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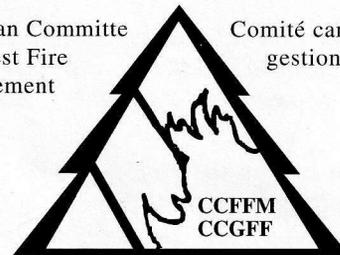
FOAM APPLICATIONS FOR WILDLAND & URBAN FIRE MANAGEMENT

**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



LOS ANGELES COUNTY FIRE DEPARTMENT CLASS "A" FOAM OPERATIONS

By Darryl Dutton, Engineer, Los Angeles County Fire Department, Los Angeles County, CA

The Los Angeles County Fire Department's entry into the field of Class "A" foam at the engine company level began in April of 1990. At that time, several Class "A" foam proportioning systems were evaluated for future use on apparatus. In addition to proportioners, aspirating nozzles and Class "A" foam concentrate were also actively tested. In 1992, Los Angeles County Fire Department began the process of purchasing new engines with Class "A" foam capabilities. After testing, it was determined that pre-plumbed, multiple-discharge, automatic Class "A" foam proportioning systems should be installed.



This system was designed to utilize 20-gallon concentrate tanks. The success of these early installations led to the department retrofitting 84 engines with the same systems in 1994. At this time, with the purchase of new apparatus, the department has 119 pieces of apparatus equipped with foam proportioning systems. This includes two Quints and two Squirts. The Los Angeles County Fire Department distributes Class "A" foam to 135 fire stations using 260-gallon bulk concentrate containers placed throughout the county. Air operations also has bulk containers for their use.

(Continued on page 3.)

*Los Angeles County Engine 64 equipped with automatic regulating,
continuous flow Class "A" foam proportioner.*

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Table of Contents

Los Angeles County Fire Department Class "A" Foam Operations	1
<i>By Darryl Dutton, Engineer, Los Angeles Country Fire Department, Los Angeles County, CA</i>	
Joshua Tree National Park Converts to Compressed Air Foam System (CAFS)	4
<i>By Tom Patterson, Area Fire Management, Officer, Joshua Tree National Park, Twentynine Palms, CA</i>	
News From the World of Foam	7
NWCG Class "A" Foam Course	8
<i>By Paul Schlobohm, Forester/Fire Management Specialist, BLM, National Interagency Fire Center, Boise, ID</i>	
CAFS Rated Hose, Yes or No?	9
<i>By Lois P. Sicking, Mechanical Engineer, USDA Forest Service, San Dimas Technology and Development Center, San Dimas CA</i>	
Class "A" Foam As Part of Suppression Strategy for Tire Fires	10
<i>By Rod Carringer, General Manager, Task Force Tips and KK Products, Valparaiso, IN</i>	
Compressed Air Foam System Powered by Allison World Transmission	13
<i>By Dan W. McKenzie, Mechanical Engineer, USDA Forest Service, San Dimas Technology & Development Center, San Dimas, CA (retired)</i>	
The Use of Class "A" Foam and Compressed Air Foam Systems (CAFS) in Firefighting	15
<i>By Paul C. Darley, Vice President and Manager of Pump Division, W.S. Darley & Co., Melrose Park, IL</i>	
M-548 Military Tracked Cargo Carrier Fire Unit Conversion	23
<i>By Samuel Duncan, Research Associate, Department of the Army Tank-Automotive Research, Fort Belvoir, VA</i>	
A 10-Cent Unbreakable Foam Nozzle for Backpack Pumps	24
<i>By Tom French, Warehouse Foreman, Payette National Forest, McCall, ID</i>	
Calibration of Around the Pump Foam Mixers Using a Temperature Compensating Conductivity Meter	25
<i>By Doug Higgins, Canadian Forest Service, Petawawa National Forestry Institute, Chalk River, Ontario, Canada, and John Hadley, Ontario Ministry of Natural Resources, Aviation, Flood & Fire Management Branch</i>	
Fire Chemicals (Qualified or Approved and commercially available)	28
<i>By Cecilia W. Johnson, USDA Forest Service, Intermountain Research Station, Missoula, MT</i>	



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Los Angeles County Fire Department Class "A" Foam Operations *(Continued from page 1.)*

Each station that has equipment with Class "A" foam capabilities keeps five-gallon containers of foam for daily and strike team use. These containers are refilled at the bulk container site via department utility vehicles.

Los Angeles County Fire Department also has five EST's (extra support team) vehicles placed throughout the county to augment staffing. These vehicles have Class "A" and Class "B" capabilities.

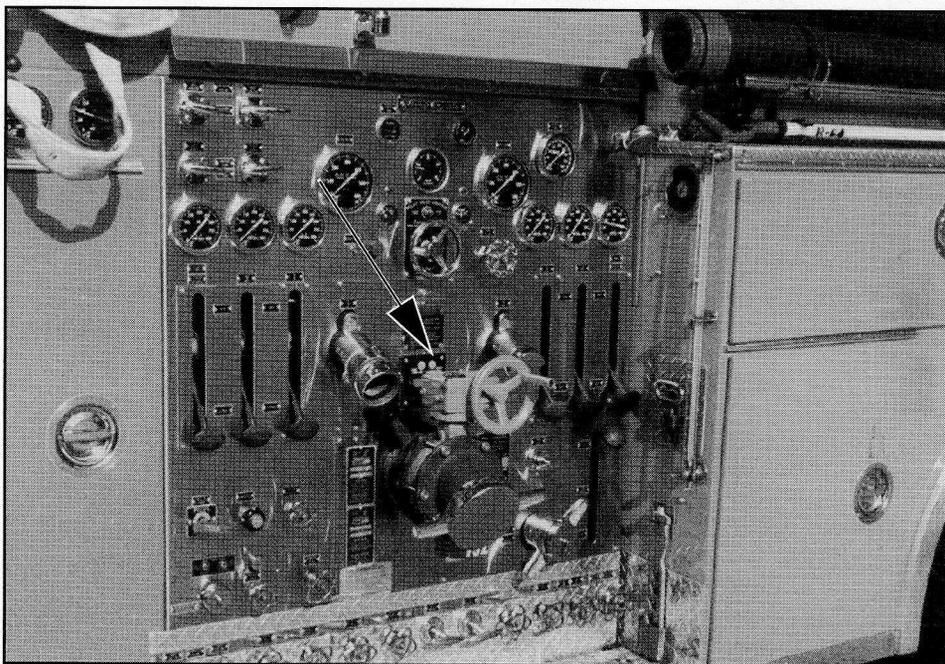
With the department's commitment to the use of Class "A" foam, the need to provide comprehensive training needed to be addressed. With that goal in mind, a 30-minute video was produced by the department.

Videos and printed material that depicted Class "A" foam technique were purchased from the National Wildfire Coordinating Group. This material

was furnished to all Los Angeles County Fire Stations.

As of April 1995, Los Angeles County Fire Department has purchased three compressed air foam systems (CAFS). These systems are being integrated into three new apparatus. The CAFS units will also give the department the ability to use air compressors on these apparatus for Urban Search & Rescue (USAR) operations; e.g., jack hammers, air bags, chisels, etc.

The department is also in the process of implementing an emergency Class "A" foam distribution system. Anytime an IC has a request for additional Class "A" foam (i.e., brush, 2nd, or 3rd alarms), this system can be put into service employing department utility vehicles manned by firefighters. The goal of this program is to deliver Class "A" foam to the engines on the fire line. This program is being supported by pumps and 55-gallon containers of Class "A" foam.



Panel of Los Angeles County Engine 64 with automatic regulating, continuous flow Class "A" foam proportioner.

JOSHUA TREE NATIONAL PARK CONVERTS TO COMPRESSED AIR FOAM SYSTEM (CAFS)

*By Tom Patterson, Area Fire Management
Officer, Joshua Tree National Park,
Twentynine Palms, CA*

Joshua Tree National Park recently retrofitted a stock Model 61 Fire Engine with a compressed air foam system, which has tripled the performance of the apparatus. The project was completed by Pneumax in Glendale, Arizona.

Eliminating the driver's-side live reel created sufficient space for an independent modular CAFS

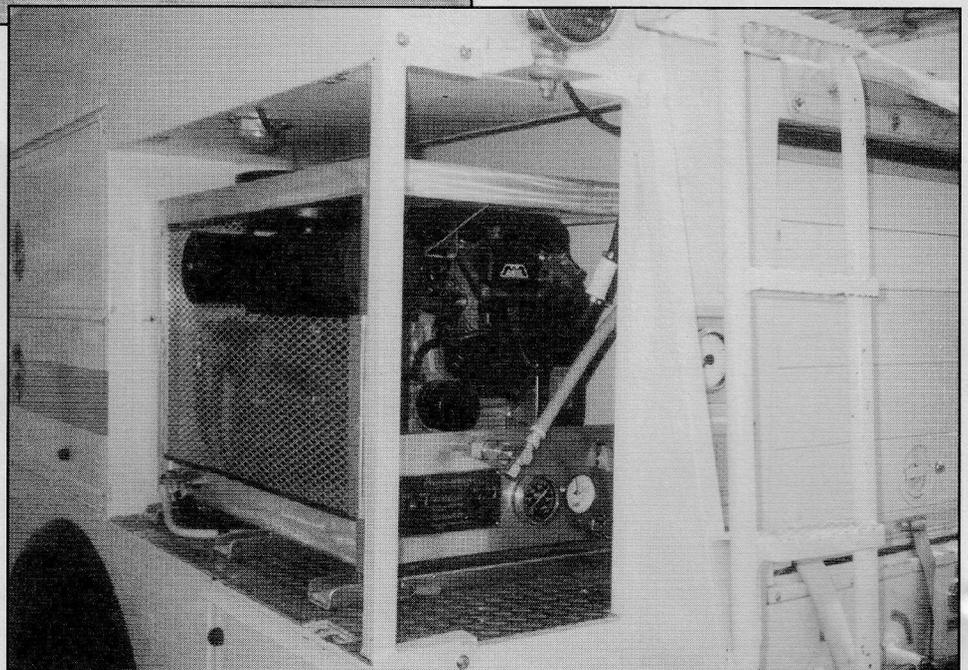
unit. The compact unit consists of a 60-cfm rotary screw compressor powered by a 22-horsepower air-cooled Kohler engine. Total weight is approximately 250 pounds; less than the weight of the original hardline and reel.

The existing foam proportioner and plumbing on the engine needed no further modification. A check valve was installed on the overboard discharge and the air line from the compressor with control valve and check valve was simply tapped into the discharge.

Pneumax cleverly designed the unit to be portable within its own frame, baseplate, and separate six-



*Pneumax CAFS modification
on Model 61 Engine.*



gallon fuel tank. This feature allows us to remove the entire module from the truck by unlocking two quick release bracket mounts. The compressor may be used in tandem with any portable pump and "folda-tank" for backcountry needs. An automatic balancing valve built into the compressor simplifies operation and compensates for any pump pressure variance.

Foam solution is created either by batch mixing or by including any of the automatic portable foam proportioners, such as Robwens' Flowmix 500. The fire engine will continue to operate unimpaired with nozzle aspirated foam when the module is separated.

Joshua Tree National Park is located in the California Mojave Desert. The high temperatures and low humidity will dwindle the protective qualities of nozzle aspirated Class "A" foam in about 25 to 30 minutes. The current literature overwhelmingly documents the advantages of compressed air foam. In addition to the increased effectiveness of Class "A" foam pre-treatments, we now have the capability to use the long lasting durable foam which has proven to be a viable tool in structure protection and prescribed fire applications.

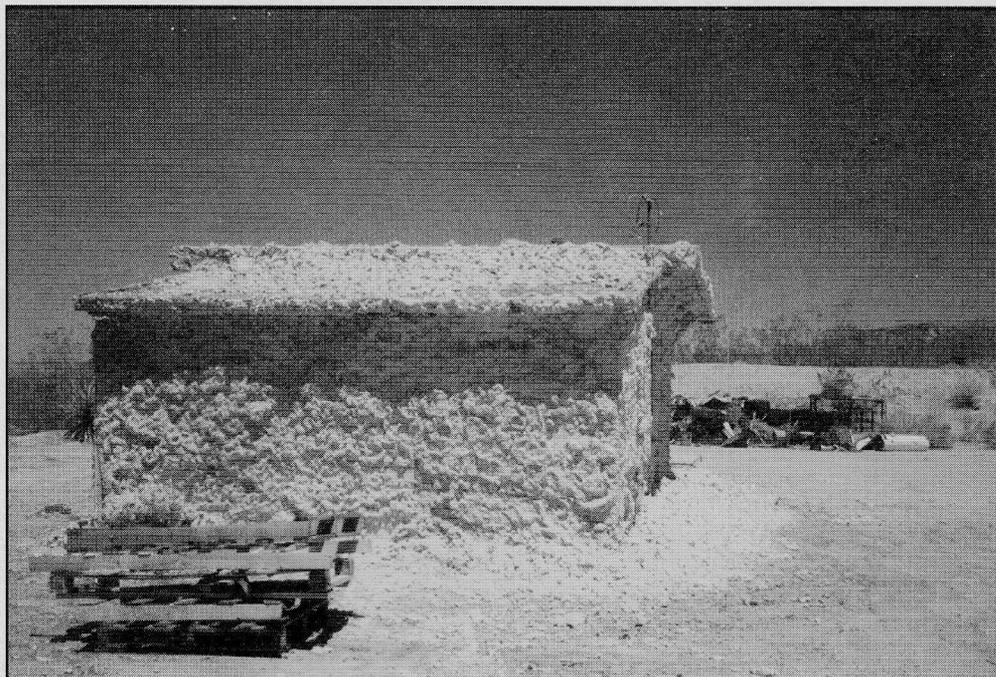
By spraying slow draining, durable foam through a CAFS unit, we can efficiently protect a large number of Joshua Trees all day long—then burn out the brush understory at night in order to meet resource management objectives during prescribed fire operations.

The same procedure may be utilized, given advanced notice of an approaching wildfire, to treat homes or high values at risk.

A three percent solution of durable foam can insulate and continue to wet burnable surfaces (structures and surrounding fuels) for over 24 hours when applied in a 2-inch layer by CAFS.

The foam solution, when injected with air, will stick to vertical walls and under eaves or can fill open spaces and ember traps.

It will even cling to non-wettable surfaces such as the metal walls of mobile homes. Time permitting, this method would allow fire suppression personnel to stage in a nearby safety zone while a rapid high intensity brush fire, for example, burns through the areas which are protected by the foam solution.



A three percent solution of durable foam can insulate and continue to wet burnable structures for over 24 hours when applied in a 2-inch compressed air foam layer.

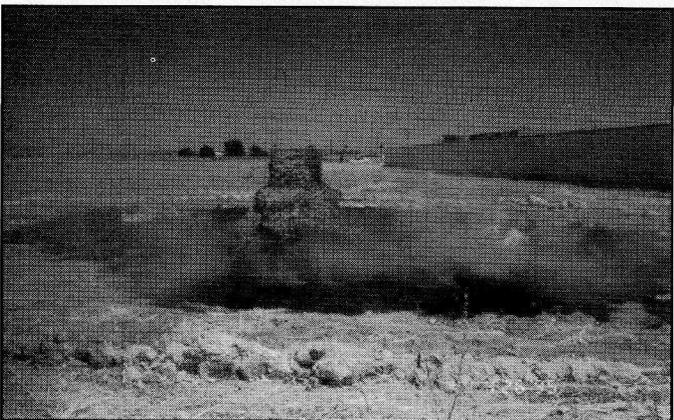
Below are photographs showing three stages of a durable foam demonstration using pallets as fuel.



The first set of pallets starts the burn.



The fire increases in intensity and size.



Both the pallets in the foreground and background are burned to the ground while the foam layered pallet remains.

The foam enhancement was first put to the test in June, during the Lost Lake Fire which burned in excess of 2000 acres of brush, mesquite, and tamarisk on the Colorado River Indian Reservation.

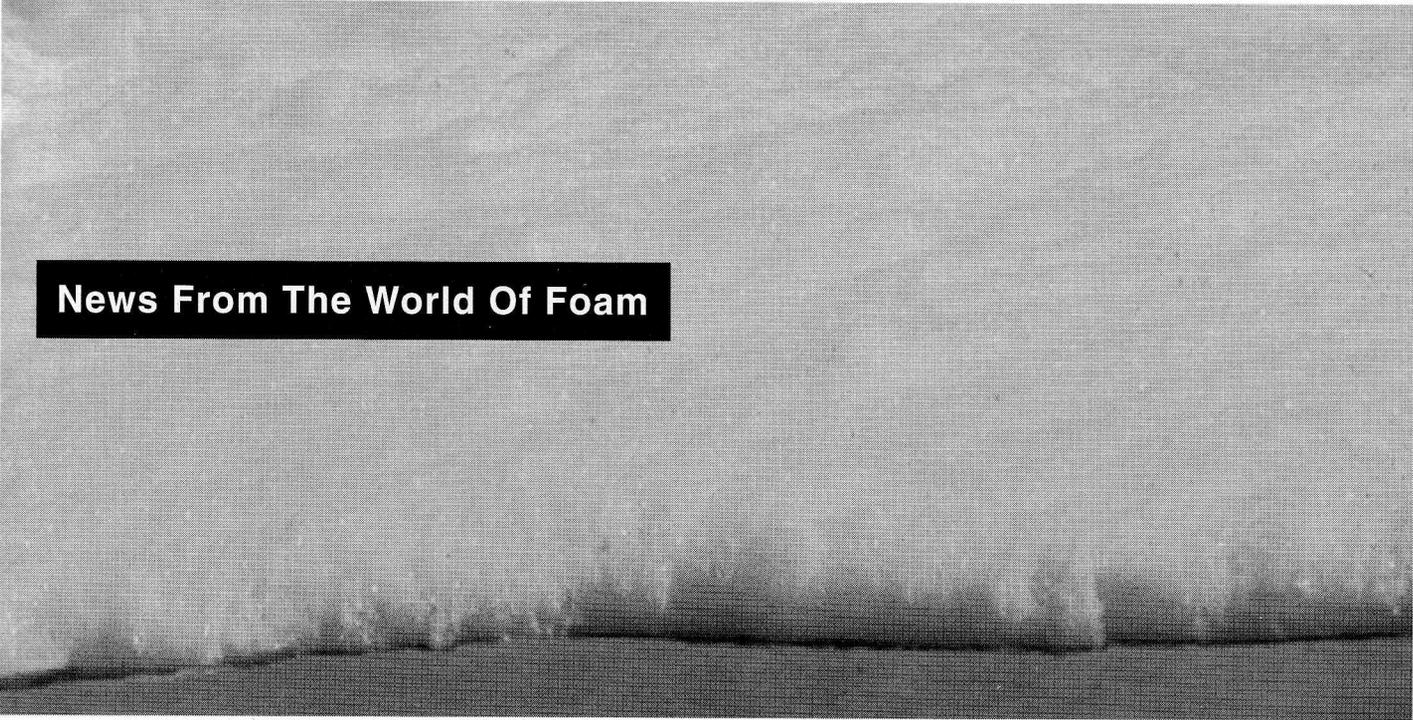
Spotting of several hundred feet constantly hampered control efforts during the hottest part of the day. The forward spread of the fire was finally stopped at a paved road during a burnout operation. The extended throw distance of Class "A" foam, provided by the air compressor, enabled us to raise the fuel moisture sufficiently to prevent firebrands produced by the firing crew from igniting the brush on the downwind side of the road. Over 3 miles of continuous brush was foamed at least 200 feet in during the burnout. A water tender ensured that our flow remained uninterrupted. Applied at 0.3 percent concentration, we knew that our 17-gallon foam reservoir would not be depleted.

The nozzleman was impressed at the ease of handling the minimum 100 feet of 1 1/2-inch hose, which is necessary for scrubbing. We have since learned that one of the fastest ways to gain converts to the benefits of CAFS is to allow the firefighters to compare the weight of dragging a water-filled hose up a steep hillside versus a hose filled with 60 percent air up the same steep slope. I wonder when Pneumax will develop a helium compressor which could float our crew up the mountain.

For additional information on compressed air foam systems, or the NPS CAFS retrofit, contact Clarence Grady at Pneumax 800-468-2237. Chemonics Industries is the sole distributor to the fire service of Fire-Trol "Durafoam." Information on "Durafoam" may be obtained from Lynn Biddison at Area Code 505-856-7287. (**Editor's Note: "Durafoam" has not been approved or qualified by the USDA Forest Service and therefore is not listed on the Fire Chemicals Qualified or Approved List.**)



CAFS equipped Model 61 Engine on Lost Lake fire.



News From The World Of Foam

NEWS FROM THE WORLD OF FOAM

- National Fire Protection Association (NFPA) standard 1906 for Wildland Fire Apparatus, 1995 Edition, is now available. This new standard covers the requirements for new fire apparatus designed to support wildland fire suppression. It provides for both on-road and off-road vehicles and requires the apparatus to have pumping capability of between 20 to 250 gpm, at least a 125-gallon water tank, hose, and equipment. There are also requirements for Class "A" foam systems, compressed air foam systems, electrical systems, and winches when they are included on the apparatus. Order item No. MJ-1906—95 (53 pages), cost is \$22.25 (members of NFPA \$20). The NFPA toll-free telephone number is 1-800-344-3555.

- Rod Carringer of Task Force Tips has prepared a course curriculum on Class A Foam, Awareness and Operations Level Workbook and Glossary. This 67-page document covers concept and chemistry of foam, identifies the types of mechanical foams and explains benefits and limitations of each. It defines proportional and non-proportional concentrate injection systems, critical application rates, initial attack strategies, foam nozzles, CAFS; presents application techniques and strategies for

structural and wildfire suppression, and also provides current research and reports on the use of Class "A" foaming agents for wildfire and structural suppression.

A free copy of this course curriculum can be obtained by calling Task Force Tips and asking for Class A Foam, Awareness, and Operations Level Workbook and Glossary by Rod Carringer at 1-800-348-2686. There are about 150 35mm slides for this course curriculum and they can be obtained from Task Force Tips at reproduction costs.

- San Diego and Riverside counties in Southern California are using durafoam to cover their sanitary landfill each night. They are using equipment designed and fabricated by Pneumax of Glendale, Arizona. About 30 gallons of durafoam are being used daily. For more information call Clarence Grady at Pneumax 1-800-468-2237.

- The Forest Service California Region (R-5) is in the process of accepting and putting into service 71 new Model 62 fire trucks being fabricated by Boise Mobile Equipment of Boise, Idaho. Four of these units are going to the National Park Service. (**Continued on page 8.**)

News From the World of Foam—(Continued)

- These units carry 500 gallons of water and have pumps which can pump up to 400 gpm at 150 psi and 200 gpm at 400 psi. They are equipped with automatic regulating, continuous flow, foam proportioning systems and are designed to carry both Class "A" and "B" foam.
- Task Force Tips has developed and is now marketing aspirating foam tube attachments for their QuadraFog 125 Series Nozzles. These foam tubes were the result of information gleaned from nearly 200 tests. Attachment is quick, as

the foam tube is just placed over the nozzle and a hand bail is pushed forward, firmly attaching the foam tube to the nozzle. For information, call Task Force Tips at 1-800-348 2686.

- Pneumax (Clarence Grady) has moved from Peoria, Arizona, to Glendale, Arizona. Their new address and telephone numbers are:

Pneumax
6051 North 56th Ave, Suite 2
Glendale, AZ 85301
(602) 842-2111
(800) 468-2237 FAX (602) 842-2121

NWCG CLASS "A" FOAM COURSE

By Paul Schlobohm, Forester/Fire Management Specialist, BLM, National Interagency Fire Center, Boise, ID

The National Operational Support Group at the National Interagency Fire Center is now completing the development of a new NWCG training course, *Class "A" Foam*. This product has long been an objective of the Foam Task Group. The 14-hour course is being developed to provide basic understanding of foam chemicals, equipment, and applications to the entry level firefighter at the local level and to support foam training in engine academies, refresher courses, and other presentations involving use of foam on wildfires and prescribed fires. The course content includes:

Foam Properties: Properties of water, surfactants, foam types, expansion, draintime, surface tension, foaming agents, and practical ways to understand them all.

Personal Safety and Environmental Concerns: Personal protective equipment, effects of foams to people and the environment, methods to avoid or minimize impacts, and supporting documentation.

Proportioning: Features and operation, advantages and limitations of six manually regulated and three automatic regulating proportioners.

Nozzle Aspirating Foam Systems: Design, construction, evaluation, operation, advantages and limitations of low, medium, and high expansion aspirating nozzles.

Compressed Air Foam Systems: Basics of design, operation, safety considerations, advantages, and limitations of compressed air foam systems.

Applications from the Ground: Extinguishment, mopup, line construction, backfiring, resource protection, and structure protection applications.

Applications from Aircraft: Rotor- and fixed-wing aircraft foam delivery systems and what affects foam generation from aircraft.

Look for instructor handouts to begin for *Class "A" Foam* by Fall 1995.

CAFS RATED HOSE, YES OR NO?

By Lois P. Sicking, Mechanical Engineer, USDA Forest Service, San Dimas Technology and Development Center, San Dimas CA

Pressure is pressure, whether created by a liquid or a gas. Fire hose constructed to the USDA Forest Service Specification 5100-186 or 5100-0187 is rated for a working pressure of 450 psi and can be used for any water or foam application, including CAFS, and maintains firefighter safety.

Some firefighters have expressed concern about the need to use only "CAFS rated hose." Typically, CAFS hose lines are operated at a pump discharge pressure of 75 to 150 psi, substantially below the working pressure of 450 psi for forestry hose constructed to USDA Forest Service specifications. In addition, there have been no "pulsations" or water hammer noted with the CAFS use of forestry hose when the CAFS unit is operated properly.

The Fire Equipment Manufacturer's Association (FEMA) has issued a Safety Alert Technical Bulletin stating that "FEMA strongly recommends that no hose be used on a CAFS system unless such use is recommended by the manufacturer on the system and the hose manufacturer. Use of non-approved hose can be dangerous and may cause hose and or coupling failure, producing property damage, bodily injury, or death." FEMA has also requested that the NFPA Technical Committee on Fire Department Apparatus expand on the section regarding CAFS rated hose in the proposed document, NFPA 1906, Standard For Wildland Apparatus. The current NFPA 1906, 1995 edition, refers to hose used in CAFS, in Section A-8-2(f) in Appendix A, Explanatory Material. This section reads, "If the hose is intended to be used with CAFS, the user should check with the manufacturer of the hose to ensure that the hose has been approved for use with CAFS."

The FEMA Safety Alert further notes that "Standard commercial fire hose carried on apparatus is not designed to transport air and may react violently under those conditions." SDTDC has reviewed technical information, solicited input from firefighters and fire hose manufacturers, and has determined that there are no known incidents where forestry hose has failed when used with a CAFS system, where the hose would not have

also failed with the use of water only. Furthermore, there are no known incidents where fire hose has reacted violently under those conditions. Fire hose manufacturers have not designed any hose specifically for CAFS use due to there being no standards at this time.

Air is a compressible substance. Unlike water, air will compress. Water is a noncompressible substance, associated with water hammer when it is used alone. A mixture of water and the amount of air typically used in CAFS will not cause water hammer. To the contrary, the air will compress, preventing water hammer and any violent reaction. One important consideration in the use of fire hose with CAFS is that, if the user introduces 100 percent air into fire hose and if the air is compressed to a high enough pressure, the air temperature will go up high enough to melt the hose. If 100 percent compressed air at 150 psi is introduced into the fire hose, the temperature can go up to a theoretical 590 °F for single stage compression. This loss of integrity by the hose is due to the high temperature generated by the compressed air, not the structure of the hose.

Ron Rochna, retired BLM, in the *Firefighter's News*, April-May, 1995, states that, "The best hose to be used with CAFS is the extruded or the rubber-lined double jacket types. However, some firefighters feel that conventional hose is not rated to be used with CAFS. This is pure nonsense. Pressure is pressure; hydraulic or pneumatic. If the hose is rated at 250 psi, it will perform no better or worse with CAFS. Of all the departments using CAFS, none have reported hose failures. The exception is a piece of bad hose that would have broken if only water had been used. The basic rule of thumb is if the hose is weak, it is not safe to be used with CAFS or with water."

There are no known incidents where forestry hose has failed when used with a CAFS system, where the hose would not have also failed with the use of water only. In addition, an informal survey of CAFS users did not find any unusual problems with fire hose when using CAFS. USDA Forest Service Specification 5100-186 and 5100-0187 fire hose is rated for a working pressure of 450 psi and can be used for any water or foam application, including CAFS, and still maintain firefighter safety.

CLASS "A" FOAM AS PART OF SUPPRESSION STRATEGY FOR TIRE FIRES

By Rod Carringer, General Manager, Task Force Tips and KK Products, Valparaiso, IN

For several years now, the positive benefits of foam enhancement for fire streams used in suppression of tire fires has been disseminated to those involved in fire management. This enhancement helped lead to a rapid termination of an otherwise problem fire in Indiana.

Tactically, there are several ways to deal with these deep-seated potential environmental disasters.

A "let it burn" policy of allowing the pile to burn out on its own was not acceptable. After three weeks of smoke contamination within a heavily residential area, the political pressure was becoming increasingly heavy to solve the problem. Air quality agencies involved in the operation identified heavy levels of pollution spreading throughout the neighborhoods as winds changed. Each wind direction change forced another round of residential evacuations.

A "bury it" strategy was virtually impossible at this location. The fire was within a large structure on a concrete floor. The structure failed early during the fire covering the bulk of the burning tires with metal construction debris. Soil and topography conditions at this urban site just would

not allow this suppression tactic to be employed. The tactic that was chosen from the beginning was a "drown it" strategy. Numerous mutual aid agencies, as well as the local jurisdiction, poured thousands of gallons a minute of water through master stream devices onto the pile. This volume of water, mixed with many of the components of incomplete combustion within the pile, proved to be a monumental challenge for the Coast Guard Atlantic Region Response Team and local hazardous waste cleanup contractors.

As with any deep-seated fire of this nature, the heavy fire streams were as much as 97 percent ineffective as they immediately generated polluted runoff that had to be dealt within a local waterway. It was at this point, several weeks into the fire with no appreciable results noted, that alternative tactics and strategies were given consideration

The use of Class "A" foam as enhancement to the water streams was considered for several reasons:

1. A reduction in the polluted water runoff had to take place as quickly as possible as contractors could not keep up with the flow rate of contaminants being generated. It was shown that using foam to reduce the surface tension of the water and improve the filming and adhesion characteristics of the fire stream was of great benefit in reducing this runoff. As water supply was not an issue in this urban area with hydrants, foam injection and enhancement allowed much of the existing fire streams to be curtailed without any loss in effective extinguishment.

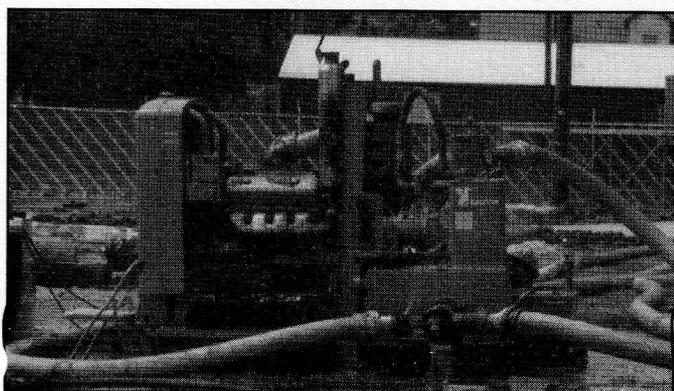
2. The foam, mixed at approximately 0.5 percent by direct injection through KK Products PRO/portioner foam systems, and applied through KK Products Bubblecup, low expansion, foam nozzles provided excellent variable foam aeration for smothering and penetrating purposes. Applications, typically, were first a wet solution, followed by a fluid dripping-type foam.



75,000 tons of burning scrap tires was the problem in Indiana.

This provided immediate penetration into the piles followed by a smothering foam over the top. This tactic proved most effective through the final extinguishment process.

3. KK Products portable PRO/portioners were chosen because of fluctuating water pressures and flows, constantly changing hose lines, nozzle operator variations and the demands of moving equipment from apparatus to apparatus. Only a portable automatic system such as this would keep accurate injection rates over the wide range of operating conditions. The variable aspiration nozzle was also an important tool in the ultimate extinguishment of individual piles.



KK Product's PRO/portioners were used for foam enhancement.

4. Tactically, the use of the foam agents in the extinguishment of this fire was only part of the overall strategic plan to deal with the mounting costs of the holding pattern that had taken place for several weeks. The ultimate strategy was to release the majority of mutual-aid assignments, bring in heavy equipment to get into the seat of the fire, and then remove to a remote location, one load at a time, the extinguished scrap tires.

The majority of the final extinguishment took place as each Payloader's load of burning and unburned tires was dumped on the ground, foamed, inspected and then taken off-site. At the receiving location, another foam application area was set up with an engine company and a portable PRO/portioner. If a "hot" load came in, it was segregated and foamed until extinguished. Within three days of this strategy being implemented, and upwards of 300 truck-

loads a day being foamed and removed off-site, extinguishment was completed.



Loads of burned and unburned tires were dumped on the ground, foamed, and moved off-site and "hot loads" were foamed again.

Benefits noted from Class "A" foam enhanced fire streams being used:

- * A reduction in polluted runoff water, and better penetration and encapsulation of the burning and smoldering scrap tires.
- * An increase in steam conversion as enhanced water filmed over and was held to smoldering scrap tires.
- * A reduction of smoke generation as foam enhanced water soaked into the deep-seated pockets of fire unreachable by the regular water fire streams.
- * A tremendous cost reduction for on-site operations as ineffective fire streams were shut down, companies released, and heavy equipment was brought in and foam enhanced fire streams were utilized.

Detriments noted from Class "A" foam enhanced fire streams being used:

- * Footing of firefighters was obscured by several inches of aspirated foam in some areas, making firefighter safety a concern.
- * While wearing the face piece of a self-contained breathing apparatus, several firefighters had their vision obscured while working with hose lines.



Some footing of firefighters was obscured by several inches of foam and some vision was affected while wearing self-contained breathing apparatus while working with hose lines.



While the cleanup and litigation continued, the savings derived from the use of Class "A" foam was now understood by those who participated in the incident from local, state, and federal agencies.

Many on-site agencies did not know of nor understand the fire chemicals qualification and testing procedures that had been established through the USDA Forest Service, Intermountain Fire Sciences Laboratory, in Missoula, MT. Several different "designer" foams showed up on-site to be used without any approvals, MSDS sheets, or environmental documentation. The foam that was chosen met all criteria and was able to be delivered over-night after a new tactical plan was laid out for implementation.

The cost of cleanup and litigation will continue for sometime, but, tactically, the savings derived from the use of Class "A" foam as an enhancement to the fire streams on this scrap fire were well understood by those that participated from each level of local, state, and federal government. The potential cost of continued air and water contamination from this incident, and the cost of prolonged suppression activities that would have been incurred if a strategic and tactical change had not been made, cannot even be estimated.

For more information, please contact:

Rod Carringer
Task Force Tips and KK Products
Center Fire and Rescue
2800 East Evans Avenue
Valparaiso, IN 46383
Phone: 800-348-2686

COMPRESSED AIR FOAM SYSTEM POWERED BY ALLISON WORLD TRANSMISSION

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

For sometime, the Allison Transmission Division of General Motors has had under development improved medium and heavy automatic truck transmissions which incorporate the latest technology in design, manufacturing techniques, and diagnostics. These products are planned to replace the MT 600 and HT 700 series Allison automatic truck transmissions. These new improved automatic transmissions are now in production and are being delivered on new trucks. These new transmissions, which the division calls "Allison World Transmissions," are available in a MD or HD series. The MD is rated up to 275 hp standard and 300 hp special rating. The HD is rated up to 450 hp standard and 500 hp special rating. These new automatic transmissions have direct engine driven pto's. The MD has a pto on both the left and right sides (3 and 9 o'clock positions) of the transmission. The HD series has the pto's in the 1 and 8 o'clock positions.

These transmissions are available in three basic models—6-speed close ratio, 6-speed wide ratio, and 7-speed with an integral transfer case for four-wheel drive. Both the close ratio and the wide ratio 6-speed transmissions are available

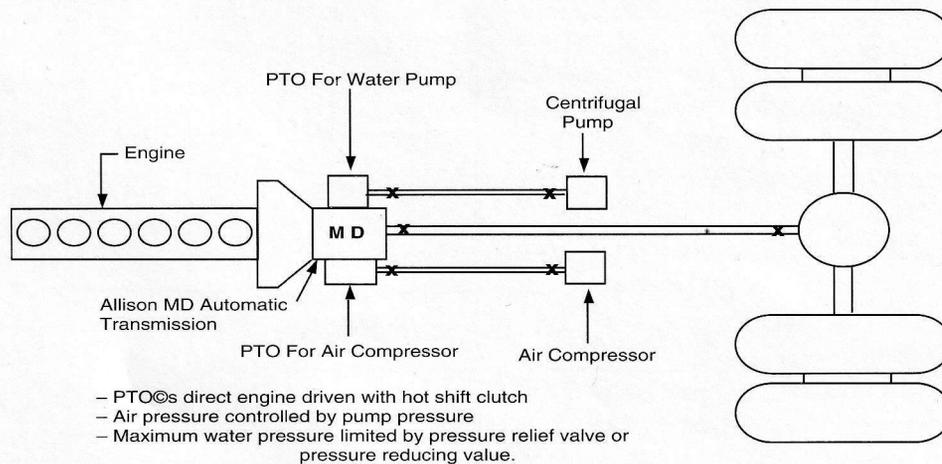
with an integral transmission mounted truck retarder.

With the use of these pto's, a fire truck equipped with the Allison World Transmission can power a Compressed Air Foam System (CAFS) and not only stand and pump but also make a running attack. To do this the CAFS must be designed and operated in a special way. The advantages of this special design and operation are:

1. High horsepower truck engine powered CAFS units can make very good running attacks and provide high foam flows
2. No auxiliary engine used or required
3. No hydraulic system used or required
4. When compared to an auxiliary-engine powered CAFS, or a truck-engine powered CAFS through a hydraulic drive system; this special design results in:
 - A. Less weight
 - B. Less cost
 - C. Less volume
 - D. Components can use space not normally used (e.g., under a six person cab).

To use the Allison World Transmission to power a CAFS unit, one pto drives the centrifugal water pump and the other drives the air compressor.

Layout of Drive System For CAFS Using Allison MD Automatic Transmission

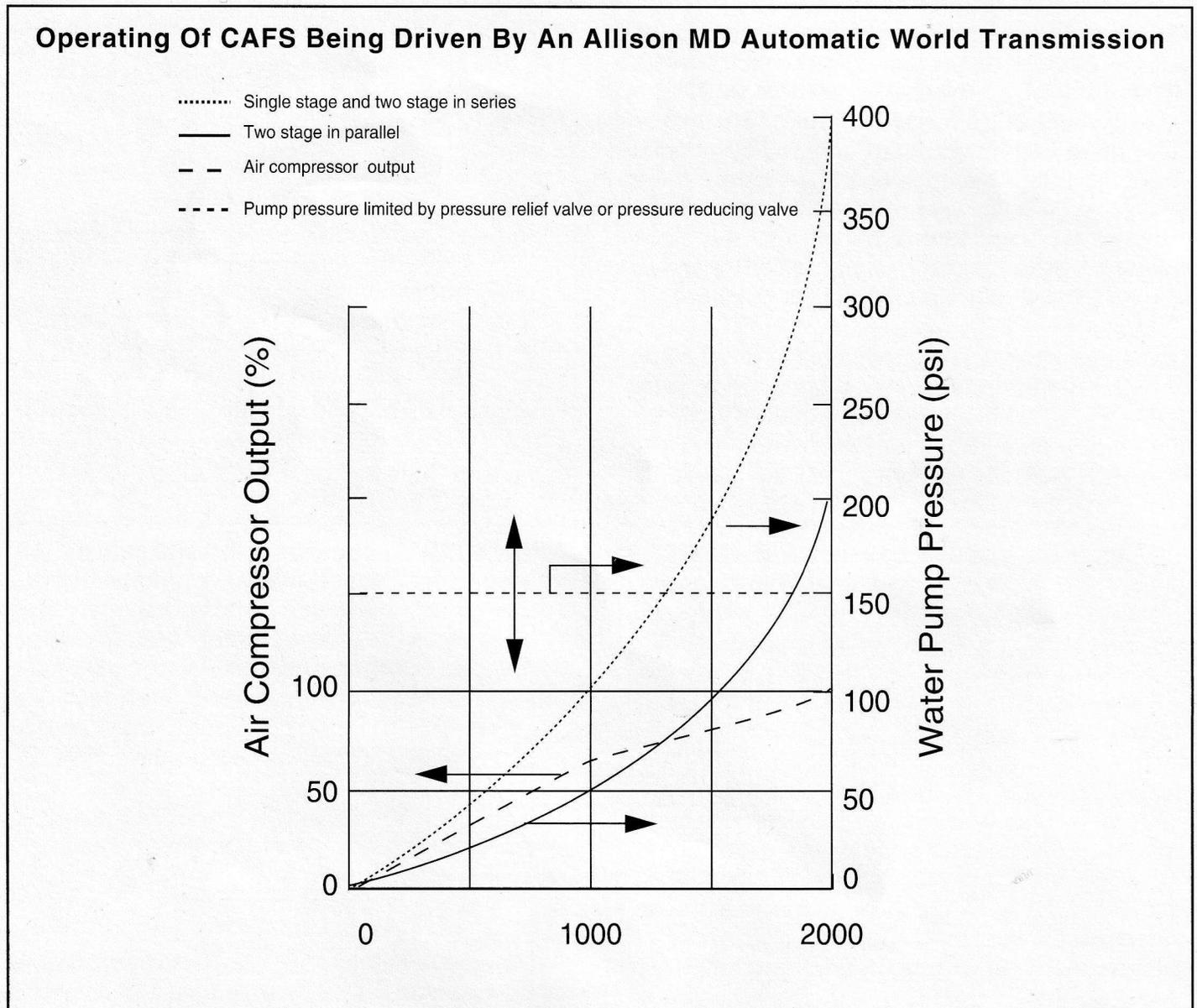


Air pressure from the air compressor is controlled by water pressure and is made equal to water pressure. Water pressure produced by the centrifugal pump is a function of pump rpm. When standing and pumping, the pump pressure can be set by adjusting engine rpm.

When making a running attack, pump pressure cannot be set by adjusting engine rpm because the driver must vary the engine rpm in order to drive the truck. Therefore, to be able to make a running attack, water pump pressure must be controlled by some way other than pump rpm. This can be done by either using a pressure relief valve or a pressure reducing valve to keep the water pressure from going over some preset pressure (e.g., 125 psi).

The pressure relief valve or the pressure reducing valve will limit the maximum operating water pressure when making a running attack regardless of how high the truck engine rpm are raised. The air pressure is controlled by water pressure and is set equal to water pressure. The graph below shows operation of the system. Either a single-stage or a two-stage pump can be used. The pump drive system should be selected to give about 100 psi at 1000 truck engine rpm. Then at 2000 truck engine rpm the pump pressure will be about 400 psi.

If a two-stage pump is used, the drive system should be selected to also provide about 100 psi at 1000 truck engine rpm when pumping in series. When this two-stage pump is pumping in parallel



at 2000 truck engine rpm, the pump pressure will be about 200 psi.

The air compressor should be selected to run from about 700 truck engine rpm to 2000 truck engine rpm. This will mean that at 1000 rpm the air compressor will be putting out 50 to 60 percent of the air compressor rated output at 2000 rpm (maximum air compressor speed).

If the air compressor selected is large enough (about 150 cfm), enough air will be produced at 1000 engine rpm (about 75 to 90 cfm) to make a good running attack (see chart on page 14). When making a running attack with CAFS, water pressure will be limited by a relief valve or a pressure reducing valve and air pressure will be controlled by water pressure, resulting in the truck being able to make a good running attack.

When standing and pumping, the same control technique can be used as when making a running attack. Or, if a two-stage pump is used, the two-stage pump can be operated in parallel—then the pump rpm can be used to control pump pressure and the air compressor will be running near its maximum rpm and output. Also, if a single-stage pump is used, pump rpm can be used to control water pressure if enough air is produced at the lower truck engine rpm.

In using this technique to drive a CAFS unit when using an Allison World Transmission, the largest truck engine displacement available for the series of truck should be selected. The wide ratio transmission also should be selected and all six speeds should be used. If the largest displacement engine available is used and all six speeds of a wide ratio transmission are also used, the CAFS unit should be able to make a good running attack.

This same technique can be used in selecting components for a CAFS unit when a truck is equipped with a manual transmission provided direct live engine rpm are available, such as from a fly wheel pto, or when the centrifugal water pump and the air compressor are front engine driven. If there is a problem of directly driving the centrifugal water pump and air compressor, these components could be driven by a simple hydraulic drive which is no more than a mechanical driveline.

THE USE OF CLASS "A" FOAM AND COMPRESSED AIR FOAM SYSTEMS (CAFS) IN FIREFIGHTING

By Paul C. Darley, Vice President and Manager of Pump Division, W.S. Darley & Co., Melrose Park, IL

Note: *The attached is a copy of a paper addressed to the Institute of Fire Engineers at the Fire Australia Conference in Brisbane in June of 1995.*

Foreword

The use of Class "A" foam in the United States Fire Service has grown at a tremendous rate over the last five years. Compressed Air Foam Systems (CAFS), while still in an infantile stage, are being purchased at a rate faster than most manufacturers, including W.S. Darley & Co., had predicted. The departments using CAFS range from small rural departments to metropolitan departments such as Los Angeles.

Compressed air foam was actually developed in the 1930s and used over the years by the U.K. Royal Navy and U.S. Navy. In 1978, the technology was reintroduced in the USA by the Texas Department of Forestry. Their first system was called the "Texas Snow Job," and despite its limitations, was quite effective. However, few outside of Texas were aware of the system.

In 1986, W.S. Darley & Co. introduced a new system called Water Expansion Pumping System (WEPS). This unit was demonstrated throughout the USA, and interest began to spread about a new way to effectively fight fires. At this same time, a new family of hydrocarbon surfactants were developed and CAFS was on its way.

By 1988, the word on CAFS had made its way to the U.S. federal fire agencies who set up a task force. The effort was headed by the National Interagency Fire Center in Boise, Idaho, which is the coordinating body for wildfires for the U.S. Forest Service, Bureau of Land Management, Department of Natural Resources, Bureau of Indian Affairs, and several other federal agencies.

These agencies had a particular interest in CAFS due to their special firefighting needs. When fighting wildfires, they needed to make their water last as long as possible, and they needed the ability to

protect structures that were in the wake of ranging wildfires.

The famous Yellowstone fires in 1988 were the first time CAFS was put to the test where it received national recognition. CAFS was used to coat the entire four story Old Faithful Lodge at Yellowstone National Park, and saved the landmark structure from what was thought to be almost certain ruin.

The Interagency Center set up a program to teach firefighters about the use of Class "A" Foam and CAFS. I was fortunate enough to attend one of the first week-long classes ever conducted at the Interagency Center in Boise in 1990. Portions of this paper are based on the teachings of Ron Rochna and Clarence Grady during this class, as well as documents prepared by Dan McKenzie of the U.S. Forest Service.

Class "A" foam is currently being used in Australia. Firefighting brigades, such as Melbourne Metropolitan and The Tasmanian Fire Service, have recently equipped their vehicles with Class "A" foam proportioners. Both brigades have unique and different fire suppression needs.

Background

In my opinion, the introduction of Class "A" foam into the fire service will, and already has, revolutionized the way fires are fought. I have had the opportunity to conduct classes and demonstrations on this subject throughout the world over the past five years and have seen the global trends begin to develop.

In my experience, I have found that in order to teach about Class "A" foam and CAFS, a basic understanding of fire is required by the students. Although, certainly not a revelation to this audience, it is important to review the fuel classifications.

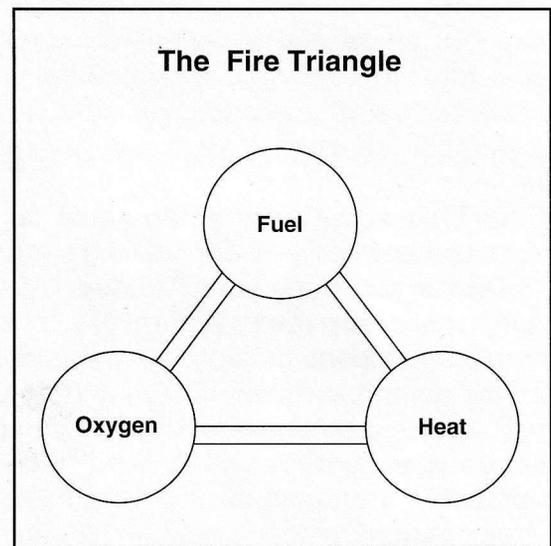
FUEL CLASSIFICATIONS

- Class A Wood, plastic, rubber
- Class B Flammable liquids, greases, gasses
- Class C Electrical
- Class D Flammable metals

For many years Class "B" foams have been well known and widely used because of their capabilities

as a hydrocarbon fire extinguishing agent. In the past decade, Class "A" foaming agents have been recognized as an extremely effective medium for use on Class "A" fueled fires. It has been estimated that when combined as solution with water, Class "A" foams are up to twenty times more effective than plain water alone.

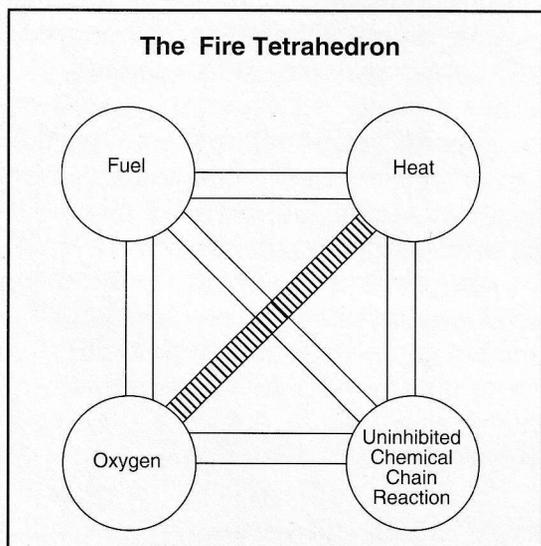
Fire is one of the least understood elements in the world. There are more than 10,000 chemical reactions per millisecond, and as far as we know, it cannot be understood mathematically. For hundreds of years, fire colleges have been talking about the fire triangle.



It was taught that in order to extinguish a fire, we had to attack one of the three legs of the fire triangle. The school of thought, at least in the United States, was that we have to attack the fire by removing the heat. We attacked the heat by pouring thousands and thousands of gallons of water on the fire in order to cool it. In Australia and New Zealand, firefighters realized the effectiveness of high pressure, high volume pumps with fog nozzles, and knew that there was something more than just attacking the heat—and they were right!

The introduction of Class "A" foam has literally changed the fire services' understanding of fire. No longer are fire colleges teaching the fire triangle. They are now teaching the fire tetrahedron. The chemists working with Class "A" foam were astonished with its effectiveness. They realized that the uninhibited chemical chain reaction

between the heat, the fuel, and the oxygen is as critical, if not more critical, to the extinguishment of fire than the actual removal of the heat, fuel, or oxygen in and among themselves.



Water in itself is simply not an effective cooling agent due to its inherent properties. According to U.S. Department of Agriculture studies, when fighting an unconfined fire, less than 10 percent of the water applied to the fire actually goes toward extinguishment. Class "A" foam concentrate, when added to water, enhances water's ability to penetrate the fuel and reduces the surface tension of the water molecule due to its surfactant properties.

The use of compressed air foam can reduce the amount of wasted water to about 20 percent. This means that 80 percent of the water is used to extinguish the fire.

How can this happen? Surface tension is the elastic-like force in the surface of a liquid, which tends to form droplets and minimize the surface area covered. A good example of this is what you see after a rain or when you wash your car. The water forms droplets on the surface and roll off. In a fire situation, this droplet formation is what reduces the cooling effects of water fog.

It also reduces the ability of water to penetrate materials, especially some of the new stain resistant fibers being created. How do we remedy this problem? We reduce the surface tension with a surfactant.

What Is Class "A" Foam and How Is It Different from Class "B" (AFFF) Foams?

Class "A" foam is simply foam designed for use on class "A" fires. Class "A" foam concentrate is a hydrocarbon based surfactant that, when added to water, enables the water to penetrate the burning surface by reducing its surface tension. In its simplest form, it is a heavily concentrated dishwashing detergent.

The basic differences between Class "A" foams and AFFF (B) foams are:

Class "A" Foam and AFFF (B) Foams

	Class A	AFFF
Mix Ratio (%)	0.1 - 1:0	1,3,6
Surface Tension (dynes/cm)	25 - 30	16
Relation to Oil	Attracted	Indifferent
Biodegradable	Yes	No

Class "A" foam extinguishes fire quicker because it:

- Absorbs the heat
- Separates the oxygen
- Isolates the fuel
- Interrupts the chemical chain reaction.

What are the advantages and disadvantages of using Class "A" foam?

There are a number of advantages of Class "A" over water

- Increases the effectiveness of water
- Extends the useful life of water
- Provides a short term fire barrier
- Effective on fire in all types of Class "A" fuels
- Reduces suppression and mop-up time
- Relatively easy-to-use
- Visible from ground and air.

The disadvantages of Class "A" Foam

- Can be irritating to the skin and eyes
- Corrosive to some metals

- May have harmful environmental effects in heavy concentration
- May reduce the life expectancy of leather products.

Getting Foam Concentrate into the Fire Stream

The terms foam concentrate, foam solution, and foam are often misunderstood and misused. It is important to understand their meaning:

- Foam concentrate: 5-gallon bucket of "foam"
- Foam solution: Foam concentrate + water
- Foam: Foam concentrate + water + air

Class "B" foams have historically been proportioned at three or six percent. Due to these relatively high percentage rates, the foam could correctly be applied through the use of eductors, provided one had a matched nozzle and eductor, and a relatively high pressure over the venturi in order to properly make foam solution.

Class "A" foam is proportioned anywhere from .1 to 1 percent dependent upon the application. There are a number of ways to mix the foam concentrate and water:

- Batch Mixing
- Suction Side Regulators
- Eductors
- Around the pump proportioners
- Automatic regulating proportioners.

The first is simply mixing the foam concentrate to the water tank. If you have a 4000 liter water tank, and 4 liters of foam concentrate are added, you will have a .1 percent mix ratio. Batch mixing is certainly the easiest and most cost effective way to use Class "A" foam, at least on a short term basis. However, it does have a number of disadvantages such as corrosion, pump-priming difficulties, pump losing pressure, foaming in the tank, and the inability to change proportion.

There are some eductors that will work for this application. However, at such low percentages, they are often not accurate, and as with Class "B" foam, require constant water flows over the venturi as well as a nozzle, which is matched in size to the eductor flow.

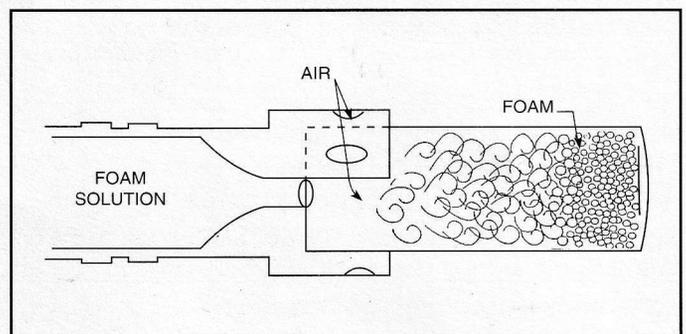
Due to the fact that Class "A" foam is proportioned at such low percentages, it is recommended to have a foam pump or proportioner in order to inject the foam concentrate into the water stream. Most departments, who have learned the benefits of Class "A" foam, will invest in a proportioner soon after they are sold on its benefits.

Just as Class "A" foam concentrates have become much advanced in recent years, the proportioning methods have also improved. There are now automatic proportioners that an operator just turns on and, regardless of pressure or flow, the proportioner adds the proper amount of foam concentrate to the water being discharged. At least two different types of proportioners are currently being used in Australia—one is direct injection and the other a venturi type.

Adding Air to Create Foam

Class "A" foam concentrate and water make up a foam solution which can be used without creating bubbles and have been found to be quite effective. As discussed earlier, in order to create foam, it is necessary to have three components—foam concentrate, water, and air.

In order to create the bubbles, it is necessary to add air to the foam solution at some point. A fog nozzle can be added at the end of the line and will slightly aerate the solution. By putting on a special aspirated nozzle you can choose the type of foam expansion desired.



The introduction of air to the line can be accomplished by two methods. The low energy method of injecting air is simply through an aspirated nozzle at the end of the line, or the air can be added through mechanical means such as a compressor which is known as Compressed Air Foam.

Scientific studies are presently under way to determine the true effectiveness of Class "A" foam. However, the following conservative reports can certainly be used:

- Foam Solution** 3 x more effective than water
- Aspirated Foam** 5 x more effective than water
- Compressed Air Foam** 10 x more effective than water

Compressed Air Foam Systems

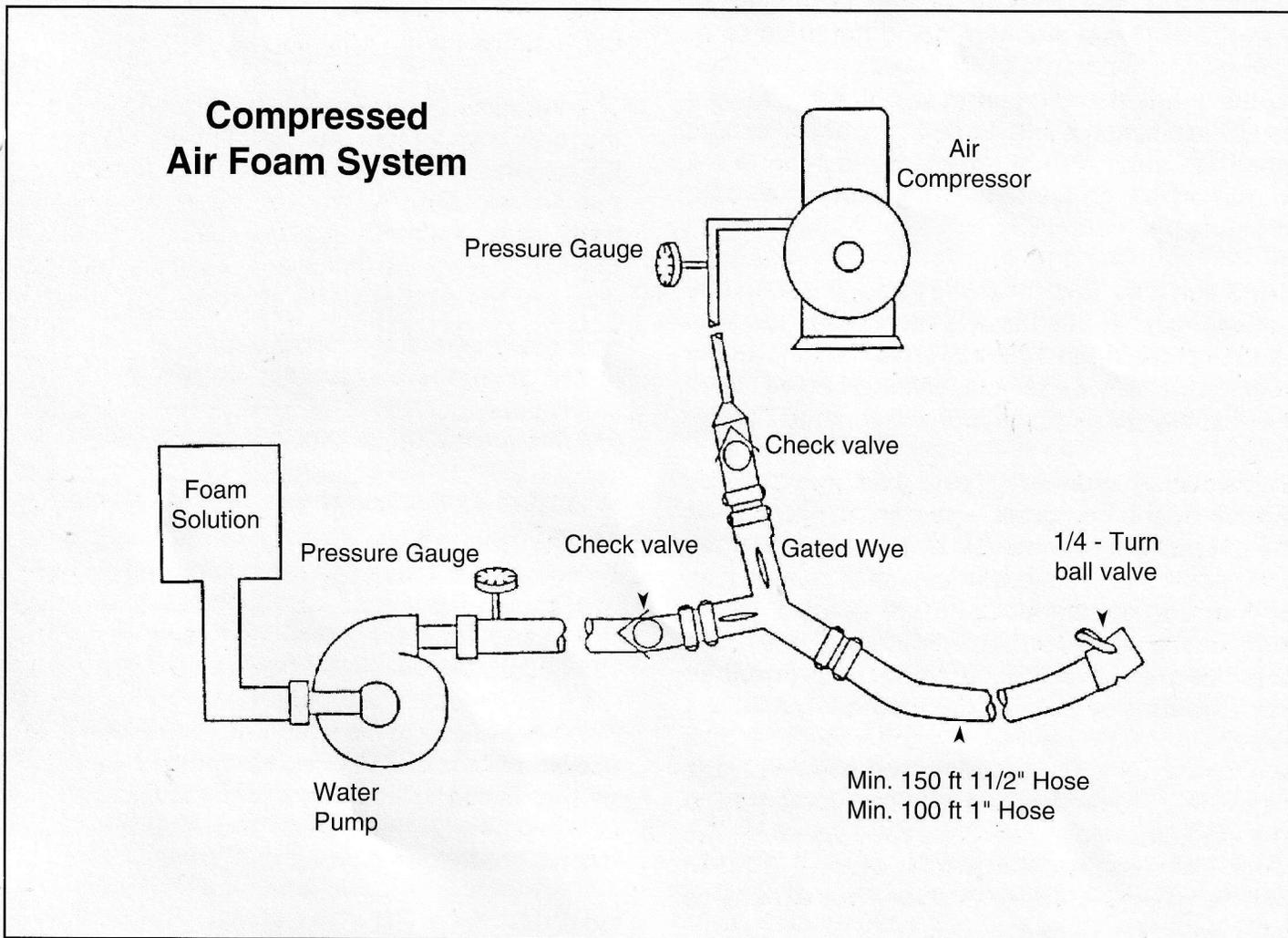
Compressed air foam is defined as the method whereby air is introduced into a foam solution by a mechanical means, and a highly aspirated, high energy foam product is generated. This is usually accomplished through the use of an air compressor, although any compressed air source will work.

The first CAFS represented a very simple use of technology and can be experimented with by any fire brigade by a setup as follows:

Compressed air provides the energy to a fire stream that is required to make it a truly effective firefighting tool. A Compressed Air Foam System is a combination of a water pump (ideally a centrifugal pump), a foam proportioning device, an air compressor, and a control valve.

When operating with compressed air foam, it is extremely important that the air pressure and the water pressure be matched. This matching of air and water pressures can be accomplished in a variety of ways including manually or through a diaphragm in which the water pressure regulates an air pressure control valve, thus matching pressures automatically.

This is a feature of some compressed air foam systems such as the Darley AutoCAFS. Most systems are designed to operate with air and water pressures set between 7 - 9 bar.



A benefit of compressed air foam over nozzle aspirated foam is the extended drain time. The drain time is usually measured as a "Quarter drain" time. This is the time that it takes for a foam to have 25 percent of the water drain from the bubble structure. A long quarter drain time is very important on incidents involving unignited fuel, where water runoff from tactical operations is a problem.

As a general rule, an operator wants to match one gpm of water for every one cfm of air, depending on the foam quality desired. The operator can change the ratio of air to water in order to create varying types of foam. If the pump operator wants a wetter foam, which is ideal for initial attack, he can simply reduce the amount of air to the stream and increase the amount of water.

Conversely, if the pump operator would like a very dry foam, such as is used often in exposure protection, he would simply increase the amount of air to the line, thus reducing the amount of water in the foam and increasing the drain time.

As the solution and compressed air foam travels down the discharge line, a scrubbing action occurs along the inner wall of the hose resulting in the formation of consistent, long-lasting bubble structure.

CAFS can also be discharged through a short line or deck gun. In this case, a motionless mixer is used to provide the agitation required to form the bubble structure, and simulate the scrubbing action that usually takes place in the discharge line.

The additional energy introduced into the fire stream by the compressed air greatly increases the projection capabilities of the stream when compared to an aspirated stream. With compressed air foam no special nozzles are needed. Pistol grip, one-quarter turn ball shutoff with smooth bore tips are typically used. Most compressed air foam systems operate on approximately a 10 to 1 expansion ratio, which is considered a low expansion ratio. The expansion ratio is simply the measure of foam that is produced compared to the amount of foam solution used to make the foam. For example, 100 gallons of foam is made with 10 gallons of foam solution. The expansion ratio would be 10 to 1.

Why Does It Work So Well?

With CAFS you are still using water to reduce the heat, but you are doing it more efficiently. With one average size drop of water, seven bubbles can be made the same size of that original droplet. Each bubble has a thin wall of water that makes up its shell that removes heat radially 360 degrees around its entire surface area. A water droplet can only do this up until the time gravity pulls the remainder of the droplet to the floor. This is where the water is wasted and then carries pollutants out of the building.

With CAFS, the foam that is applied stays in or on the fuel in the fire. The bubbles stay in place releasing moisture as they diminish and are then absorbed by the fuel.

CAFS will also cut the supply of oxygen off to the fuel by laying a blanket of foam bubbles over the fuel. This method actually smothers out the fire and also is a great way to reduce the smoke emissions. Firefighters are also able to see where the foam has been applied.

The increased penetrability and wetting ability of the foam also affects the fuel to bring it to a more fire retardant level. It is the fuels that are smoldering that are releasing the smoke. Water cannot penetrate these smoldering fuels rapidly enough to diminish the smoke emissions. In short, foam can do three things that water cannot:

1. More efficiently cool the fuel
2. Blanket the fuel to cut it off from the oxygen supply
3. Penetrate the fuel faster and deeper.

What Are The Advantages Over Aspirated Foam?

By using compressed air foam, many advantages are immediately evident. CAFS is most often acclaimed for its lightweight hoses and great reach capabilities.

The hose lines are much lighter. This is due to the addition of air that is injected into the water and foam solution stream back at the truck. The line now is partially filled with air and actually reduces the weight by as much as four times.

HOSE WEIGHTS

Comparative weights of cotton-synthetic-jacket, rubber-lined hose filled with compressed air foam, solution, and water. Hose length is 100 feet. Foam weights are based on 10 to 1 ratio of foam to water.

Inside diameter (in)	Total weight (lb.) for Water, Foam Solution, Aspirated Nozzles	Total weight (lb.) for Compressed air foam	Percent(%) Difference
1	56	25.4	45
1.5	103	34.7	34
2.5	271	79.3	29

These lightweight lines provide for greater maneuverability and less firefighter fatigue. The lines will actually float on water due to the air in the line. The actual weight of the lines will vary slightly based on the water pressure.

The discharge distance of propulsion is much greater than with water alone. Even 25 to 50 gpm streams are able to reach 100 feet with the addition of compressed air. Unlike water, a compressed air foam mixture has the ability to be compressed or packed into a hose line. It is for this reason that when shutting down a nozzle, no water hammer can take place. Upon reopening the nozzle, care must be taken to discharge this stored energy because of its increased propulsion factor.

The stored energy will come surging out with much higher nozzle reaction than what was experienced prior to shutting that nozzle valve. It is the storage of this compressible mixture that allows the firefighter, depending on total length of hose, many seconds or even minutes of valuable firefighting time even if the truck was rendered inoperable. Imagine if when you run out of water, or lose prime, or run out of fuel, or any reason the truck or pump quits—the firefighter is still safe for a while because of the stored energy in the hose. The more hose installed means more time available.

The advantages of CAFS are not limited to the above most often cited points. Compressed air foam got its start in wildland firefighting in the Western United States due primarily to its exposure protection capabilities. When fighting forest fires,

for instance, firefighters were able to protect a non-burning surface for up to a day at a time, thus protecting the structure from raging wildfires. In addition, these firefighters were attracted to compressed air foam's ability to make their water go further when often restricted to very limited amount of water when fighting a fire.

Major metropolitan cities are currently attracted to compressed air foam for many of the same reasons. The possibility of the applications in respect to high-rise building standpipes are beginning to open new opportunities due to the fact that there is reduced head pressure in the standpipe.

The use of compressed air foam not only makes for more effective firefighting, but also helps the environment by using less water. Less water usage means less water damage to structures. Less water damage means less repair material is needed (like boards, joists, and paneling) to rebuild houses. Not only does CAFS reduce water damage, it also reduces smoke damage. Smoke damage can sometimes be the most costly of all fire related damages.

Other advantages include the following:

1. You will use less water
 - a. Save taxpayers money
 - b. Less environmental damage
 - c. Reduced water damage to structures
 - d. Water supply lasts longer
 - e. Less need for tanker support.

2. You will be safer
 - a. Stay further from the fire
 - b. Lighter hose lines for less firefighter strain
 - c. Ability to see where the foam has been applied
 - d. Foamed areas less likely to rekindle
 - e. Stored energy in CAFS hoses for escape time.

3. You will be kinder to the environment
 - a. Less water runoff carrying pollutants
 - b. Reduced water resource usage
 - c. Foam is biodegradable and used at 0.2 percent (small amount)
 - d. Reduced smoke emissions and smoke damage.

4. You will be easier on equipment and personnel loss
 - a. Lower truck operating rpm
 - b. Less pressure needed, due to lack of friction
 - c. CAFS does not allow water hammer
 - d. Reduced fire ground times, less spare air bottles needed
 - e. More efficient mopup, less tools needed.

Disadvantages

There are several disadvantages such as the fact that one has more mechanical components, additional training is required, and higher initial costs are associated in the procurement of the vehicle.

In the event that no foam solution is flowing through the line when the air is added, a condition called slug flow will occur with the line causing pulsation resulting from the air not bonding with the water due to the lack of a surfactant.

What is Ahead for CAFS

Although Class "A" foams have been designed specifically for fighting Class "A" fires, within the past six months, there has been a number of applications where CAFS with Class "A" foam was found to be effective in the extinguishment of Class B fires. Note this is not recommended at this time until further testing is conducted because Class "A" foam does not have the strong filming properties of Class "B" foam and consequently, if

not properly covered, the fire could move under the foam unknown to the firefighter.

It should be noted that CAFS can be used with AFFF (Class "B") foams very effectively. The U.S. Air Force is currently evaluating the possibility of retrofitting airport crash tenders with CAFS.

As the supply of resources like water and wood become limited, there are some things that we in the fire service can do to help reduce the damages that we do to the environment. Using a tool known as Compressed Air Foam (CAFS) can be the most beneficial thing for both man and nature. We can be safer, while using less water and reducing smoke emissions. Compressed air foam may just be the most sensible way to fight fires today and tomorrow.

To learn more, contact:

W.S. Darley & Co.
 Mr. Paul C. Darley
 2000 Anson Drive
 Melrose Park, IL 60160
 Phone: 708-345-8050
 Fax: 708-345-8993

and/or

National Interagency Fire Center
 Attn: Supply
 3833 S. Development Ave.
 Boise, ID 83705
 Phone: 208-387-5542
 Fax: 208-389-2573

M-548 MILITARY TRACKED CARGO CARRIER FIRE UNIT CONVERSION

By Samuel Duncan, Research Associate, Department of the Army Tank-Automotive Research, Development and Engineering Center (TARDEC) Mobility Technology Center, Belvoir Fire Research and Development, Fort Belvoir, VA

M-548 CONVERSION

At Ft. Polk, Louisiana the Tank-Automotive Research, Development and Engineering Center (TARDEC), Mobility Technology Center, Belvoir, in cooperation with the Center for Public Works and the Ft. Polk Directorate of Public Works, demonstrated the conversion of an M-548 Cargo Carrier for wildland, liquid fuel, and aircraft/rescue firefighting. This system is a first for the Army and demonstrates what can be done by changing the mission of equipment once thought to be obsolete.

The fire suppression system consists of a 1000 gallon water tank, a Hale CAFSMaster compressed air foam system, and a drafting pump to fill the onboard tank. The CAFSMaster is equipped with two foam tanks, one for wildland fires (Class A) and one for liquid fuel fires (Class B), and can pump foam concentrate and water (foam solution) or plain water at 250 gallons per minute. Water or foam can be flowed through a 2 1/2-inch deck gun or 1 1/2-inch handline. The foam can be injected with compressed air (commonly called a CAFS) allowing increased projection of the stream, better fire knockdown, and more efficient water use.

The M-548 has a 265 hp Detroit Diesel engine capable of propelling the unit fully loaded up to 38 miles per hour on paved roads. Off-road capability is unparalleled—the vehicle will go where you point it. The Ft. Polk unit is equipped with a light dozer blade to turn grasses and thick layers of pine needles or leaves or to cut a fire line. A bumper turret was added recently to enhance aircraft rescue firefighting response capability. The 1994 fire season saw the deployment of Army and Marine Corps personnel to cut fire lines using shovels. This system would be much more effective and safer.

Total weight of the system, including the empty water tank, the CAFSMaster, and the drafting pump is approximately 32,000 pounds. It can be transported by C-130 aircraft. The vehicle can be legally driven on most public roads in the U.S.

Agencies interested in acquiring the basic vehicle should contact the Tank-Automotive Command Item Management Office at 810-574-7578.



Conversion of a M-548 cargo carrier into a tracked wildland firefighting and aircraft rescue vehicle that includes a light dozer blade.

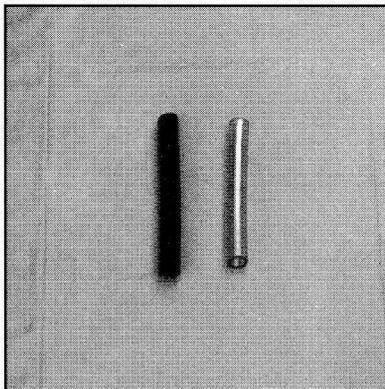
A 10-CENT UNBREAKABLE FOAM NOZZLE FOR BACKPACK PUMPS

By Tom French, Warehouse Foreman, Payette National Forest, McCall, ID

An unbreakable, inexpensive normally aspirating foam nozzle has been developed by personnel of the Payette National Forest. The Payette has used foam in backpack pumps, with this nozzle, for the past four years with great success in fire suppression. We have not been able to break one yet and, as a former Smokejumper, I call the nozzle "Smokejumper or Hotshot crew proof."

THE FOAM NOZZLE

We made the foam nozzle from a piece of 1/2-inch (12mm) inside diameter (ID) garden hose. Each 4-inch (102mm) nozzle cost approximately 10 cents. We also made some nozzles from plumbers flexible polyvinyl chloride (pvc) tubing which is 1/2-inch (12mm) ID and 3/4-inch (18mm) outside diameter (OD) by 4-inches long which works as well but costs about 23 cents each to make. Simply cut the garden hose or tubing into 4-inch (102mm) pieces and, using a leather punch, punch four each 3/16-inch (4mm) holes 3/4-inch (18mm) from the end. Each nozzle may take approximately 20 seconds to make.



Foam nozzles made from 1/2 inch garden hose or plumbers' flexible polyvinyl chloride (pvc).

The Trombone Pump

We used a single action, adjustable tip trombone pump manufactured by H.D. Hudson Co., 500 North Michigan Ave., Chicago, IL 60611, telephone number 800-523-9284. They also make a double action pump that works as well. The cost was \$31.80 for the pump.

THE WATER BAG

We used the Cordura 5-gallon water bag, with liner, manufactured by Paradise Designer Cushions, Inc., 6018 Canyon Drive, Amarillo, TX 79109, telephone number 806-354-2382.

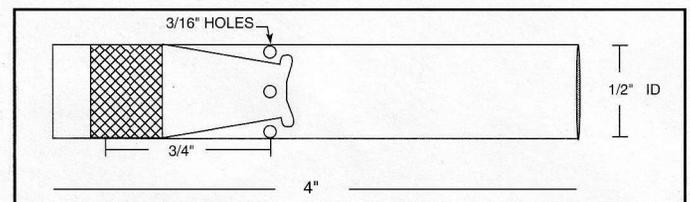
We like this backpack design because it has an external pocket in which we place an extra water bag liner, four each, 4-ounce bottles of Monsanto WD-881 Class "A" fire foam and our foam nozzle. FEDCO and INDIAN companies also make backpack pumps for fire suppression.

THE OPERATION

The complete backpack pump outfit may be acquired from the National Interagency Fire Center (NIFC), 3833 Development Avenue, Boise, ID 83705, telephone number 208-387-5542. Catalog number 1149 at a cost of \$64.04. One should specify that you would like the single action, adjustable tip trombone pump when ordering the backpack pump outfit.

Fill the 5-gallon bag with water, adding 4 ounces of Class "A" fire foam. Slip the foam nozzle over the tip of the pump so the holes are aligned just past the tip. Adjust the nozzle tip to full spray for foam application. One may select the desired quality (wetter/drier) foam by adjusting the nozzle tip from full spray to straight stream. With slight adjustment of the nozzle tip, foam quality is monitored. Simply slip the foam nozzle off for conventional pump operation. It is recommended that the pumps be flushed out with clean water after foam use. After many uses, the foam nozzle may become loose. A simple 1/2-inch (12mm) hose clamp will secure it.

For those agencies that have the twin tip trombone style pumps, the foam aspirating nozzle design that was identified in FM Notes Volume 51, No. 4, 1990, "Power Backpack Pump" by Tom French will work as well.



Garden hose or pvc foam nozzle sketch.

CALIBRATION OF AROUND THE PUMP FOAM MIXERS USING A TEMPERATURE COMPENSATING CONDUCTIVITY METER

By Doug Higgins, Canadian Forest Service, Petawawa National Forestry Institute, Chalk River, Ontario, Canada, and John Hadley, Ontario Ministry of Natural Resources, Aviation, Flood & Fire Management Branch

INTRODUCTION

The present ground foam injection system used by the Ontario Ministry of Natural Resources is the Coson Around the Pump system. The use of the foam mixer solution by ground foam evaluation staff determined the need to define the settings on the meter dial. The use of a temperature compensating conductivity meter, designed in New Zealand, was used to determine each dial setting. To get accurate, reliable, and fast foam percent readings, it is necessary to use a water temperature

compensating conductivity meter. The field work was conducted using the following:

- A Wajax Mark III power pump with an around-the-pump Coson foam mixer to deliver the foam solution
- A Digifoam portable temperature compensating conductivity meter to measure the percent solution in the hoseline
- A flow meter installed in the hoseline to determine the flow rate of the solution being pumped
- The Ontario Ministry of Natural Resources ground foam kit contents.

Below are portable temperature compensating foam conductivity data for twenty foam mixer settings A,B,C,D,E, A-A, MAX. (5 1/2 turns).

DATA FOR 20 FOAM METERS
USING THE DIGIFOAM TEMPERATURE COMPENSATING METER
(flow rate 168 l/m (28 U.S. gpm)
SETTING

Foam Mixer	A	B	C	D	E	A-A	MAX.
1	0.03	0.15	0.35	0.57	0.78	1.32	1.68
2	0.01	0.07	0.23	0.44	0.73	1.23	1.63
3	0.01	0.1	0.28	0.48	0.68	1.25	1.64
4	0.01	0.07	0.19	0.39	0.62	1.19	1.59
5	0.02	0.09	0.26	0.47	0.7	1.3	1.66
6	0.01	0.12	0.34	0.59	0.82	1.36	1.73
7	0.03	0.07	0.25	0.5	0.73	1.33	1.77
8	0.05	0.11	0.38	0.57	0.8	1.38	1.75
9	0.03	0.08	0.26	0.51	0.73	1.34	1.79
10	0.03	0.1	0.27	0.5	0.73	1.35	1.77
11	0.04	0.1	0.27	0.55	0.7	1.33	1.73
12	0.04	0.08	0.23	0.45	0.72	1.3	1.73
13	0.03	0.11	0.27	0.51	0.7	1.33	1.7
14	0.03	0.05	0.19	0.36	0.57	1.25	1.69
15	0.06	0.13	0.32	0.59	0.83	1.32	1.73
16	0.08	0.16	0.34	0.58	0.76	1.28	1.74
17	0.05	0.14	0.36	0.55	0.78	1.34	1.71
18	0.04	0.06	0.19	0.4	0.66	1.36	1.78
19	0.05	0.13	0.31	0.54	0.74	1.34	1.74
20	0.04	0.07	0.17	0.42	0.66	1.3	1.78

The purpose of the field testing was to determine the percent solutions that match each of the dial settings on the Coson around the pump foam mixer. A secondary objective was to do a reliability check on 20 newly manufactured Coson around the pump foam mixers. A third objective was to compare the temperature compensating conductivity meter with a non-temperature compensating conductivity meter while measuring percent solutions.

**Blizzard Wizard
Foam Mixer
Model BB**

NOTE: Using temperature compensating conductivity meter.

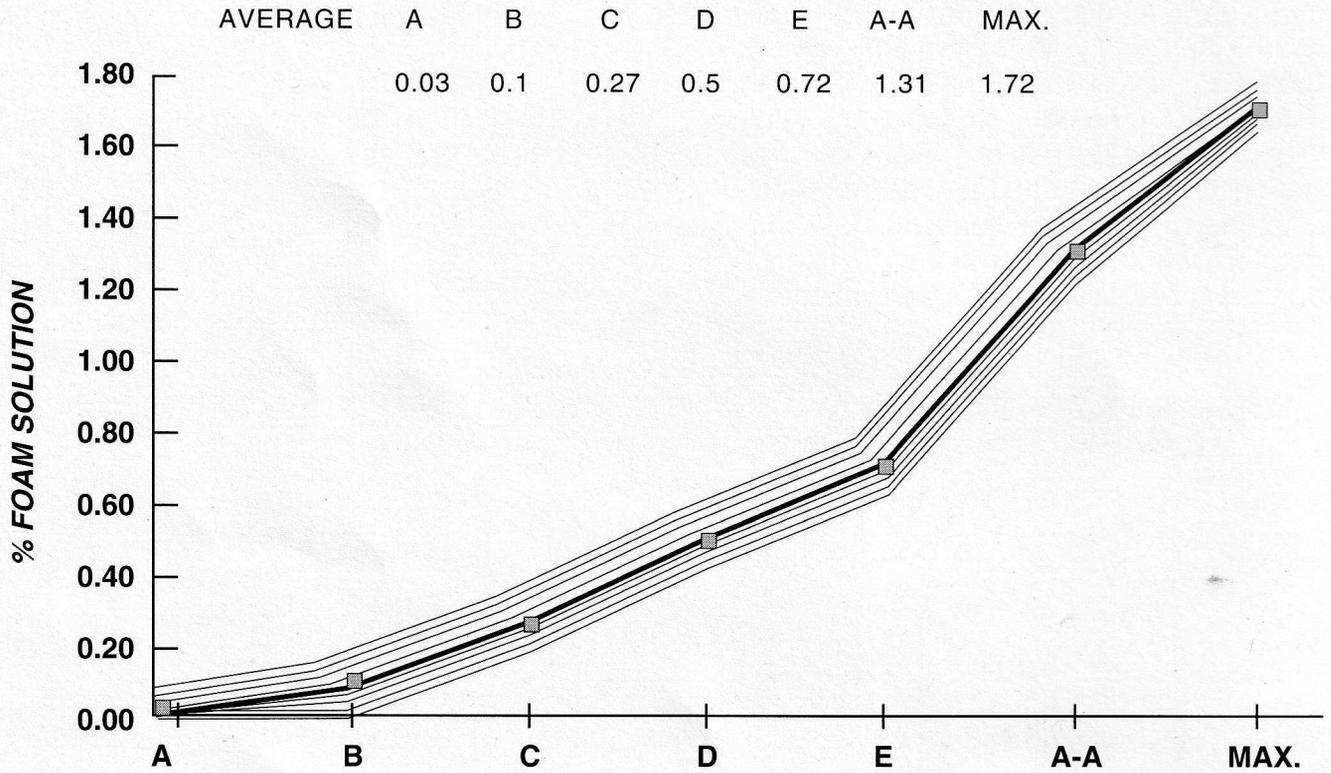


TABLE 1.—COMPARISON OF DIGIFOAM METERS

DIGIFOAM NON-COMPENSATING FOAM METER

AVERAGE	A	B	C	D	E	A-A	MAX.
	0.01	0.06	0.18	0.34	0.49	0.91	1.19

DIGIFOAM TEMPERATURE-COMPENSATING FOAM METER

AVERAGE	A	B	C	D	E	A-A	MAX.
	0.03	0.1	0.27	0.5	0.72	1.31	1.72

NOTE: All tests were conducted with a flow rate of 168 l/m (28 U.S. g/m),

CONCLUSIONS

1. Setting A to B is 0.03 to 0.1 percent foam solution (mopup), Setting C to D is 0.3 to 0.5 percent foam solution (Initial Attack), and Setting E to A-A (1 Turn) is .7 to 1.3 solution (values protection).
2. The twenty Coson around the pump foam mixers all draw foam concentrate within the similar acceptable operational range.
3. There is a difference in the readings between the temperature compensating meter and the non-temperature compensating meter. The percent solution readings are lower for the non-temperature compensating meter.
4. To accurately measure the percent solution and the reliability of the foam mixers, a temperature compensating meter should be used.
5. Because of the relative constant flow rates of the Wajax Mark 3 high-volume pumps, the around-the-pump system works very well.

Authors from numerous agencies, worldwide, have been contributing to the issues in the series. Publications group personnel at the USDA Forest Service San Dimas Technology & Development Center (SDTDC) have been taking the original inputs and performing editorial and graphic functions to produce each newsletter in the series.

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For your free copies contact:

Program Leader, Fire Management
 USDA Forest Service
 Technology & Development Center
 444 East Bonita Avenue
 San Dimas, CA 91773-3198

Phone (909) 599-1267
 FAX (909) 592-2309
 DG, SDTDC: W07A

12/30/94

FIRE CHEMICALS
(Qualified or Approved and commercially available)

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

- ¹ Administrative approval given when interim requirements are met.
- Administratively Approved
 - Temporary administrative approval
- ² Temporary administrative approval for use from fixed-tank helicopters until a new or modified formulation meeting magnesium corrosion requirements is commercially available (GSA).