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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



Canadian Committee  
on Forest Fire  
Management

Comité canadien de  
gestion des feux  
de forêt



## CDF ADVANCES CLASS A FOAM

by Paul Blankenship, Staff Chief,  
Mobile Equipment Management,  
California Department of Forestry  
and Fire Protection

Progress has been made on several fronts in the development and application of the Class A foam concept in the California Department of Forestry and Fire Protection (CDF). Field evaluation and trial work has been sufficiently done to indicate a strong viability for the use of the fire suppressant foam products on all fire involving Class A fuels. A performance specification was developed to make the concentrate available to all California State and local fire agencies easily and at low cost. Procedures have been developed to test proportioners for accuracy and durability. Initial actions have been taken to quantify the fire suppression capability of the foam solution when compared to using water only. Class A foam use and the equipment will be included in the revised National Fire Protection Association minimum standards for fire apparatus.

Several types of ground application equipment have been used by CDF fire control personnel over the last 2 years. In all cases, the benefits and advantages of the use of the foam products in fire knockdown and mop up are strongly advocated, "Let's go with it" is the comment. The need for reliable and accurate proportioning equipment is always emphasized by the field users. Use and operational directions are needed to expedite training and use methodology of the foam products and equipment. Field reports indicate

a need for accurate control of the concentrate use rate to maintain cost effectiveness of the foam products. A need existed for a stable supply of the foam concentrate so the foam could be used for all applicable fire incidents.

A performance specification was developed for CDF that will meet the general requirement of the California fire service. Bids were solicited and a contract established for the Class A foam concentrate. All California State agencies and local governments can now utilize the State contract to acquire foam concentrate.

The USDA Forest Service approval list was used as a requirement to assure the physiological and environmental suitability of the concentrate products.

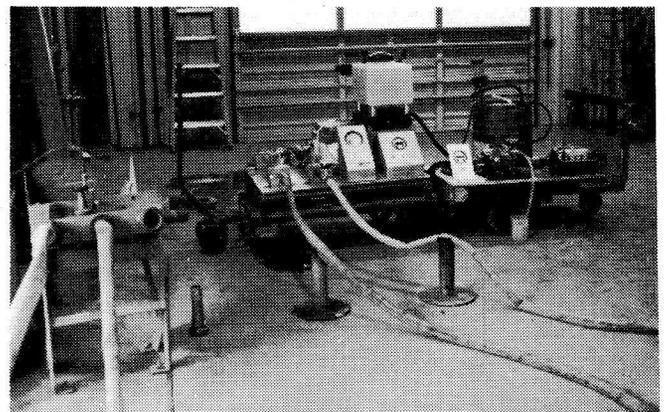


Figure 1. Foam concentrate proportioner testing setup. Test unit at the right, flow and measuring unit in the center and discharge pilot manifold on the left of the picture.

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A temperature viscosity limit is stated to assure the usability of the foam at low temperatures. Surface tension is addressed to assure suitable fuel penetration and saturation to eliminate rekindles and reduce mop up. The flash point limit used by Underwriters Laboratories for Class B foam products is specified for the CDF Class A foam concentrate. The specific gravity is specified to assure the solubility of the concentrate in water. Standard industry testing methods are specified for confirming the compliance to the CDF requirements.

There are several benefits expected from the use of a performance specification and contract in addition to low cost. It will establish a consistent quality level on which the field users can depend. A consistent performance characteristic will enable fire control and training personnel to begin developing application methodology based on repeatable results. The use of the same product over a period of time will allow the users to learn and become more experienced with using different concentrate ratios for a variety of regular fire incident situations, such as flashy vegetative fuels compared to deeper more dense fuels.

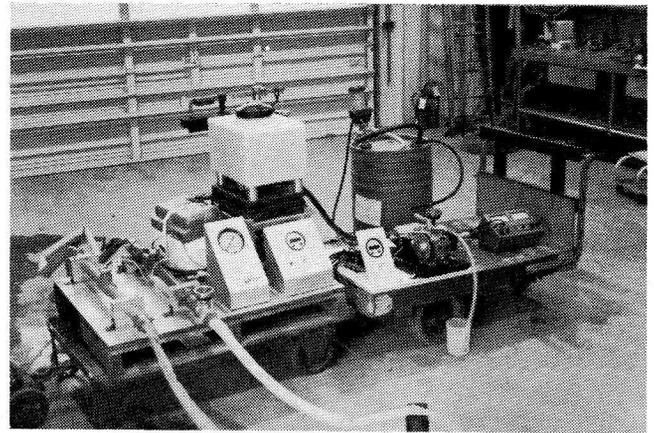
Concentrate proportioner specifications to meet CDF performance needs have been developed. Automatically controlled, direct discharge injection, adjustable ratio units capable of working over a wide range of flow characteristics are needed. The flow proportioning equipment also must be of a design that can be retrofitted on existing CDF fire apparatus as well as be incorporated into the buildup of new units.

A procedure has been established to test foam proportioners for performance compliance. Units that are presented to CDF by manufacturers will be tested and placed on the acceptable bid list if they are found to be satisfactory. The procedure will validate the accuracy, capability, and durability of the proportioners. The units must work over a range of 5 to 200 gallons per minute (gpm) of water flow and at pressures from 0 to 400 pounds per square inch (psig). The combinations of pressures and flows used for testing will be done within the capabilities for apparatus. The concentrate injection rate will be determined by weight of the product dispensed on a timed/rate basis. This procedure will provide equipment that will perform satisfactory in all fire incident situations of CDF responsibility. It is patterned after the fire pump and pump drive acceptance test procedure that has been used in the past by CDF and the Forest Service for suitability and quality control of those products.

CDF has had eight fixed and two automatic rate direct injection proportioners in service on fire engines for the past year. Much of the field use information came from the people assigned to those units. The fixed rate units will be upgraded to the fully automatic types in the next few months. The fixed rate units have

worked well, but have limitations to the flow ranges over which suitable foam solution can be developed because of the constant injection rate.

The aspirating nozzles have been very suitable for the wide range of fires encountered by CDF fire control personnel. The safety provided to the firefighters by having full control of the flow rate and nozzle pattern is a great benefit availed by the use of aspirating nozzle in both wildland and structural fire conditions that are being encountered. It will also allow for better use of the foam product as more application knowledge develops and, in turn, improve the cost effectiveness. There is much to be learned in the application of Class A foam products and the variables provided to the firefighter by using aspirating nozzles will help develop that knowledge.



*Figure 2. Foam concentrate proportioner testing pressure; flow and concentrate weighing equipment—left side. Test unit and current measuring equipment is on the right; concentrate supply at the right rear.*

The National Institute of Standards and Technology has been contacted by CDF to determine the actions needed to qualify the fire controlling ability of the Class A foams as compared to water for the same fire intensity. The Class A foam use concept is widely accepted as a much better method of controlling fire than the use of water only. Quantifying the difference will allow fire agencies to obtain recognition and credit from the grading organizations for using this advanced technology. Objective of the test procedures will be developed and funding sought to proceed with the necessary work.

The Fire Department Equipment Committee of the National Fire Protection Association (NFPA) will be publishing extensively revised minimum standards for several types of fire apparatus in February 1991. These standards will include descriptions and information about the different types of Class A foam equipment. There will also be a discussion of the differences between Class A and Class B foam products and their application to help fire agencies better understand

the advantages of this technology. When the new NFPA standards are published, the Insurance Service Office will incorporate them in their fire department grading methods. These actions are going to further motivate the use of Class A foam products in routine fire applications.

The fire control responsibility of CDF continues to be more complex and demanding. Fires must be dealt with more rapidly, firefighter safety must be improved, property loss must be reduced, environmental damage must be reduced, and air pollution must be controlled, all in the most economical way possible. The use of Class A foam is one of the tools that will help attain these objectives.

## **THE BASIC USE OF CLASS A FOAMS WITH ASPIRATING NOZZLES ON WILDLAND FIRES**

*by Steve Raybould, Program Assistant,  
USDA Forest Service.*

*Excerpts from a draft basic foam training document from an ad-hoc training committee, Foam Task Group, Fire Equipment Working Team (FEWT), National Wildfire Coordinating Group (NWCG) and "The Use of Foam in Wildland Firefighting: Some of the What, Why and Hows," by H.L. Vandersall.*

Foam is mechanically generated bubbles made by introducing air into a mixture of water and foam concentrate (foam solution). The bubbles carrying the solution attach to the fuels.

Foam affects the fire by absorbing heat, forming a barrier to oxygen, causing a cooling effect, allowing water to penetrate fuels and providing a protective barrier for unburned exposed fuels.

The foam clings to all types of fuels on application and it releases its water slowly over time. In addition, the water that is released contains the wetting agent which facilitates the water's spread over a large area.

Visibility of the foam plays a role in the conservation of often scarce water. The ability to see the foam avoids waste of water from over-treatment, and pinpoints where the foam is breaking down so that the control line can be reinforced as needed.

### **Personal Safety and the Environment**

Foam concentrates have health effects similar to those of common household soaps and shampoos. Presently there is no evidence to suggest that foams are harmful. The foam concentrates have varied toxicities with respect to fish but when used in a diluted form for application they are predicated to be non-toxic. A small proportion of the population may experience allergic reactions to the material.

All personnel should follow the manufacturer's recommendation as per the product label. Foams are detergents and, as such, will dry the skin. The foam concentrate possess skin sensitizing properties and can produce moderate to severe eye irritation. To eliminate possible health problems from either prolonged exposure to the skin and eye irritation the following warnings should be heeded and precautions taken:

When mixing concentrates, goggles, waterproof gloves (rubber or plastic), and disposable coveralls should be worn when possible. The use of leather boots at the mixing site should be avoided, since foam concentrate will penetrate leather, resulting in wet feet.

If clothing becomes soaked with foam concentrate, it should be removed and thoroughly rinsed with water.

Eyes splashed with foam concentrate or a foam solution should be flushed with large amounts of clean water as soon as possible for at least 15 minutes.

With skin contact, wash off with water, and remove contaminated clothing.

A non-allergenic lotion/hand cream should be available to avoid raw chapping of skin.

Inhalation of foam vapor can be irritating to the upper respiratory tract, and should be avoided.

Ingestion of foam concentrate or solution can be harmful if ingested in quantity.

Slipperiness can be a hazard at the mixing site. Caution should be used in all areas where foam concentrates or solution are being used. All spills must be cleaned up as soon as possible to avoid hazards to personnel and the environment.

Spills of foam concentrate should be physically removed with a shovel. Sand or absorbent material can be used to facilitate removal. Spills should not be flushed into drainage ditches or storm drains. Do not flush equipment near domestic or natural water supplies, creeks, rivers, or water bodies.

Locate foam mixing and loading areas where natural water contact is minimal. Leave at least a 100 to 200 foot buffer between the foam source and the high water line. Avoid direct application or drops into rivers, streams, lakes, or lake shores. Use alternate methods of line building or terminate the use of foam altogether. Notify authorities promptly of any spill into a water body or fish kill.

## Clean Up

All foam concentrates have a detergent base. Therefore, cleansing of all plumbing, pumps, tanks, and other exposed surfaces can be expected. This may promote the corrosive actions of water. Flush pumps exposed to foam solution at the end of each shift. Special care should be taken when flushing pumps that lubrication is not washed off. Equipment may have to be lubricated more than once a shift.

## Foam Generation

An aspirating nozzle introduces air into the foam solution (foam concentrate and water). The nozzle uses the velocity of the solution to provide air injection. Air is drawn in through holes as a result of the expansion of the solution, agitation causes mixing, and foam is produced.

A simple way to deliver foam solution is with existing nozzles. These nozzles will give penetration and spread but will not give a foam structure or body for heat reflection and insulation. This may be the best method for mop-up.

## Application

A 0.5 percent solution expanded by a factor of 10 in reality is 90 percent air, 9.95 percent water, and only 0.05 percent foam concentrate.

10:1 expanded foam has been said to expand 200 gallons of water solution to 2,000 gallons of water, or to replace 100 gallons of water with 10 gallons of water. The fact is, making foam out of water does not increase the volume of water; 200 GALLONS OF WATER IS ONLY 200 GALLONS—NO MATTER WHAT FORM IT TAKES. Creating a foam makes water more efficient at absorbing heat and wetting. To extinguish a given fire, less water as foam may be needed, giving better results per volume than plain water.

Foam makes water work more effectively in fire applications. Water alone works on one side of the fire triangle. Foam, on the other hand, works on all three sides of the fire triangle. As a foam, water is most efficiently turned to steam, absorbing heat.

A foam's effectiveness as a barrier should not be judged by visibility alone. Much of foam's water penetrates into adjacent fuels. The exact amount of water absorbed depends on the amount of water as foam, method the foam is applied, amount of water evaporated, the foam stability, and the fuel type. Foam's visibility is not a measure of its performance; quality foams will leave behind wet fuel.

Foam durability depends on the weather. Bubbles collapse when their water evaporates, causing foam to breakdown. In general, foam will be visible in exposed areas for about 1 hour in hot weather; for

up to 4 hours in cool weather. Foam in shaded areas will be visible even longer.

Rates of application depend primarily upon wind, temperature, fuel moisture, and fuel loading. For most uses manufacturers recommend a 0.5 PERCENT MIX RATIO for aspirating nozzles AS A STARTING POINT; go up or down with the percentage as circumstances require. The higher the level of concentrate in the solution, the greater the amount of foam which can be obtained and greater will be its stability; however, you will be using up the concentrate at a faster rate.

A well proportioned foam accomplishes the goal of the application. The following is a guide to help you in setting the percent of concentrate:

<i>Fuel Type</i>	<i>Foam Need</i>	<i>Percentage</i>
Duff/mop-up	Soapy or foamy water	0.1 to 0.2
Grass	More body, but still wet	0.3 to 0.4
Brush	More cling and rigidity	0.5 to 0.6
Indirect attack	Remain wet for longer time	0.6 to 1.0

To be effective, the properties of the foam need to be matched with the types and orientation of the fuels to be treated. The foam needs to be applied in such a manner that the fuels are coated or covered.

When treating duff, the goal is to penetrate the fuel layer so that the fire is not carried by untreated fuels below the foam cover or wet top layer. A straight stream with a mixing action best achieves this. Or in standing fuel, lofting the foam stream so that it will fall vertically into brush or trees would give the best results. In most cases, a combination of these application techniques is desirable.

Apply foam to the base of a linear flame front. On wide hotspots, secure the fire edge and move toward the center. While attacking the edge, direct a portion of the foam stream onto immediately adjacent unburned fuels.

Apply the foam stream as you would a water stream for best penetration into burning material. Apply long enough to ensure extinguishment, but realize this will not take very long. As soon as steam is visible move on. Vapor suppression, cooling, and wetting have occurred. Leave a foam blanket over the hot fuels to smother, and continue to wet the fuel.

## Mop-up

Begin applying foam on the burn edge and work in; concentrating on hot spots. Apply foam as you would a water stream into burning material for best penetration. The frothy foam quickly penetrates the fuel and ground where it lies, and as a blanket separates oxygen from any remaining smoldering fuel.

For deep-seated fires in stumps, landings, and log decks use a mop-up wand or Forester nozzle. Application techniques are not different than old water methods, but the water used is able to accomplish more.

Before leaving the area check for steam rising from the foam. Steam plumes indicate a pocket of heat which may need more attention.

The ability of foam to continue wetting and cooling fuels long after the applicator has left the area is a key to foam-use strategies. It will be important for all applications of foam. Greater efficiency is achieved when the applicators can move on to a new flame or smoldering stump because they know the foam will continue to work where it was applied.

## **USE OF CLASS A FOAM IN ORGANIC SOIL FIRE SUPPRESSION IN FLORIDA**

*by J.P. Greene, Fire Resource Manager,  
Florida Division of Forestry*

Organic soil fires are a challenge to wildland firefighters in many parts of the world. Florida is one of those areas. Organic soil, or "muck," is formed by the incomplete decomposition of organic material, mostly plant residues. In Florida, muck is usually deposited on lake and swamp bottoms in layers several inches to several feet in depth. Drained muck fields are highly productive croplands and are exploited to drainage or drought; however, these deposits also become available wildfire fuel.

In addition to the loss of the soil resource, muck fires also drastically degrade ambient air quality in highly populated areas and, when mixed with morning fog, severely impact highway visibility on many heavily travelled routes in Florida. Complete suppression and mop-up, therefore, is often a necessity.

Muck fires have been traditionally fought using large volumes of water. If the firefighter is lucky, a nearby canal or lake provides ample water. If he is unlucky, the water must be transported by vehicle or long pipeline. If the water could be made more effective, transportation costs could be lowered, thus reducing the overall cost of organic soil fire suppression. Class A foams may be able to accomplish this end.

During the 1990 fire season, side-by-side trials were conducted with water and class A foam on muck fires in central Florida by Division of Forestry personnel at the Sebring Work Center. Forest Ranger Mike Sawyer, in his "Ground-Applied Foam Evaluation" for the Greenbrier fire, Highlands County, March 13, 1990,

explains: "The area burning was 250 acres of dry muck with pasture grass covering most of it. The grass had been burned off to prepare the area for planting corn. We started taking water from nearby canals to suppress the many burning potholes forming over the tract. We used three engines with one man each, two using plain water and one using foam mix at 0.1 percent and an aspirating nozzle. The foam-equipped unit used about 200 gallons of water, while the other trucks used 900 to 1200 gallons to suppress the same area of burning muck. The potholes where the foam was used were extinguished on the first pass, while the areas where plain water was used often required return visits."

Sawyer added later that a different nozzle technique allowed by the use of foam further assisted firefighters. While using plain water, a straight stream is often necessary to penetrate burning muck beds. This technique can often scatter the fire to unburned fuels. Foam, on the other hand, can be applied to the burning surface at low pressure and allowed to penetrate and extinguish the fire without the mechanical mixing required by water.

Another evaluation by Sawyer was done for the Apthorpe Bay fire, also in Highlands County, March 1990: "This was a typical fire in transition zone between sand ridge and bay swamp. The surface fire had burned in an area of three acres. Fuels were heavy palmetto-gallberry, bay trees, grape vine, and muck. We made the initial attack with two engines and a light dozer. The dozer was used to open the area to allow us access with hose lines. Both engines used foam produced by aspirating nozzles and 0.1 percent foam mix. Overall, the foam was effective. Without a nearby water source, the foam would do the trick."

In summary, class A foams have the following advantages over plain water when used in organic soil fires in Florida: (1) Foam makes water more effective by increasing its penetration of the often unwettable fuel; (2) foam reduces the need to stir the burning muck with a straight stream, thus reducing the scattering of the fire into unburned fuel; (3) foam reduces the amount of water needed to extinguish burning muck, thus reducing transportation costs and total suppression costs and (4) foam may reduce environmental damage by reducing the need to disturb soil and residual vegetation for mop-up.

For additional information please contact J.P. Greene, Fire Resource Manager, Florida Division of Forestry, 3125 Conner Blvd., Tallahassee, FL 32399-1650, 904/488-6111

GROUND-APPLIED FOAM EVALUATION

Evaluator Philip M. Sawyer Position Forest Ranger Telephone No. (813) 655

Federal  
Agency \_\_\_\_\_  
Forest \_\_\_\_\_  
District \_\_\_\_\_

State/private  
State Florida  
County Highlands  
Organization D.O.F.

Date of incident: \_\_\_\_\_

Incident type:  Wildfire (name): Apthorpe Bay No.: 629  
 Prescribed fire  Other: \_\_\_\_\_

FUELS/WEATHER

Fuel type: Bay swamp/muck Model No. \_\_\_\_\_ NFFL  NFDRS   
Duff Depth (in):  1  1-3  3-10  10  
Aspect:  N  S  E  W  
Slope (%):  10  10-30  30-60  60  
Temp. 92 °F Humidity 40 % Wind speed 5 mph  
Fire behavior:  Creeping  Running  Crowning  Spotting  
Flame length 1-2 ft

FOAMS

Product brand: Fire-trol 103 Approx. Water Temp. 80 °F or description \_\_\_\_\_

Mix method:  Batch mix  Eductor  Injector/meter

Was concentrate mixed on day of use? yes If not, when? \_\_\_\_\_

Gal. of concentrate used 1 qt - 1/2 gal Gal. of water used 300  
or approx. solution mix ratio 1/10 = 2/10 %

Foam consistency: (Very dry, fluffy, 1, 2, 3, 4, 5, watery) \_\_\_\_\_

Application:  Compressed air (WEPS) Size \_\_\_\_\_ cfm Manufacturer: Sawyer  
 Air aspirating nozzle (gpm rating): 6-10 Type: tube  
 Other (describe): \_\_\_\_\_

PUMPING DATA

Engine size: GVW \_\_\_\_\_ lb Water tank 300 gal.

Water pump:  PTO  Auxiliary  Portable

Type of pump:  Positive displacement  Centrifugal  gpm rating \_\_\_\_\_

Number of nozzles used: 1" \_\_\_\_\_ 1.5" \_\_\_\_\_ Other (1) Sawyer

For hoselays: Length of hose to nozzle 100 ft  
Elevation (+, -) from pump to nozzle 0 ft  
Hose mainline diameter:  1"  1.5"  2.5"  3"

(OVER)

APPLICATION

Direct attack: \_\_\_\_\_ ft applied \_\_\_\_\_ ft of line held.

Pretreated line: Length \_\_\_\_\_ ft  
Width \_\_\_\_\_ ft  
Length held \_\_\_\_\_ ft

Pretreated to protect:  Snags  Piled fuel  Structure  
 Timber/reproduction  Other \_\_\_\_\_

Mop-up: (Briefly describe technique) Filled potholes with foam to extinguish. Potholes were scattered over 250 acres which required driving spot to spot. We were able to use hose from the cab on most of the potholes.

OPERATION

Problem(s) with mechanical components? \_\_\_\_\_

Was foam produced of expected quality? yes Was quality consistent? yes

Comment on operational events or problems: Using the Herman nozzle was effective but slow. More volume would have allowed us to work.

Can your engine make a running attack? Yes  No

If YES, was a running attack used? Yes  No

If NO, would you like the capability? Yes  No

Rate effectiveness of application: More effective than water  Same effectiveness as water   
Less effective than water

Effectiveness comparison based on: Direct comparison to water  Past experience with water

Comment on possible reasons for the success or failure of your operation: The foam provided a barrier between the ash & air to help smother the muck.

Do you feel a need for further training in foam operations? Yes  No

REMARKS The area burning was 250 acres of dry muck with pasture grass covering most of it. The grass had been burned off to prepare area for planting corn. The landowner was trying to disc the muck to put out the fire, but due to the size of the track this was unsuccessful. We started taking water from nearby canals to out the many potholes forming over the tract. We used 3 engines with 1 man each, 2 using water only & 1 using foam. I used about 200 gal of water as the other trucks used 900-1200 gal. The potholes where the foam was used were outed on first pass. Where water was used we would often find areas still burning.

COMPLETE EVALUATION FORM FOR EACH ENGINE INVOLVED IN INCIDENT.  
SEND COMPLETED EVALUATION FORMS TO ONE OF THE FOLLOWING COLLECTION POINTS:

USDI—Bureau of Land Management  
Boise Interagency Fire Center  
Attn: Jack Wilson  
3905 Vista Avenue  
Boise, ID 88705

USDA—Forest Service  
Intermountain Fire Sciences Lab.  
Attn: Fire Suppression Res.  
P. O. Box 8089  
Missoula, MT 59807

USDA—Forest Service  
Technology & Development Center  
Attn: Prog. Ldr.—Fire Mgmt.  
444 E. Bonita Avenue  
San Dimas, CA 91773

GROUND-APPLIED FOAM EVALUATION

Evaluator Philip M. Sawyer Position Forest Ranger Telephone No. (813) 655-3131

Federal Agency \_\_\_\_\_  
 State private State Florida  
Forest \_\_\_\_\_ County Highlands  
District \_\_\_\_\_ Organization D.O.F.

Date of incident: March 13, 1990

Incident type:  Wildfire (name): Greenbriar No.: 621  
 Prescribed fire  Other: \_\_\_\_\_

FUELS/WEATHER

Fuel type: muck Model No. \_\_\_\_\_ NFFL  NFDRS   
Duff Depth (in):  1   1-3  3-10  10  
Aspect:  N  S  E  W  
Slope (%):  10  10-30  30-60  60  
Temp. 82 °F Humidity 43 % Wind speed 7 mph  
Fire behavior:  Creeping  Running  Crowning  Spotting  
Flame length 0 ft

FOAMS

Product brand: Fire-Trol 103 Approx. Water Temp. 80 °F or description \_\_\_\_\_  
Mix method:  Batch mix  Eductor  Injector/meter  
Was concentrate mixed on day of use? yes If not, when? \_\_\_\_\_  
Gal. of concentrate used \_\_\_\_\_ Gal. of water used 300  
or approx. solution mix ratio 2/10 %  
Foam consistency: (Very dry, fluffy, 1, 2, 3, 4, 5, watery) \_\_\_\_\_  
Application:  Compressed air (WEPS) Size \_\_\_\_\_ cfm Manufacturer: Herman  
 Air aspirating nozzle (gpm rating): \_\_\_\_\_ Type: tube  
 Other (describe): \_\_\_\_\_

PUMPING DATA

Engine size: GVW \_\_\_\_\_ lb Water tank 300 gal.  
Water pump:  PTO  Auxiliary  Portable  
Type of pump:  Positive displacement  Centrifugal  gpm rating \_\_\_\_\_  
Number of nozzles used: 1" \_\_\_\_\_ 1.5" \_\_\_\_\_ Other (3/4) 1  
For hoselays: Length of hose to nozzle 100 ft  
Elevation (+, -) from pump to nozzle \_\_\_\_\_ ft  
Hose mainline diameter:  1"  1.5"  2.5"  3/4"

(OVER)

APPLICATION

Direct attack: \_\_\_\_\_ ft applied \_\_\_\_\_ ft of line held.

Pretreated line: Length \_\_\_\_\_ ft  
Width \_\_\_\_\_ ft  
Length held \_\_\_\_\_ ft

Pretreated to protect:  Snags  Piled fuel  Structure  
 Timber/reproduction  Other \_\_\_\_\_

Mop-up: (Briefly describe technique) Walked through swamp with hose  
trucks parked on edge of bay. Saturate pot holes  
with foam.

OPERATION

Problem(s) with mechanical components? Nozzle sensitive to clogging

Was foam produced of expected quality? yes Was quality consistent? yes

Comment on operational events or problems:  
Water must be drafted with fire mesh strainer

Can your engine make a running attack? Yes  No   
If YES, was a running attack used? Yes  No   
If NO, would you like the capability? Yes  No

Rate effectiveness of application: More effective than water  Same effectiveness as water   
Less effective than water

Effectiveness comparison based on: Direct comparison to water  Past experience with water

Comment on possible reasons for the success or failure of your operation:  
We did not do as good as I expected, probably due to the  
rough fuels + roots overlying the muck! It did do quite  
well compared to plain water use.

Do you feel a need for further training in foam operations? Yes  No

REMARKS This was a typical fire in the transition zone between a  
sand ridge + bay swamp. The surface fire had self-contained  
in an area of 3 acres. Fuels were heavy palmetto-galberry, bay trees  
grapevine + muck. We made an initial attack with 2 engines +  
JD 350. The 350 was used to open the area to allow us  
access with water lines. Both engines used foam, most of area  
where foam was used remained out. There were some spots  
we did come back to. Overall the foam was effective but  
just too slow for this particular incident. We did have a water  
source nearby that would have done a much faster job by setting  
up one of our volume pumps + deluge gun. However without a  
nearby water source, the foam would do the trick with a  
minimum amount of travel.

COMPLETE EVALUATION FORM FOR EACH ENGINE INVOLVED IN INCIDENT.  
SEND COMPLETED EVALUATION FORMS TO ONE OF THE FOLLOWING COLLECTION POINTS:

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444 E. Bonita Avenue  
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## CLASS A FOAM WORKSHOPS IN TEXAS

by Mark Stanford, Head of the Rural Fire Defense Section, Texas Forest Service

The Texas Forest Service is conducting Class A foam workshops for the fire service across Texas. To date, four workshops have been held in Midland, Denton, Amarillo, and San Antonio. A total of 300 firefighters representing 41 metropolitan and rural departments have attended the classes. Five additional workshops have been scheduled for the fall, and the agency plans to continue this program through 1992. The metropolitan fire departments of the host cities, local fire marshals and county firefighter associations have sponsored the classes and provided meeting facilities. This joint effort has helped to foster a tone of interagency cooperation between the participants.



Figure 3. David Abernathy, District Technician, demonstrates medium expansion nozzle in Denton, TX.

These 1-day workshops begin with a 3-hour lecture followed by equipment demonstrations in the afternoon. Due to the diverse backgrounds and experience levels of the students, the class format was designed as a basic introduction to Class A foam. The presentation provides an overview of properties of class A foam, foam equipment, and applications. Emphasis is placed on the effectiveness of foam and the diversity of equipment available to fire departments. Students have the opportunity during the demonstrations to test some of the principles discussed during the lecture. The demonstrations also allow them to compare the different equipment while getting some hands-on experience.

Of all the training courses which we offer to our fire department cooperators, this workshop has generated the most excitement among the participants. Because of the diversity of equipment and innovations in foam technology, there is now equipment which is suitable for the largest metropolitan department to the smallest rural volunteer organization.



Figure 4. Mark Stanford, Head of the Rural Fire Defense Section presents Class A foam lecture to Amarillo area firefighters.

## FIRE DEPARTMENTS AND INDUSTRY ARE ON-TIME IN CANADA

by R.R. Lafferty, Fire Management Officer, MacMillan Bloedel Limited, Woodlands Services Division

Exciting things are happening at the Sproat Lake Volunteer Fire Department (SLVFD) with the purchase of the first compressed air foam system (CAFS) in Canada. The SLVFD at Port Alberni, BC, is the first municipal fire department to purchase this new technology. Others are on stream for purchasing CAFS.

Harold Bishop, Fire Chief, says that their new CAFS will do an excellent job, especially in the rural/urban intermix. They have already used it to contain some prescribed fire and they have used it on a house fire. The unit performed above expectations.

Harold Bishop expects the CAFS to reduce water and fire damage and give them faster and better fire



Figure 5. Sproat Lake Volunteer Fire Department's new CAFS unit.

knockdown. Their CAFS is a Mallory 1001 which produces 100 cubic feet of air and up to 150 gal per minute of water at 150 pounds per square inch. The unit will drive a 2.5-in top-mounted monitor or two 1.5-in hose lines.

Rob Gornall, Training Officer, notes that special training of Sproat Lake's 28 to 30 volunteer firefighters has progressed well. The more the firefighters use the CAFS, the more they like it; especially with the light hose and the knockdown power of Class A foam.

Rob Gornall of SLVFD has considered possible environmental impacts of foam. Foam concentrates are strong detergents and wetting agents, requiring special handling procedures common to any strong detergent. The firefighters follow manufacturer's recommendations, abide by WHMIS, and follow the National Fire Protection Association's recommendations noted in NFPA 298.

Incidentally, Harold's Bishop's father, a training officer for a Vancouver fire department in the late 1940's, was demonstrating high expansion foam to his peers one day. He filled a house full of foam and then walked through the house, and explained foam's fire suppression characteristics. Mr. Bishop Sr. seemed to be ahead of his time, because the benefits of Class A foam are just now becoming appreciated.

The SLVFD has three stations that protect a large sparsely populated geographical area. Values at risk include MacMillan Bloedel's large Sproat Lake Logging Division Shop and Forest Industries Flying Tankers airdrome, where the two largest fire bombing aircraft are kept along with several other aircraft. Other values are MB Alpulp water line, portable sawmills, farms, houses, forested area, highway bridges, and the like.

In 1985, Woodlands Services Division of MB and an equipment and foam supplier introduced CAFS in Canada. Since then, MB has championed the use of CAFS and has just ordered two units. The second municipal volunteer fire department to purchase one is Sayward, on Vancouver Island and Beaver Creek Volunteer Fire Department at Port Alberni is next to purchase one.

SLVFD and MacMillan Bloedel believe that they are "on time" by being the first municipal and industrial users of CAFS in Canada.

For additional information please contact R.R. Lafferty, Fire Management Officer, MacMillan Bloedel Limited, Woodlands Services Division, 65 Front Street, Nanaimo, BC Canada, V9R 5H9

## SIDETRACK

The Oklahoma Forester  
*Fire Training*  
by J. Howard Parman

For the first time in 6 years I didn't go on any wildfires. I was ready though. I trained and prepared for this fire season better than any previous. I was in the best shape of my life.

How did I do it? The first thing I did was lose twenty pounds. I did that by giving up the things I loved; pizza, potatoes of all kinds, pasta, beef, pork, lamb, chili, corn, crackers, white bread, fried anything, chips, cookies, and ice cream. I ate so much poultry and seafood I felt like the Chicken of the Sea. But no sacrifice would be too great, I was going to be in the best shape of my firefighting career.

Then I worked on my endurance. I have two sons under 6 years old at home so I decided to do everything they did. When they ran, I ran. When they walked, I walked. When they slept, I slept. I lasted 3 days. After that all I could do was sleep, no matter what they were doing.

But I got my stamina up. My weight was down, my strength increased but I felt I was ignoring an important point. I was missing a key element. Then while reading "The Goat Roper News" it slapped me between the eyes like the free end of a pigging string. I was omitting mental preparation.

I needed a program that toughened myself up mentally. Something that would make me immune to hurry up and wait, the ridiculous decisions by no-nothing overhead and *The Forest Service-way-is-the-only-way* attitude. I had to devise my own program since no one had ever thought of such a thing.

So I developed the Get Mentally Tough for Fire Fitness Program or GMTFFP. If successful I could market it and be some sort of Yuppie guru consultant making big bucks. As a consultant, I would stroke my chin, nod sagely whenever someone asked me a question, and never give them a straight answer. But first I had to try the program on myself. I figured a week would be plenty.

On Monday I went to work as usual but with a twist. The alarm clock woke me at 4:15 a.m. For breakfast, I ate some half-way defrosted frozen pancakes off the flimsiest paper plates I could find. I used a plastic fork typical of fire camps so it broke as I worked up my first mouthful. I sat at my patio picnic table in the predawn dark. I turned on a fan to blow ashes from the Weber barbecue across the picnic table. Then nourished, I left for work.

I walked to work carrying a shovel and a 50-pound pack. In the pack were rocks and underneath the rocks was my lunch in a paper sack. I peeled the plastic off my flat sandwich and dropped it in the dirt before I ate it. I made sure the meal was too salty. I drank no cold water during the time I was on the GMTFFP. I drank water specifically heated to 105 °F and laced with quinine to get that sour fire camp taste.

After work I rode home in the trunk of neighbor's car. My wife had fried a chicken for supper. I took my supper on another flimsy paper plate and poured the left over grease from the skillet on my portion to give it that fire camp flavor. Again I sat at the picnic table. I turned on the fan again and set a full garbage can next to it for an extra touch.

I had 50 transients come to my house for a shower. I stood at the end of the line to make sure all the hot water was used up by the time I got there. I used two Hefty paper towels to dry off when I got done.

That night I slept on the sidewalk underneath the street light. To make it more realistic, I put some gravel under the sleeping bag. I found a cassette tape of motor and generator noises to play on my Walkman as I dozed off. I had a neighborhood kid with a loud car stereo drive slowly by. Another neighbor woke me at intervals asking if this was the Mt. Hood crew. The area dogs were an unplanned but handy irritant, especially when one woke me with a warm, wet feeling.

I varied this routine every day by the addition of different events. One day I slid down a rope to make my hands sore. On another, I walked to work barefoot. I trapped a squirrel in my red pack and had him chew up my underwear. I put a rock in my shoe. I had a street person talk to me in a loud voice about the cosmic significance of mayonnaise for 5 hours.

I had a guy in a faded green uniform pop up randomly with the thought of the day, things like:

"We didn't bring you here to think."

"You can't get new batteries for your head light until you bring in the dead ones."

"Not until you get this form signed by the IC, all the chiefs and bring a note from your mother."

"It's great idea but don't do it again unless the IC clears it."

"It's logical, clear and concise. That's the reason we won't use it."

I got to admit the Get Mentally Tough for Fire Fitness Program worked swell. After a week I had experienced all the mental situations of a wildfire. I was

ready. I had my physical fitness up. I was mentally tough. The problem was I had absolutely no desire to fight wildfire so I didn't.

Maybe GMTFFP worked too well.

## PUMP FLOW TESTING

by Dan W. McKenzie, Mechanical Engineer,  
USDA Forest Service

With a little ingenuity, firefighting personnel can determine, accurately, the flow rate of a pump using equipment on hand (a short piece of pipe, a tape measure, a level, and a plumb bob) and at almost no cost. Knowing how to go about this can be very handy, since accurate flow meters are often not immediately available for firecrew use. This method of determining pump flow rate is very accurate and needs no calibration. It is based on the principle that when an object is released it falls at a given rate, independent of its horizontal velocity. So when water is released from a pipe that is at a given height from the ground, it always hits the ground in the same time.

As explained in detail below, how far away from the pipe exit that the water hits the ground is directly proportional to the water's horizontal velocity as it exits the pipe. Further, the horizontal velocity is directly proportional to the amount of water coming out of the pipe, and depends on the area of the pipe opening. Knowing this area, the height of the pipe exit above the ground, and the the distance out from the pipe that the water hits the ground; the water flow rate can be accurately calculated using the formula given at the very end of this text.

For want of a better name I call this pump flow test method a "splash test." The steps to take to accomplish a slash test are:

A. Couple a short length (3 to 4 ft) of pipe of known *inside* diameter to the hose coming from the pump. (NOTE: In some cases, as flow rates approach maximum, hose ripple can occur. To prevent this, use either hard suction hose or a longer pipe.)

B. Mount the pipe level, horizontally, at a convenient height ("h") above the ground. (NOTE: Select the height suggested in the table for the pipe size and flow *range* you are going to use to avoid having to do a sequence of calculations.)

C. Run the pump and have the water splash on the ground.

D. Measure the distance ("D") along the ground from the end of the pipe to where the water hits the ground (fig. 1). At the time of the measurement, the

pipe must be running full of water. Let a plumb bob hang from the pipe exit down to the ground—this locates where to start measuring “D.”

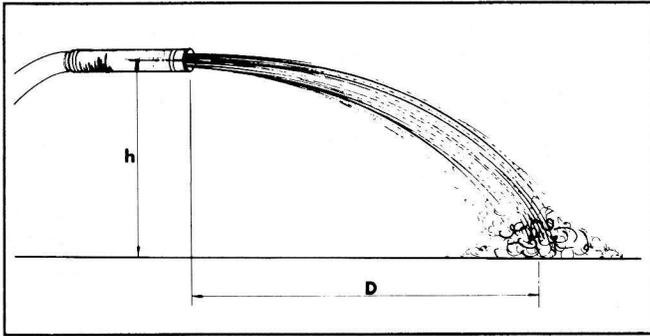


Figure 6. Relation of pipe exit to “h” and “D”.

How far out from the end of the pipe that the water hits the ground depends on the horizontal velocity as the water exits the end of the pipe. The higher the exit velocity, the higher the “D;” i.e., “D” is directly proportional to water flow velocity. Knowing “D” and the height of the pipe (“h”) above the ground, the velocity of the water out of the pipe can be determined. From this and the pipe exit area, the flow rate can be calculated.

To obtain the flow rate in gpm for the pipe size being used, when employing the height suggested in the table, multiply “D” by the gpm per inch found in the final column of the table. NOTE: Be sure to check the inside diameter of the pipe being used to see if it is as listed in the table; if it is not, **the flow formula**,

**presented following the table, must be used**—as would be the case **for any setup (pipe size or height) that is not presented in the table.**

Mounting the pipe on a fork lift is very convenient way of holding the pipe (fig. 2), since now the pipe can easily be adjusted either horizontally or vertically. And, if the test is conducted at a station or work center, a pipe can be mounted permanently on a stand or building, and permanent marks placed on the ground (these can be in gpm). This would permit flow tests to be conducted very quickly and easily. Remember that a splash test only determines the gpm flow from the pump. To check pump performance, the pressure at which the water is flowing must also be known. The engine pressure gauge can be used to obtain this pressure by partially closing the overboard discharge valve to create a resistance for the pump.



Figure 7. Splash test with 1-1/2-in pipe at suggested height of 54-1/4-in; the calculated flow rate was 84 gpm.

As there is a limited number of pipe sizes and practical heights for the water to fall from each of these pipes, the following table has been developed:

Splash test table.

Pipe size (in)	Pipe ID (in)	Pipe opening area (sq in)	Flow range (gpm)	Suggested height (in)	Unit linear flow @ suggested height (gpm/in)
0-1/2	0.62	0.30	2-10	18-3/4	0.25
0-3/4	0.82	0.53	5-20	29-7/8	0.35
1	1.05	0.86	10-40	38-9/16	0.50
1-1/4	1.38	1.50	20-100	45-13/16	0.80
1-1/2	1.61	2.04	40-150	54-1/4	1
2	2.07	3.36	60-250	65-3/8	1.50
2-1/2	2.47	4.79	100-400	74-3/4	2
3	3.07	7.39	150-600	79-1/8	3
4	4.03	12.73	200-900	84-1/2	5
5	5.05	20.01	300-1200	81-1/2	8
6	6.07	28.89	400-1600	108-3/4	10

For pipe ID's or heights not in the table, the flow rate can be calculated using the following formula:

$$\text{Flow (gpm)} = 3.61 \times AD / (h)^{1/2}$$

[(h)<sup>1/2</sup> = square root of h]

where:

**A** = Area (in square inches)  
of the pipe opening = (3.14) x (r<sup>2</sup>)  
[r = 1/2 of pipe ID (in)]

**D** = Distance along ground (in inches) from  
the pipe exit to the midpoint of where the main  
body of water splashes.

**h** = Height above ground (in inches) of the  
midpoint of the pipe exit.

**3.61** = Constant that adjusts answer for  
measurement units used in formula.

### INITIAL REPORT OF UNUSUAL OCCURRENCE OR EVENT Los Padres National Forest

**INSTRUCTIONS:** Report to be submitted to ADFMO within 48 hours of occurrence or event. ADFMO will forward to Captain, Superintendent, ADFMO, Steering Committee Mailroom. Mailroom will forward to all Los Padres National Forest employees.

**DATE & TIME:** 6/23/90 1830  
**DISTRICT:** Ojai Ranger District

**LOCATION:** Pole Fire, mutual threat fire with VNC, LPF-526 (P53141)

**PERSONNEL PRESENT:** LPF engines: 52, 53, 54, 60, and 66, Bat 51 and 52 and Bear Divide Hotshots

**EQUIPMENT INVOLVED:** E52 (FS# 6002 diesel model 61)

**CONDITIONS AT THE TIME OF OCCURRENCE OR EVENT:** (i.e., fuel, weather, topography, or any other factors.) Sunny and clear. Temps in mid to upper 80's, RH in mid to lower 20's and winds out of the SW at 10 mph. Steep terrain, 2000 ft + progressive hoselay with engine pressure at 250 psi.

**PURPOSE FOR WHICH PERSONNEL WERE INVOLVED:** (i.e., line construction, hose lay, mop-up, vehicle t.c., project work, etc.) Progressive hoselay anchoring the NW corner of the fire out of Pole Canyon; supporting Bear Divide Hotshots in constructing underslung line (fingered) as fire was backing downhill.

**BRIEF DESCRIPTION OF OCCURRENCE OR EVENT:** Engine crew was in the process of picking up spot fires (and fingers) below crews working uphill, when E52 lost water prime (3/4 tank on gage). Firefighters were pulled back into the "black" and crews were

notified of water status. Water was restored to the lay within 5 minutes.

**EXTENT OF DAMAGE OR POTENTIAL FOR:**  
**Potential safety problem to crews working the spot fires and crews they were supporting. Potential damage to Model 61 as pump lost its prime.**

#### REMARKS:

Problem: with the 5:1 speed increaser on E52, pumping at 250 psi and recirculating water through the #2 caused the foam in the tank to become aerated and frothy. This produced the false reading on the water level gage (3/4) when the tank was nearing EMPTY, causing the pump to lose its prime. Short term solution to the problem is use the #4 to knock down foam generated in the tank created through continuous pumping. Long term solution is to purchase and install external foam (intervention) systems similar in operation on E41 and E66.

### FOAM USE ON THE PAINT FIRE

by Roger Dahlen, Station Captain,  
San Marcos Fire Station,  
Los Padres National Forest

On June 27, 1990, a brush fire was reported as being two miles south of the San Marcos fire station on the Los Padres National Forest. Engine 41, 38, 47, and 35 were responded along with Santa Barbara County, Santa Barbara City, and other cooperators in the mutual threat area. Engine 41 being first on the scene quickly sized up the fire, and a progressive hose lay was deployed on the right flank of the fire (approx. 2 to 4 acres). With erratic winds and extreme fire behavior, the initial attack effort was futile in these conditions. Our game plan was changed and we began to establish a wet foam line on the west flank of the fire to keep it from spreading to the west and threatening the numerous structures in the area.

Even in these conditions, the foam line was a success. With temperatures ranging from 98 to 103° and winds pushing 30 to 60 mph., the fire was moving at an estimated 250 feet per minute. The fire had quickly moved into the suburbs of Santa Barbara within 20 minutes. After losing the initial attack on the wildland portion of the fire, we formed a task force and started saving structures and out buildings were possible. Throughout the night we were successful in saving 10 to 12 structures. The foam unit was a very valuable tool on Engine 41, it performed well and never failed us during the 8 to 10 hours of pumping. The other engines all used foam directly poured into the tank, but could not produce the consistency that the built-in unit on Engine 41 could. At the end of the Painted Cave fire, a critique revealed that an installed foam unit be installed in all engines and brush trucks.

## FOAM PROPORTIONING SYSTEMS

by Dan McKenzie, Mechanical Engineer,  
and Steve Raybould, Fire Specialist,  
USDA Forest Service

### Background

Foam initially described as a fire suppression agent was patented in England about 1877. Class B foams (AFFF type) for flammable liquid fires have been used for many years. Recently, foams for Class A materials have been found to increase the fire suppression effectiveness and efficiency of water.

### Introduction

When using foam to fight fire, proportioning the foam concentrate directly into the high-pressure, or discharge, side of the pump using a direct injection type proportioning system is very desirable. This eliminates problems associated with adding foam concentrate into the water tank (batch mixing), drafting the foam concentrate into the suction side of the pump, using an around-the-pump proportioner, or using an eductor on the discharge side of the fire pump. Many of the problems associated with traditional suction-side proportioning systems and methods and eductor proportioning systems on the discharge or high pressure side of the pump can be alleviated with the use of direct injection proportioning system injecting on the discharge or high pressure side of the fire pump. A direct injection proportioner system, one injecting into the discharge side of the pump, will help eliminate some of the following problems:

#### *For batch mixing:*

- Foam proportion cannot be conveniently changed while operating—it can be increased by adding more foam concentrate to the water tank
- When refilling a partially used pre-mixed tank of water, dip sticking or gauging is required
- Fire engine can not draw water directly from a nurse tanker or hydrant and make foam solution
- Foam solution degrades over time, tends to lose potency, and does not foam as well

#### *For suction side proportioners:*

- Incoming water pressure to the pump must be kept below atmospheric pressure (negative pressure) in order to move foam concentrate into the suction of the pump
- Flow must be known to set proportion correctly
- If operating conditions change such as flow rate of water or water level in the tank proportioning rate may change

#### *For around-the-pump-proportioners:*

- Flow must be known to set proportion correctly
- They require specific operating conditions to maintain accuracy

*For batch mixing, suction side proportioner and around-the-pump-proportioners:*

- Corrosion (caused by the foam concentrate clearing the tank, pump and plumbing)
- Pump priming difficulties
- Water-level gauge troubles
- Foaming in tank
- Use of more foam concentrate than required
- Problems with pump and valves caused by the foam concentrate washing out their lubricants.
- Contamination of the water tank—making water from the tank unusable for other purposes (such as drinking or supplying water for lookout towers)

*For pump discharge eductor proportioners:*

- Require specific operating conditions to operate, any change in operating conditions may result in large changes in foam concentrate ratio or may not work at all.
- High pressure loss in flow line, 35 percent or more.
- Can be sensitive to increased hose lengths and changes in nozzle sizes

To eliminate these problems, a foam concentrate proportioner injecting into the discharge side of the pump can be used. Ideally, a pump discharge side foam concentrate proportioner should:

1. Be proportional over the entire range of desired use. When the percent of foam concentrate is set, it should not change over the range of operation of the water pump (both flow and pressure), be proportional down to almost zero flow, and stop flowing when the water is completely shut off.
2. Not require that chemicals be added to the water tank; run through the pump; nor be recirculated back to the tank or through the pump. This is important because most centrifugal fire pump installations have [if they do not, they should] a continual small bleed back to the tank for pump cooling when the water is shutoff in the hose line.
3. Inject foam concentrate into the water stream on the discharge side of the pump in the correct proportion to make foam solution in the desired ratio of concentrate to water. Foam solution should flow directly from the piping system into the hose line with no possibility of the foam solution recirculating and contaminating the water tank, plumbing, and pump.
4. Be low in cost and simple in design; have both very high reliability (infrequent breakdown) and very high availability (work nearly all of the time); and have very high maintainability (if it does not work, can be repaired very quickly).

5. Be able to use different types of foam concentrates at up to 1 percent concentration—even higher percentages may be desirable—and be able to change percentage while operating.

6. Be able to gauge how much foam concentrate is left in the foam concentrate tank.

7. Cause no, or low, water pressure loss.

8. The proportioner should maintain accurate foam proportioning (within  $\pm 10$  percent of the set concentration) across the range of operating flows and pressures of the proportioner. In addition, the proportioning should not be effected by engine pressure, hose length and size, changes in water flow, or changes in nozzle elevation or size.

Different types of foam proportioners are available on the market today that will proportion both Class A and Class B (AFFF) foam concentrate. The following foam proportioners listed below address most of the guidelines listed above for they will fit, attempt to, or are advertised to fit most of the above guidelines. They are particularly designed with the guidelines of proportioning not being effected by engine pressure, hose length and size, changes in water flow, or changes in nozzle elevation or size and to be used on the discharge side of the the pump. The user should evaluate his equipment needs based on the use and vehicle to be outfitted, fire fighting applications, and performance requirements.

#### *AQUATEK SYSTEM*

Aquatek System; Div. of Komax Systems, Inc. injects foam concentrate directly into the discharge or high pressure side of the water pump proportional to water flow. Water flow rate is measured by a flowmeter which sends the flow rate signal to a micro processor which controls a positive displacement foam concentrate metering pump. This foam concentrate metering pump injects the foam concentrate directly into the water stream at the proper rate. A manually controlled foam concentrate metering system is also offered.

For additional information on the Aquatek Systems proportioner, contact Komax Systems, Inc., 508 East "E" Street, Wilmington, CA 90744, (213) 830-4320 or FAX (213) 830-9826.

#### *FLOW-MIX*

The FLO-MIX proportioner is designed to be used on the discharge side of the pump or at any point in a pressure hose line. The standard model is available either as a portable or a built-in. The unit is self powered and; therefore, no external power is required.

The unit operates by line pressure being exerted on a bladder filled with foam concentrate contained within

a pressure tank. The pressure in the tank is created by the flow of incoming water from the hose line. The concentrate is forced through a variable metering orifice down a feed line to the discharge side of a differential valve or venturi. The differential valve or venturi causes a differential pressure lower than incoming line pressure when water is flowing. This lower pressure is a function of water flow rate.

The system can be set for proportioning from 0.1 percent to 1 percent calibrated in settings of 0.2 percent. When the water flow through the differential valve stops, pressures within the differential valve becomes equal and foam concentrate flow stops.

A modified hand or electric pump, with built in check valves refills the system in less than two minutes. The proportioner can be refilled at any time without shutting down the hose line flow. However; doing refill no foam concentrate is injected into the hose line.

The FLOW-MIX proportioner is available in 5, 10, 15, and 20 gal sizes. Other sizes can be specially ordered. It can be mounted almost anywhere on the engine. If servicing of the unit is required, it can be carried out in the field in approximately forty-five minutes. The unit is self powered, wires and electricity are not needed nor are plumbing, flowmeters, or switches.

For additional information on the FLOW-MIX in-line proportioner, contact Robwen Inc., 1945 Blake Ave., Los Angeles, CA 90039, (213) 665-5633 or FAX (213) 665-2588.

#### *FOAMPRO*

The FoamPro system is an automatic, electronically controlled proportioning system which utilizes a positive displacement Hypro metering pump to directly inject foam concentrate into the discharge side of the water pump. FoamPro monitors water flow and not pressure. By directly measuring the engine's water flow with a flow meter, this system is able to maintain the proportion of foam concentrate to water based on volume.

The positive displacement metering pump directly injects a known quantity of concentrate into the water stream with each revolution of the pump shaft. None of the foam is bypassed or recirculated back to the foam tank. This makes for an efficient system by saving power for only the foam concentrate required is pumped.

The system uses a "closed-loop" operation, constantly monitors the output of the foam concentrate pump and comparing this actual value with the desired output to maintain the specified percentage of foam concentration in the flowing water. Because of this feedback, the system can automatically adjust

to variable operating conditions such as changing discharge pressures and foam concentrate viscosity.

In normal operations in automatic mode, water flow is directly measured by the flowmeter, with the foam proportioning corresponding to this flow measurement. The system can also be operated in a manual mode where the operator inputs a specified water flow into the system, and foam injection occurs proportional to this "simulated flow" value. This allows the operator to override the flow meter signal and tell the system how much foam concentrate to inject.

The operator can switch between automatic and manual mode by using the control switches on the totalizer display. The simulated flow rate can also be varied with the switches.

The totalizer readout displays can show current water flow in gpm, cumulative water flow in gal, and display and/or change the foam concentrate injection rate in increments of 0.1 percent even while the system is operating.

Several new features are being added to the FoamPro product line. A two tank system is available where either Class A or Class B foam concentrate can be injected into the water stream by the flipping of a switch. The totalizer display has been upgraded in new packaging for more rugged performance and better visibility in bright sunlight. Also new in the conversion to the Hypro Powerline three plunger, or triplex, pump. In addition to the standard Hypro paddlewheel flowmeter, Hypro, will offer, as an option, the Span Flowminder flowmeter.

For further information on the FoamPro proportioner, contact Hypro Corporation, FoamPro Department, 375 Fifth Ave. NW, New Brighton, MN 55112, (612) 633-9300 or FAX (612) 633-6864.

#### **PRO/PORTIONER**

The PRO/PORTIONER uses no electronic monitors or electronic flow sensing equipment. Using a proportioning block it meters class A or 1 percent AFFF from 0.1 percent up to 1 percent into the discharge or high pressure side of the pump. Flow ranges from 5 gpm to 250 gpm at 0.5 percent and 5 to 125 gpm at 1 percent and pressure ranges up to 450 psi.

PRO/PORTIONERS are available with a choice of power options. Twelve volt DC electric motor units for truck mounted applications when a fixed or running attack must be made with the engine. Two and four cycle engine models can either be mounted on engines or used for applications with portable pumps or when water relays require remote injection of foam concentrate. Also, under development is a mechanically driven PRO/PORTIONERS that can be driven by the

centrifugal water pump drive line (thus not adding to the electrical system load of the fire engine).

For additional information on the PRO/PORTIONER contact, KK Products, 1004 Silhavy Road, Valparaiso, IN 46383 (800) 537-7553 or FAX 219-464-0620.

#### **A REPORT ON GROUND APPLIED FOAM**

*by Ronald R. Rochna and Paul M. Schlobohm,  
USDI Bureau of Land Management*

We have made many advances in ground-applied foam; some of which are quite controversial at this time. We have generated worldwide interest on use of foam in fire suppression.

The most important step we can take to further the development and use of foam would be to proclaim the inefficiencies of water, and remove all ties the Bureau has to pure water use for fire suppression in the wildland environment as well as the urban/rural interface. We must continue research efforts with the Fire Growth and Extinguishment Department, Center for Fire Research, National Institute of Standards & Technology (NIST). We must continue to work with the Federal Emergency Management Agency and the U.S. Fire Administration.

Future efforts must quickly be concentrated in the following areas: education; research, evaluation, and documentation; equipment development; worldwide information distribution; and program priority.

In 1987, we learned far more about foam and water than could be recorded in this summary. Each answer brought several more questions and this fact is indicative of the current development stage of foam technology. We have a long way to go. Our experience in the field and in the library tells us that the most important step the fire community can take for the development of foam is to proclaim the inefficiencies of water and remove all ties the Bureau has to pure water use for fire fighting. No evidence exists that water by itself is the best way to extinguish fire. In fact, much has been documented to show that reducing water's surface tension with a surfactant, such as a foaming agent, is far superior to plain water for extinguishing fire.

Water has been perceived for years to be cheap, or free. This is not true. Hydrants are not free. Time and equipment spent hauling water is not free. The public has been misled for years to believe that a fire that cannot be put out with water is more fire than man can handle. That is not true, and we should not continue to support this misunderstanding.

Selling the concept of foam will not be successful if we merely praise the glories of foam. Others, such

as Fireout and slippery water, have died by this tactic. One cannot understand how foam works without knowing how water fails.

In early April, we concluded this year's testing of foaming agents with the flame test at Chemeketa Community College. We were pleased to find that all synthetic foaming agents (i.e., Angus Forexpan—then Surefire-Foam, Ansul Silv-ex, Chemonics 103, and Monsanto WD861) were at a performance level for insulation/reflection acceptable to us. Since all products were not at this level in June of 1986, we consider the test to be a success. Furthermore, by their apparent acceptance of the test, the foam industry has indicated that we, the users, have the lead with the development of the technology.

Insulation/reflection is not the only characteristic by which we can now judge foaming agents. In their foam standard due later this year, the NFPA will be requiring that concentrates have no change in viscosity above freezing. This characteristic is necessary because the future of the technology is in proportioning systems which require flow through small orifices at low temperatures. We recommend a full-scale survey of all concentrate containers at above freezing storage temperatures for crystallization and thickening.

The use of proportioners is vital for accurate and variable mix ratios, but also because it is important to keep the water supply clean. We discovered that residual foaming agent left in a water supply may promote the formation of noxious hydrogen sulfide. Naturally occurring anaerobic bacteria found in well water throughout the country will convert sulfate in the water to H<sub>2</sub>S. Foaming agents with bacteriacides may not be sympathetic to this reaction; however, because the bacteria can "hide" in tank sediments, a clean tank is the ultimate solution.

We would like to share with you our experiences during a recent trip to Washington D.C., and Maryland. The reasons for the trip were (1) to observe and review the progress made by National Bureau of Standards (now the National Institute of Standards & Technology [NIST]) on their radiant panel test and (2) to meet with the U.S. Fire Administration and show them the merits of compressed air foam.

February 7, 1987, we met with Dave Evans, Fire Growth and Extinguishment Department Head, Center for Fire Research, NIST. Dave is conducting the radiant panel ignition resistance test for us.

February 8. We toured the Center for Fire Research at NIST, Gaithersburg, MD, and met with Evans' staff. We watched a repetition of the panel test. The test shows that 9 grams of low expansion compressed air foam (1/4" x 6" x 6") is twice as effective at delaying

ignition of T 1 11 as 9 grams of plain water. A complete report by NBS is forthcoming.

We raised questions about the test concerning the foam bubble size. The test apparatus made foam at low velocities in order to control output. Bubble sizes were, therefore, more variable and generally larger than bubbles we typically generate at higher discharge velocities. We felt smaller, more uniform bubbles would improve this 2:1 ratio.

Evans explained that combined performance ratios of insulation, wetting, and extinguishment would more closely describe the difference between water and foam we were expecting. He hoped we could stimulate more interest in foam to provide funding for the wetting and extinguishing tests.

February 9. At the National Bureau of Standards, we attended the symposium entitled: Revolutions in Solving Fire Safety Problems: Materials, Tests, Suppression, and Measurements.

At the conference, we met with Tom Smith and Roger Lanahan, both from the U.S. Fire Administration, Emmitsburg, MD. They suggested that we go to Emmitsburg and present our information to Ed Wall and Clyde A. Bragdon, Jr.

Information we brought about surface active agents was useful to Evans' studies of reduced water droplet sizes from overhead sprinklers.

February 10. We traveled to Emmitsburg, MD, home of the Federal Emergency Management Agency and the U.S. Fire Administration.

We met with Edward Wall, Deputy Chief; Roger Lanahan, Firefighter Health and Safety; Bob McCarthy, Firefighter Health & Safety; Gary Bassett, National Fire Academy Wildland/Urban Interface Program; and John Ottoson, U.S. Fire Administration.

We gave them a quick overview of our work with compressed air foam on wildlands, structures, and hydrocarbons. Using a small air pressure tank, we gave a simple demonstration of what this foam is. We answered questions for 2 hours. They were inquisitive and supportive.

They asked us to return and present our material to the U.S. Fire Academy in the future. They suggested we take part in a fire protection conference occurring the following week to be attended by the Department of Defense, as well as local and State fire agencies.

We went back to Gaithersburg to conduct a radiant panel test with foam bubbles made at higher discharge velocities. Results indicated no significant difference

at that foam depth and relative bubble diameter between the test method and our apparatus. The significance of this is that a stringent requirement of foam bubble structure will not be necessary to ensure performance. Application parameters can remain simple.

February 11. In Washington, D.C., we visited the USDA Forest Service Fire & Aviation. With Francis Russ, manager of Fire Management Notes, we discussed publishing: how and what. We decided to give Russ our latest paper, Relationships of Water, Wet Water, and Foam to Wildland-urban Interface Fire Suppression, for publication in "Notes" later this year. He suggested a call for other material about foam to accompany this article. The use of National Wildfire Coordinating Group (NWCG) newsletter space was also discussed with Russ and Bill Shenk.

We discussed the merits of compressed air foam, aspirated foam, educators, and surfactants with John Chambers.

We traveled across town to the USDI Bureau of Land Management Fire and Aviation group and met with Gardner Ferry. The intent of this visit was to inform the Washington Office of the results of our visit to NBS and to give them an update on our project. We briefed Ferry on our activities and showed some of the staff short video sequences. In response, they asked if we would (1) return to present our information to the entire staff and (2) keep them posted on our progress and our project needs.

Due to the financial nature of our visit to Washington and the inquisitive receptions from our audiences, a summary of our project's accomplishments and future directions is in order:

1. Realized, studied and demonstrated the single most important and most basic element of foam use: the ineffectiveness of water.

2. Measured the effectiveness of foam in lab and field:

- A. Developed a still recognized foam performance test.

- B. Demonstrated and documented that compressed air foam (CAFS) is more effective than water in all fire work.

- C. Compared CAFS with other foam on wildland vegetation and structures.

- D. Raised questions about what is occurring during the extinguishment phase when using a surfactant.

- E. Developed joint BLM-Forest Service Foam Evaluation Form.

3. Hosted the first international foam symposium, sparking interest and involvement by NFPA, NWCG, U.S. Forest Service, and National Park Service.

4. Convinced the National Institute of Standards & Technology to become involved with testing and promoting this concept of foam.

5. Designed and evaluated foam generating hardware, including inexpensive foam metering system.

6. Developed a foam training package in response to field users requests to gain our understanding of foam.

7. Presented material at over 30 demonstrations, training sessions, or conferences, each received with positive comments and requests for more information.

8. Wrote two papers about our work and presented them at symposia.

9. Compiled the largest known wildland foam bibliography.

10. Compiled a foam information catalog which is being distributed internationally.

11. Produced a 7-minute introductory video to wildland foam.

12. Became the focal point in the world on wildland foam use.

Based on these accomplishments, our experiences, and user comments, we believe the direction of this program should focus on five major goals.

1. Training—actually education
  - develop foam use education course
  - increase staff training capability
2. Evaluation and documentation
  - field evaluation form
  - specific tests of apparatus (i.e., nozzles) or capability (structure)
  - priority video coverage
3. Equipment development
  - State-of-the-art engine
  - motionless mixers
  - rotary engine
  - concentrate injector systems
  - other

4. Information distribution
  - publication of material
  - quality, official duplication
  - availability of personal contact
5. Program priority expansion
  - personnel
  - computer that is compatible with other agencies

Throughout the evaluations on the following pages, the bottom line is that effectiveness of plain water versus water treated with a surfactant:

1. A straight stream of water is only 5-10% effective at direct attack (Haessler).
2. In Montana, mop-up with compressed air foam was 10-20 times more effective than mop-up with water.
3. Evaluations from others in the field note a 30-70 percent reduction in mop-up costs with foam.
4. Compressed air foam offers increased capability over water for direct attack because of greater discharge distance and a more useful form of water.
5. Davis noted in 1952 that wet water was 3 times more effective than water on wood fires.
6. Godwin stated in 1936 that his chemical foam pretreated lines were 8 times more effective than water.

**April**  
**Hydrocarbon/liquid fuel pit fire demonstration, in cooperation with the Portland City Fire Bureau.**  
**Location: Portland, OR**

**Accomplishments:** A burning, 600 square foot fuel pit filled with diesel and gas was attacked with wildland foam. The compressed air foam system was used with Silv-ex at 0.3 percent. Two attacks were made with two 1-in foam lines. Their extinguishment times were 44 and 60 seconds; water usage was 18 and 24 gallons, respectively. A third attack made with one 1.5-in line required 24 seconds and 13 gallons of water for extinguishment.

Analysis of film footage of an attack using 3 percent AFFF and a 1.5-in line on a similar fire showed that 32 seconds was necessary with a water use of 52 gallons (100 gpm flow).

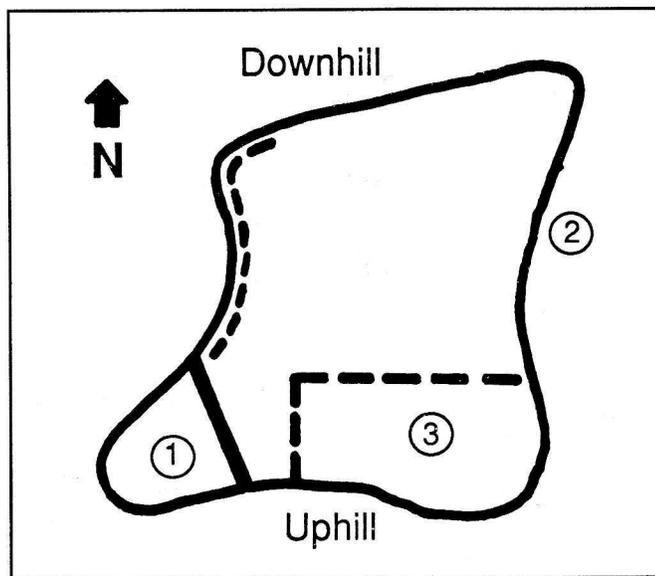
Very successful attacks were also made with two 1-in CAFS foam lines on a burning oil transfer platform and a burning fuel truck.

This event made it clear that CAFS and wildland foams together offer a versatile extinguishing tool for today's urban-rural fire fighters.

**June 25-27**  
**Demonstration of the merits and techniques of foam applications during a burn-boss certification program.**  
**Location: St. Mary, Blackfoot Indian Reservation, Montana**

**Accomplishments:** Toad Creek Unit. 14 acres. Fuel Type: Lodgepole pine/Alpine Fir. Fuel Model No. 13. Fuel load: 100 tons/ac.; Duff Depth 1-3"; Aspect: North; Slope > 10%; Temp. 70°F; Humidity 40percent; Wind speed 1-4 mph; Behavior: Running, Crowning; Flame Length 3' - 20', crowning to 60 feet.

1. We placed 150' x 10' x 5" of foam across one tip of the unit. No tools were used, no fuel removed to make this foam line. See 1 on map. A test fire was lit on the unit edge to gauge fire conditions. Flame lengths of 30 feet and fire whirls of 60 feet developed and the fire moved rapidly through the heavy, dry fuel to the foam line. When the fire reached the foamline, its forward progress stopped. Time elapsed from foaming to fire contact was one minute. This was the most intense test of foam used without a cut fire trail that we know of. (Soon after, the rest of the unit was lit, and fire was on both sides of the line, yet only two one-foot-wide sections were breached; where logs lay across the foam line.)



2. Despite the wind shift from south to southwest, the ignition of the unit commenced. Lighting began by the test fire, opposite the foamline 1. Higher than expected winds, and high fuel concentrations with many standing poles propelled the fire towards

our planned foamline 2 adjacent to a cut fire trail. Fire whirls and flame lengths of 30 feet tossed embers towards and over the foamline, and were indicative of the long duration, intense heat fire created. Line 2 was 1400 ft long. Foam was applied into the adjacent forest 100 ft wide, 75 ft up into crowns and 1-2-in thick. Application of foam stayed just ahead of the igniters as they moved downhill across the unit. This fire was expected to escape and become a project wildfire by those familiar with burning under these conditions. The foamline was not crossed by moving fire. The width of the line prevented many spots from kindling. The fire did not escape. Two men applied all the foam with one nozzle. Burn time was 5-1/2 hours.

3. Mop-up the following day. Area 3 indicates the 100,000 sq. ft. mopped up by 5 people using compressed air foam versus the 24,000 sq. ft. worked by 25 people using straight water. No one knew such a comparison was taking place. Those using foam were trained that day and had never used it before. Work time was about four hours. Water availability was not a factor. Combined water flow was 30 GPM.

In summary, all in attendance (the Blackfeet tribe, the USFS, BIA, BLM) were impressed with foam's performance. They wished to know how they can use it on existing equipment. They felt our efforts had averted a catastrophe. They wanted us to come back in the fall of 1987.

**June 29**  
**Wildfire Suppression**  
**Location: Boise, ID**

*Accomplishments:* We noticed a brush/grass fire burning in hills above the north of the city of Boise. Homes appeared to be threatened. We offered our services, knowing foam is well-suited to structure protection. We were dispatched to the fire by the Boise BLM District. The fire had been burning for at least an hour above town before we were dispatched. We were the first engine of any kind to reach the top of Horizon Drive where a cul-de-sac was surrounded by five homes. Three of these homes were actively threatened by fire as we arrived. We quickly deployed our 1-in Angus booster line flowing 12 gallons/minute and knocked down the most immediate fire, burning in the rubble of a woodpile, grass cuttings, and decking. The fire swept around the house opposite from the truck. We deployed our 1-1/2-in line for greater reach and discharge capability. Now with 60 gallons/minute of water as foam (far less than conventional urban fire trucks) we attacked and extinguished fire on the far side of the homes. This all occurred in 10 to 15 minutes. Then we noticed that fire had continued ahead of us up the hill towards two more homes. We added 150 feet of hose and

reached the first. Its garage, with a pickup inside, and front face were on fire. Here, we were joined in attack with a city fire truck. Its turret and our nozzle worked on the garage and saved the house. The second house went up in flames as we ran out of water. It was the only house destroyed. We were able to pump extinguishment (foam) for approximately 30 minutes because water was expanded. Since sprinklers down the hill in town removed all water pressure from nearby hydrants, our pumping time (and effectiveness) would have been much less without foam.

**June 30**

We spent the day with Boise District personnel training and exposing them to mop-up with foam. On Bennett Mountain, an area of approximately 1/4 acre was mopped-up with foam in 1-1/2 hours by their people. They assured us that this was a two-day job for the normally. (Fire had started at 7,000 feet in Douglas-fir timber with heavy fuels and duff layers.)

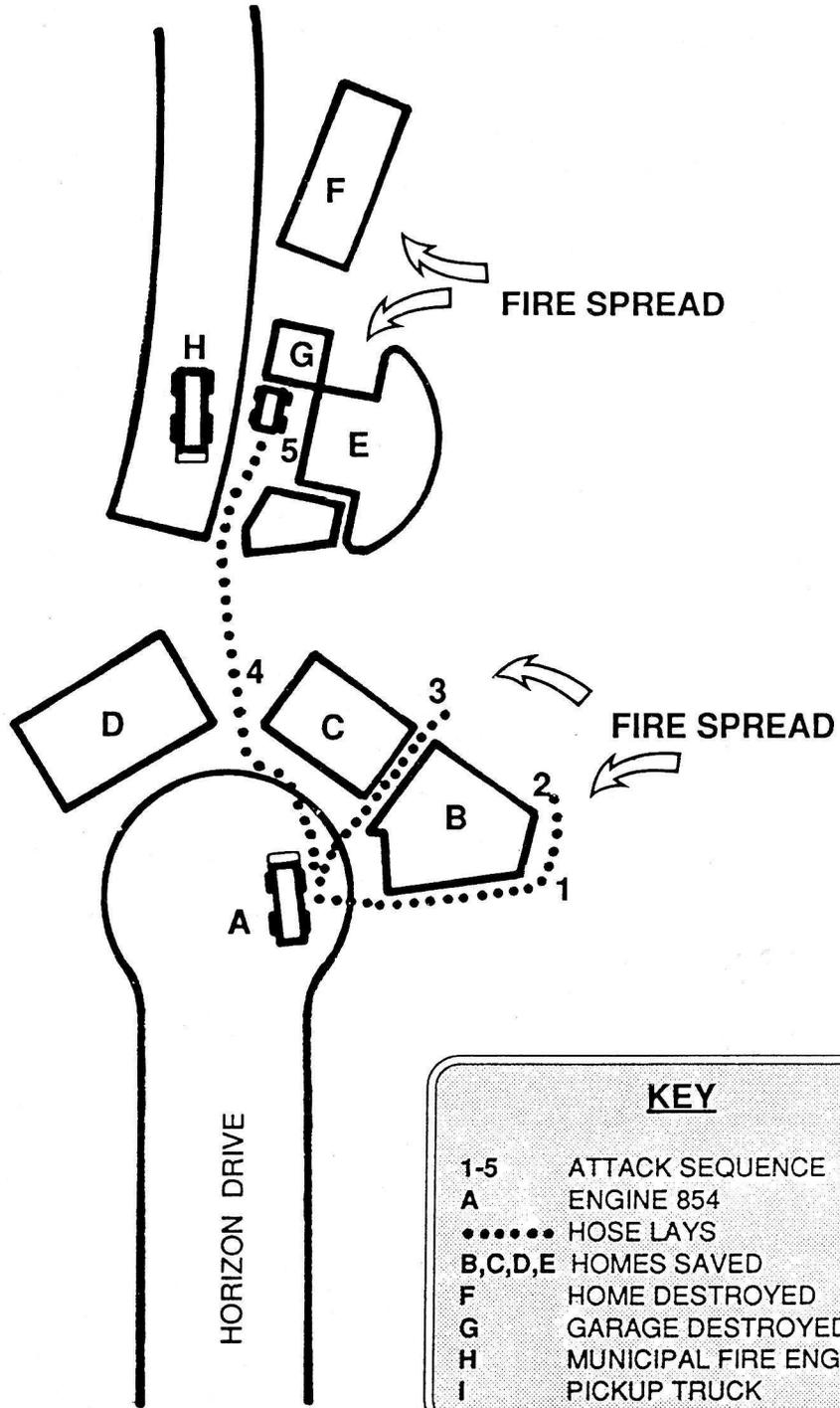
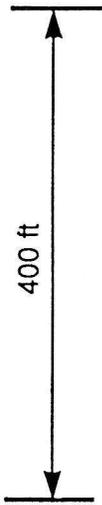
**July 1**  
**Lightning strike**  
**Location: Brothers, OR.**

*Accomplishments:* Extinguishment of a western juniper, approximately 12-in dbh. The tree was fully involved upon arrival. We used an 0.3 percent mix ratio of CAFS foam delivered through a mop-up wand. The rich mixture created a thick foam blanket to suffocate the volatile juniper pitch. The mop-up wand and reduced tip provided enough pressure to (1) strip bark off the tree at low water flows and (2) push foam into hidden or vertical spaces where pitchy fire persisted. Complete extinguishment occurred in 5 minutes with 70 gallons of water.

Crew: Foam Project: Ron Rochna  
Paul Schlobohm  
Clarence Grady  
Salem Dist. Sam Caliva

**July 18-19**  
**Bland Mountain Fire**  
**Location: Canyonville, OR**

*Accomplishments:* Mop-up of deep-seated fire in understory of Douglas-fir forest. We showed workers with limited or no experience with foam some of our techniques for mop-up. These included: (1) filling vertical and horizontal cavities with foam for extinguishment, (2) applying the appropriate amount of water, as foam, to a warm area and then letting the foam cool and suffocate while the applicator moves on. In the instance of item (2), a foam must not be dry that it holds all its water. A foam blanket should be wet enough to penetrate duff and soils



KEY	
1-5	ATTACK SEQUENCE
A	ENGINE 854
.....	HOSE LAYS
B,C,D,E	HOMES SAVED
F	HOME DESTROYED
G	GARAGE DESTROYED
H	MUNICIPAL FIRE ENGINE
I	PICKUP TRUCK

**SCENE OF BOISE STRUCTURE PROTECTION**  
**June 29, 1987**

during mop-up. Dry foams merely act as a lid on a pot of boiling water.

We used one 1-1/2 trunk line feeding five 1-in laterals. Pumping distance was 1500 feet.

**July 26.**

**Pearl Fire**

**Location: Emmett, ID**

**Accomplishments:** We participated in initial attack of sagebrush-grass type fire. We used the 1600-gallon foam engine in pump and roll attack of grass fire flanks of two-foot flame length. Hot temperature (+100°) and low humidity were indicators of a situation where a relatively dry foam barrier is not going to be successful preventing fire spread. Foam had to be wet enough to drain moisture into vegetation. And adequate moisture had to be available to completely wet these very dry fuels. Flame knockdown will be instantaneous, but, unless the water necessary for wetting is provided, foam will not be effective. The fire will rekindle and continue on its way.

Water is still the extinguishing tool. It is important to realize that the water in the foam is doing the work required, not the foam itself. Foam is created to (1) hold the water in place long enough for it to be used and (2) make the water more usable. Many direct attack and mop-up applications require a delivery of wet, frothy water rather than thick, durable foam.

**August 26**

**Structure Fire Demonstration, in cooperation with the Boise City Fire Dept.**

**Location: Boise, ID**

**Accomplishments:** This was a demonstration for the Boise Fire Department. We showed what a low water flow as foam can do on interior and exterior structure attack. A two-story, three-bedroom home of approximately 900 ft<sup>2</sup> was ignited. When the first floor was fully involved, Clarence Grady began to instruct the attack. Using 1.5-in hose, the flow was 35 gpm of water. The nozzleman moved slowly compared to high-water flow, conventional tactics, but as foam was applied, fire extinguished and stayed out. Total attack time on the first floor was approximately 2.5 minutes.

During post-analysis, we realized the method of attack more closely resembled today's present water techniques of direct application. This was not the technique used on attacks made in Jefferson in 1985 and elsewhere. These attacks were similar to indirect attack tactics developed by Lloyd Layman in the 1950's. The concept then was to project a small water flow in the more usable fog droplet form into the superheated space of a burning compartment. The water would then expand, forcing air out of the space,

extinguishing the fire. We experienced immediate success with indirect attack and CAFS.

**August 27**

**Hydrocarbon/Liquid Fuel Pit Fire Demonstration, in cooperation with the Boise City Fire Department and the United States Air Force.**

**Location: Boise, International Airport**

**Accomplishments:** This was the second demonstration for the city fire department. Two attacks were made on hydrocarbon fires burning in a 2,000 ft<sup>2</sup> fuel pit with 600 gallon JP 4 fuel. Attacks began when flame lengths reached 40 ft.

The first attack was made with a 1.5-in hose using a 1.5-in waterway. Wildland foam (Silv-ex) was mixed at 0.2 percent. The 40 cfm compressed air system flowed 35 gpm. Extinguishment was rapid with the type 3 foam. However, knockdown time was lengthened when heat of radiation prevented the nozzleman from reaching the fire. By reducing the tip size to 1-1/4-in, the discharge distance (45-70 ft into the wind) was long enough to complete the attack.

The second attack was made with a 2.5-in hose using a 2-in i.d. full flow ball valve as a nozzle. Air was supplied by a 100 cfm trailer air compressor taken from the airport. Water flow was 80 gpm at 0.2 percent mixing. The attack began on 60-ft. flame lengths encompassing half the surface area of the pit. Very quickly, gaps in the fire appeared as the foam began building and spreading on the fuel surface. The fire was out within one minute.

These attacks, although not directly compared to AFFF or other systems, were impressive to all people involved. Questions as to why the foam has such success with these fires are numerous. A vapor seal appears to form on the liquid fuel, but is there more to the picture than we can see? Why is such a low water flow capable of reaching the fuel surface rather than vaporizing when projected into the midst of a 40-foot flame length liquid fuel fire? Is the chemical compound of the foaming agent aiding extinguishment by some other means, such as disrupting the chemical reaction that is fire?

**September**

**Longwood Complex Fire**

**Location: Cave Junction, OR**

**Accomplishments:** We began the process of foam education. This included an introduction to foam use for all those who worked with us and an introduction to the blind tradition of water use for us. At an individual level, we were able to communicate and demonstrate the values of foam over water.

9/1-9/2: We demonstrated the use of foam for structure protection during burn-out around an interface community. We applied foam to and around many homes prior to backlighting to reduce the potential for uncontrolled fire in the area.

9/3: We worked initial attack above the rapidly moving fire on a mid-slope road. Two people laid and worked a 1,600 ft. 1.5-in foam line uphill to cut off the fire head where it had already crossed the road from below. This line fed by the 1,600 gallon foam engine. Then, in an adjacent draw, the fire roared up from below the road. The engine broke away from the uphill line and proceeded to the point where the fire was crowning with 50 feet flame lengths from below the road to above. Two people on the crew knocked down the fire with 1-in handlines flowing 20 gpm each in a matter of seconds. Foam was wet and frothy. Burn area above the road was held to 400 ft<sup>2</sup>.

This was a phenomenal sequence of events. Because foam makes hoses light and very manageable, the first two workers could rapidly create a long uphill hose lay along the flank. Elevation rise of about 400 feet did not affect foam performance. The crowning fire that moved across the road would probably never have been attacked with water alone. The common firefighter's concept of water's effectiveness tells him that the water pumping systems in use at the fire would not have been successful. Therefore, the normal reaction would have been to pull back and let the fire go. This notion was supported by several hydroseeder operators contracted for water support at the fire. Their equipment has large water flow capability, but did not feel comfortable in high intensity situations with their machines until they began adding a foaming agent to the tank. Before the complex was under control, they, too, instantly knocked down running crown fires as the fire moved across mid-slope roads.

This begins a series of extinguishment events which lead us to ask questions about what is happening at the fire interface during extinguishment with a foaming agent.

9/6-9/13: We continue the success we experienced in Montana with multiple lines, low water flow, and high pressure during mop-up. Much time is spent demonstrating to and educating other workers. The mop-up wand becomes the preferred tool for deep-seated fire. Most importantly, we realize that the best tactics are no different than those using plain water. Digging and probing are still valid. A layer of foam will not magically put out fire. We know that less water will be used to put out fire if it is better able to spread or penetrate or remain in one place. What foam provides is less water in a more usable form.

**September 14-19**  
**Silver Complex Fire**  
**Location: Agness, OR**

*Accomplishments:* We worked side by side with BLM 700-gallon water engine for 4 days doing mop-up and indirect attack from a foam line. Direct comparisons could be made between the performance of CAFS and water and between CAFS and aspirated foam. CAFS provided longer discharge distance at given water flows than water or aspirated foam. CAFS operating time per gallon of water was about 3 times greater. CAFS more readily provided the type of foam necessary for different tasks than aspirated foam. Applications were made with CAFS which would not have been attempted with aspirated foam or water, such as protecting massive slash piles. Water pumping crews immediately noticed a benefit to foam-filled hose during an up-hill hose lay. When members of the foam crew had to work with water, a reduction in efficiency was observed.

For additional information, please contact Ron Rochna or Paul Schlobohm, Bureau of Land Management, Boise Interagency Fire Center, 3905 Vista Avenue, Boise, ID 83705.

**STRUCTURE FIRE DEMONSTRATION**

*by Paul M. Schlobohm, Forster,  
USDI Bureau of Land Management*

The Chemeketa Community College Fire Protection School, in cooperation with the St. Paul Rural Fire Protection District, held a fire attack training session on a farm outside St. Paul, OR. The purpose was to demonstrate firefighting procedure, training firemen for attacks on large structures, specifically a house and a 144,000-cubic-foot barn. The procedure was to make the initial attack with wildland compressed air foam. The second attack or back-up would be made with straight water.



Figure 8. Exterior attack on fully involved barn.

Compressed air foam was applied to the barn fire after the barn became completely engulfed in flame. The barn dimensions were 60 by 80 by 30 ft. According to the Iowa formula for water attack requirements, 1,440 gpm (144,000/100) would be required to extinguish this fire with conventional water methods.

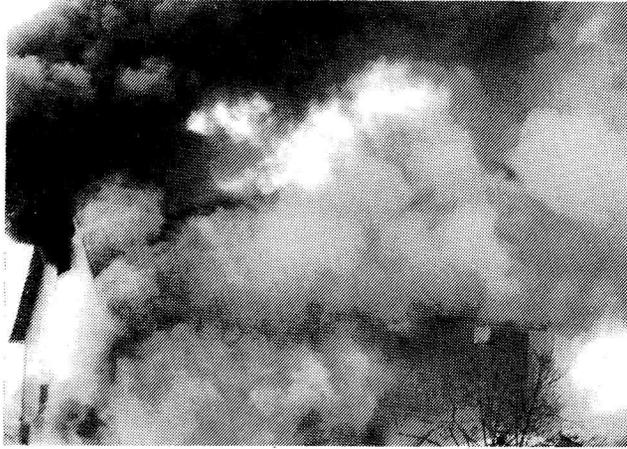


Figure 9. Water flow was 70 to 100 gpm as compressed air foam.

The compressed air foam was made with a 40-cubic-foot-per-minute air compressor mixing air with 0.5 percent Silv-ex foam solution. The concentrate was injected into the water line. Water flow as foam was 70 to 100 gpm through one 1.5-in woven rubber hose. The nozzle had a 1.25-in bore.

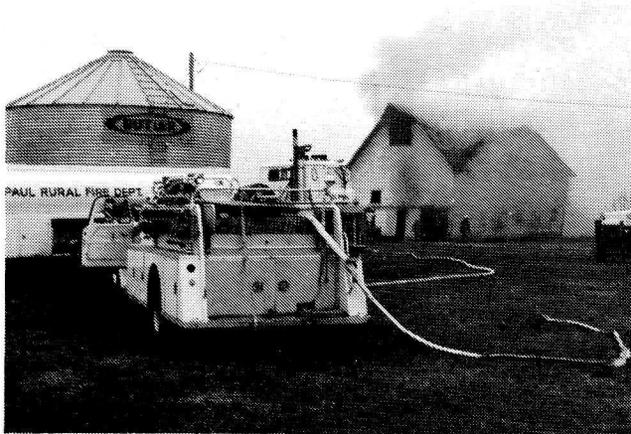


Figure 10. Fifty seconds after attack began.

The attack began on the ground level, with applications to the upper air space, the ceiling, and the walls. Application continued to the upper loft. Exactly what processes were occurring is not clear. However, blackout was achieved in 50 seconds. Thus, less than 100 gallons of water from one 1.5-in line was necessary to extinguish the fire.

## AN EXTRACT FROM A STUDY ON THE EFFECTIVENESS OF GROUND APPLIED COMPRESSED AIR FOAM SYSTEM (CAFS) IN WILDLAND FIRE SUPPRESSION IN ALASKA

*A Research project for the State of Alaska Division of Forestry—September 1989*

### Introduction

Wetting agents are widely known to increase the effectiveness of water as an extinguishing agent. The addition of an air compressor produces a shaving cream like mixture which causes the extinguishing agent to remain where it is applied for an extended period of time. This causes fuel moisture to increase in the same manner that shaving cream wets a beard.

This report on the compressed air foam system (CAFS) project will evaluate the effectiveness of this revolutionary firefighting concept and determine its cost effectiveness to incorporate the system into existing or new fire apparatus.

### Problem Statement

Given the fact that the use of wetting agents makes water more effective as an extinguishing agent, does the addition of an air compressor further increase or enhance the capabilities of water solution under different wildland fire conditions to the extent that the added costs are offset by the benefits gained.

### Purpose Statement

Our purpose is to provide a recommendation on compressed air foams effectiveness on direct and indirect fire suppression strategies in the variety of fuels encountered in the wildland - urban interface of Interior Alaska.

### Project Report

This test unit was set up on an existing type three engine from the Fairbanks Area within the Alaska Division of Forestry. This engine is built on a 4 X 4 Ford F-700 chassis (GVW21,200) with a 300 gallon fiberglass slip-on water tank. The water pump is a Wajax-Pacific Model BB-4 powered by a 16 hp four cycle Briggs and Stratton gasoline engine with electric start. The BB-4 pump has a rated capacity of 87 gpm @ 150 psi and 31 gpm @ 350 psi. The air compressor is a Mallory Model 4400 with a Dayton Speedaire Model 32183B compressor powered by a Kohler Magnum Model 18 (18 hp) four cycle gasoline engine with electric start. The air compressor has a rated capacity of approximately 40 CFM @ 150 psi.

The engine was set up to deliver compressed air foam through 1-1/2-in hoses, one inch booster lines and a 1-1/2-in deck mounted monitor. It should be noted that the pump capacity can be exceeded by simultaneous use of all discharge ports provided.

The existing CAFS engine is set up as diagrammed with an itemized list of components including cost estimates. Costs for connection of the piping system and other miscellaneous labor are not included. It is estimated that two mechanics can set up this system in approximately two days.

Basic operational steps for foam production are outlined in the 1989 CAFS Operational Manual. In this system, the foam concentrate is injected into the intake side of the pump. After this solution passes through the water pump, compressed air is introduced and then is passed through an in-line mixer pipe. Check valves prevent air from entering the water pump and water from entering the air compressor. This mixture is then discharged through a variety of hoses and nozzle openings as compressed air foam. Both the water pump and air compressor must be operated at equal static pressures of 150 psi. This system is designed to deliver plain water, surfactant treated water or compressed air foam as determined necessary by the pump operator.

General safety considerations and individual qualification procedures are outlined in the 1989 CAFS Operational Manual. The main areas of concern are to avoid contact with the foam concentrate in the eyes and mucous membranes as well as understanding reactions of appliances opened rapidly under high pressure. The foam mixture appears to be no more harmful than household dish soap or shampoo. Eye protection should be worn the same as when using any high pressure water streams. Eye wash solution should be made readily available in case of emergency.

Two types of foam concentrate were used during this evaluation period. They were Ansul Silvex and Monsanto Phoschek WD-861. We were unable to determine any noticeable difference in foam quality between the two foams tested.

The following are prices for foam concentrates maintained in our warehouse inventory. It should be noted that these prices *do not* include shipping costs.

Manufacturer/Brand	Size	Price	Source
3M FB100 Firebreak	55 gal	\$ 8.50/gal	Alaska Branch—3M
Chemonics Fire-Trol	55 gal	12.15/gal	GSA
Monsanto Phoschek—WD861	55 gal	10.50/gal	Monsanto
Monsanto Phoschek—WD881	55 gal	11.25/gal	Monsanto
Ansul Silvex	55 gal	11.60/gal	Wajax-Pacific

These foam concentrates are mixed with water at 0.3 percent. Three gallons of foam concentrate makes

one thousand gallons of surfactant treated water. A 55-gal drum of foam concentrate makes approximately 18,300-gal of surfactant treated water. Using the above prices, the average cost of surfactant treated water is about three cents per gallon.

Operator proficiency of CAFS equipment and techniques were readily learned by experienced firefighters within two or three days. For this system, the best foam production and stream reach was achieved by using a 3/4-in ball shut off valve or a 5/8-in opening on a forester nozzle with the straight tip removed. Use of smaller nozzle openings or fog nozzles causes the CAF to break and separate. Use of larger nozzle openings causes the reach of the stream to be reduced considerably. The deck monitor with a 3/4-in ball shut off has a maximum horizontal reach of approximately 125 ft. The handlines with a 3/4-in ball shut off have a maximum horizontal reach of approximately 100 ft. Surfactant treated water under high pressure of the BB-4 pump through an aspirating nozzle produces a stream with a maximum horizontal reach of only 30 ft.

Application of CAF into trees and brush allows a high percentage of the extinguishing agent to remain in place on the vegetation rather than run off onto the ground. CAF applied to moss and duff soaks in rapidly and holds moisture in place for periods of 2 or 3 hours.

Evaluation and documentation of fire tests were reported on the BIFC Ground-Applied Foam Evaluation forms (Appendix IV). Additionally, video footage was taken to visually document test results. An edited video program is being planned to accompany this report.

The following is a list of field trials, test burns and fire evaluations that were conducted in 1989:

- March 31 Evaluation of foam production with and without in-line mixer.
- April 8 Evaluation of knock down capability of CAF on interior structure fire (Airport Road Liquor Store).
- April 29 Application of CAF on vertical structural surface with deck monitor (BLM open house).
- May 13 Evaluation of CAF for wetline construction on perimeter of hay field burn (Echo Acres Road).
- May 13 Evaluation of CAF on a brush and tundra fire (Fire 911-024).
- May 15 Application of CAF on vertical structure surfact with handlines and deck monitor (Fire Training Center).
- May 28 Evaluation of CAF on a grass and brush fire (Fire 911-053).
- June 12 Evaluation of CAF on a grass and brush fire (Fire 911-080).
- June 14 Evaluation of CAF on a deep smoldering berm pile (Fire 911-089).

- June 14 Evaluation of CAF on torching spruce trees (Fire 911-090).
- July 9 Evaluation of CAF on flammable liquids pit fire (Fire competition).
- July 18 Evaluation of CAF on overhaul of structure fire demolished by a propane explosion (Fire 911-145).
- July 30 Evaluation of CAF on brush and trees exposed to structure fire (Steese VFD control burn).
- Sept. 9 Evaluation of plain water on mop-up of deep smoldering duff fire (Fire 911-165).

### Conclusions

1. The air compressor was found to be more useful on direct attack of hot line. The air compressor produces a much longer reaching fire stream which allows firefighters to attack longer flame lengths without being subjected to intense heat and smoke. CAF is an excellent IA tool.

2. The air compressor is not needed for most mop-up operations. A lower energy surfactant injected solution is sufficient. The high back pressure of CAF is a disadvantage when applying agent directly in front of firefighters using hand tools because of splattering.

3. Injection of surfactant on the intake side of the pump does not allow recirculation of water for pump cooling or pressure relief back to the water tank. Foam created in the water tank will cause the pump to cavitate. Without these features, pump overheating occurs within one minute of nozzle shut down.

4. The in-line (motionless) mixer produces better quality foam than 100 ft of hose line agitation. This mixer is mandatory for use of the deck monitor without pumping through a length of hose in order to produce CAF.

5. The air compressor was quite useful in draining hose lines allowing for rapid demobilization.

6. The BB-4 pump and the Mallory Model 4400 air compressor do not appear to be well matched. The water pump runs at low speed and the air compressor runs at maximum speed to produce CAF at 150 psi.

7. Surfactant injected water and CAF allow much greater penetration of extinguishing agent. A 50 percent reduction in man hours for mop-up time can be expected in most situations.

8. CAF allows approximately 90 percent of the extinguishing agent to remain on the surfact applied to rather than run off. This greatly extends the use of limited water supplies.

9. Accurate determination of foam mixtures is not possible without the addition of a water flow meter.

10. This system worked much better with 1-1/2-in piping rather than 1-in piping used in 1988.

11. Use of non-weeping forestry hose is mandatory in using CAF.

12. The weight of a 100 ft of hose line full of CAF is only 20 lb, compared to a hose line full of water weighing 90 lb. Several lengths of CAF charged hose can be moved by one person using only one hand.

13. The control panel for the pump and air compressor is located where noise levels make radio operations nearly impossible.

14. Separate pump and air compressor controls make it more difficult to match up pressures for compressed air foam production.

15. There were no adverse environmental or health problems observed from use of the foam concentrated tested.

### Recommendations

1. Each roadside area within the Alaska Division of Forestry should be equipped with a minimum of one CAFS engine. The benefits of CAFS for both hot-line and mop-up overall efficiency to the extent that additional equipment costs are offset within one fire season.

2. All engines and water tenders within Alaska Division of Forestry should be equipped with surfactant injection.

3. Surfactant injection systems should only be installed on the discharge side of the water pump to allow for pump cooling and pressure relief piping to be recirculated into the water tank. A flow mix model 500 surfactant injection system would be suitable with an electric refill pump to eliminate the need to shut down the system after flowing 1,600 gal of water (Appendix V).

4. The in-line (motionless) mixer pipe should be installed on each CAFS engine to produce better quality foam for both handlines and the deck monitor.

5. A Mallory Model 6600 with a Dayton Speedaire Model 32410 compressor powered by a Kohler 23 hp four cycle gasoline engine would be a better match for the BB-4 pump. This compressor would produce 50 percent more air than the existing Mallory Model 4400 and would allow greater utilization of the BB-4 pump with longer reaching streams than the existing set up.

6. A water flow meter should be installed to enable accurate and cost effective mixture of foam concentrate. A digital "totalizer" manufactured by Foam Pro displays current water flow rate (gpm), cumulative volume of total water discharged and foam concentrate percentage.

7. Use of non-weeping forestry hose such as Wajax hot-line (test pressure 450 psi) is mandatory for compressed air foam.

8. A single pump and air compressor operators panel should be designed and located away from high noise levels. A better exhaust system for the pump and air compressor could reduce noise levels and the need for a remote control panel to enable radio operations.

9. A pump to tank valve should be installed to allow tank refill while drafting or while being supplied from a water tender.

10. The pressure relief valve should be vented back to the water tank. A small diameter (1/8-in) pump cooling line with filter screen should be installed to prevent pump overheating.

11. New engines should be equipped with 500 gal tanks to increase water carrying capacity by 66 percent. This combined with CAF would increase the extinguishing capability considerably.

12. All CAFS engines should be set up in a standardized configuration statewide to simplify training and operations.

13. The BB-4 pump is a good choice as it provides up to 350 psi and allows for pump and roll capability.

14. The existing pump discharge gate valve should be replaced with a 1/4 turn ball valve to allow more precise manipulation for creating different types of foam.

15. Water tank level gauges should be installed on the operators panel. It is difficult to see the water level through the fiberglass tanks.

16. A minimum of three days training and hands-on experience should be conducted for all persons working on CAFS, this training should be in addition to the proposed engine academy curriculum.

For additional information please contact State of Alaska, Dept. of Natural Resources, Division of Forestry, Fairbanks Area Office, 3700 Airport Way, Fairbanks, Alaska 99709-4699

## The Safe Handling Of Foams

by Ceci Johnson, USDA Forest Service

All approved foams used by wildfire control agencies have been tested to assure that they do not present a hazard to personnel when they are used in the manner prescribed. This does **NOT** mean that they are completely harmless. A very small percent of the general population—and, therefore, of firefighting personnel—will have an allergic reaction to any substance that might be used. People having this type of reaction should be particularly careful about following safe handling instructions and/or should request alternate assignments.

For that much larger portion of the firefighting population who are not allergic to the foams (especially the concentrate), there are still reasons for following safe handling instructions that are printed on the foam concentrate container and in the material safety data sheet that comes with the product.

By their very nature—*foams are basically detergents*—they are drying to skin. Care should be taken to avoid exposure of the skin to the concentrate, especially for long periods of time. Since concentrates are generally handled in an area near a source of water, this should not constitute a problem. However, be alert for exposure and remove the concentrate from the skin as soon as possible. *Rubber gloves and long-sleeved shirts* are recommended. If clothing becomes wet with the concentrate, rinse out the item of clothing. Failure to follow these steps may result in extreme dryness of your skin, characterized by chapping and even broken skin.

The eyes are potentially the biggest problem. *Goggles* should be worn whenever the concentrate is being handled. Also, be sure hands are clean before rubbing eyes. The eye is especially sensitive to detergents and the alcohol that is contained in some formulations. Irritation and redness may be minor; or could be severe enough to warrant several days (or weeks) off work. Dizziness may also occur, and may take several days to subside.

Foam is a useful fire management tool. However, remember to respect the harm it can do to you and use it safely. Follow the manufacturer's suggestions; they are for your safety.

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