation.

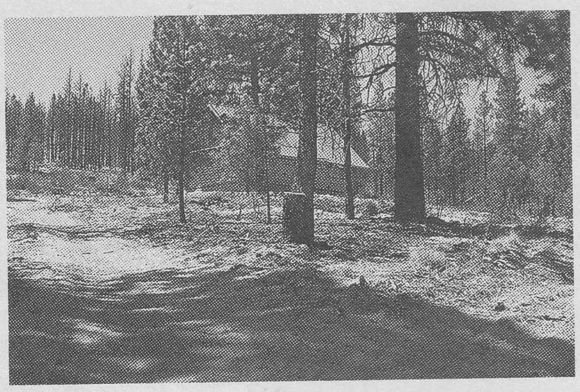


Figure 6—Home saved by foam application.

Lone Pine Fire, August 1, 1992
Chiloquin Ranger District,
Winema National Forest, OR

Photos by Tim Sexton, David Howe, and Sam Hescock

Figure 7.—Foam engines on Lone Pine Fire.

CLASS A FOAM IN MUNICIPAL FIRE OPERATIONS

By Dominic J. Colletti, Hale Fire Pump Company, Conshohocken, PA

Dominic J. Colletti is a Fire Protection Systems Engineer and the Foam Systems Product Manager at Hale Fire Pump Company in Conshohocken, PA. Dominic is a volunteer firefighter with the Humane Fire Company in Royersford, Pennsylvania. Hale Fire Pump Company had developed one of the first Compressed Air Foam Systems over forty years ago for the U.S. Navy. Currently, Hale has developed state-of-the-art foam proportioning and Compressed Air Foam Systems for Forestry, Rural, Municipal, and Crash Fire Rescue Firefighting applications.

Class A foam, originally used in forestry applications, is steadily gaining acceptance for structure firefighting. State-of-the art equipment, incorporated into new and existing municipal apparatus, makes this technology more user friendly and cost effective than ever before. Because class A foam technology is relatively new to structural fire service, many questions are being asked. Does it work? Is it the same as wet water? Will it replace the need for a large fire pump & water tank on our apparatus? Should we take a close look at using class A foam?

Each department should carefully weigh the cost of foam agent, equipment and training required, against the benefits of the technology for their specific fire needs. Most units, after looking at the body of technical knowledge known about class A foam and examining the benefits, decide to implement its usage because predominantly, fires burning "class A" - ordinary combustibles are some of the most typical, hazardous, and resource consuming fire challenges within most fire districts.

Foam Agent Concepts

While not readily considered until recently for class A - ordinary combustibles, the application of foam agents to manually combat class B - flammable liquids is well accepted within the fire service.

Typically, class B foam concentrates are mixed with water, creating a foam solution and then aerated to create a finished-foam bubble mass. The finished-foam bubble blanket applied correctly reduces total water supply need to extinguish most flammable liquid fires through increasing suppression abilities of gallon-per-minute water flows. The use of plain water in the extinguishment process is not eliminated, however, the effectiveness of its ability to suppress the fire is enhanced by the addition of foam chemical. For example, a handline flow of 95 gpm of plain water will work to remove only the heat side of the fire tetrahedron when applied to a flammable liquid fire. This same 96 gpm flow mixed with a Fluorocarbon Surfactant (class B foam concentrate) and then aerated and applied as a finished-foam blanket will enhance fire killing abilities of the same water flow through vapor sealing the flammable liquid—thus removing the oxygen and fuel sides of the fire tetrahedron. The net effect is the efficient use of the gpm flow and total water supply available to promptly extinguish the fire. The perception that plain water is abandoned for foam chemical is false. Rather, its ability to suppress fire is enhanced by the addition of foam concentrate.

This improved ability of water as finished-foam to suppress flammable liquid fire increases fire operational efficiency and firefighter safety while reducing property damage.

Water treated with class A foam concentrate, applied to ordinary combustibles including structure fires, shows these same three net effects in municipal fire operations by increasing the ability of water to suppress burning class A type fuels. Class A foam solution has excellent ability to wet and penetrate ordinary combustibles. This capacity results in reduced fuel core temperatures and aids flame knockdown, extinguishment, and fuel securing capabilities.

Plain Water

Plain water has the capability to absorb a large volume of heat if it can be held in contact with burning ordinary combustible fuels. One inherent problem preventing it from utilizing its full potential is surface tension, or simply stated, the tendency of water to form into droplets, or bead. This is caused by water molecules bonding together affecting its ability to spread over the surface of fuels. Plain water's high surface tension reduces the surface area in contact with the combustible, limiting its ability to absorb heat. Gravity causes the water droplets to roll off, the majority ending on the floor. A study in 1974 showed that a conventional solid fire stream is only five to ten percent effective at actual extinguishment. Approximately ninety percent of the heat absorbing potential is wasted because of the effects of surface tension and gravity when water is applied to three dimensional structural fuels. Not only is the water wasted, it may also contribute to structural collapse and exceptional insurance claims for water damage far exceeding the actual structural damage from fire.

Class A Foam

Class A foam concentrate, a synthetic detergent hydrocarbon surfactant mixed at concentrations from 0.0 to 1.0 percent with water, turns water into a very effective wetting/penetrating and cooling agent. By reducing high surface tension and allowing more surface area of water applied to contact the ordinary combustible, fuel cooling abilities increase.

Not only will the foam solution spread over the fuel surface, it will seek to bond with carbons and enhance waters penetrating abilities. This could result in "wet" class A fuels further cooling and the prevention of rekindles.

Class A foam solution, mechanically agitated with air creating a finished-foam bubble blanket, will enhance this ability by "cheating" gravity through causing foam solution (as finished foam) to adhere to vertical fuels. This has practical advantages upon direct structure attack because the class A finished-foam, applied as a quick draining low expansion foam blanket, will:

- Hold water (as foam solution) on three dimensional class A fuels allowing maximum water utilization to cool fuels.
- Vapor seal fuels momentarily (until the foam solution drains out of the bubble mass evaporation or wetting the material) aiding extinguishment by removing the oxygen and fuel sides of the fire tetrahedron, causing a reduction in flammable vapors/smoke.
- Increase surface area of water droplets through application as a foam bubble structure, maximizing heat absorbing capabilities.

Effectiveness

Class A foam methodology is easily understood after a close look at the dynamics at work. However, claims of increases in effectiveness of water in the suppression of fire remain controversial. Anecdotal/empirical evidence and limited comparative testing has yielded a "three to five times more effective than plain water" standard. An effort undertaken earlier this year by members of private industry and the fire service toward a preliminary step in quantification of class A foam for structure suppression, provides insight into its effects and possible ramifications in municipal fire operations.

A series of controlled room and contents fires were performed at Wallops Island, Virginia and Salem, Connecticut by Hale Fire Pump, the Atlantic Virginia Fire Department, Ansul Fire Protection, the International Society of Fire Service Instructors, Elkhart Brass, the National Aeronautic and Space Administration-Goddard Flight Center Fire Department, the Charlotte, North Carolina Fire Department, the Fairfax County, Virginia Fire Department and F.I.E.R.O.(Fire Industry Equipment Research Organization) and the Salem, Connecticut Fire Department.

Using a thermocouple-strip chart recorder, identical rooms in acquired structures were instrumented. The objective was to measure time/temperature reduction relationships with the application of water, class A foam solution, and Compressed Air Foam Systems (CAFS) aspirated class A foam solution.

The goal in using acquired structures was to perform testing in a manner as "real world" as possible, while still giving the utmost attention to variables such as fuel loading, fuel placement, agent application, and room ventilation. The same nozzleman was used on each interior attack, duplicating agent application, with streams being applied after flashover occurred.

After indirect (ceiling) application for 60 seconds, direct application was made to room contents for an additional 60 seconds. Identical gallon per minute and total water flow rates were established through the use of sensitive flow measuring equipment. In the Connecticut burn series shown in the chart below, room sizes were 11 feet and 10 feet and 8 feet high with moderate fuel loading. The fuel was straw and pallets providing a duplicate scenario with similar fuel combustion characteristics.

A 20 gpm flow of plain water in burn number one provided a flow slightly above the mean critical application rate. Any additional improvement in fire suppression capability would be identified in the time/temperature chart during burns two and three with the application of class A foam solution, and class A foam solution as Compressed Air Foam—all delivered at the same application rates. (Note: These evolutions were not NFPA 1403 training burns, but data collecting fire performed by veteran professionals).

TEST RESULTS

The ceiling thermocouple time/temperature difference recorded on all three burns was negligible. This was not surprising because agent application was made directly to the ceiling for the first 60 seconds.

The four foot level thermocouple, however, yielded graphic results.

Temperature Drop - 4 feet high level - 1000°F down to 212°F.

	Time (sec)	Drop Rate (deg/sec)
Water	222.9	3.5
Foam Solution	102.9	7.6
Compressed Air Foam	38.5	20.5

Firefighter/Victim Stress

These four foot level thermal readings would directly affect stress/survivability of trapped occupants in close proximity to the room of involvement and also firefighting personnel involved in rescue/suppression operations in an actual fire. These clearly show an increased Btu absorbing ability of the same amount of water applied, thus reducing stress and increasing tenability. In this test, water as CAFS discharge was 480 percent more effective than just plain water in working to lower room temperature.

From a property water damage viewpoint, the total water supply needed to lower the temperature as indicated was 13 gallons using compressed air foam, 34 gallons using foam solution, and 74 gallons using plain water, had the nozzle been shut at the 212°F point. Practical experience with class A foam and common sense dictates that there would be a reduction in water damage, and smoke/fire damage—however these tests were not run to yield data proving this point.

In all tests, one specific point commented upon by the attack crew, time and time again, was the outstanding visibility with little smoke and steam generated from the application of Compressed Air Foam. The vapor sealing/penetrating ability of CAFS discharge produces only small amounts of steam, maintaining a stable thermal balance providing superior ventilation and removal of combustion products, increasing visibility.

In all tests, a total of nine rooms were instrumented, with agent applied in the same fashion. Results of the Salem tests were typical of all tests. An important factor in the effect of class A foam solution application is the type of aspiration device employed. Note that in the plain water and foam solution applications, an adjustable fog nozzle set on straight stream was the application device. Experience shows that had an air aspirating nozzle been used, higher efficiency would have been gained from the application of the foam solution.

The goal in these tests was to duplicate agent application using the same straight fire stream. CAFS application used a ball shut-off valve only, providing a straight stream.

Practical Ramifications

The introduction of rapidly burning synthetic furnishings over the last two decades has reduced the ability of handline water flows to suppress interior fires. Modern day interior attacks using water flows of 90 to 120 gpm with 1 3/4-inch hoseline and automatic nozzle have increased application rates from years past. However, limited personnel resources, nozzle reaction force, and larger diameter hoseline immobility dictates that there are practical limits to introducing higher gpm application rates to increase flame knockdown and firefighter safety. Adding class A concentrate through a proportioning system on structural pumpers can be one way to increase fire killing ability of water flows.

A possible 100 percent increase could make 120 gpm of plain water, if applied correctly. This increase justifies the cost (from $750 up to $4000) of a proportioning system and the minimal education and training required to implement the use and application of the foam. Installing CAFS equipment on new and existing pumpers can cost from $8000 to $25,000.

Initial attack apparatus that rely on tank water may be able to improve that water's suppression ability by 300 percent to 500 percent with CAFS when applied correctly. Considering new class "A" pumpers cost in the range of $100,000 to $250,000, adding 10 percent to the cost for a CAFS that could increase fire stopping ability three to five fold should be an option well considered because of the cost versus benefit ration involved.

Considering scientific and anecdotal evidence available, along with this practical test, there is little doubt that class A foam can increase our ability to manually combat ordinary combustibles including structure type fire. This confirms the need to perform full scale laboratory controlled scientific comparative testing by third party agencies.

The implementation of a departmental class A foam program requires education and training for proper results. Class A foam concentrate enhances water's ability to suppress fire and is not a replacement for water. Care should be taken not to reduce practical plain water flow rates with its usage.

Preferably, use the same application rates of plain water with class A foam concentrate added to those rates. Applied correctly, class A foam can increase firefighter safety, improve operational efficiency, and reduce property damage. It should be one tool considered when looking at ways to improve fire operations.

FIRE SUPPRESSANT FOAM—TOXICITY AND ENVIRONMENTAL ISSUES/CONCERNS

By Chuck George and Cecilia Johnson, Forest Service, Intermountain Fire Sciences Laboratory, Missoula, MT

Fire suppressant foams, diluted for use in fire-fighting, are more than 99 percent water. The remaining one percent contains surfactants (wetting agent), foaming agents, corrosion inhibitors, and dispersants.

Approved fire suppresant foam concentrates and the solutions resulting when the concentrate is mixed with water have all been tested and meet specific minimum requirements with regard to mammalian toxicity:

- Acute oral toxicity
- Acute dermal toxicity
- Primary skin irritation
- Primary eye irritation.

As with any chemical substance, a small percentage of the population may be allergic to or have an unusual sensitivity to a specific product that will not be detected during testing.

Foam concentrates are strong detergents. They can be extremely drying and exposure to the skin may cause mild to severe chapping. This can be alleviated with the application of a topical cream or lotion to the exposed areas.

All of the currently approved foam concentrates are mildly to severely irritating to the eyes. Anyone involved with or working in the vicinity of foam concentrates should use protective splash goggles. Rubbing the eyes or face may result in injury to the eyes if hands have become contaminated with the concentrate during handling.

The primary toxic effect of foams on fish occurs as a result of the surfactant action. The surfactant in the water interferes with the ability of the gills to absorb oxygen from the water causing the fish to suffocate.

Because a very small amount of foam concentrate retains very good wetting capabilities, extra precautions should be taken to avoid getting any concentrate into the water.

The following guidelines and precautions should be followed to minimize the likelihood of foam concentrate or solution entering a stream or other body of water:

1. During training or briefings, inform field personnel of the potential danger of fire chemicals, especially concentrates, in streams or lakes.

2. Locate foam mixing and loading points where contamination of natural water, especially with the foam concentrate, is minimal.

3. Maintain all equipment and use check valves, where appropriate, to prevent release of foam concentrate into any body of water.

4. Exercise particular caution when using any fire chemical in watersheds where fish hatcheries are located.

5. Locate dip operations to avoid run-off of contaminated water back into the stream.

6. Use a dip tank, rather than dipping directly from a convenient body of water, to avoid releasing any foam into these especially sensitive areas.

7. Use a pump system equipped with check valves to prevent flow of any contaminated water back into the main body of water.

8. Avoid direct drops of foam into rivers, streams, lakes or along lakeshores. Use alternative methods of fireline building.

9. Notify proper authorities promptly if any fire chemical is used in an area where there is likelihood of negative impacts.

DURABLE FOAM

By Paul Schlobohm, Bureau of Land Management, National Interagency Fire Center, Boise, ID

The class A foams in use today have evolved after six years of development and input from wildland firefighters. Class A foam concentrates are generallly synthetic detergent-based products that create unstable foams with relatively rapid draintimes. The products are biodegradable and meet requirements for operator health and safety. The concentrates are formulated to perform at mix ratios less than one percent, thereby solving some of the logistical problems of ground-applied retardants and other foams of the past. Class A foams are suppressants and they have improved our efficiency with water for fire knockdown and mop-up.

Despite these improvements to fighting fire with water, we may be asking too much from class A foam. At least 50 percent of the tasks given to foam on wild and prescribed fires are to prevent something from burning. The most common use of foam-equipped engines on wildfires is structure protection, not fire extinguishment.

One method of rendering woody fuel unburnable is to raise its fuel moisture above the moisture of extinction. With rapid draintimes, degreasers, and wetting agents, class A foams do very well at raising fuel moisture. This technique has been used successfully many times to prevent the ignition of not only homes, but forest resources as well.

Yet class A foams are nothing more than water stretched into films of bubbles. Once the water evaporates, no residual product continues to prevent ignition. And, because they are rapid-draining foams, these products do not last long in hot, dry conditions. This is why foam-equipped engines can be seen applying and reapplying foam to structures as the fire makes its often unpredictable assault on a development. This is both wasteful in effort and product, but also detrimental to the building as it becomes wetter and wetter.

A popular application for foam in prescribed fire is as a fuel break. If ignition can immediately follow creating the barrier, foam has been shown to be an effective tool for preventing or reducing escapes. But the short-term effectiveness of a foam line limits the options for time of ignition.

The non-suppressive applications we have for suppressant class A foams suggests a need exists for a long-lived, fire resistant product. This product may be a foam, retardant, or a gel.

The Foam Task Group of the Fire Equipment Working Team has established several criteria for such a foam product based on compatability with current foam systems and the expected use in structure and resource protection. A foam that product that meets these recommendations will be referred to as Durable Foam. The criteria for Durable Foam are:

1. Mixed at 1.0 percent the applied product must remain effective at preventing ignition for 12 hours (one burning period, one shift).

2. The equipment must work (perform 1.) with present class A foam equipment including proportioners, aspirating nozzles, and compressed air foam systems.

3. The product should be capable of wetting and draining as well as being stable.

4. The product must be usable (perform 1.) from aircraft, both fixed-wing and helicopter.

5. The product must be essentially odor-free.

6. The product must pass current requirements of foam for corrosion and health/safety.

7. The product must be pumpable through 1.5-inch hose for 2000 feet.

8. The product must be environmentally acceptable.

Protein-based foam products exist which can maintain foam structure for well over 12 hours when generated with the compressed air foam system. Whether a foam product can be made to meet all of these criteria is not yet known. However, the widespread use of short-lived class A foam on applications requiring durability demonstrates the need for such a product.

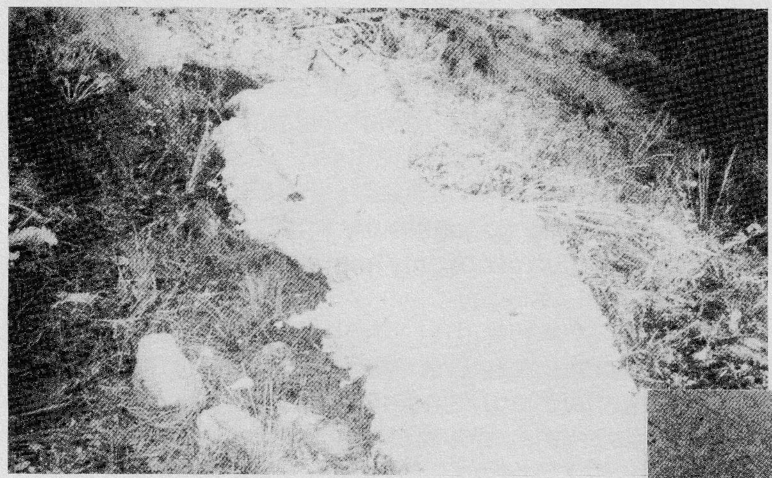


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Figure 8.—A foam line made with a prototype durable foam and a compressed air foam system.

Figure 9.—The outer "crust" and the residual density of a prototype durable foam 24 hours after application.

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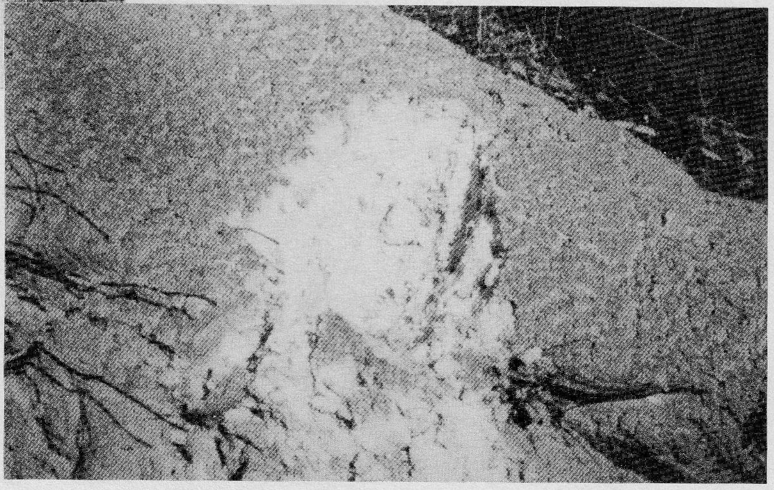


FOUR NEW ITEMS TO HELP THE FIREFIGHTER

By Dan W. McKenzie, Mechanical Engineer, USDA Forest Service, San Dimas Technology & Development Center, CA

The Center has become aware of four new items related to foam that may help the firefighter. They are:

A. FireCal Pocket Computer by Akron Brass calculates fire stream flows

B. Foam concentrate automatic shutoff for use with suction side proportioners when foam container is empty by Machinery R & D

C. Foam meter from New Zealand for reading out the percent of foam concentrate in water flow stream in real time

D. Standard Conductivity meter for determining foam concentration percent by Cole-Parmer.

FireCal Pocket Computer

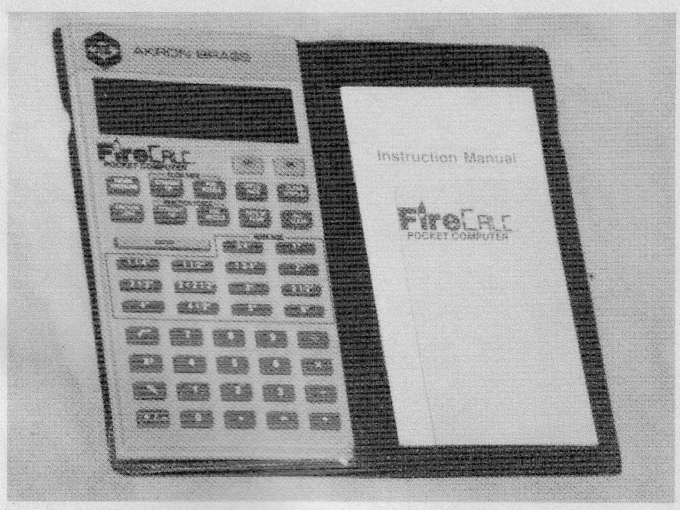


Figure 10.—FireCal hand-held preprogrammed calculator by Akron Brass.

The FireCal is a hand-held calculator preprogrammed to solve water hydraulic problems common to firefighting. The preprogramming includes:

1. Engine pressure
2. Friction loss in hoselays
3. Flow rates in gpm for nozzles & hoselays
4. Nozzle reaction force
5. Application rates.

The calculator is available from Akron Brass, (216) 264-5678, for a list price of $69.

Foam Concentrate Automatic Shutoff For Suction Side Proportioner

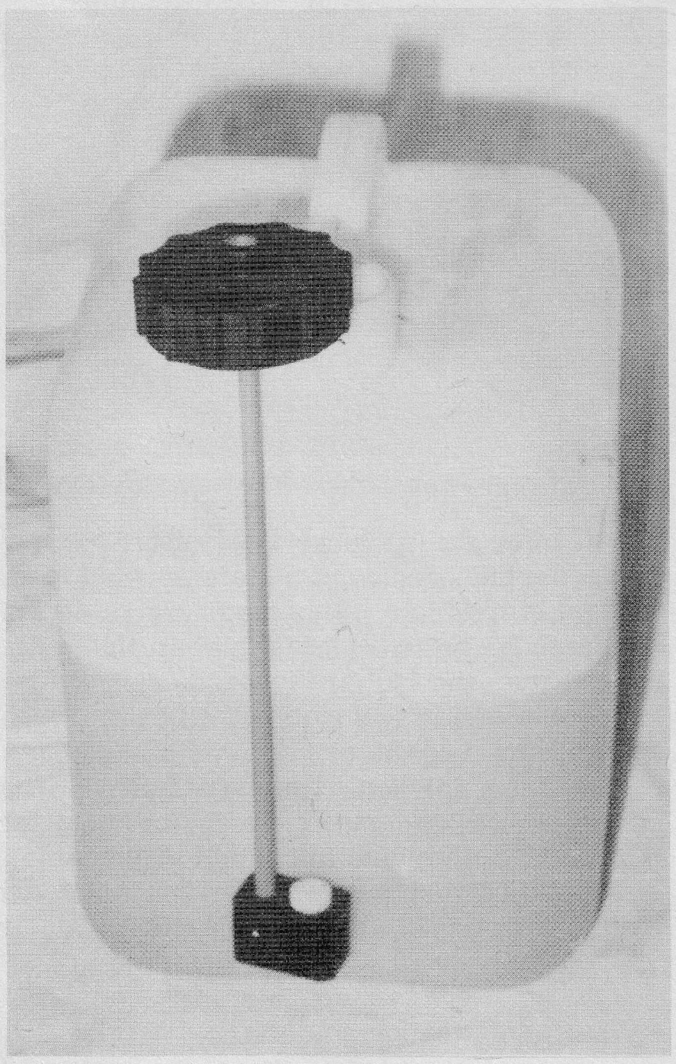


Figure 11.—Foam concentrate shutoff for use with suction side proportioners.

An attachment is now available for use with a foam concentrate container (5-gallon pail or other container) that will automatically shut off the suction of the foam concentrate when the container is out of foam. This attachment has a small plastic ball that floats in foam concentrate.

When the container runs out of foam, it will drop down and cover the outlet hole; shutting off the foam suction. This prevents air from being sucked into the inlet of the pump and the pump losing its prime. The attachment is available from Machinery R & D of Twin Falls, ID (208) 734-2709 for a list price of $25.

Foam Meter from New Zealand

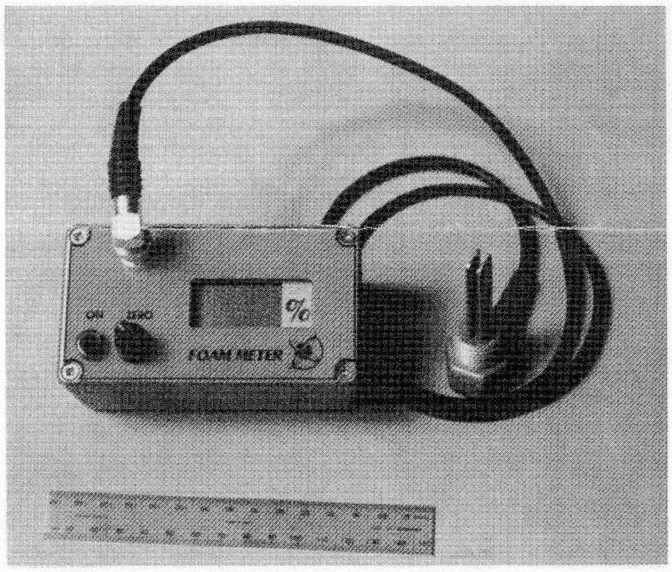


Figure 12.—Foam meter from New Zealand.

The New Zealand Institute of Geological & Nuclear Sciences, Ltd., designed a meter to read foam percent in real time. This meter works on the conductivity principle—the higher the foam concentrate, the higher the conductivity. The meter will read to two significant figures which will allow readings to one one-hundreds of one percent foam solution. The meter has a ZERO control to set the meter to compensate for temperature and mineral content of the water. The meter can be powered by an internal 9-volt battery or by the 12-volt vehicle system. Cost is $280. U.S.

For more information contact:

Institute of Geological and
Nuclear Sciences, Ltd.
Attn: Dr. Gavin Wallace
30 Gracefield Road
P.O. Box 31212
Lower Hutt, New Zealand
64-4-569-0637

Standard Conductivity Meter

Cole-Parmer offers a hand-held standard conductivity meter which appears to give good results in checking percent of foam solution. This meter is low cost ($44.95) and appears to read to two one-hundreds of one percent foam solution.

The meter is available from Cole-Parmer, (800) 323-4340. Part No. is G-19800-20 for the meter and G-35624-41 for a carrying case. They also have a more expensive ($125.) hand-held conductivity meter which appears to be able to read to one one-hundreds of one percent foam solution. Part No. is G-01491-70.

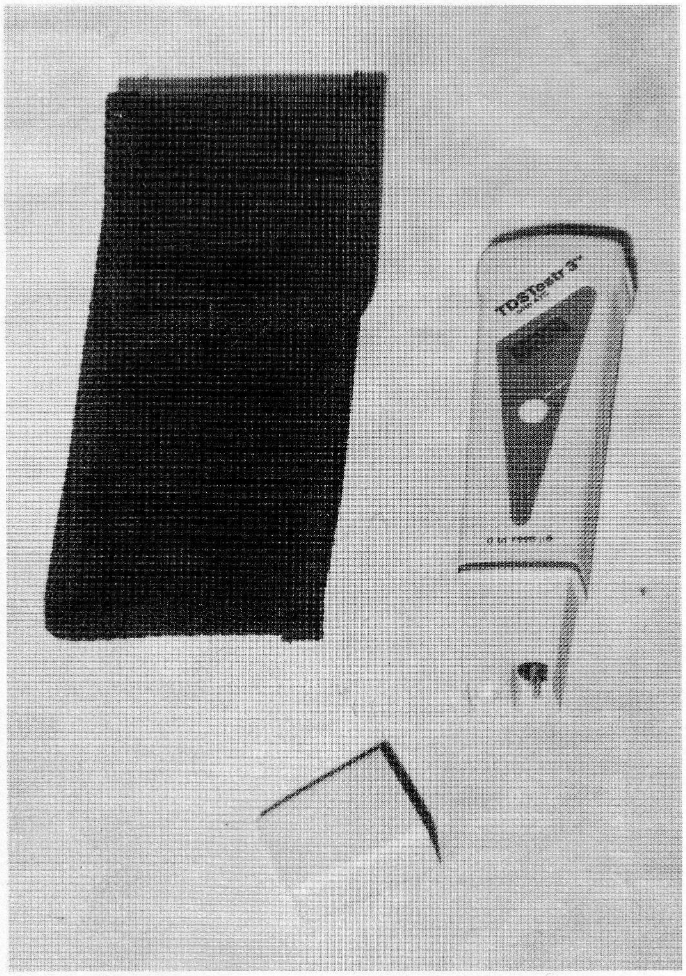


Figure 13.—Standard conductivity meter from Cole-Parmer.

ROBWEN FLAMECO ANNOUNCES THE FLAMECO FOAM GUARD PORTABLE FIRE PROTECTION SYSTEM

By Keith Adamson, Flameco division of Robwen Inc., Los Angeles, CA

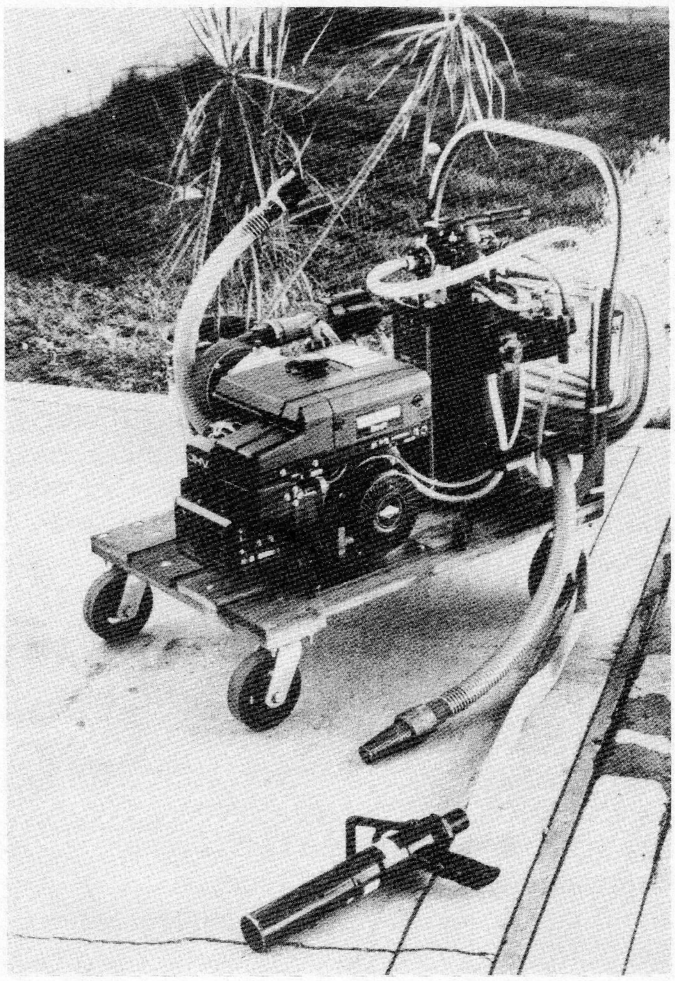


Figure 14.—Flameco Foam Guard portable fire protection system.

This compact foam system is mounted on a 3-foot by 2-foot cart with 6-inch x 2 1/2-inch rubber casters. It is a complete mini fire rig, less a water tank, which can be used in a variety of different ways.

A portable fold-up tank, which Flameco can supply, or a swimming pool, spa, hot tub, stock tank, pond, running stream, or any other source of water can be used with the system. The Flameco Foam Guard System is supplied with a 9 hp Briggs and Stratton Van Guard Motor powering a centrifugal water pump, a Flow Mix Foam Proportioner (which is used by many agencies and municipal fire departments), 100 feet of 1 1/2-inch hose, a 1 1/2-inch shutoff, a 40 gpm Flameco Aspirvent nozzle, and a hard suction hose with strainer and foot valve.

The output of the Flameco Foam Guard System at 40 gpm is 135 psi. It is equal to many slip-on rigs and can be used as a portable slip-on. It is used also at helipads for protection, freeing up much more expensive rigs for firefighting.

The Flameco Foam Guard System can be used with class A, wildland and structure foam, or class B, A-FFF type foam.

Easily stored, this compact portable foam system is a powerful firefighting tool that is simple to use and maintain. It comes with a one year warranty and is available for immediate shipment. Other options are available including nozzles, hose, motors, etc.

CLASS A FOAM ON A FLORIDA MUCK FIRE

By John T. Koehler, Orlando District Manager, Florida Division of Forestry, Orlando, FL

On May 21, 1993, the Orlando District of the Florida Division of Forestry responded to a wildfire. The containment size of the wildfire was ten acres, however, eight acres of muck were involved. Muck is an organic soil which only quantities of water will extinguish. A muck fire burns deeper into the soil with time rather than laterally as a surface fire does. Therefore, the quicker suppression is started the easier it is to extinguish.

In Florida, muck fires are the least favorite fires among our firefighters. They are time consuming to suppress. The water applied to the fire makes equipment use difficult and as a result the fires are very labor intensive. Also, the smoke irritates the eyes and lungs and some react to the ash by developing itchy rashes on their legs.

Previously, the district used six-inch hard aluminum pipe to deliver water and was limited to operating one deluge rainbird covering .25 acres per set up. An 1150 gpm diesel pump drove the system. Suppression essentially involved flooding the involved acres.

Several problems were associated with this system. Many trips were needed to get all the pipe, pump, and accessories to the fire. Historically, it had taken up to eight hours to respond with the equipment and another 24 to 30 man hours to deploy the system. It was difficult to find a water source that could supply the volume needed to support the pump and flood the area involved.

Muck fires occur when drought conditions exist, making a reliable water source difficult to find. Additionally, moving the pipe and rainbird was difficult slogging through the muck after flooding. Heavy equipment would bog down and walking the wheel mounted rainbird and carrying pipe was physically demanding.

To overcome this, the district developed a "quick attack" muck system. The conversion used 2 1/2-inch hose to replace the six-inch hard aluminum pipe and a smaller pump to drive the system. The purpose was to reduce setup time, match the volume rating of the pump with the small quantity of water available, be compatible with fire department hardware, treat more area with a single setup, and be able to economically use class A foam with the system. The quantity of water pumped with the large 1150 gpm diesel pump made the use of foam costly.

The resultant system is a trailer mounted 30-hp pump. The trailer is outfitted with 350 feet of 2 1/2-inch hose, six one-inch impulse sprinkler heads, and five gallons of Silv-ex class A foam concentrate. The concentrate is educted into the system with a needle valve.

The new quick attack system was deployed and operating on this fire in 55 minutes. The in-line setup of the sprinkler heads, at each hose length, treats approximately 1.4 acres per setup. It took three setups with almost three hours of run time at each to suppress the fire.

This was the first actual use of the system with foam. We learned that a better metering device was needed. Half a pail of foam concentrate was used on the initial setup before the excess use was noted. A total of seven and a half gallons of class A foam concentrate was used during suppression of the fire.

Additionally, we found that a constant eduction of foam concentrate was not necessary in this fuel type. The foam concentrate was educted for three to five minutes at each initial setup. It is estimated that a .03 percent solution was used. This wet the surface of the fuel and then allowed straight water to penetrate and suppress the ground fire. The system also proved less costly in both quantities of foam concentrate used and more efficient use of the small water supply available in the shallow canal from which we were drafting.

The use of class A foam reduced additional mop-up work with hand lines. Traditionally, once a setup was moved, spot fires would flare up where the water beaded up and ran off. The class A foam wet the soils and allowed deeper penetration with the untreated water. The only hand line work necessary was around the base of trees that blocked the sprinklers. This was one of the first muck fires that we did not have to repeatedly return to for small amounts of additional mop-up work at the level of drought we were experiencing.

LOW-VOLUME, MEDIUM-EXPANSION FOAM NOZZLE—FROM YOUR WORKSHOP

by Alan K. Olson, Fire Management Specialist, Bureau of Land Management, National Interagency Fire Center
and Roger A. Spaulding, Fire Management Specialist, U.S. Fish and Wildlife Service, National Interagency Fire Center, Boise, ID

INTRODUCTION

Class A wildland foam is a very useful tool for both fire suppression and prescribed fire operations. A particularly useful version is medium-expansion foam. It can be used in direct attack, blanketing fuels in mop-up, protecting selected resources and anchoring and building wetlines for backfiring, burnout, and prescribed fire operations.

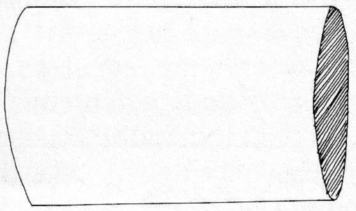
Commercially available medium-expansion aspirating nozzles are expensive. Typically, prices range from $300 to $500 per unit. Additionally, these nozzles are all designed to work with flow rates in excess of 50 gpm.

Most U.S. Fish and Wildlife Services (FWS) refuges are equipped with small slip-on packages varying in capacity from 75 to 200 gallons. The small water tank capacities of most FWS engines combined with limited funding suggested that an alternative to current nozzles be developed. Most other agencies, including the Bureau of Land Management (BLM), also experience this problem. All are looking to minimize costs of equipment, while accomplishing the task.

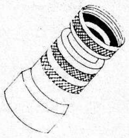
The BLM program at the National Interagency Fire Center includes a Foam Technology Development group. As part of the many foam workshops this group presents, one demonstration shows the basics behind generating aspirating medium-expansion foam. The demonstration is done with a 4-inch stove pipe with screening taped over the end and a variable pattern type nozzle found in NFES caches. The results are crude, but low-to-medium-expansion foam is generated.

A medium-expansion nozzle was built using simple materials—materials available at local hardware and plumbing suppliers and through the NFES caches. The design of the nozzle then could be used by any agency wishing to produce a low-cost efficient nozzle.

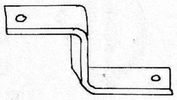
Parts List



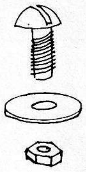
1 each 14" length of
6" diameter PVC pipe



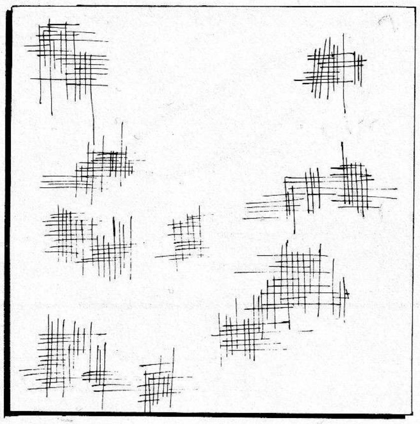
1 each 1" variable
pattern nozzle NFES #1081



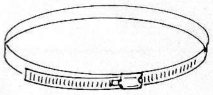
3 each 1/8 x 1/2 flat
stock brackets
(2" x 1" x 1 1/2")



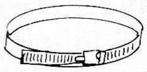
3 each nuts,
pan bolts,
and washers



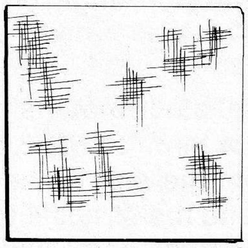
1 each 20" x 20"
nylon window screen



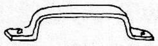
1 each 8" diameter
hose clamp



1 each 2 1/2" diameter
hose clamp



1 each 10" x 10"
nylon window screen



1 each strap handle

By using a 1-inch variable-pattern type nozzle, the resulting foam nozzle has the flexibility to produce both low-expansion foam (discharge distance 30 feet) and medium-expansion foam (discharge distance 15 feet). Another benefit is it also allows the nozzle to deliver foam solution at either the 10 gpm or 24 gpm flow rate. One can see these flow ranges are well below the 50 gpm flows normally produced by most commercial nozzles.

Note: For higher flows and more expansion, a 12- to 14-inch length of 8-inch diameter PVC pipe can be used along with a 1 1/2-inch variable-pattern type nozzle (NFES 1082; GSA 4210-01-167-1123). This nozzle allows the operator to deliver foam solution at either the 40 gpm or 60 gpm flow rate.

ASSEMBLING THE NOZZLE

Most aspects of assembly are not critical. However, for best foam production and discharge distance, the nozzle must be centered within the opening of the PVC pipe. This is critical because if the nozzle is not completely centered and balanced, foam production is dramatically decreased.

To determine the three places to mount the brackets, place a piece of string around the PVC pipe's circumference. Mark the spot where the string meets itself and cut off the excess string. Next, divide and cut the string into three equal parts. One piece of string will be the "measuring tool." Place the measuring tool in an arc on the PVC pipe edge, and mark the beginning and ending point. At the ending point, place the measuring tool in another arc and mark. (See Figure 15).

Directions

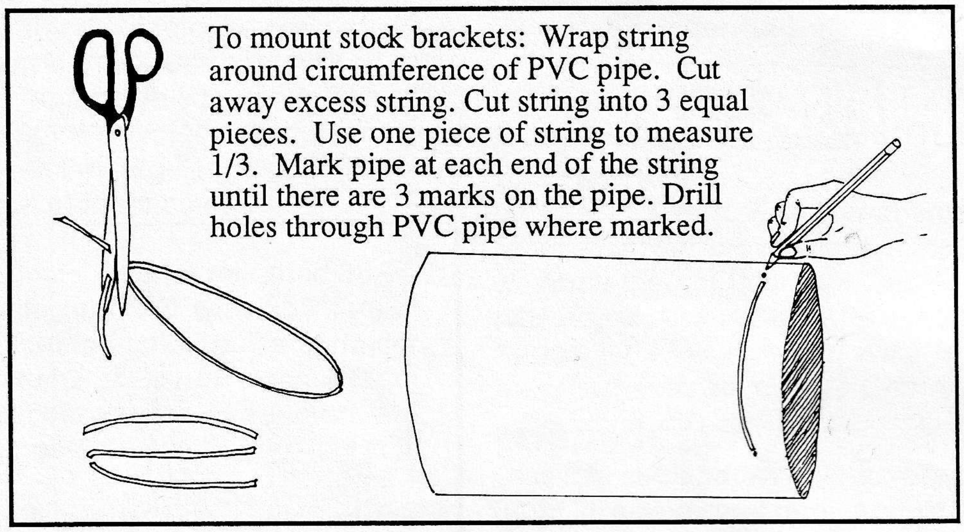


Figure 15.—Locating the drilling points.

At these three points, measure down 1/2 inch, and drill a 1/4-inch hole. These will become the anchor points for the brackets. This will also become the rear end of the medium nozzle. Now mount the strap handle parallel with the pipe length on the outside and halfway down the PVC pipe. The exact location does not matter.

Using the 1/2-inch flat stock material, build the brackets to hold the nozzle to the PVC pipe. Cut the flat stock material into three straps 5 1/4-inches long. On each strap, drill one 1/4-inch hole, with the edge a half-inch from the end of the stock (the center of the hole will be 5/8ths of an inch). The measurements to bend the straps into brackets will be taken from these drilled hole ends. All three brackets will be bent in the same way. (See Figure 16).

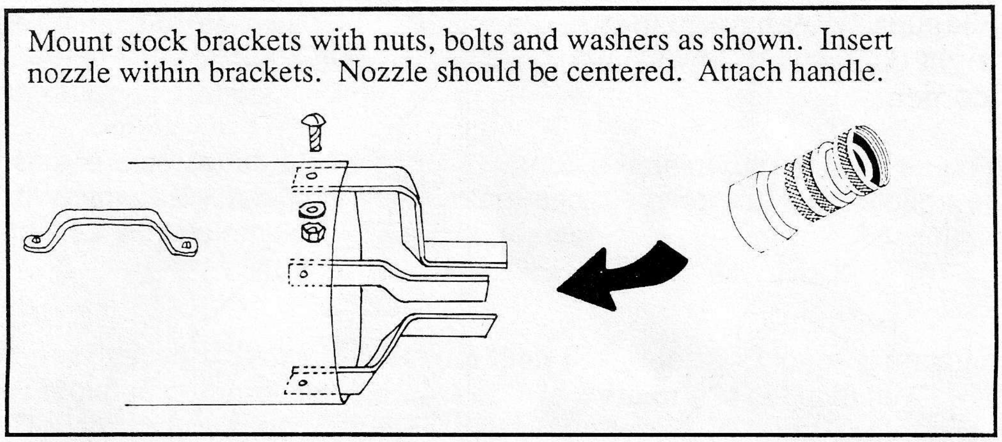


Figure 16.—Mounting the stock brackets.

Measure two inches along the strap. This is the location of the first 90-degree bend. Now measure another 1 3/4 inches. This is the next point to make a 90-degree bend. The two bends made to the finished bracket will look somewhat like a "Z" (with 90-degree corners). The ending run, or "tang," which is about 1 1/2-inches long, is where the nozzle will be attached. Place the nozzle between the tangs with the nozzle tip pointing towards the front of the medium nozzle. Place the small hose clamp over the tangs and nozzle, then screw tightly. This action will compress the tangs against the nozzle and secure it in a centered position. Make sure the tangs do not interfere with the twist open/close action of the nozzle. (See Figure 17).

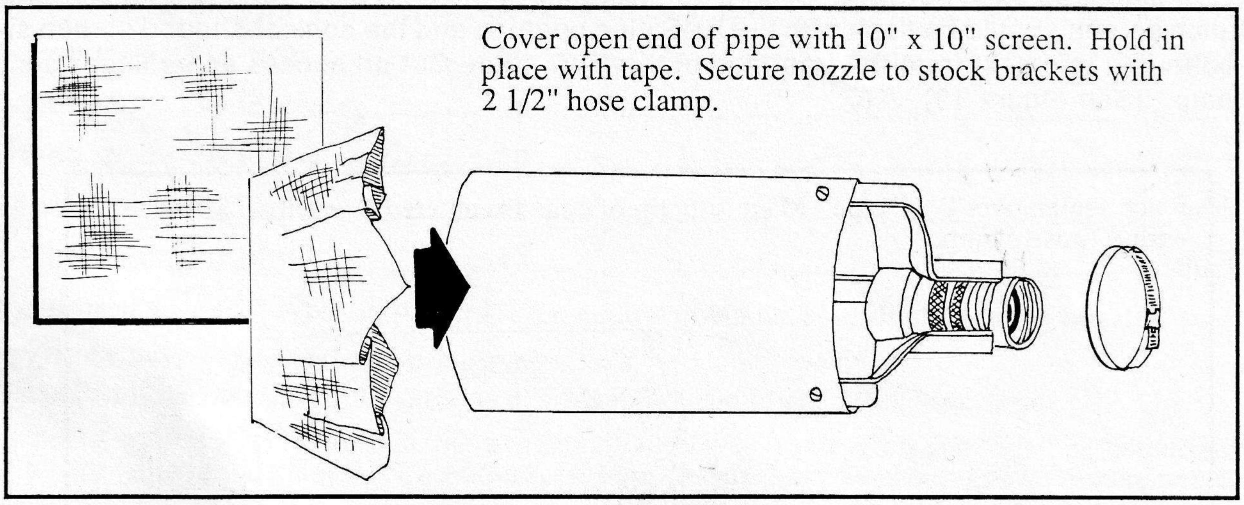


Figure 17.—Positioning the nozzle in the stock brackets.

Next comes the nylon window screening used to fracture the foam solution stream that is flowing through the PVC pipe. Building the two fracturing screens is simple. Take the 20-inch screen and fold two opposite corners together to form a triangle. Sew up (with an ordinary sewing machine) one side of the triangle-shaped screen, forming a conical screen. (See Figure 18).

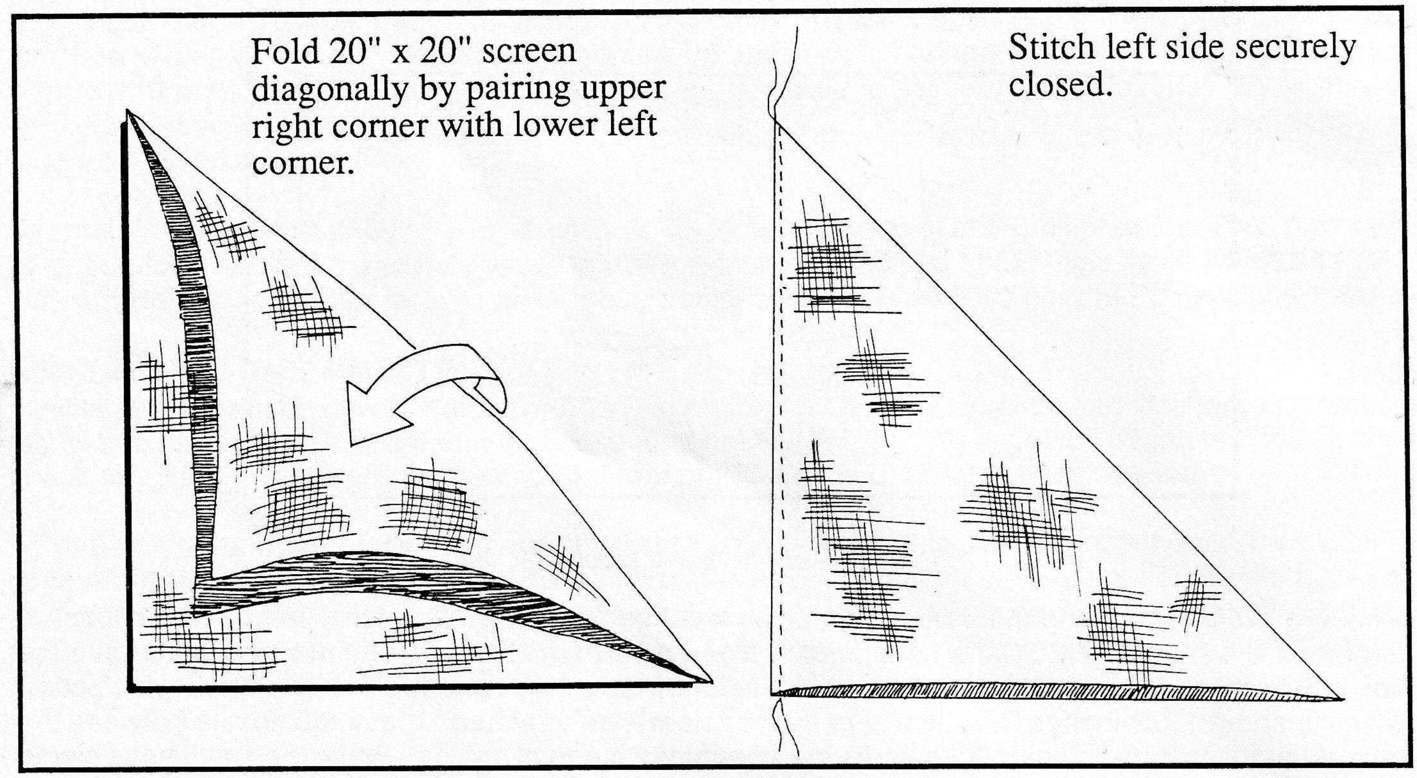


Figure 18.—Preparing the nylon screen.

Place the 10-inch screen over the non-drilled end of the PVC pipe, and then the conical-shaped screen over the 10-inch screen. The 10-inch screen should be flat across the end of the pipe. The conical screen should be pulled down tightly over the pipe and the flat screen, with the point centered in the circle of the pipe projecting outward. Secure both screens to the PVC pipe with the large hose clamp. The 10-inch screen should be flush with the PVC pipe opening and the conical-shaped screen should form a cone (big to small) from the front end of the PVC pipe. Cut off excess screening around the hose clamp. (See Figure 19).

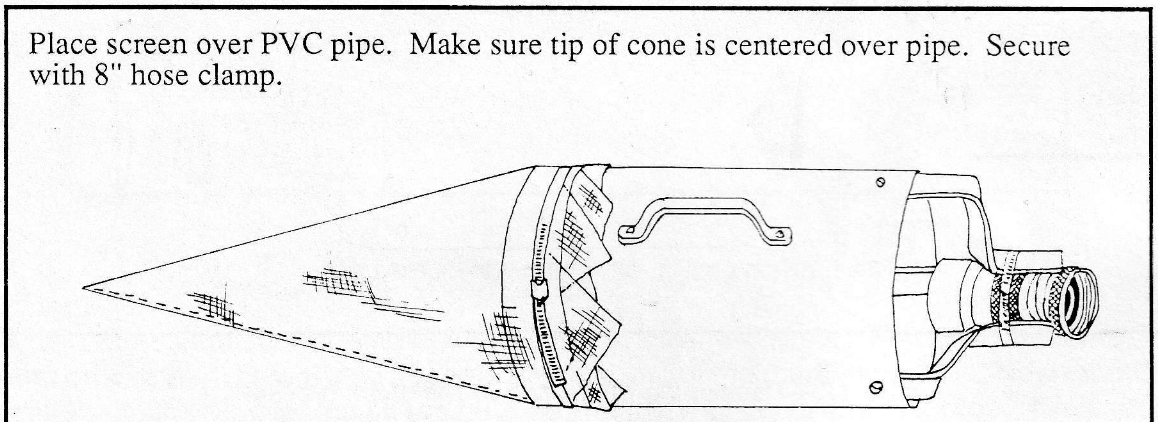


Figure 19.—Attaching the screen to the foam nozzle.

The inexpensive, low volume, medium-expansion nozzle is now complete. The materials used to build this nozzle cost roughly $35.

ADJUSTING THE NOZZLE

A brief explanation of how the variable-pattern nozzle works is needed to understand how to produce low as well as medium-expansion foam. Both the 1-inch and the 1 1/2-inch nozzle have a two-setting gpm flow range. At 100 psi, the 1-inch nozzle has a 10 and a 24 gpm range. The 1 1/2-inch has a 20 and a 40 gpm range at 100 psi.

These nozzles are also capable of producing variable-flow patterns, from straight stream to a fog pattern in both ranges. By using the flow pattern and the different gpm settings, we can create low-expansion foam as well as medium-expansion foams.

TEST RESULTS

The resulting nozzles were tested to measure their flow rates and foam-expansion ratios. By using an automatic regulated proportioner, we were able to monitor and set both flow rates and concentrate mix ratios. The concentrate mix ratio was set at five-tenths (0.5) percent and remained constant during all flow volumes. Expansion ratios were determined by collecting the foam generated from a timed volume of solution flow at a set nozzle pressure of 70 psi. Then the volume of foam was measured. The two nozzles were compared to the Angus MEX225 medium-expansion nozzle, the closest performing commercially available nozzle. The results are by no means to be considered scientific. They are rough field evaluations, but they do give a feel for the nozzle's performance.

Nozzle Discharge and Expansion Rates

Nozzle	Flow Rate (gpm)	Discharge Distance (feet)	Expansion Ratio[1]
Angus MEX225	55	13	70/1
6-inch med., SS low	7	12	25/1
6-inch med., FG low	11	5	50/1
6-inch med., SS high	25	25	70/1
6-inch med., FG high	26	12	80/1
8-inch med., SS low	20	10	80/1
8-inch med., FG low	20	7	80/1
8-inch med., FG high	40	21	80/1
8-inch med., FG high	42	7	80/1

SS=Straight Steam FG=Fog Pattern Low=Low flow end of variable pattern nozzle

High=High flow end of variable pattern nozzle

[1] "Expansion Ratio" compares the Gallons of Foam produced to each Gallon of Water.

"Medium-Expansion" Foam falls in the range of 20/1 to 80/1. There is no one "best" or "preferred" ratio, since the various tasks—direct attack, mot-up, wetlines, etc.—have their own requirements.

CONCLUSION

By following these instructions you should be able to make an inexpensive, low-volume, medium-expansion foam nozzle. By doing some experimentation, i.e., adding or subtracting screens, regulating pressures, changing flow patterns, you could get different expansion ratios and varying discharge distances to meet different objectives.

If you have problems building the nozzle or come up with better ways to build the nozzle, let the foam development group know. Phone (208) 389-2433 or write: BLM Foam Development Group, NIFC, 3905 Vista Ave., Boise, ID 83705.

UNDERSTANDING THE ENVIRONMENTAL EFFECTS OF CLASS A FOAMS

by Paul Schlobohm, Bureau of Land Management, National Interagency Fire Center, Boise, ID

As our nation strives to reduce human impacts to forest and rangeland ecosystems, it is a good time to review what we know about the environmental effects of class A foam products. Since we have to handle the concentrates, we should wonder if they are hazardous materials. No, they are not. A hazardous material is "any substance that poses an unreasonable risk to life, the environment, or property when not properly contained."[1] Actually, class A foam products are similar to common household liquid dish soaps.

Since we apply these products to the vegetation and soil during wildfires and prescribed fires, we should be concerned about biodegradability and toxicity. Class A foam products are combinations of hydrocarbon surfactants, glycols, ethers, alcohols, and other components. To be biodegradable, a manufactured substance like foam concentrate must separate into naturally occurring compounds or elements such as water, carbon dioxide, and salts. Class A foam products are required by the National Fire Protection Association (NFPA) to be 50 percent biodegraded within 28 days. Tests indicate foam products are 50 percent biodegraded between as few as 3 days and as many as 21 days. These products degrade easily because they are food sources for the bacteria that perform the biodegradation. Until the foam product is biodegraded it may have positive and negative effects to animals and plants. A measure of a product's negative impact to the environment is toxicity. Mammalian toxicity is a measure of a product's impact to mammals such as people, rabbits, deer, and the like. Aquatic toxicity examines effects to fish and the rest of the aquatic food chain. Toxicity to plants, birds, and other organisms is also measurable. Class A foam products are required by the USDA Forest Service and NFPA to meet specific toxicity limits for mammals and fish.

Aquatic toxicity is perhaps the most scrutinized effect of class A foam products because the surfactants in the foam products interfere with the ability of fish and other aquatic organisms to obtain oxygen from water. Aquatic toxicity is determined by measuring the concentration (or mix ratio) at which 50 percent of a test species fry population dies from exposure (LC_{50}) over a certain time period, such as 96 hours. Toxicity for fish is considered "slightly toxic" when the 96-hour LC_{50} occurs between 10 and 100 milligrams per liter (mg/l) and "non-toxic" when the 96-hour LC_{50} occurs above 1000 mg/l. The 50 percent level is used as a reference because it can be repeatedly measured in a laboratory. The result does not suggest that a 50 percent mortality in the field is acceptable.

To meet the NFPA standard for "slightly toxic," a foam product must have a "96-hour LC_{50} greater than 10 mg/l." This means that the concentration level of class A foam necessary to kill 50 percent of the test fish in a tank of water after 96 hours of exposure must be over 10 mg/l. Foam products which meet the NFPA standard for fish toxicity are shown in Table 1.

Table 1. Foam products which meet the NFPA minimum standard for fish toxicity as measured by 96-hour LC_{50} for rainbow trout[2].

Product		96-Hour LC_{50} (mg/l)
Angus:	Forexpan	10.4
Ansul:	Silv-ex	25
Chemonics:	Firefoam 103	41.1
Chemonics:	Firefoam 104	41
Monsanto:	WD881	22

[1] International Society of Fire Instructors, 1991. Hazardous materials operations for first responders, Student manual, 2nd ed.

[2] Pyrocap, a Unified Products foam concentrate, has a 96-hour LC_{50} for mummichog of 45.2 mg/l.

What is 10 mg/l? Ten mg/l approximates 0.01 milliliters per liter; 10 parts per million (ppm); 1 gallon in 100,000 gallons; or 1 cup of concentrate in 6000 gallons of water (see Figure 20)—or 1 cup of concentrate in the tanker shown on pages 1 and 3. This is equivalent to a mix ratio of 0.001 percent.

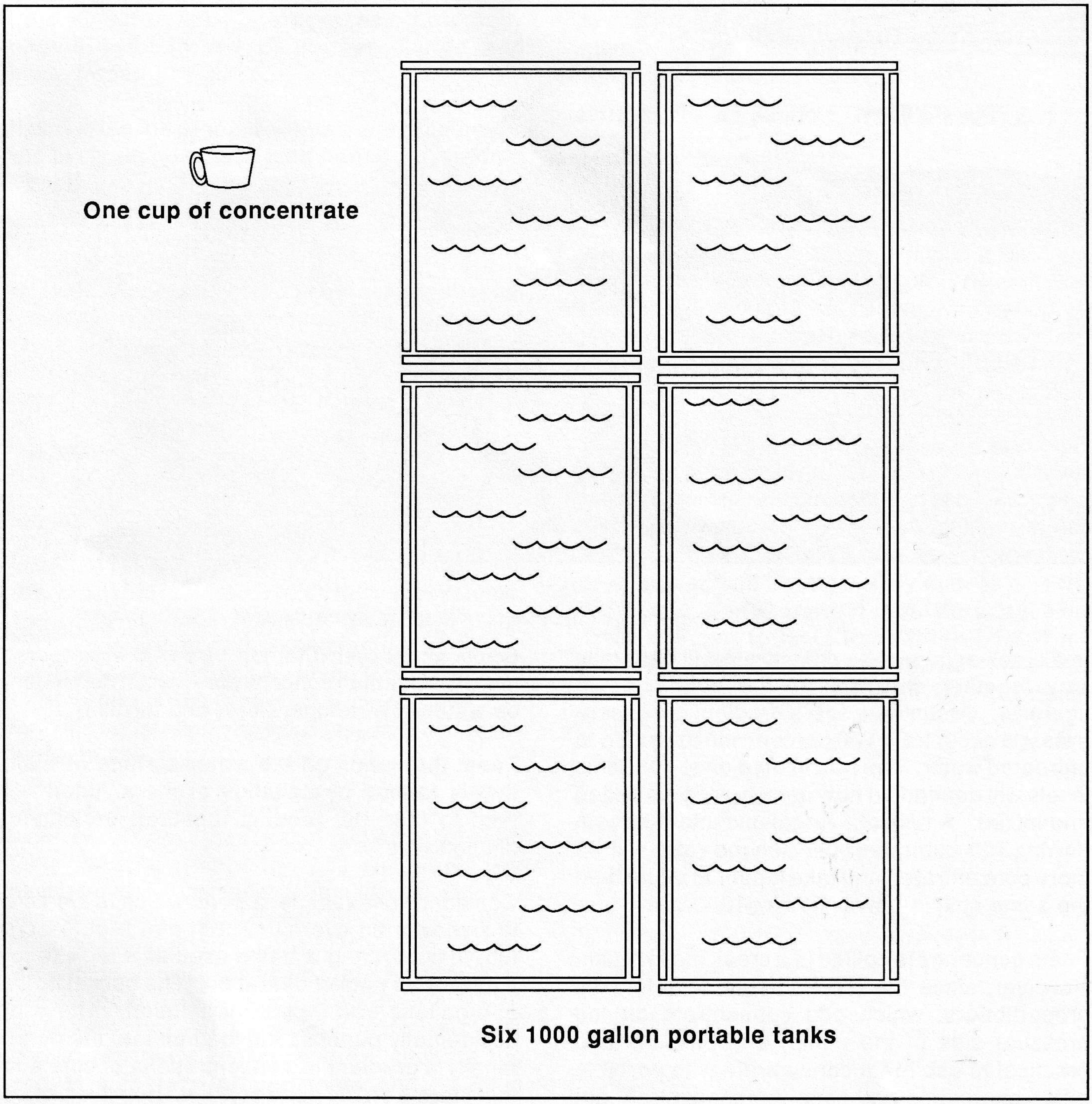


Figure 20.—One cup of concentrate in 6000 gallons of water is appproximately a mg/l or 10 ppm.

When firefighting with class A foam we carry concentrate on engines and aircraft. We use foam solution at mix ratios between 0.1 percent and 1.0 percent. Is this a problem for aquatic environments? Let's examine this question in detail. Any impact would depend on the dilution of the product and where the product is applied. Spillage of foam concentrate is of greatest concern for aquatic toxicity because uniform dispersion will not be immediate; dilution will take time.

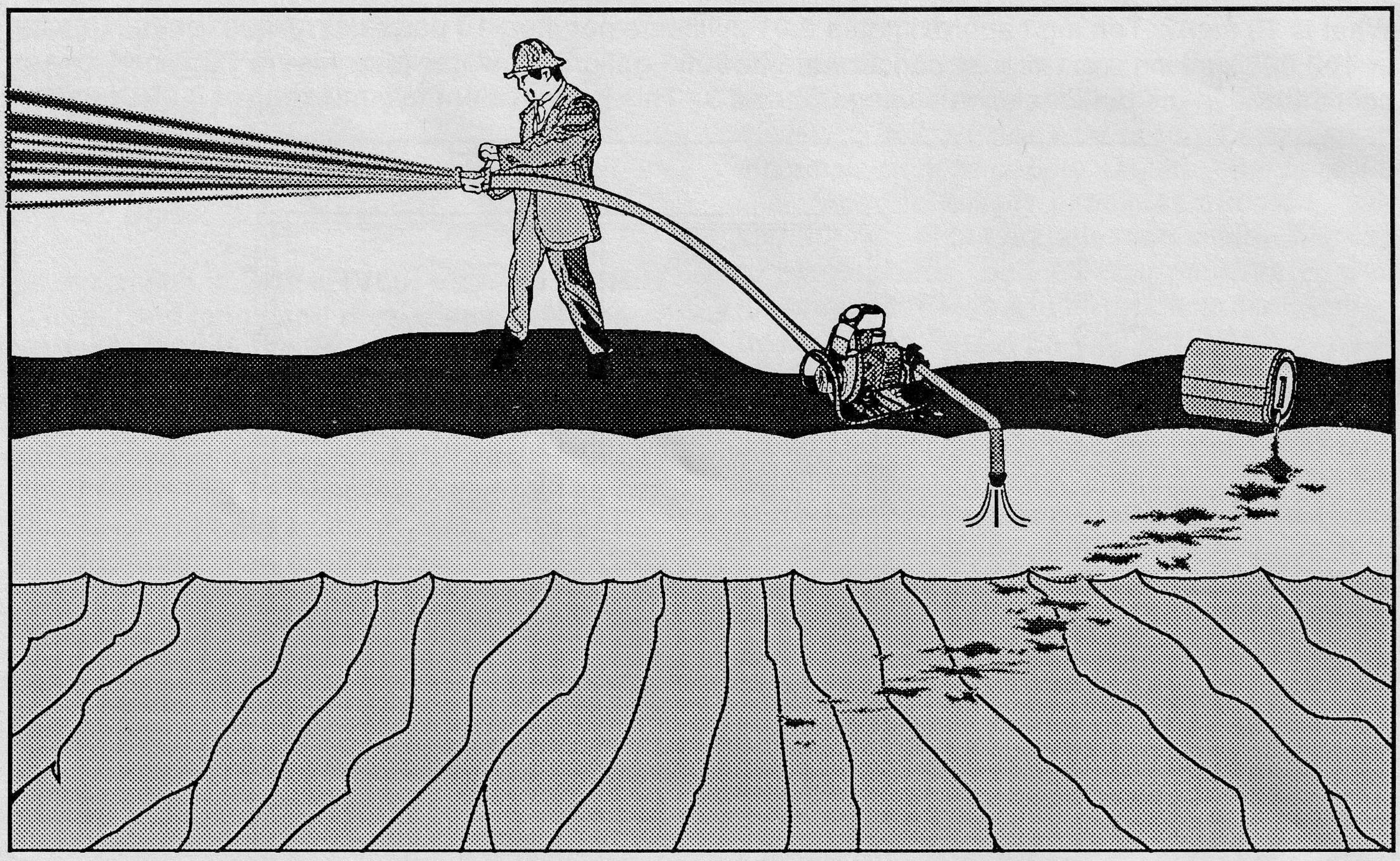


Figure 21.—Illustration of hypothetical foam concentrate spill.

In a creek or lake, the concentrate will generally stay together and drop to the bottom as in figure 21. Around the spill a gradient of concentrate will occur from 100 percent concentrated to untreated water. The rate of dilution to non-toxic levels will depend on how quickly water is added and mixed. A spill of five gallons into a stream flowing 100 cubic feet per second (cfs) will be more concentrated and take longer to dilute than the same spill in a river flowing1000 cfs.

Foam concentrate spilled in a creek may kill fish. However, since the development of automatic proportioners, which add concentrate on the pressure side of the pump, it is possible and practical to use foam concentrate with portable pump operations and keep the concentrate out of the water and well away from the pump site. To prevent backflow into the water source, a suction side check valve must be in place for any portable pump operations with foam.

A direct application of foam or foam solution to a water source will also create a gradient of concentrations as the solution disperses. Solutions between 0.1 and 1.0 percent will disperse more quickly than concentrate— again dependent on water flow, temperature, and turbidity.

Foam that lands on the water surface or foam that is formed by agitation of the solution will tend to hold the product together, prolonging dilution time.

Consider, for example, a pond which is 1/4 acre in size with an average depth of 4 feet (1-acre foot of water) and is being used as a dip site for a helicopter bucket operation. The bucket holds 250 gallons of 0.5 percent solution. The pilot accidentally punches the load off into the pond. Initally a gradient of concentrations occurs and foam forms on the pond surface. However, once the solution from the bucket disperses completely, the resulting concentration level in the pond becomes 0.0004 percent which is less than the LC_{50} of 0.001 percent.

An application of foam to the ground or vegetation will be less likely to impact fish than a direct application to a water source. To do so, the product will have to find its way to water. Several factors will influence the movement of the product to water including soil type, soil moisture, slope, water flow through the soil, and erosion such as from rainfall or slides. In the process, the already diluted solution will be further diluted and biodegraded.

If and when the product enters a water course, it will likely do so over a long period of time in a wide area, rather than all at once in a single location as might occur in a concentrate spill or direct application of foam.

In forests and rangelands the combination of materials and events influencing biodegradation and toxicity is complex. Prediction of effects on particular organisms in forests and rangelands would be difficult without site-specific testing.

Two studies are underway to improve the confidence with which we can predict the effects of foams in specific situations. The Department of Interior Fire Coordination Committee is funding research to study the effects of foams on aquatic and terrestrial animals and on their ecosystems. The USDA is funding a risk evaluation to study the human health and environmental effects of the individual components of the foam products. The information from studies such as these may form the foundation of a risk assessment process for foam use.

Class A foam is one of many tools we have available for fire suppression tactics. Like hand tools, dozers, retardants, and wet water, we must consider carefully when to use it. We should be careful because the products may have serious effects on aquatic ecosystems. We should also acknowledge that foam products, which meet USDA specifications or NFPA standards, are not hazardous materials. We should recognize that measures, such as the use of automatic proportioners and avoiding direct applications into water sources, are available and will minimize exposure.

Several other factors besides environmental effects need consideration when a decision is necessary on the use of class A foam. These factors include suppression effectiveness, cost, value of threatened resources or property, short term effects of foam versus long term effects of fire, and firefighter safety. A local decision analysis process should be used on fire incidents to evaluate the risks, benefits, and mitigating measures related to foam use and to determine when and where foam can be used.

UPDATE—APPROVED, AVAILABLE FIRE CHEMICALS

A wildland chemical qualification, testing, and approval program is carried out for the various agencies by the National Wildfire Suppression Technology (NWST) Group, Missoula, MT, and the Technology and Development Center, San Dimas, CA (SDTDC). The program covers all fire chemicals—including long- and short-term retardants, as well as foam concentrates.

Table 1 (page 30) is the very latest Qualified Product List (QPL) of approved wildland fire foams and their status. Due to a printing error in the last Foam Applications for Wildland & Urban Fire Management publication, Volume 5, No. 1, 1993, page 17, Table 1, Fire Chemicals (Qualified or Approved and Commercially Available), Fire-Trol FireFoam 103 was left out of the table. Fire-Trol FireFoam 103 and Phos-Chek WD881 are the only two foams that have temporary administrative approval for use from fixed-tank helicopters.

12/4/92

FIRE CHEMICALS

(Qualified or Approved and commercially available)

Chemical	Mix Ratio	Status	Qualified/Approved Applications[1] Fixed-Wing Airtanker	Fixed-Tank Helicopter	Helicopter Bucket	Ground Engine
WILDLAND FIRE FOAM (Administrative approval using Interim Requirements for Wildland Fire Foam)						
Phos-Chek WD 861	.1-1%	Adm. Approval			•	•
Ansul Silv-Ex	.1-1%	Adm. Approval			•	•
Fire-Trol FireFoam 103	.1-1%	Adm. Approval[2]		o	•	•
Phos-Chek WD 881	.1-1%	Adm. Approval[2]		o	•	•
Fire-Trol FireFoam 104	.1-1%	Adm. Approval			•	•
Angus ForExpan S	.1-1%	Adm. Approval			•	•
Pyrocap B-136	.1-1%	Adm. Approval			•	•

[1] Administrative approval given when interim requirements are met.
- • Administratively Approved
- o Temporary administrative approval

[2] Temporary administrative approval for use from fixed-tank helicopters until a new or modified formulation meets magnesium corrosion requirements.

OBTAINING COPIES OF THIS PUBLICATION SERIES

Are you reading your own copy of this document, or a hand-me-down copy? Do you wish to obtain back issues and get on the mailing list for future issues? Do you even know who put this together and what the objectives are? Read on!

The National Wildfire Coordinating Group (NWCG)—which is sponsored by the United States Departments of Agriculture and Interior and the National Association of State Foresters—in cooperation with the Petawawa National Forestry Institute and Forestry Canada , has been issuing documents jam-packed with information on "Foam Applications for Wildland & Urban Fire Management."

This publication series contains articles presenting background, historical, health and safety, use, equipment, and suggested reading data on foams and applications systems. The series of publications represents a complete compendium on everything you ever wanted to know about foam but perhaps didn't know enough about to ask.

Authors from numerous agencies, worldwide, have been contributing to the issues in the series. Publications group personnel at the USDA Forest Service San Dimas Technology and Development Center (SDTDC) have been taking the original inputs and performing editorial and graphic functions to produce each issue in the series. So far, the following have been published: Vol. 1, No's 1 to 3 (1988); Vol. 2, No's 1 to 3 (1989); Vol. 3, No's 1 and 2 (1990); Vol. 4, No. 1 (1991) and 2 (1992); Vol. 5, No. 1 (1993) and now this present issue: Vol. 5 No. 2 (1993).

For your free copies, contact:
Program Leader, Fire
USDA Forest Service
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444 East Bonita Avenue
San Dimas, CA 91773-3198
(909) 599-1267; FAX (909) 592-2309
DG, SDTDC:WO7A

FOAM TASK GROUP QUESTIONNAIRE

The Foam Task Force Group needs information for future planning and direction. If you used foam, please fill out the attached survey form and return it to the Group:

H.B. "Doc" Smith, Chairperson
800 South 6th Street
Williams, AZ 86046

NWCG (FEWT)

FOAM TASK GROUP QUESTIONNAIRE

Date ______________________________

Agency ______________________________

Position ______________________________

Specific Location ______________________________

(District/Station,City/State) ______________________________

____

____

What is your present foam use?

Type of foam

Hardware:

Ground type ______________________________

Air type ______________________________

How are you using foam?

Ground:

Initial Attack ______________________________

Mop-Up ______________________________

Prescribed Fire ______________________________

Air:

Direct Attack ______________________________

Level of satisfaction:

Products ____________________

Hardware ____________________

Training ____________________

Information ____________________

What's missing ?

Want to see, but do ***NOT*** have? __________

Sources of frustration? __________

From:

How effective is Foam vs. Water only? __________

What are your environmental concerns? __________

What are your health & safety concerns? __________

Factors limiting applications:

Chemicals ____________________

Hardware ____________________

Recommendations, remarks, comments:
Include any recommendations, remarks, or comments on a separate sheet and enclose inside this self-addressed questionnaire mailer.

Signature ____________________

H.B. "Doc" Smith, Chairperson

Foam Task Force Group

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