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PURPOSE

To familiarize the Fire Department with the uses and limitations of firefighting foam products and foam equipment used by the fire service and specialized industries.

To meet NFPA 1001, Standard for Fire Fighter Professional Qualifications - firefighting foam training requirements.

To meet NFPA 1002, Standard for Fire Apparatus/Driver Professional Qualifications - firefighting foam training requirements.

To meet NFPA 1021, Standard for Fire Officer Professional Qualifications - firefighting foam training requirements.

REFERENCES

NFPA 11 Standard on Low-, Medium-, and High-Expansion Foam (2005)

NFPA 1145 Guide for the Use of Class A Foams in Manual Structural Fire Fighting (2006)

NFPA 18 Standard on Wetting Agents (2006)

NFPA 18A Standard on Water Additives for Fire Control and Vapor Mitigation (2007)

Bioassay Report, Chronic & Acute Bioassays Conducted, Prepared for Ray Poland & Sons, Kennewick, Washington, Prepared by CH2M Hill

FoamPro Operation Manual

SFD Policy 5003- Firefighting Foam

SFD Operating Guideline 5003- Bulk Foam

DEFINITIONS

Aqueous Film Forming Foam (AFFF) - A perfluorinated surfactant(s) with a foam stabilizer and viscosity control agents. The AFFF acts both as a barrier to exclude air and, in addition, produces an aqueous film on the fuel surface capable of suppressing the evolution of fuel vapors. AFFF is a static pool fire suppressant that is not effective in three dimensional fires involving flowing, boiling, or spraying fuel. Fire Fighters will encounter this product on Airport Crash units and at bulk Flammable Liquid Storage facilities.

Aspirate -To draw in air; air-aspirating nozzles utilize the energy of a flowing water stream to draw air into the foam solution, creating an aerated, finished foam.

Balanced Pressure Proportioner - A foam proportioning system that uses a pressure controlled, positive displacement pump to supply foam concentrate to a balancing diaphragm valve. The diaphragm valve senses the foam concentrate pressure and balances it with the water pressure. The foam concentrate is then metered through a fixed orifice into the water stream.

Batch Mixing - The manual addition of foam concentrate to a water storage container or tank to make foam solution. SFD pressurized water extinguishers contain a batch mix of a wetting agent & water.

Boiling Point - An indication of a flammable liquid's volatility; the amount of vapor produced by a liquid at any temperature is directly related to its vapor pressure and boiling point. Generally, the lower the boiling point of a liquid, the higher the vapor pressure and evaporation rate. The higher the vapor pressure, the more likely it is that the foam blanket will be penetrated, releasing flammable vapors.

Compressed Air Foam System (CAFS) - A foam system that combines air under pressure with foam solution to create foam in the hose or a mixing chamber. The pressurized air adds kinetic energy to the stream, providing long reach, and it creates a very uniform, stable bubble matrix. The pump operator can “dial-in” a wet, or a drier foam solution as dictated by incident requirements.

Eductor - A device that uses the Venturi principle to introduce a proportionate quantity of foam concentrate into a water stream; under the proper flow conditions, the pressure at the eductor's throat is below atmospheric pressure, allowing foam concentrate to be pushed into the eductor by the atmosphere.

Emulsifier - An emulsifying agent is one that is capable of rendering the fuel nonflammable by encapsulating the hydrocarbon molecules.

Flash Point - The lowest temperature at which the vapors above a volatile, combustible substance can ignite in air when exposed to a source of ignition.

Fluorosurfactants - The ingredient in AFFF and Fluoroprotein foams that allows the foam solution to shed hydrocarbon fuels, giving the foam solution the ability to spread across and cover the fuel.

Finished Foam - The mixture of foam/water additive concentrate, water, and air as it exits the nozzle.

Foam - The aerated solution created by forcing or entraining air into a foam solution by means of suitably designed equipment or by cascading it through the air at high velocity.

Foam Concentrate - The undiluted foam, water additive, or wetting agent product in storage.

FoamPro system - An electronic direct injection foam proportioning system consisting of a flow meter, a foam pump, a computer display/control unit, and associated plumbing.

Foam solution - A homogenous mixture of foam/water additive concentrate & water at the selected rate.

Polar Solvent - Polar solvents are combustible and flammable liquids that have an affinity for water. Polar solvents extract the water contained in firefighting foam, breaking down the foam blanket.

Water Additive - Any agent that, when added to water in proper quantities, suppresses, cools, mitigates fire and/or vapors, and/or provides insulating properties for fuels exposed to radiant heat or direct flame impingement.

Wetting Agent - A water additive that reduces the surface tension of water, increasing its penetrating and spreading abilities. Wetting agents can also provide emulsification and foaming characteristics that extend the efficiency of water in protection against fire exposure and extinguishment of various classes of fire.

WATER, FOAM, AND FIREFIGHTING

For years, fire departments have been utilizing chemicals to improve the effectiveness of water, leading to greater knockdown efficiency and increased firefighter safety. These water additives are sold in high concentration and require mixing to form a solution at percentages dictated by the application, or as recommended by the manufacturer. Hundreds of these concentrates are available today, and advances in chemical engineering continue to produce new types of firefighting agents. However, the products of the various manufacturers must be labeled for the following: testing/certifying agency, listed classes of fire, and approved application and proportioning rates.

Fire fighting “foams” are a mixture of water with some type of extinguishing agent concentrate. Air may be introduced, depending upon the intended application. Before being aerated, the foam is referred to as solution- a mixture of water and concentrate. Once aerated, it is referred to as finished fire fighting foam- a matrix containing both foam solution and some amount of air in the form of bubbles.

Finished fire fighting foams are also defined by expansion capabilities and are subdivided into three ranges - low expansion (up to 20:1); medium expansion (20-200:1); and high expansion foam (200-1000:1). The foam used on SFD units is low expansion when used with standard SFD nozzles.

Universal Firefighting Foam- Class-A/B/D/K

The Seattle Fire Department has selected Novacool UEF (Universal Extinguishing Foam) as its standard water additive for firefighting. Novacool UEF has been U.L. certified to NFPA 18 standards for fire extinguishing capabilities and environmental effects.

When added to water in proper quantities, Novacool UEF reduces the surface tension of water, increasing its penetrating and spreading abilities. It also provides emulsification and foaming characteristics that extend the efficiency of water in protection against fire exposure and the extinguishment of Class-A, B, D, and K fires.

Novacool provides rapid cooling beyond the standard effects of water. This rapid heat absorption allows its use on Class D metal fires. Additionally, it is rated to extinguish three-dimensional (cascading/boiling/pressurized) fires.

- **Use at 0.4% for Class-A/D/K fires**
- **Use at 0.5% for Class B fires, including polar solvents**
- **Use at 0.1% for overhaul**

Per the manufacturer, 1% is the MAXIXMUM proportioning rate for Novacool.

Above this percentage, the firefighting capabilities of the foam solution diminish. Reasons for applying Novacool above 0.5% include but are not limited to: enriching the foam blanket during heavy rain; enriching the foam for extreme fire conditions; performing structural coating (pretreatment) during wildland ops.

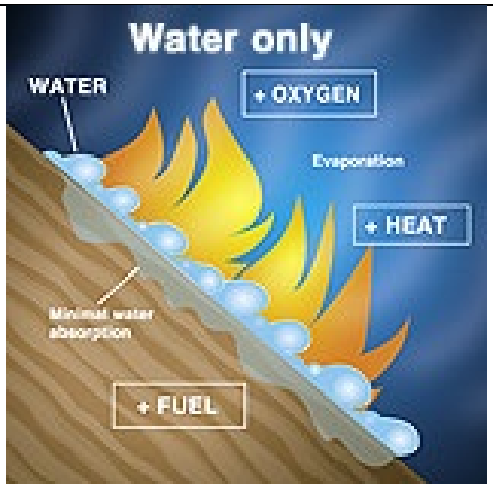
While Novacool is rated for use on three-dimensional gas fires (methane, propane, LPG, etc.), extreme caution should be used due to the danger of continued gas flow and the possibility of explosive re-ignition.

Novacool UEF is non toxic, contains no reportable hazardous substances, and can be used with fresh, salt, or brackish water; the finished foam is non-corrosive, however the **concentrate** will affect aluminum and should be rinsed off if spilled.

Foam for Class A Fires

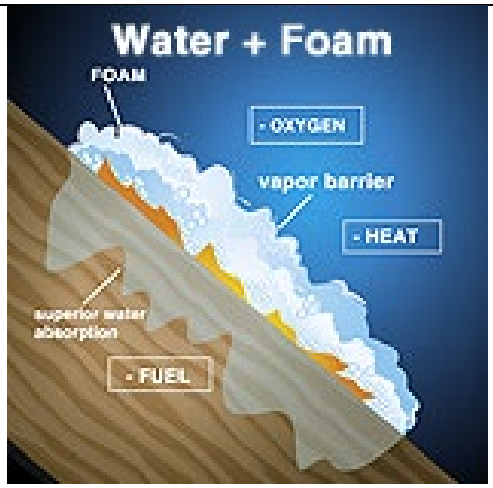
Class A Fuels & Structural Firefighting - Water Only

By absorbing heat, water attacks one leg of the fire triangle. However, surface tension, a natural characteristic of water, “holds” a fire stream's water together in relatively large droplets. This limits the water's heat absorption capability as only a small percentage of the droplet (outer 10%) actually removes heat, while the majority (inner 90% of droplet) runs off the fuel source and “out the front door.” Surface tension also limits water’s ability to penetrate fuels and inhibit combustion.



- Minimal water penetration
- Large drops absorb less heat

Diagram courtesy of Hypro LLC



- Superior water penetration
- Low surface:mass ratio absorbs more heat
- Foam clings to fuel, maximizing effects

Class A Fuels & Structural Firefighting – Water + Foam

At its simplest, Novacool functions as a typical Class A surfactant, reducing surface tension. When added to water and discharged from a nozzle, the resulting foam solution consists of many smaller droplets with much more surface area, allowing faster heat absorption. An example would be like cooling a glass of water with a single ice cube rather than crushed ice of the same volume. The crushed ice would cool it faster.

In addition to creating smaller droplets, the surfactant improves water's ability to penetrate fuels, dramatically raising the moisture content. This isolates the fuel leg of the triangle, increasing the resistance to burning. Typical Class A Foam application forms a low-expansion, quick draining bubble blanket that adheres to horizontal and vertical fuels, allowing prolonged contact with the fuel and increased fire suppression via evaporation and penetration.

Novacool UEF can be used at low percentages for grass fires and overhaul operations. At higher concentrations, and properly aerated, it can be used for coating, or pre-treating structures during wildland incidents.

Class A Foam Application Techniques

SFD Fire Fighters should follow standard structural firefighting procedures when using Novacool:

- Standard fire flow & hydraulic calculations
- Utilize nozzle and attack method of choice
- Reduce proportioning percentage following knockdown
- No need to flush equipment on pick up. Novacool solution is non-corrosive & highly biodegradable

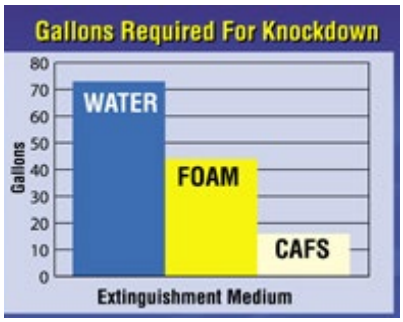
The primary consideration in any handline attack, whether using water or foam, is adequate fire flow and fire stream contact with the burning fuels. Smoothbore nozzles have a greater ability to penetrate thermal columns and reach fuels. Combination nozzles provide more aeration of the foam solution than smoothbore nozzles, generally resulting in a more developed, more resilient bubble matrix that will cling to vertical and horizontal surfaces for a longer period of time.

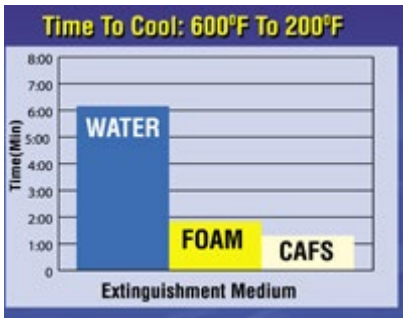
Firefighting Foam is More Efficient than Water

In 2001, the Los Angeles County Fire Department performed live fire comparison tests on three identical 1100 ft². homes. Each was fully furnished with identical sets of furniture. 4 rooms in each structure were set afire, windows were pulled at approximately 700°, and the fires were allowed to free-burn prior to commencing the fire attacks.

The same Engine crew fought each fire flowing 90gpm (per Iowa Formula). Foam concentrations were 0.5% for the Class A Foam attack; 0.2% (with 30cfm air) for the CAFS attack. Data was collected throughout the testing.

Fire Chief Magazine, "Bubbles Beat Water, July 2001





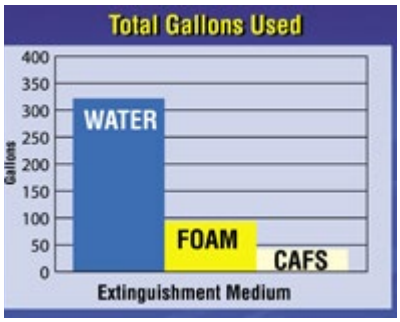


Diagram courtesy of Hypro LLC

KNOCKDOWN

Class A Foam provided faster knockdown than water alone

Water - 50 seconds; 73 gal.
Foam - 25 seconds; 44 gal.
CAFS - 11 seconds; 16 gal.

COOLING

Class A Foam cooled the area 3.5 times faster than water

Water - 6:03 min
Foam - 1:45 min
CAFS - 1:28 min

EXTINGUISHMENT

Class A Foam was 3.4 times more efficient than water at extinguishing the fire

***Water - 320 Gallons**
Foam - 95 Gallons
CAFS - 45 Gallons

* After 225 gallons, IC ordered foam

Class A Overhaul

The purpose of overhaul with foam is to assist the movement of water into the fuels. This is best accomplished using a low (0.1%) proportioning rate to create a wetting agent solution (as per SFD practice in the pressurized pump cans). Placing a thick foam blanket in the post fire area, via higher percentage foam application, is an incorrect technique for overhaul. However, this may be appropriate on burn debris piles with void spaces, in order to wet all of the surfaces within the pile.

Foam as a Wetting Agent

Foaming and Turning a Debris Pile for Overhaul

Smoldering combustibles that are shielded by impervious materials, such as roofing or plastic bags, will not be extinguished by foam application. The material must be overhauled and exposed. Collapsed buildings may require heavy equipment to remove walls or roofs in order to access smoldering debris. Smoldering combustibles in shipping containers, trash compactors, or dumpsters may need to be dumped or removed by hand in order to achieve extinguishment.

Despite hard work, numerous access points, thousands of gallons of water, and foam application, these containers had to be dumped out onto the pavement in order to achieve extinguishment. The plastic wrapping around the products shielded the combustibles from extinguishment. ***Terminal 18, 10/11/08***

Foam Use and Impacts on the Fire Investigation Unit (FIU)

Both the needs of Operations Division and of FIU need to be considered when conducting fire attack with foam:

Operations Division and foam use:

- faster fire knockdown
- faster compartment cooling
- less Firefighter fatigue
- less water utilized for extinguishment = less water damage to property

Fire Investigation Unit and foam use:

- ability to make timely fire cause determinations
- need to delay investigation due to residual foam blanket
- longer Operations company standby awaiting FIU's investigation
- inability to determine fire cause (due to foam obscuring view)

0.4% Novacool foam application, immediately after shutting down the nozzle

'Porta Potty' Fire - note the residual foam layer that causes investigative issues for FIU members (see the beer bottle for scale reference). A gentle rinse with 0.1% foam solution, or plain water might resolve the issue with the residual foam blanket.
Photo provided by Capt. Baer, FIU

Incident Commanders/Apparatus Operators should **IMMEDIATELTY** lower the foam percentage to 0.1% upon achieving knockdown of the fire; consider using plain water (turning off the FoamPro injector) for overhaul in some instances since residual foam will be in the hoseline(s) and on materials in the fire compartment.

- Officers need to ensure that Drivers/Actors are properly operating the FoamPro system, delivering the correct percentage of foam for the given incident.
- **The FoamPro system is accurate down to flows as low as 10 gpm**; overhaul foam operations can utilize gentle application of 0.1% foam, causing little or no aeration of the overhaul foam or disturbance of post-fire debris.

0.1% Novacool 'overhaul' application, immediately after shutting down the nozzle. This was done immediately after a 0.4% 'attack' application of Novacool on the same surfaces.

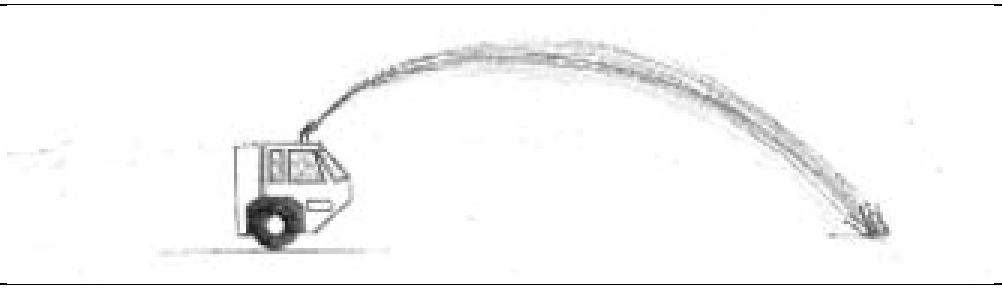
Foam for Class B Fires- Combustible and Flammable Liquids

Novacool solution extinguishes Class B hydrocarbon fires by creating an emulsion across the surface of the fuel, suppressing fuel vapors and excluding oxygen. It also cools the fuel and surrounding surfaces to ambient temperature. When applied with a low or medium-expansion nozzle, the blanket of foam bubbles provides a 'reservoir' to re-supply the vapor-blocking emulsion on the surface of the fuel.

Novacool will extinguish Polar Solvent fires and reduce the involved area to ambient temperature, but it will not produce a polymeric seal across the surface of the liquid as an alcohol resistant AFFF would. While Novacool is U.L. certified for polar solvents, the foam blanket is susceptible to destruction due to water being leached from the finished firefighting foam. Following extinguishment, a staffed foam line should remain ready, and air monitoring should be conducted to check LEL readings.

Class B Foam Application Techniques for Spill Fires- shallow, spreading fuels

The FAA/USAF jointly participated in a large-scale fire test program to evaluate new fire fighting technologies. One specific area of research related to the most efficient angle of application for firefighting extinguishing agents on Class B spill fires. It became evident in early testing that the lower to the ground the agent was applied to the surface of the fuel, the more rapidly the fuel vapor could be suppressed. Data produced from the comprehensive testing indicated that the **raindrop method** of application was not the most effective method for applying extinguishing agents to a large fuel spill fire. Fifty percent of agent applied to the fire never reached the fuel surface. It was carried up vertically in the thermal column.



Raindrop Application - Less efficient, slower extinguishment for spill fires. 45 degree application results in the greatest reach for hose streams, but agent loss can occur in the fire plume and splashing on the fuel surface disrupts the surface film buildup process. *Transport Canada Civil Aviation*

Parallel to ground application accelerates extinguishing agents across the fuel surface of a spill. This type of low-to-the-ground attack allows a 10 degree power cone spray effect that disperses agent more rapidly. Fire is extinguished with considerably smaller quantities of extinguishing agent and in much less time than when using a lobbing, or raindrop technique.

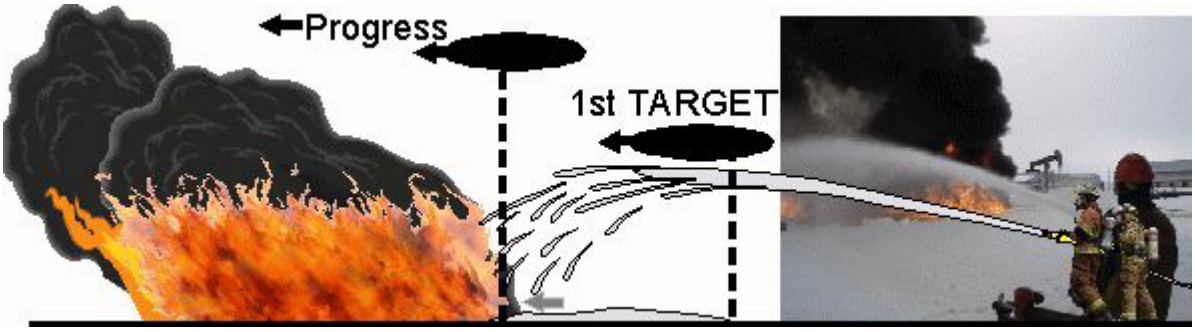
<u>Parallel to Ground Application</u> – Best for Spill Fires. A low application angle accelerates more agent across the fuel's surface, providing faster extinguishment and using less agent during spill fires. ***Transport Canada Civil Aviation***

A low application angle for spill fires provides faster knockdown.

Class B Foam Application Techniques for Deep Fuels- pooled fuel or tanks

Foam streams should not be plunged into deeper fuels in order to avoid "fuel pickup" in hydrocarbons or foam degradation in polar solvents. Foam should be applied gently to the surface of deeper fuels, either via an aerated blanket pushed across the surface, or by gently lobbing foam upward to deliver a soft rain of low mass droplets that will not plunge past the surface of the fuel. **Engines equipped with FoamPro systems can throttle back the bales of their nozzles to produce a gentle flow of foam-** unlike an eductor, foam proportioning will remain accurate at flows as low as 10 gpm.

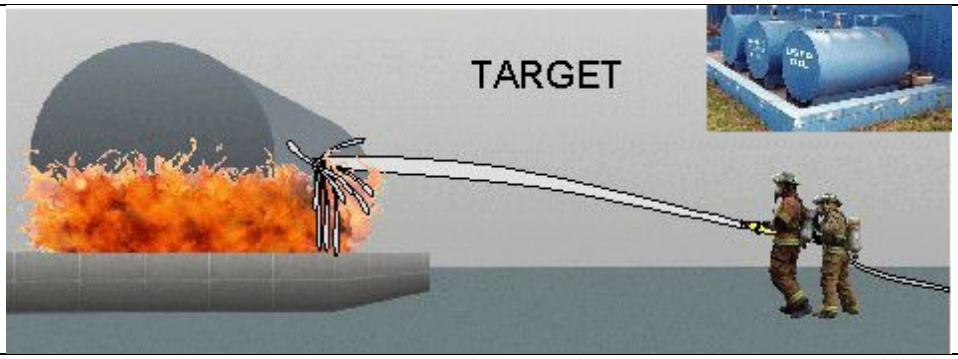
<u>Lobbing</u> may be required when objects block rolling techniques or when debris clutters an area. Lobbing decreases the effectiveness of a spill fire attack, but is preferable for fires in deeper fuels. The nozzle is adjusted to maintain a gentle rain onto the fuel's surface. The area is "painted" progressively.

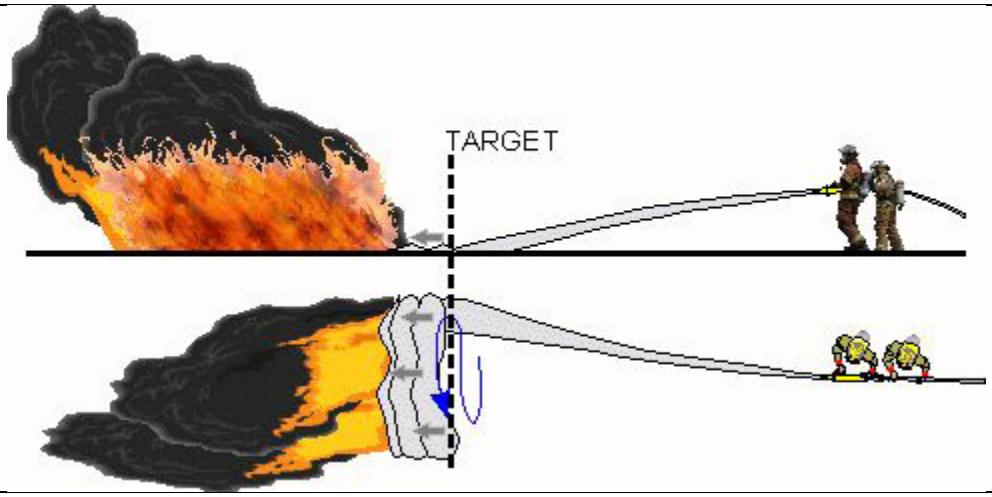


Even with the bale throttled back, Fire Fighters were unable to extinguish this trough.

By throttling back the bale <u>AND</u> adjusting their attack position, a gentler Lobbing application produced lighter droplets that did not plunge past the fuel's surface. The deep fuel in the trough was extinguished.

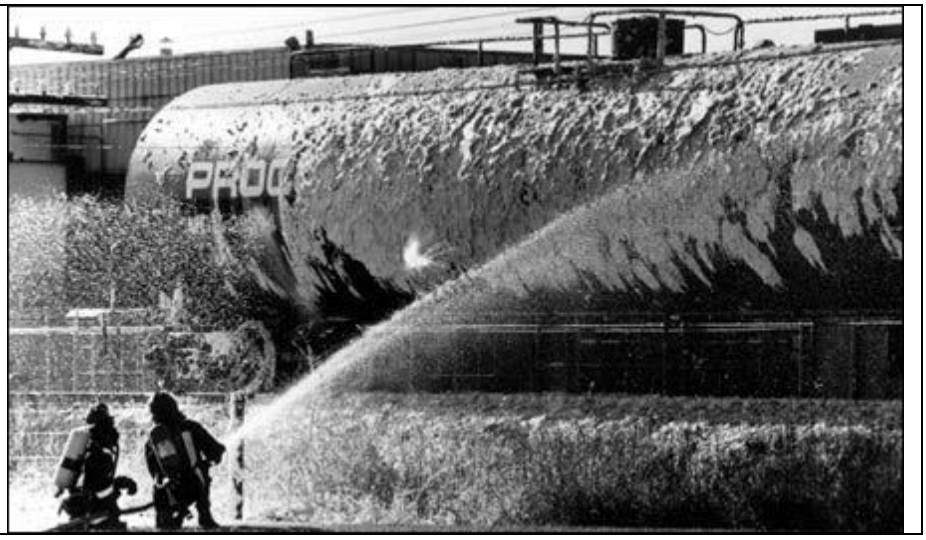
<u>Banking</u> uses deflection from another object such as a tank or wall to allow foam to flow downward and spread out over the intended area. Can be useful when storage tanks have a containment area.



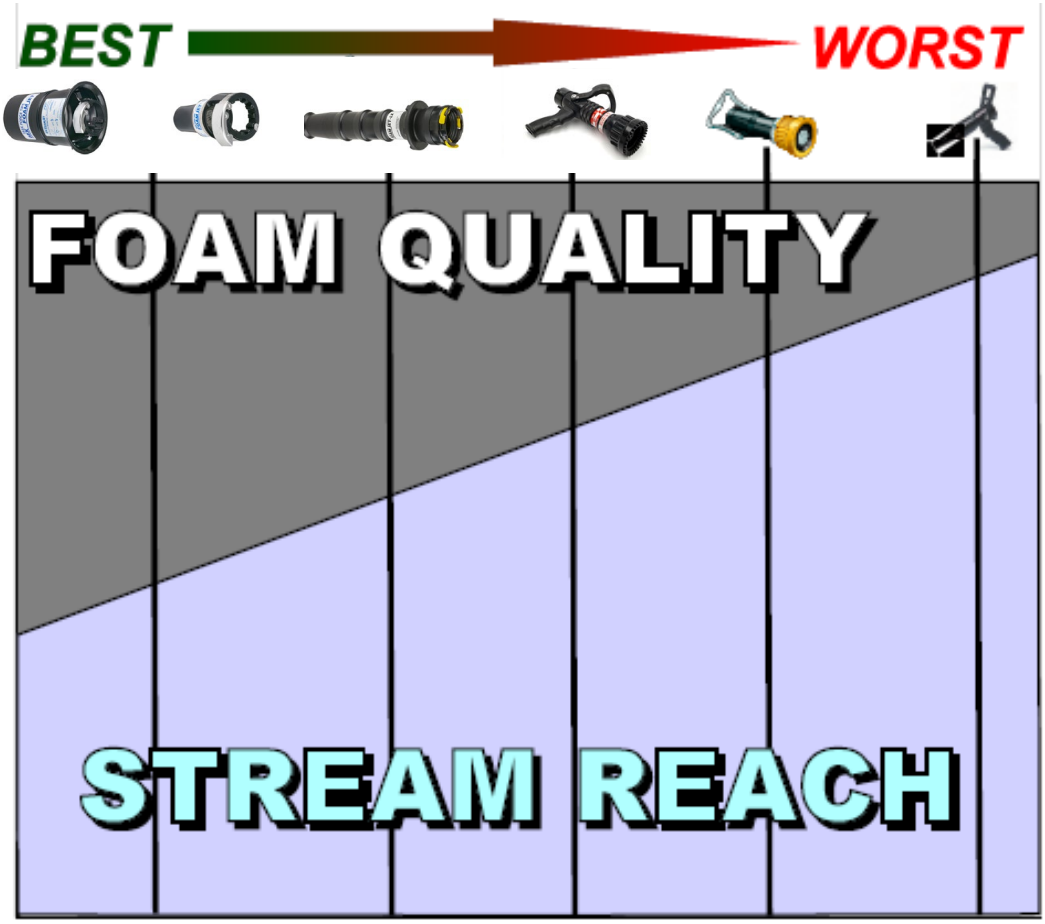


<u>Rolling</u> is conducted by targeting the foam stream before the flame/fuel front and using the stream to push a "wave" of foam over the area by sweeping the stream left to right. This technique helps prevent plunging the foam stream into deeper fuels.

The deflection of the foam stream off of the ground during the Rolling technique also provides additional aeration of the foam.

Banking/lobbing may be used to cool or insulate other surfaces.	

SFD Nozzles for Class B Foam Operations



Novacool foam can be applied with any type of nozzle. The proper nozzle for the circumstances is the one that should be utilized. There is generally a trade-off between foam aeration ('blanketing') and stream reach. Fire control is not necessarily affected by the stability/quality of the bubble matrix, but vapor control is generally enhanced by a more aerated, more stable foam matrix, or 'blanket'.

Combination Nozzles- Standard nozzles are not designed to entrain air into the fire stream for creating a foam "blanket". However, with the proper application technique, they are effective for both shallow Spill Fires as well as for fires in Deep Fuels.

Applying Novacool to a spill fire; a combination nozzle provides pattern control and reach with some aeration as droplets travel through the air. The goal during a Spill Fire attack is to push the foam across the surface of the fuel, providing a cooling emulsion that should rapidly extinguish the fire.

Aspirating Foam Nozzles - Air aspirating nozzles utilize the fire stream flow to entrain air into the foam solution, producing aerated, finished foam. The use of the fire stream's energy to entrain air and expand the foam reduces the reach of the stream, but provides a thicker, more uniform, and more stable bubble matrix. This can provide better vapor control during a Class B incident.

Low-Expansion Nozzles – FoamJet Low-Expansion Aspirators produce foam through the full range of a Task Force Tip nozzle's rated flow. They can be clipped directly onto the nozzle.

FoamJet Low-Expansion Aspirators for 2.5" and 1.75" Hoselines

Use in Straight Stream Only – for blowback, shut down the bale, go to straight stream, and re-open the bale.

FoamJet

- 2.5” nozzle
- 50-350 gpm
- 75’ throw at 100 psi
- Use in straight stream

FoamJet - LX

- 1.75” nozzle
- 70-200 gpm
- 50’ throw at 100 psi
- Use in straight stream

Multi-Expansion Nozzle – Marine and Haz Mat Team units carry this nozzle. It is adjustable from straight to wide stream and can produce a more aerated, higher expansion foam. These nozzles are useful for bilge spaces on ships, containment areas in haz-mat facilities, and during overhaul on small vessels.

MX FoamJet

- 2.5” nozzle
- 50-350 gpm
- Adjustable foam
- Fog **or** straight stream
- Directions on side label

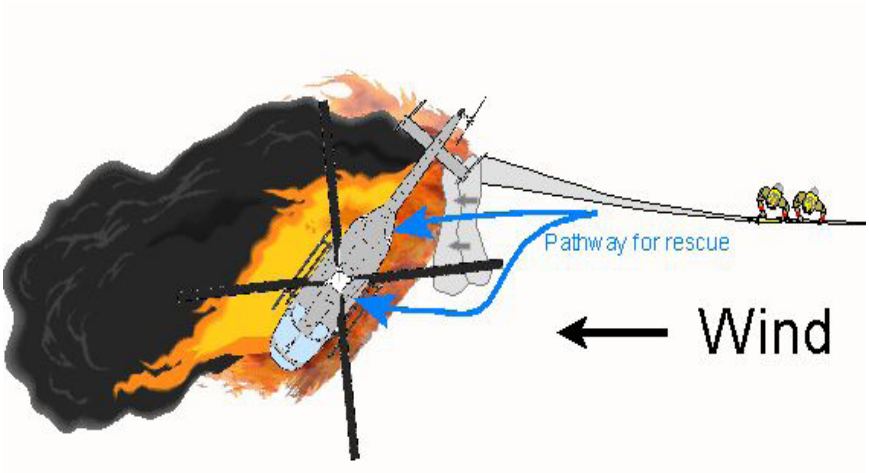
Standard nozzles can be used for longer reach and cooling. Aspirating "foam" nozzles can be utilized to produce a thicker foam blanket for vapor control. Either can be effective on fires involving spills or pooled fuels- when proper application techniques are used.

Safety During Class B Operations

Following fire control, a foam blanket should be maintained to secure the exposed area until fire department operations are completed. Reapplication may need to be continuous or every 10 to 15 minutes depending on the type of product being protected, the topography of the site, and the environmental conditions. Volatile vapors can bubble up through a foam blanket and build a false foam blanket; the fuel vapors are replacing air bubbles with flammable vapors. This problem can only be prevented by constant re-application of foam.

Water streams used to protect exposures should not be placed in such a position that they cause dilution or breakdown of the foam blanket. Water lines used to cool exposures should usually be shut down when foam application begins.

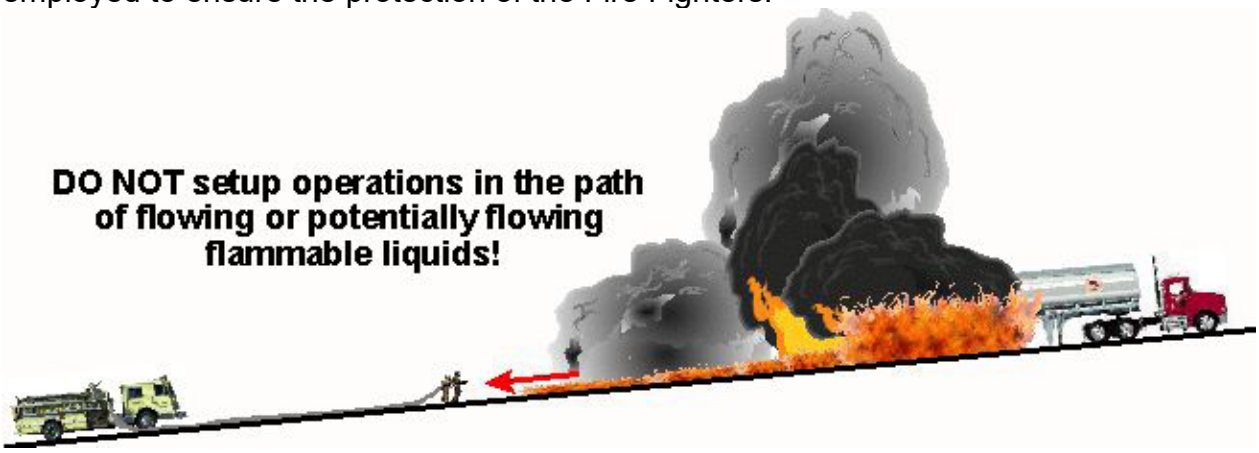
When any doubt exists about the adequacy of the foam concentrate stockpile, for either extinguishment or foam blanket maintenance, Fire Fighters should focus on protecting life and the evacuation routes from the hazard area. Once adequate concentrate is on site, foam attack can begin on the main body of the fire.



Consider the wind direction when approaching the hazard. Foam application does not always have to cover the entire fire area. Coverage may only be needed to create a pathway for rescue.

When possible, a foam attack should be made from the windward and uphill side of a fire or spill. It is suggested that a path of foam be laid into the fire or spill area for personnel protection, and the initial application should be made on the fire or spill edge nearest the hose team. The attack should then advance as the fire is extinguished or the spill secured. Fire Fighters and hoselines should stay out of the fuel if at all possible.

Safety of personnel is the primary consideration. Protective clothing and SCBA should always be employed when combating a fire or spill, and a back-up line should be employed to ensure the protection of the Fire Fighters.



Although some containment efforts may be employed well ahead of the flow, a sudden and massive release of fuel from the container may occur. Anything downhill is in danger!

Good judgment is necessary on the part of Fire Fighters when sizing up an operation requiring foam.

Control will be easier when gpm's meet or exceed the listed application rates. Fireground variables that will affect the amount of foam solution and gpm's needed are:

- Characteristics of the fuel
- Amount of fuel available
- Pre-Burn time (ignition to first application of foam)
- Topography of the involved area
- Environmental Factors
- Application techniques
- Intensity of the fire

Olympic Pipeline Fire, Bellingham WA

Class B Foam Application Rates and Required GPM's

The "application rate" is the amount of foam solution recommended per square foot per minute. Using the recommended application rate, we can calculate the recommended amount of solution needed per minute for any given area. During an un-ignited spill incident, the foam application rate will be less, as the destructive nature of the fire will not be present.

U.L. Listed Class B Application Rates for Novacool UEF at 0.5%

CLASS B FIRE	APPLICATION RATE
Hydrocarbon	**0.16 gpm/ft²**
Polar Solvents and Tank Fires	**0.2 gpm/ft²**

Rules of Thumb for Novacool coverage with standard flows

- **1 ¾" hoseline** gas tanker ***or….***
  standard house footprint (25' x 25')
- **2 ½" hoseline** 35' x 35' (1200 ft²)
- **500 gpm monitor** 50' x 50' (2500 ft²)

*The listed values are for **polar solvents**; for hydrocarbon incidents, Novacool foam will provide coverage for a 20% larger area.*

Simple Math for Class B Firefighting with Novacool

This is a quick, "In-the-Street" method for estimating foam attack needs at an incident.

Quick Calculation Method

For practice, assume there is a **Class B** fire in an area **approximately 1000 ft².**

1. **Estimate** the square footage **≈ 1000 ft²**
2. **Drop the last digit** to get base gpm. 100Ø ft² becomes **100 gpm**
   (provides 0.1 gpm/ft²)
3. For **Hydrocarbons** add **60%** 100 gpm + **60%** **= 160 gpm needed**
   *(provides **0.16 gpm/ft²**)*

OR

4. For **Polar Solvents** add **100%** 100 gpm + **100%** = **200 gpm needed**
   *(provides **0.2 gpm/ft²**)*

Example #1 - Assume a 40'x 40' area with a flammable liquid fire (approx.1600 sq ft):

Estimate the square footage	**≈ 1600 ft²**
Drop the last digit to get base gpm	160Ø ft² becomes **160 gpm** *(provides 0.1 gpm/ft²)*
Add 60% for Hydrocarbon fires	160 gpm + 60% **= 256 gpm** *(provides **0.16 gpm/ft²**)*
Add 100% for Polar Solvent fires	160 gpm + 100% = **320 gpm** *(provides **0.2 gpm ft²**)*

Example #2 - Assume a **hydrocarbon** fuel tanker is on fire:

Fire Area = Approximately 50' x 10'

A fuel tanker which has burned to mid-level - actual area is 450Ft² (53' x 8.5')... plus whatever spilled area is involved.

HYDROCARBON TANKER FIRE

Estimate the square footage ≈ **500 ft²**

- Drop last digit - 50Ø ft² becomes **50 gpm**
- Add 60% for **Hydrocarbons** **50 gpm** + 60% = **80 gpm**

An approximate **80 gpm foam** flow is required for this tanker. Foam must be applied with the correct technique in order to achieve extinguishment in deep pools of fuel, otherwise the fire will burn until either the fuel, or the container, is gone. *(see tanker fire photo on page 39)*

Foam for Class D Fires- Burning Metals

Fires involving only Class D materials are rarely encountered by municipal Fire Fighters. Some vehicle fires will involve Class D materials, usually noted when they flare up during water stream application at car fire incidents. Additionally, metal fabrication and recycling occupancies may have bins of scrap metal and turnings that present purely Class D fires. Fortunately, these have been rare occurances in Seattle.

During product evaluation testing involving test burns with magnesium, Seattle Fire Department members successfully extinguished fires involving blocks & shavings of magnesium. Per the manufacturer, the “best practice” method of applying Novacool to burning Class D materials involves using a narrow fog pattern moved across the fire, pausing momentarily to allow steam dissipation, and then repeating this process until the fire is cooled and the stream can be directed into the material without any burning metal being ejected.

Two 45 gal. drums of magnesium chips

Prior to application of Novacool foam

Sweeps with narrow fog pattern: 1 min.

After repeated sweeps: 4.5 minutes

	
45 gal of magnesium in clothes dryer shell	**2 min. free burn, very hot**

	
3.5 minutes of Novacool application	**Final extinguishment with direct stream**

The preceding photos are from Novacool Class D fire extinguishment tests performed in 2010 by Pratt & Whitney industrial Fire Fighters in Nova Scotia. Magnesium was the fuel.

SFD FOAM APPARATUS

Engines

All SFD engines carry a 125 gpm in-line eductor and 5 gallon containers of Novacool. The eductors are adjustable, but are used at 0.5% for Novacool This enables Engine companies to operate a 125 gpm foam handline for up to 8 minutes for each 5 gallon container of Novacool foam.

See the “SFD Foam Proportioning Equipment” section for more information concerning eductor operations.

FoamPro Engines

The majority of first-line Engine apparatus are now equipped with FoamPro systems that deliver foam concentrate from 0.1% - 0.5% at flow rates of up to 1000 gpm. Higher percentages can be utilized at lower gpm flow rates. Integrated foam storage tanks are rated for 10 gallons of concentrate. All SFD Engines carry spare containers of foam; there should normally be a minimum of 30 gallons of foam onboard each Engine.

FOAMPRO ATTACK TIMELINES @ 0.4% Firefighting Foam

APPLIANCE	GPM	Available Foam (10 gal tank + 20 gal)
1 ¾" nozzle	125	60 minutes
2 ½" nozzle	250	30 minutes
Portable Monitor	500	15 minutes

See the "SFD Foam Proportioning Equipment" section for more information concerning the FoamPro system and its operation.

Engine 11 at Washington State Fire Training Academy, summer 2009; Training Division videotaping of FoamPro/Novacool live fire evolutions.

FoamPro Engines

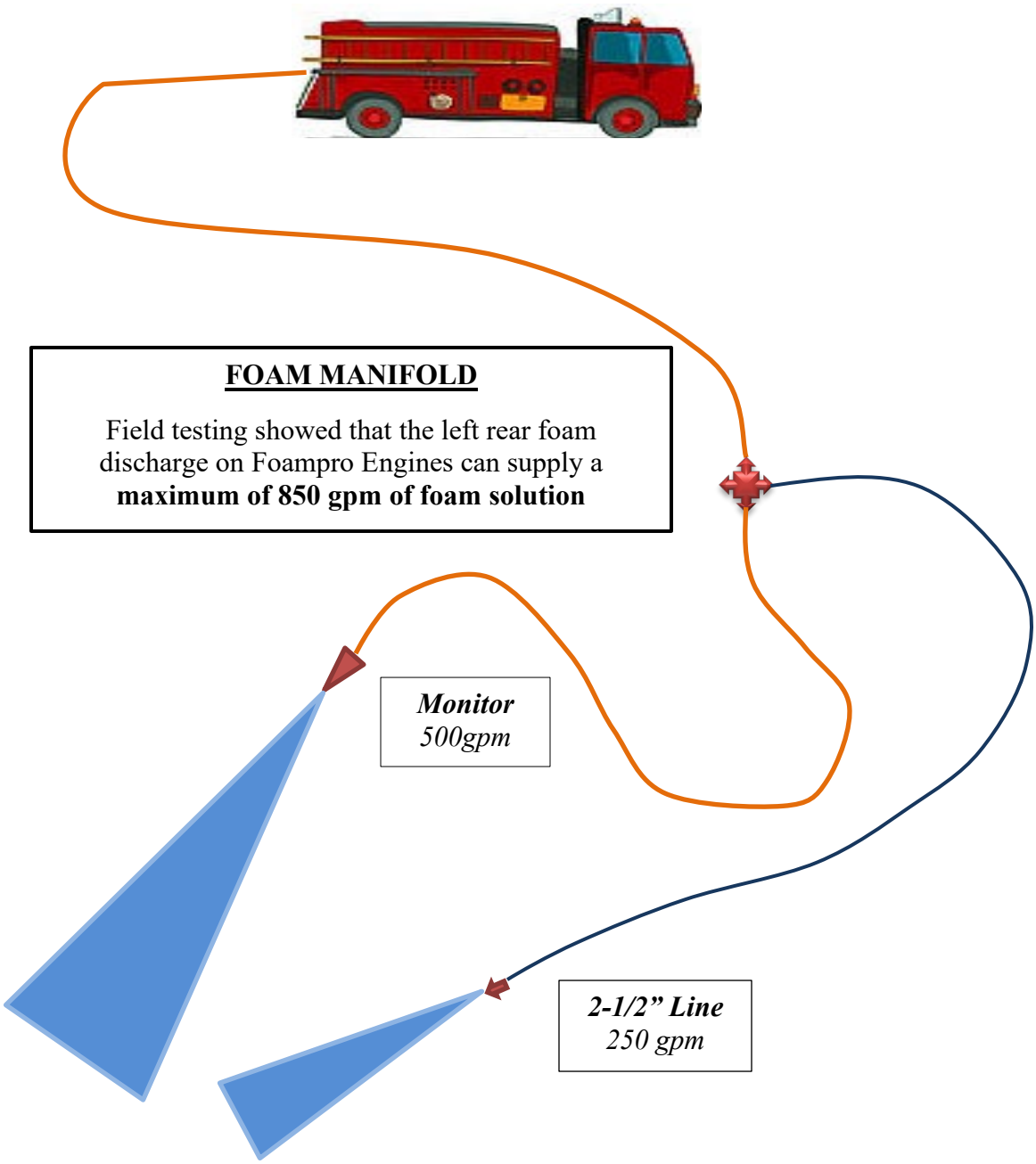
Engine Companies with FoamPro systems are able to deploy a foam attack line just as rapidly as a standard attack line, allowing for faster control of fires.

- 1 ¾" Preconnect
- 2 ½" Blitz Line
- Foam Manifold
- Dry Standpipe
- Portable Monitor
- other hose lays?

FoamPro Engines

All of the FoamPro Engines are capable of pumping enough foam solution to support both a **2 ½" Blitz Line** as well as a **Portable Monitor** operation.

Any FoamPro Engine should be able to supply a foam manifold via the left rear Foam Discharge port.



Hose Wagons

The two Hose Wagons provide for extended foam operations, water supply relay operations, and provide additional Engine apparatus during disasters.

An around-the-pump foam proportioner can supply foam to every discharge port. The apparatus are equipped to support standard Engine Company operations.

- 250 gallon Foam Tank and 250 gallon water tank
- Williams Fire WATP 1500 pre-plumbed foam system capable of delivering foam flows up to the maximum capacity of the pump
- Accessory foam equipment: eductors, aspirators, electric foam concentrate transfer pump
- 4000 ft. of LDH supply hose, hard suction, and floating strainers for emergency water supply operations
- Two preconnected (crosslay) 1.75” attack lines

FIREBOATS

The Fireboats have bulk foam concentrate tanks and carry an assortment of foam equipment including eductors, nozzles, and monitors. All of the Fireboats can supply foam handlines to land-based companies or can flow foam master streams for large incidents.

Fireboat Leschi – 6000 gallons of foam storage

- Multiple foam monitors: 1000 gpm flow for 24 hours up to 10,000 gpm foam monitor flow for 2.5 hours
- Three 4” foam ports for supply or attack lines
- Capability to refill foam containers for restocking other units during an emergency
- Low and Medium-Expansion Foam Aspirators

Fireboats 1 and 2 – 200 gallons of foam storage

- Foam monitor – up to 1200 gpm; foam for 45 minutes
- Two 2.5” foam discharge ports

Fireboat Chief Seattle - 1000 gallons of foam storage

- Foam monitors: 4000 gpm, 3000 gpm & 1400 gpm
- Three 4” ports for supply or attack lines from a 1400 gpm foam capable manifold
- Low and Medium-Expansion Foam Aspirators

Mutual Aid Firefighting Foam

Additional Class B Foam is available via mutual aid through the Fire Alarm Center. ARFF apparatus (e.g. Boeing Fire Department mutual aid units) are not equipped with Polar Solvent type Class B Foam. However, Novacool UEF may be applied simultaneously at an incident with other types of foams.

I-90 Tanker Fire, Issaquah, Washington, 2002

Boeing Fire Department- Seattle, Renton, and Everett

- Multiple Aircraft Rescue and Fire Fighting (ARFF) units with Class B Foam
- AFFF Class B Foam containers
- Multiple buildings with Class B Foam sprinkler systems

It is Boeing Fire Department policy to dispatch one foam tanker/tender truck with a crew of two for a request for assistance. The foam tanker/tender carries 5000 gallons of water and 600 gallons of 3% AFFF. It can supply 1.75" or 2.5" hand lines and has two 1,000 gallon per minute monitors.

King County Airport - Sheriff ARFF Unit

Oshkosh Striker - 3000 gallons of water with AFFF.

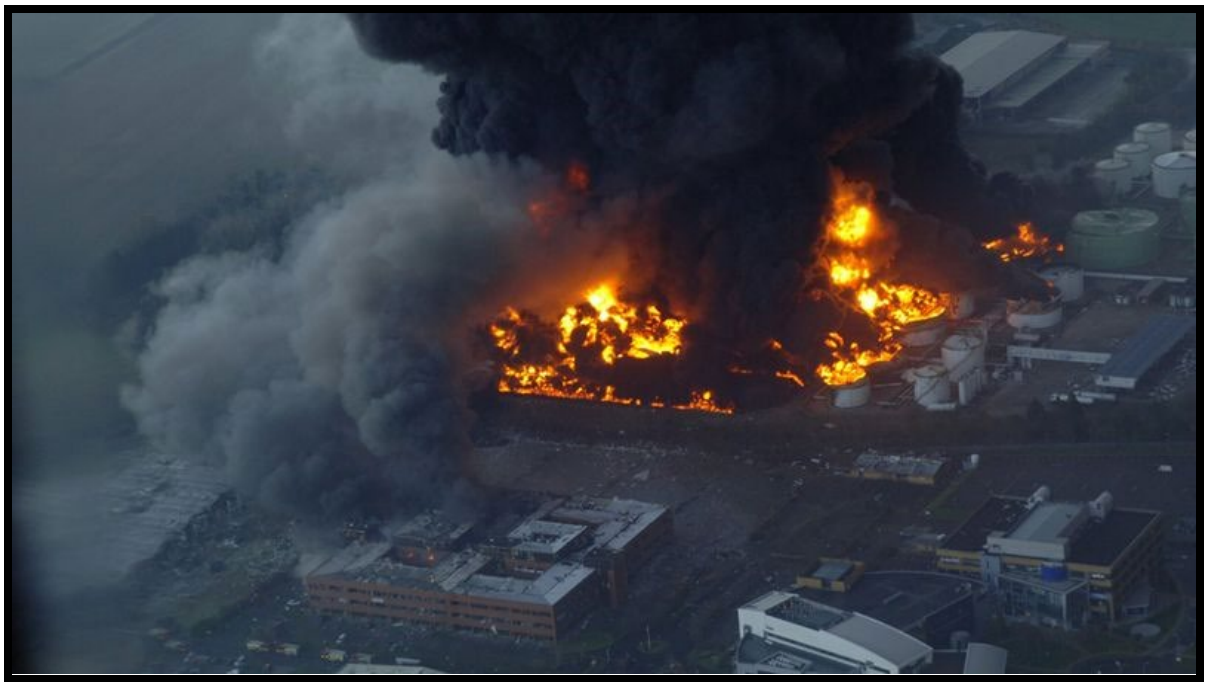
Class B Bulk Storage Fires

Class B bulk storage facilities are a special hazard. These facilities usually have engineered foam systems designed per NFPA 11, providing in-tank application of foam as well as yard foam hydrants and monitors- if the systems are still intact. These engineered systems are designed specifically for the hazards on site, and responding companies should contact facility personnel upon arrival to ensure that the systems are being utilized. The foam control center should be well labeled (per SFC, NFPA and insurer requirements), providing clear directions on valve operations to initiate foam application. The primary problem may be in determining which tanks and piping systems are involved in the incident.

Fires in these facilities are resource intensive and require large fire flows for exposure protection and adequate penetration of thermal columns. Case studies of large tank fires show the benefit of contacting specialized contractors early in the incident. They can provide technical advice, experienced personnel and specialized equipment to assist in incident mitigation.

Novacool is compatible with any other foam product when applied as a solution.

NFPA recommends that 65 minutes of foam should be available for tank fires.



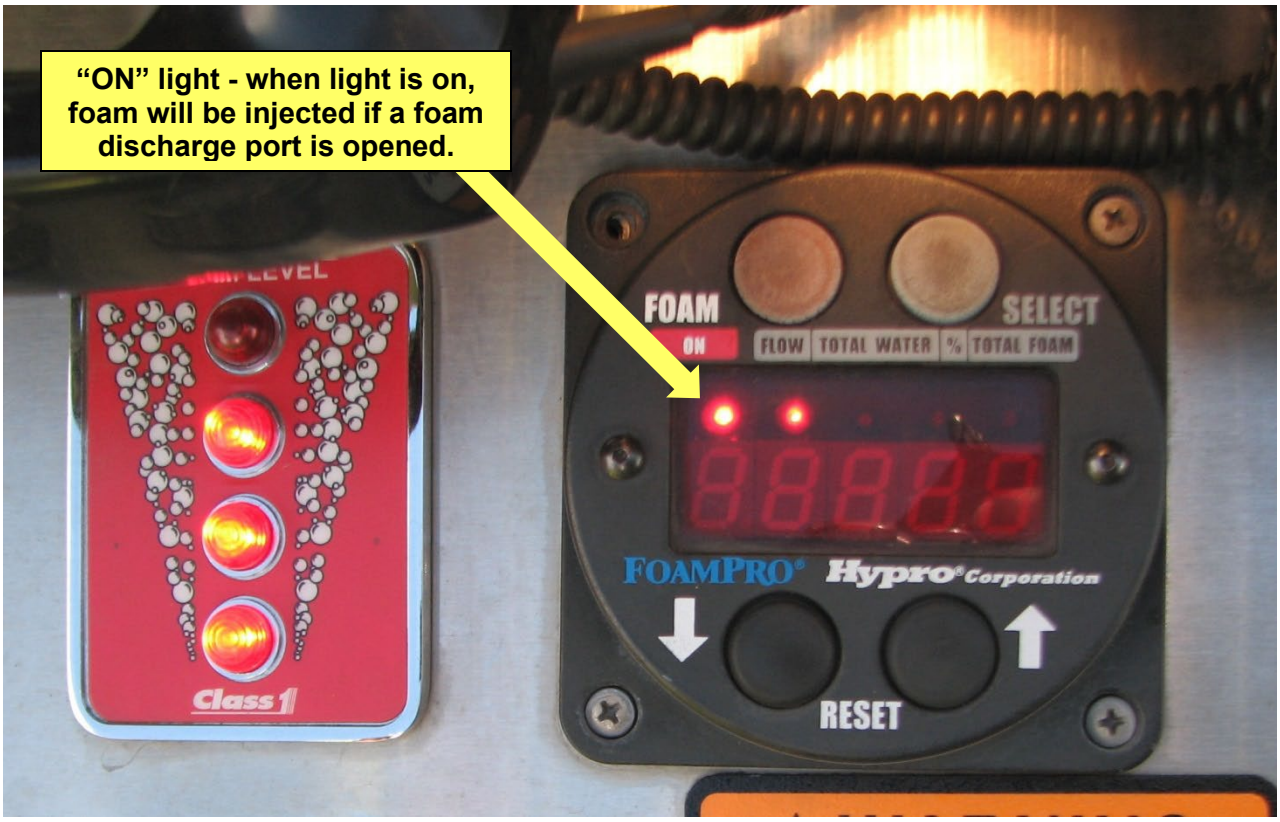
Buncefield Oil Depot explosion at Hemel Hempstead, north of London, 12/11/05.

Water supply operations

It never hurts to have the facility hire some extra help.

SFD Firefighting Foam Proportioning Equipment

FoamPro System – The FoamPro system is an electronic direct injection proportioner that can be used with any length/size of hose. Pump pressures should be based on standard fire flow calculations. The SFD default proportioning setting for the FoamPro system is 0.5 %. The system is serviced and evaluated annually by the Fire Garage mechanics.



FoamPro Control Panel

Turn on the foam injection with the red activation button, and utilize the arrow buttons as required to adjust the proportioning percentage once the class of fuel is determined. Additional features on the control panel allow for checking total foam concentrate used, actual gpm fire flow through the foam manifold, as well as several other functions of the system.

- If electing to use the FoamPro system at an incident, **TURN ON THE FOAM INJECTION PRIOR TO CHARGING THE HOSELINE**; this will ensure foam solution at the nozzle when it is opened.
- Up to 1000 gpm foam attack is available at 0.1% - 0.5%. Higher percentage foam injection is possible at lower gpm flows.
- Information placards for the FoamPro system are mounted on the pump panels on each apparatus.
- Lower the foam percentage once the fire is knocked down; 0.1% should be used for overhaul operations, or plain water.

FoamPro Control Panel

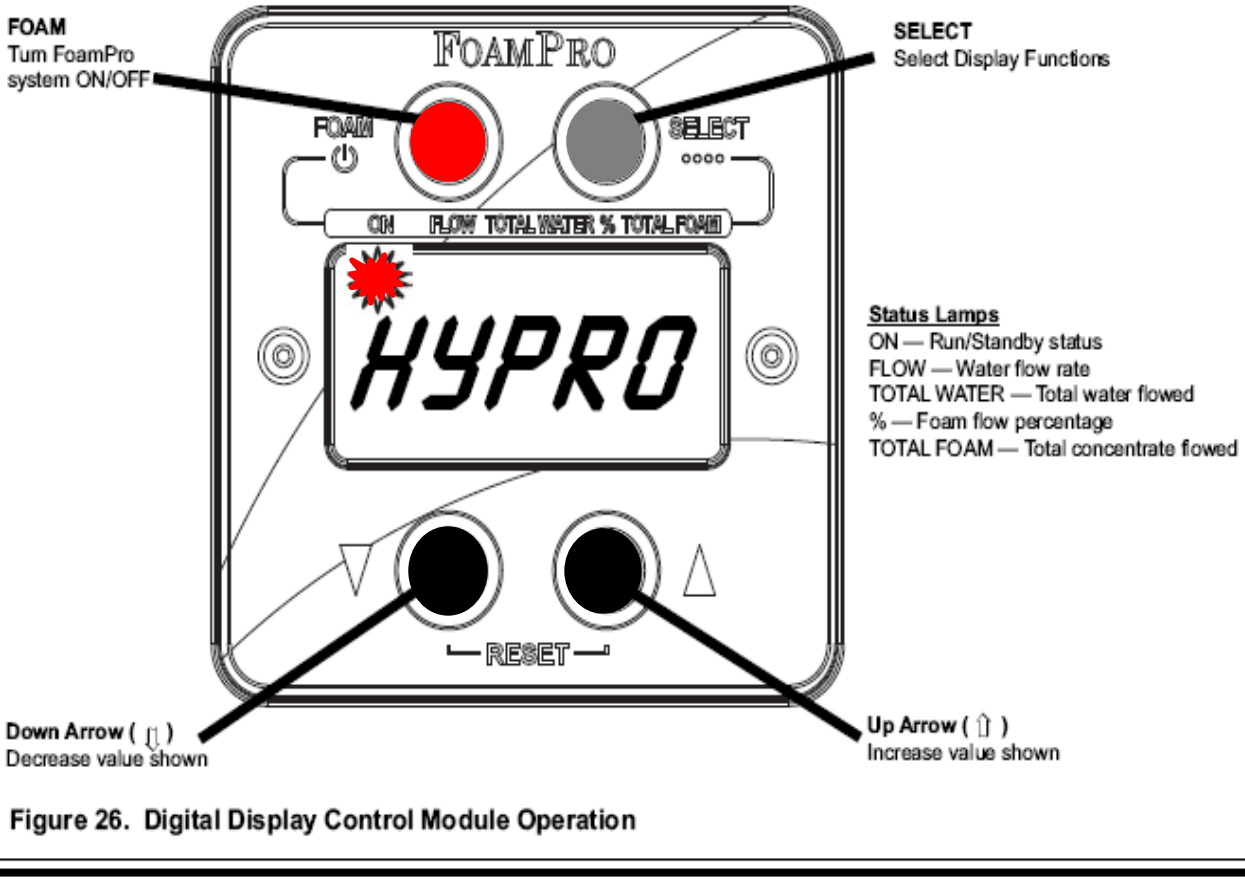
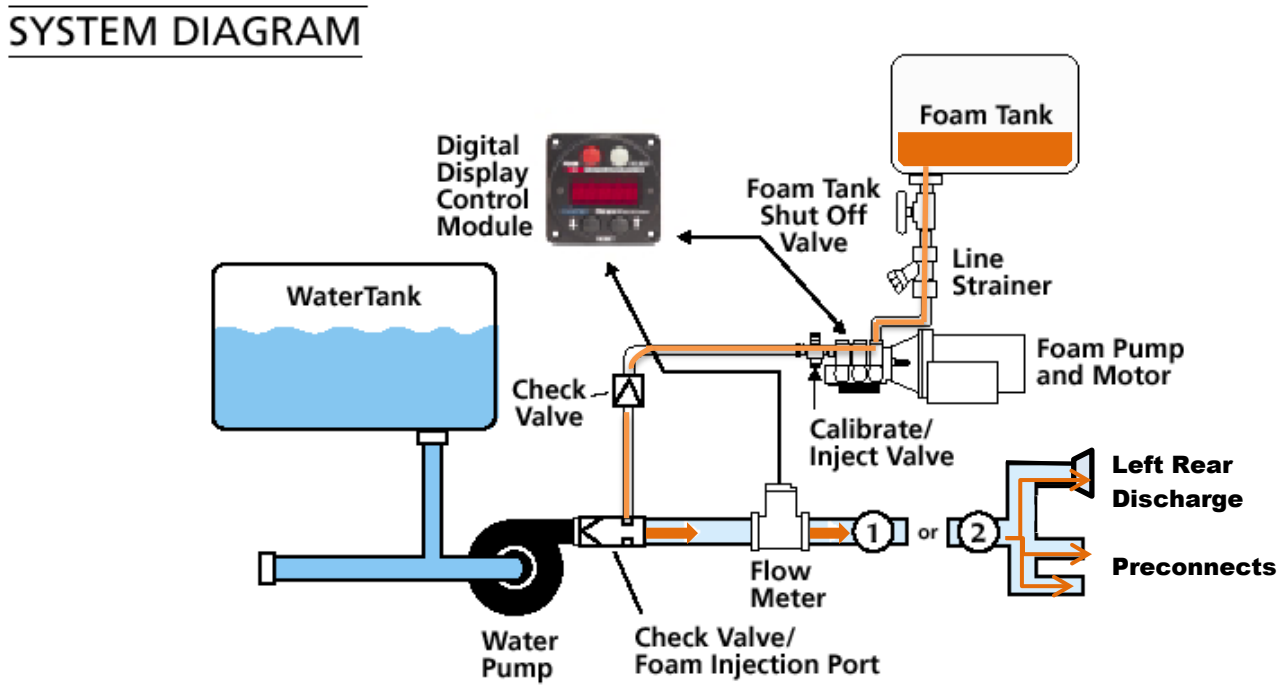


Figure 26. Digital Display Control Module Operation

FoamPro System Diagram



SFD testing has shown that the rear 2 ½" foam discharge port on FoamPro equipped Engines has a maximum flow of approximately 850 gpm.

Balanced Pressure Proportioner- Fireboats Leschi and Chief Seattle use Balanced Pressure Proportioners to produce foam solution for their monitors. The proportioners are adjustable, but are preset for Novacool at 0.4%.

The system uses a pressure controlled, positive displacement pump to supply foam concentrate to a balancing diaphragm valve. The diaphragm valve senses the foam concentrate pressure and balances it with the water pressure. The foam concentrate is then metered through a fixed orifice into the water stream.

Elkhart In-Line Eductor Operations

- **The eductor is rated for 125 gpm flow @ 200 psi inlet pressure**
- **200' maximum of 1-3/4" hose from the eductor to the nozzle**
- **Eductor setting will normally be 0.5% for Novacool**

- Proper foam delivery while using eductors requires a 200 psi inlet pressure and a **FULLY OPEN** nozzle bale when applying foam
- Eductor setting of 0.5% will provide 8 min of foam operations per 5 gal container
- The Elkhart eductor is adjustable at settings of 0%, 0.5%, 1%, 3%, and 6%, allowing it to be used with both Novacool as well as with mutual aid foams.
- The eductor can be utilized from an Engine, on a manifold, or on a 2 ½" supply hose.

ELKHART INLINE EDUCTOR

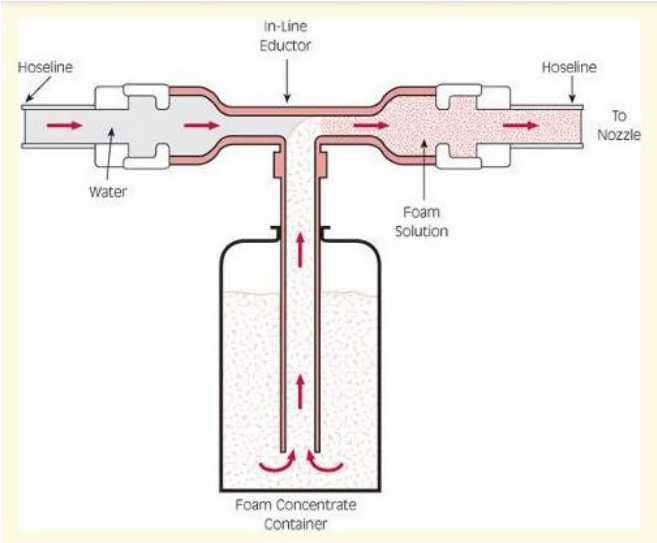
Caution must be used when applying foam using an in-line eductor; the eductor requires an adequate, steady water flow across the eductor venturi to draw concentrate into the hoseline to form solution. **Opening and closing of the nozzle's bale interferes with this process**. This will result in water being applied to the fire until a flow of foam solution is again established. Whenever the nozzle is shut down, and then foam is again required, the nozzle should be directed away from the fire until a flow of finished foam is established.

Eductors utilize the venturi principle to induct concentrate into a water stream. Water enters the inlet side of eductor, and the velocity of the water is increased by use of a flow restriction (basically a smoothbore nozzle inside the eductor), creating suction in the venturi throat. Connected to the throat is a concentrate pick-up tube and a combination check valve/metering valve that prevents water back-flow into the pick-up tube.

Eductor Trouble Shooting

Improper pressure is a major problem Fire Fighters encounter with foam eductors. Utilizing a variable pressure eductor substantially reduces or eliminates this problem. Areas where problems can still occur are the **pickup tube** and the **eductor ball**.

When foam is not being generated, check the base of the pick-up tube for suction. If no suction exists, remove the tube from the eductor and check for suction at the eductor. If suction exists at the eductor, the pick-up tube is either plugged or leaking air. Clean out the tube or replace it with another unit. With the 4' length of the standard pick-up tube, it is unlikely that the maximum recommended lift of 4' will be exceeded, but that should be considered.

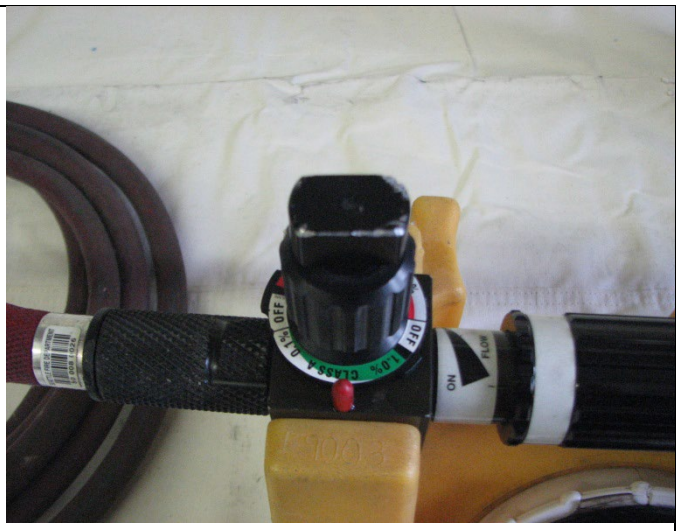


Troubleshooting Checklist if Eductor Fails to Pick Up Foam

	Proper pressure – 200psi inlet pressure
	Partially closed nozzle
	Kink in hose
	Hose lay too long – 200' max 1-3/4" from the eductor to the nozzle
	Incorrect nozzle – rated > 125 gpm
	Clogged Nozzle
	Metering valve closed
	Metering valve set improperly = 0.5% for Novacool use
	Metering valve clogged
	Eductor ball check stuck
	Nozzle elevated too high
	Plugged pick-up tube

Pro Pak

The ProPak can hold up to 2.5 gallons of product. It can be used for overhaul at fire incidents, and can be used as an extinguisher for Class K fuels. When used for Class A overhaul purposes at 0.1%, the ProPak should provide over 200 minutes of wetting agent flow.

	
ProPak instructions are printed on the side of the unit.	**The control knob must be kept in the "Class-A" configuration, with the green label facing the selection marker.**

The ProPak is only rated to flow 12 gpm at 100 psi. The manufacturer advises against using the ProPak for large flammable liquid spills due to the potential danger of ignition and rapid heat release. **A foam hoseline should be used on any hydrocarbon spill larger than 10' x 10', or 100 sq ft.** (60 sq ft. for Polar Solvent spills).

TRAINING WITH FOAM EQUIPMENT

Large flows of foam for training purposes should be done at the JTF, in the designated foam/vehicle extrication prop near the overpass. Small flows of foam for training purposes must drain to the sewer, not to storm drains.

Companies may drill with eductors by educting water from a container, (instead of Novacool), at any designated Wet Hose Drill Site.

FoamPro controls can also be used for wet hose drills without activating the foam injection system (as indicated by the red LED underneath the “ON” label); the proportioning percentage numbers can be adjusted, and the total gpm flow can be checked without actually injecting foam into the hose stream.

Environmental Considerations

AFFF and Alcohol Resistant AFFF Foams utilize fluorosurfactants to achieve their performance on Class B products. Many countries now ban products containing fluorosurfactants due to their degradation products which are considered to be “PBT” (persistent, bioaccumulative and toxic).

Novacool UEF has been environmentally tested to NFPA 18 standards. Even above its normal dilution rate of 0.4%, the foam solution has been demonstrated to produce zero fish or plankton kill, and only a marginal effect on algae growth. There are no reportable hazardous substances in the product.

When utilizing other brands of foam for firefighting or training purposes, members need to maintain an awareness of the foam runoff. Most Class A and Class B Foams are considered aquatic toxins- both in concentrate and as foam solution. Many large fish kills have been associated with firefighting foam reaching waterways. City Engineering and Washington DOT may be able to assist in controlling runoff that is threatening to reach watershed areas.

Members should consult the department MSDS binder for further information on various foam products.

I think it’s time to call the PIO (and Ecology, and USCG).

NFPA STANDARDS FOR FOAM, WETTING AGENTS & WATER ADDITIVES:

NFPA 11- Standard on Low-, Medium-, and High-Expansion Foam (2005)

This standard covers the design, installation, operation, testing, and maintenance of low, medium, and high-expansion foam systems for Class B fire protection in facilities. It is not the intent of this standard to specify where foam protection is required.

NFPA 1145- Guide for the Use of Class A Foams in Manual Structural Fire Fighting (2006)

This document presents fundamental information for agencies planning to use Class A Foam for structural fire fighting and protection. It presents information on foam properties and characteristics, proportioning and discharge hardware, application techniques, and safety considerations. This document does not apply to the use of Class A Foam in sprinkler systems or on fires involving Class B flammable or combustible liquids. This document is not intended to discourage the use of future technologies and practices provided that the recommended level of safety is not lessened.

NFPA 18- Standard on Wetting Agents (2006)

This standard is limited to qualification tests, methods of evaluation, and general rules for application of wetting agents and wetting agent solutions as related to fire control and extinguishment of Class A and Class B fires. Wetting agents may be used on Class K and Class D fires when listed for that purpose.
Novacool UEF was U.L. certified to this standard in 2007.

NFPA 18A- Standard on Water Additives for Fire Control and Vapor Mitigation (2007)

This standard provides the minimum requirements for water additives used for the control and/or suppression of fire and mitigation of flammable vapors.

ACKNOWLEDGMENTS

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Lt. Robert Kerns
Lt. Brian Maier
Lt. Kevin Martineau

Foam Evaluation Committee:

Live Fire Testing, 2004 - Port of Moses Lake Dept. of Public Safety, ARFF Training Facility

- SFD members attending - Michael Endicott, Brian Harrison, Ron Jensen, Heidi Jindrich, Keith Nagel, Rob Olsen, Kurt Plunkett, Rich Schultz, Patrick Williams

Live Fire Testing, 2006 - Bellevue Fire Department, Training Facility

- SFD members attending - Todd Langdalen, Kurt Plunkett, Gene Zimmerman

Live Fire Product Comparison, June 2008- WSP Fire Training Academy; Renton & Kent Fire Departments

- SFD members attending - Jay Carnegie, Chris Dahline, Todd Langdalen

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Appendix A - "FOAM QUICK REFERENCE"

Per the manufacturer, 1% is the MAXIXMUM proportioning rate for Novacool; above this percentage, the firefighting capabilities of the foam solution diminish. Reasons for applying Novacool above 0.5% include but are not limited to: enriching the foam blanket during heavy rain; enriching the foam for extreme fire conditions; performing structural coating (pretreatment) during wildland ops.

FoamPro Engine- Foam Attack Timelines at 0.4%

APPLIANCE	GPM	Available Foam (10 gal. tank + 20 gal.)
1 ¾" nozzle	125	60 minutes
2 ½" nozzle	250	30 minutes
Portable Monitor	500	15 minutes

The FoamPro system has no restrictions on hose lays (length or diameter)

Elkhart Inline Eductor Operations

- **Eductor rated for 125 gpm flow @ 200 psi inlet pressure**
- **200' max 1 ¾" hose from the eductor to the nozzle**
- **Eductor setting for Novacool will normally be 0.5%**
- **Proper foam delivery while using eductors requires a FULLY OPEN nozzle bale when applying foam**

Standard Novacool coverage for Polar Solvent fires

- **1 ¾"** line- fuel tanker; standard house footprint
- **2 ½"** hoseline- 35' x 35' (1200 ft²)
- 500 gpm monitor- 50' x 50' (2500 ft²)

Novacool Firefighting Foam

Class-A/D/K Fuels	**use at 0.4%**
Class B Fuels ***including polar solvents***	**use at 0.5%**
Overhaul	**use at 0.1%**