

Foam System Proportioning & Testing

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National Foam



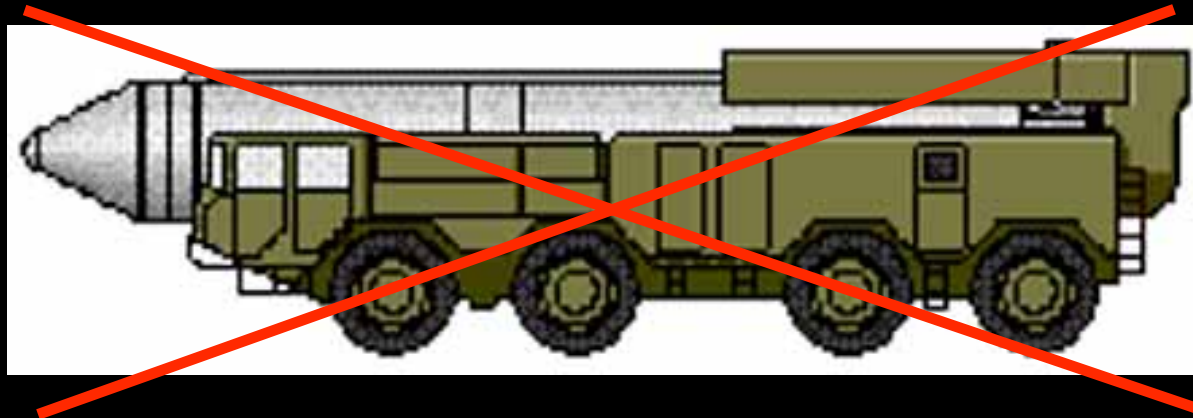
Cottrell Associates, Inc.

Factory Representatives

Product Development, Tech Services, Training & Distribution Mgt.



RELAX!



This isn't rocket science

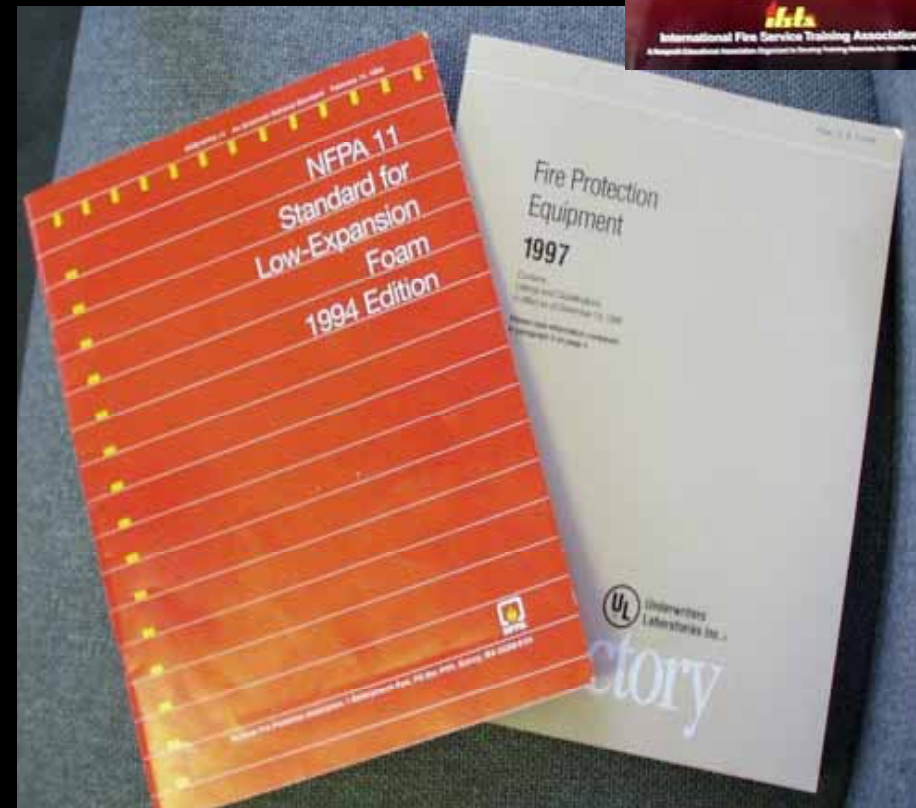
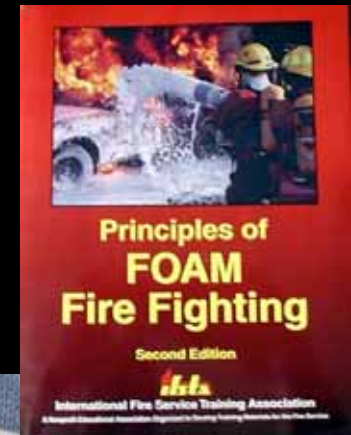
The Foam Rule Books

**NFPA 11, 1901, 1911,
1145, 1150, 18, 414, 412,
etc.**

**U.L. Fire Protection
Equipment Directory**

FAA regulations

**IFSTA Principles Of Foam
Fire Fighting (training)**



Underwriters Laboratory Listings...

The industry's assurance that the product will perform as advertised.



Gasoline:

**MTBE Methanol And
Ethanol Blends**

Diesel Fuel

Jet Fuel

Isopropyl Alcohol

Acetone

Engineered Systems



In the class B world, everything depends on proportioning accuracy.



At crash scenes, lives depend on proportioning accuracy.

Proportioning accuracy is mission critical in terms of extinguishing liquid fires.

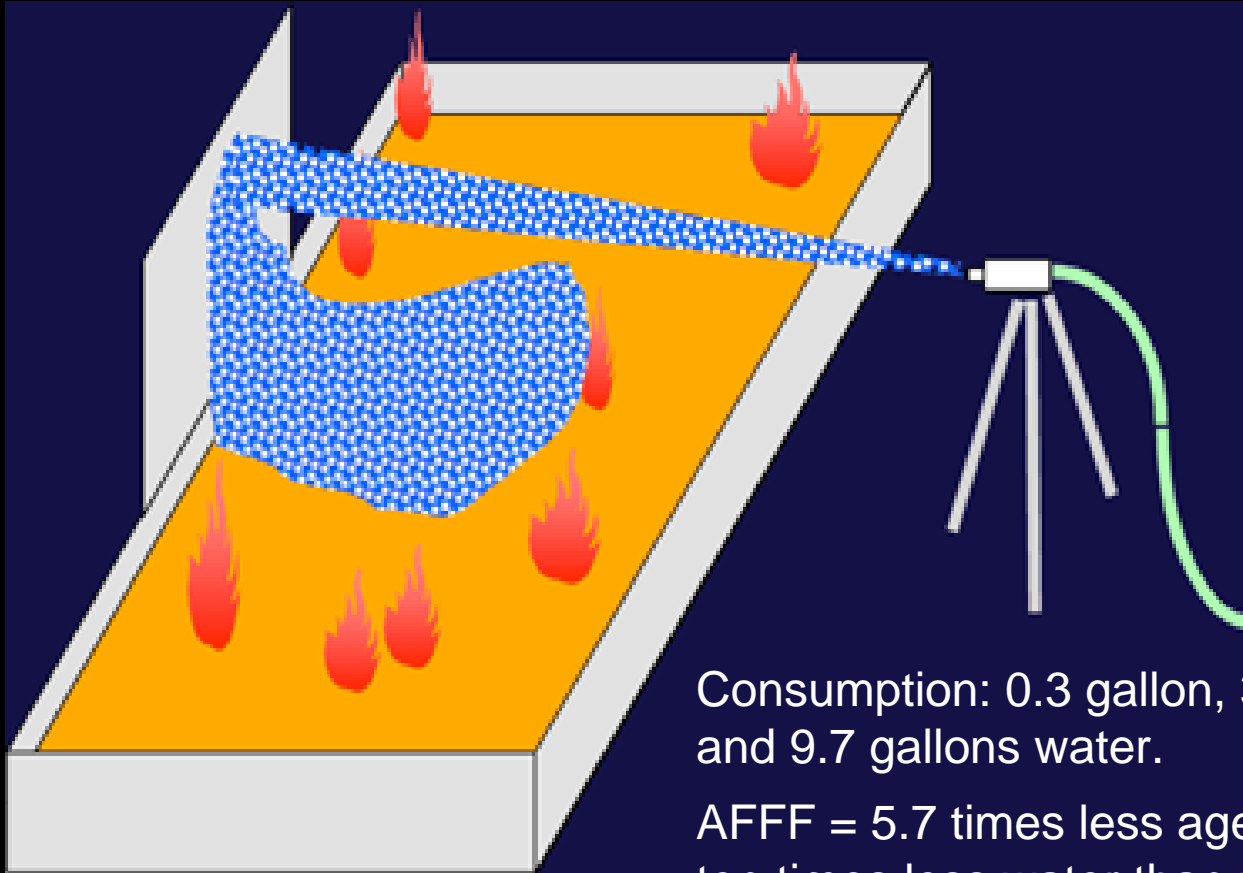
Proportioning accuracy is mission critical in terms of protecting crash scene spills.

Proportioning accuracy is critical to foam use economics \$\$\$



Underwriters Laboratory Fire Tests

The BASIC UL162 fire test for simple hydrocarbon fuels requires foam to extinguish a 50 sq. ft. heptane fire at 2 GPM, in five minutes or less; prevent burn back and hold vapors secure against a torch for fifteen minutes. Similar tests are conducted on high performance gasolines and polar solvent fuels.



Consumption: 0.3 gallon, 3% AR-AFFF
and 9.7 gallons water.

AFFF = 5.7 times less agent, and almost
ten times less water than wetting agents.

Class A Proportioning Accuracy

Nobody dies if your class A system proportions lean...



CAFS Proportioning Accuracy

On the other hand, there could be a problem if the system misproportions when you're inside with a 70 GPM / 35 CFM handline.



For most municipal customers, if it makes bubbles, you're good to go... WRONG!



1/2% - 3% or 6%?

Systems Make Foam Solution

Definition

Concentrate added to
water makes
Foam Solution

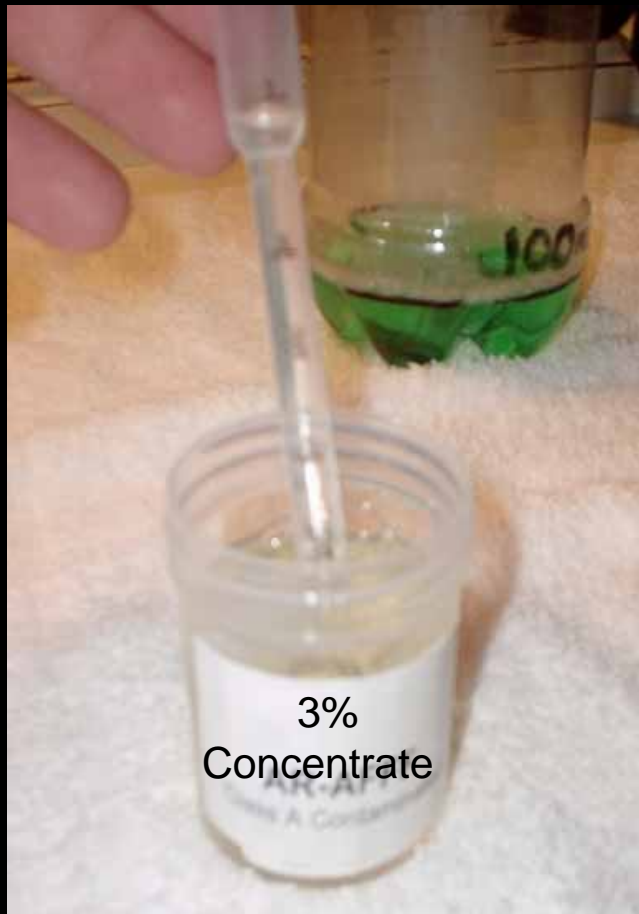


Foam systems do this on the fly



Adding 3 ml. of foam concentrate to 97 ml. water, makes 100 ml of foam / water solution.

Make 3% Foam Solution

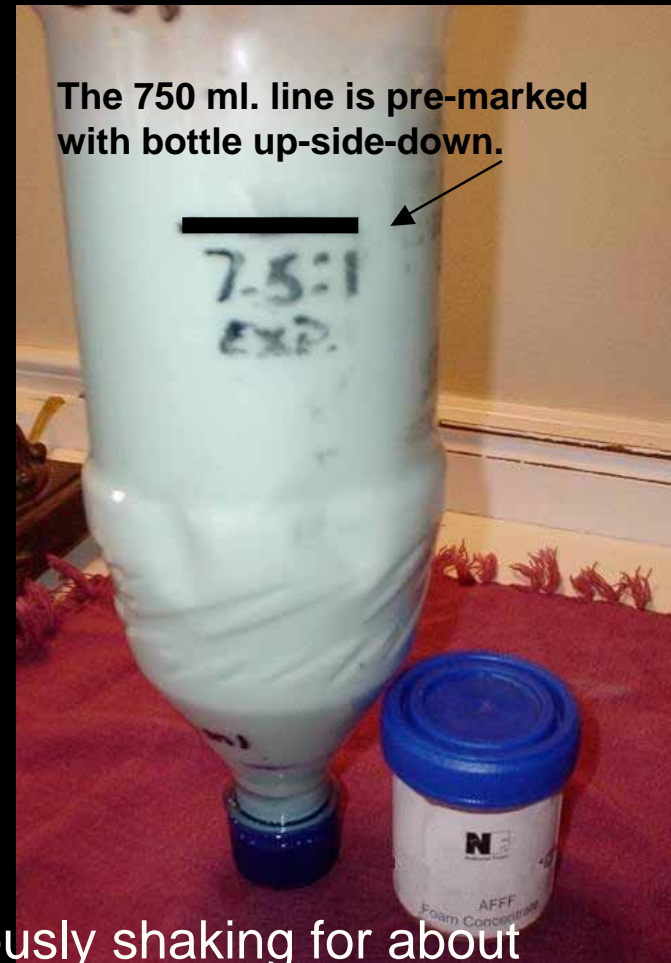


Draw up 3 mils. of foam concentrate using a graduated eye dropper or a plastic, medication syringe.



Add concentrate to the 97 ml. of green colored water.

Make Finished (expanded) Foam



Aerate the solution sample by vigorously shaking for about fifteen seconds. This sample has expanded to the 750 ml. line, which is a 7.5:1 expansion ratio.

More On Foam Solution



Ratios

1% - 99:1 = 99 parts water - 1 part concentrate

3% - 97:3 = 97 parts- water 3 parts concentrate

6% - 94:6 = 94 parts- water 6 parts concentrate

NFPA 1911

Foam System Solution Testing

20.1.1 At minimum, the foam proportioning system shall be tested annually.

20.2.1 The system output shall be measured to determine calibration accuracy.



NFPA 1911

(Annual System Testing)

20.3 Testing Methods.

One of the following four methods for testing a foam proportioning system for calibration accuracy shall be used:

- (1) Substituting water for foam concentrate
- (2) Measuring foam concentrate pump output directly
- (3) Determining foam percentage by use of a refractometer
- (4) Determining foam percentage by use of a conductivity meter

NFPA 1901

Less than 1%

19-9-4* Foam Proportioning System Accuracy. (Paraphrased)

Foam proportioning shall be accurate throughout the manufacturer's stated range of flows and pressure(s). Systems designed to produce foam at less than one percent (class A for example) shall proportion foam concentrate to an accuracy of **+/-20%**.

Therefore, if your system is set at 1/2% (0.05) it's ok if it proportions at 0.04 or 0.06%.

There's no life safety down-side to lean proportioning with Class A systems.

NFPA 1901

Greater than 1%

19-9-4* Foam Proportioning System Accuracy. (Paraphrased)

Foam proportioning shall be accurate throughout the manufacturer's stated range of flows and pressure(s).

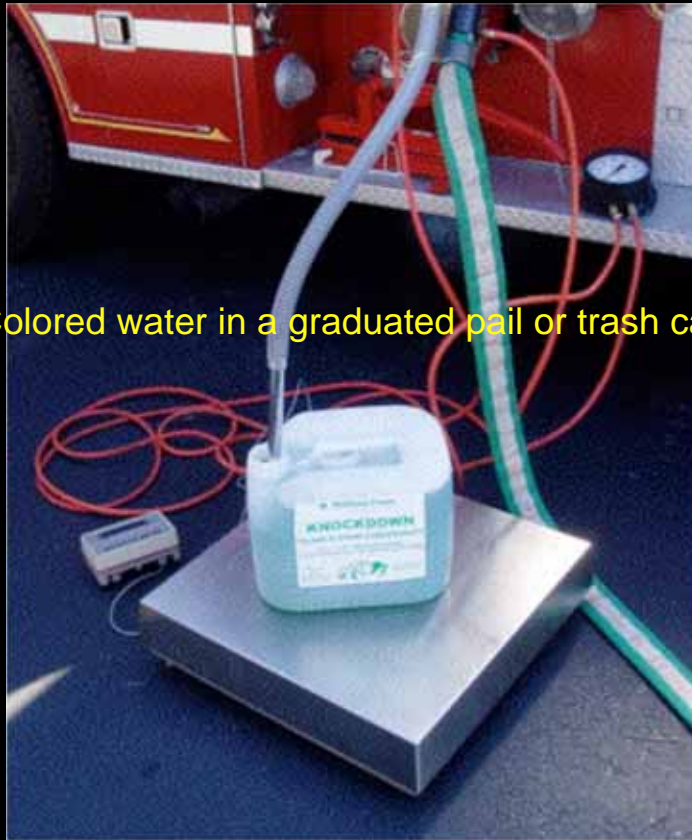
Systems designed to produce foam greater than **1 percent (class B for example)** shall proportion foam concentrate to an accuracy of -0 to +30%, or 1 percentage point, whichever is less.

Therefore, if your system is set at 3% (0.3) it's ok if it proportions at 0.39 (4%). If at 6%, it is OK at 7%.

Solution can be rich - but no lean...

NFPA 1911

Water Substitution Method



Colored water in a graduated pail or trash can

This method relies on substituting water for foam concentrate. Where measuring how much water (by weight or volume) is drawn into the proportioning system over time.



I would add foam concentrate equivalency factors here. As foam viscosity can be cause for lean proportioning.

NFPA 1911

Water Substitution Method

(National Foam) Foam Concentrate Equivalencies



A 500 GPM system, set at 3% will drink fifteen-gallons of water or more in sixty-seconds. If it drinks fifteen-gallons of water in a minute, it will drink about 99% of that using AFFF or Class A foam.

If using fluoroprotien foam or Alcohol Resistant, AFFF (AR-AFFF) the same system will consume about 15% less, or 85% of water's value.

NFPA 1911

Foam Pump Outlet Flow Measurement

Suitable For Direct Injection Systems



A 3%, 100 GPM solution setting should discharge three gallons of concentrate in sixty-seconds. If water were in the foam tank, it might discharge slightly more than 3 GPM. I recommend viscosity equivalents be considered for fluoroprotein and AR-AFFF foam concentrate.

If using a scale to determine exact foam concentrate output, consult foam manufacturer's data sheet for your foam's weight (specific gravity) compared to water.

NFPA 1911

Foam Pump Outlet Flow Measurement



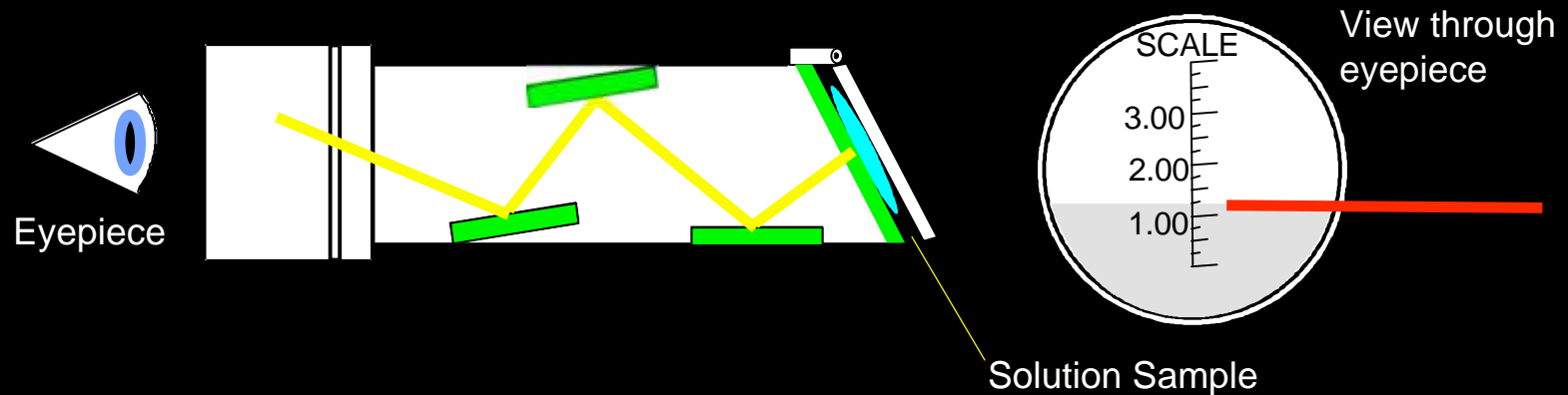
Cause for inaccuracy using this method may be due to lack of back pressure against the foam pump's discharge hose.

A foam concentrate pump in good or new condition may well perform to specification. If the pump is worn or slipping, back pressure may be a cause for lean proportioning.

A restrictor valve and pressure gauge fit on the pump's discharge hose can be helpful where tests against the water pump's discharge pressure is desired.

Refractive Index Method

A system sample compared to a bench-mark sample



The refractometer works fine for protein based foam solutions

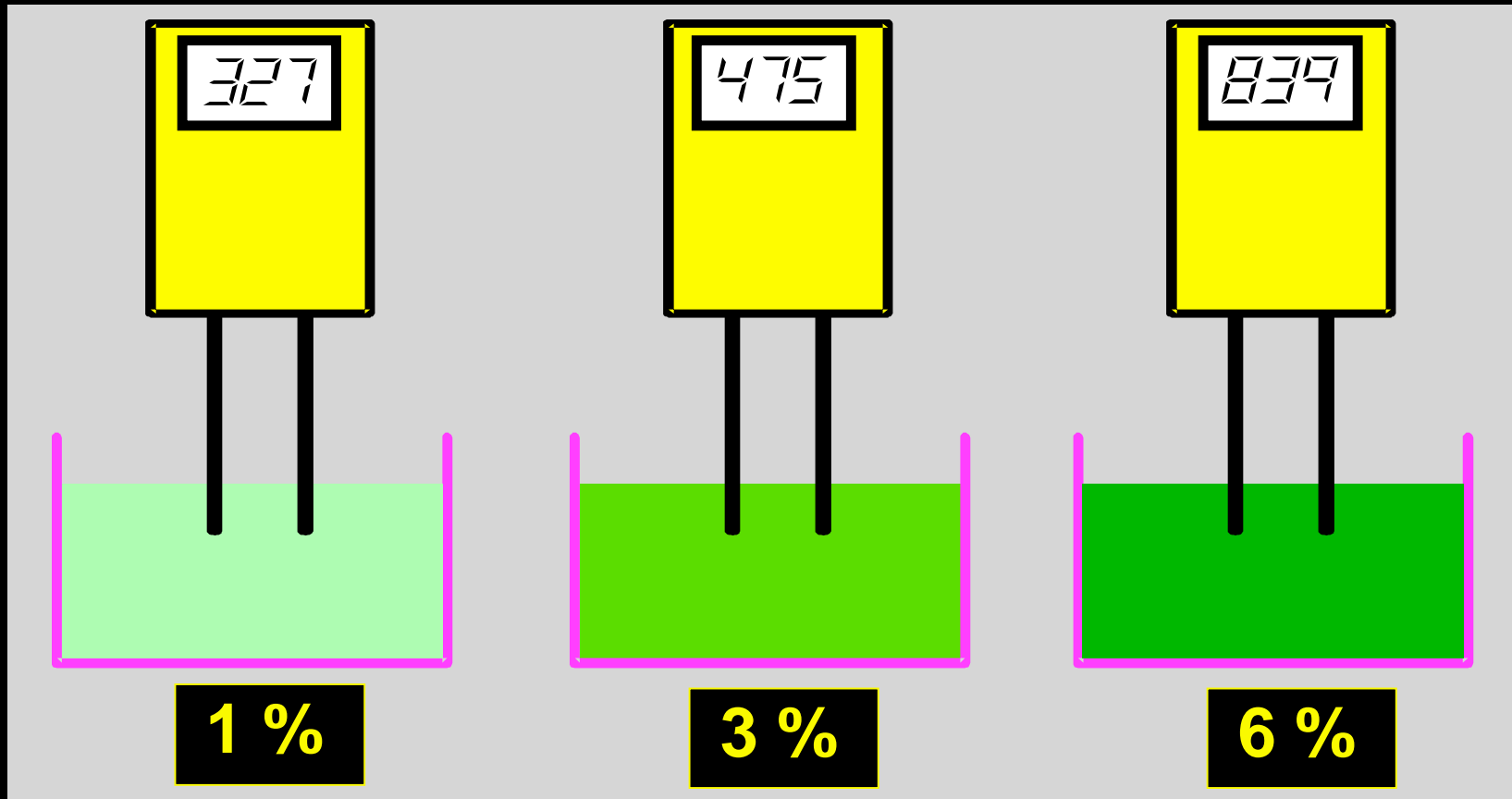
Readings should be done with solution at 50 degrees (10 C) or higher.

OK for mil spec. AFFF (mil. F24385) Butylcarbitol is the refractive chemical.

Not recommended for class A, civilian AFFF and AR-AFFF's, as refractive chemicals may not be present in enough quantity to produce accurate readings.

Accurate readings are difficult achieve in solutions of 1% or less.

ELECTRICAL CONDUCTIVITY



As concentrate is added to water, solution becomes increasingly conductive.

A properly proportioned sample is compared to system discharge.

Not appropriate for solutions produced with sea water.

Down and dirty - In the field



Need:

Stop watch

Two empty, 1000 ml plastic bottles

Cylinder graduate

Marking pen



Using water measured in a graduate, mark the two bottles (as shown) at 100 - 500 - 750 and 25 mil. The 25 ml line should be at the capped end of the bottle.

Down and dirty test...

Step 1



Add 3 ml of foam concentrate the system will be using for the test to 97 ml test water.

Booster tank or hydrant water.



Down and dirty test...

Step 2



Vigorously shake the bottle for fifteen seconds or longer. Make sure all the concentrate and water has fully expanded.

Turn it on its cap and start the watch...

Down and dirty test...

Step 3



25 ml drainage line

When 25 ml have drained to the line, stop the watch. This is the quarter drain time of the bench-mark sample. You're going to compare this to a system discharge sample in the next step.

Down and dirty test....

Step 4



Run the foam system (make foam) for at least thirty seconds at a setting that compares with the bench-sample.

Down and dirty test... Step 5



Throttle down.

Bleed pressure.

Shut the discharge nozzle.

Capture a solution sample from a discharge hose coupling.



Down and dirty test...

Step 6



Put 100 ml of the system discharge sample into the other test bottle.

Shake till its fully expanded. Compare the system sample's quarter drain time to your bench-mark sample.



Down and dirty test...

Step 7

If the quarter life is near the same (+/- 5%) as the bench sample, you're good to go.

Five-minutes is 300 seconds. Five % would be +/- fifteen seconds.

If it's less, you're lean

If it's more you're rich.

A little rich is OK

Lean is not good

Note: Although this test method is not as scientific as the tests described in the NFPA standard, it's close enough to determine if something is very wrong.



Down and dirty test... Alcohol Resistant?



In terms of your foam's ability to resist polar solvents, (alcohols) shake it again and apply it to dish of isopropyl alcohol (UL's test alcohol)

Isopropyl alcohol can be found as dry gas. Be sure it is isopropyl. Methyl alcohol is not as aggressive.

If the foam is destroyed as you apply it, it is either not alcohol resistant or your system is proportioning too lean.



This (sugar) membrane (polymer) will form on alcohol if the foam is alcohol resistant.

Causes for test failure:

- Contaminated concentrate
- Debris in the foam concentrate plumbing.
- Concentrate plumbing too small (viscosity issues)
- Too much system back pressure
- System not installed to manufacturer's specification. **VERY IMPORTANT!**
- Foam tank not properly vented
- Low budget, non-listed foam concentrate

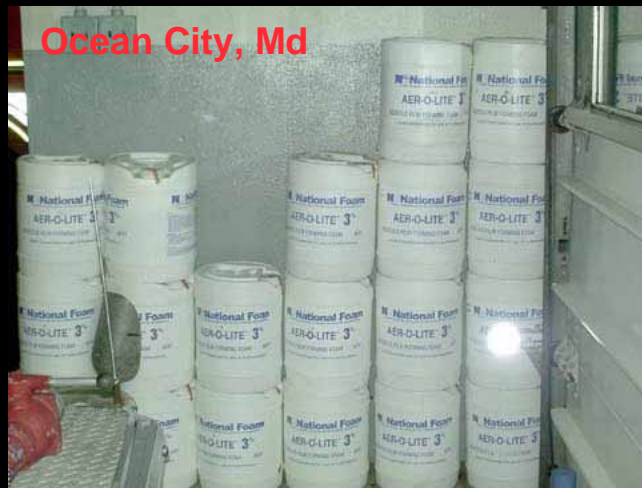




Foam Storage

Storing Fire Fighting Foams

Store between 35 and 120 degrees



Keep containers closed. Do not store foam concentrate in boiler rooms, outdoor sheds or attics. Storage temp. range should be between 120 f and 35 f. Freezing and thawing will not harm foam. Per NFPA 11:
Do not mixing unlike foam brands.
Never mix class A foam with Class B foam. Not even trace amounts

Shelf life is indefinite as long as foam is stored in original packaging or in approved tanks.



NFPA 11 says:
Do not mixing unlike foam brands. Never mix class A foam with Class B foam. Not even trace amounts

Accidental A or B mixing can be system fatal...

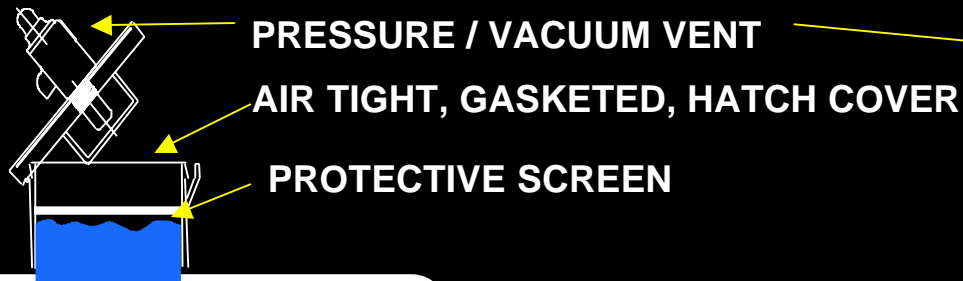
Half cup alcohol based class A foam or regular AFFF and a shot glass of AR-AFFF will do this in minutes.

The AR-AFFF's xanthan is doing what it should... in your tank, rather than on a spill...



Apparatus Foam Tanks

Store foam as if it were latex paint.



NFPA CONCENTRATE TANK

MINIMISE AIR TO CONCENTRATE INTERFACE

Keeping the tank full prevents sloshing. This tends to stop aeration of the foam in your tank which will result in lean proportioning.

Keep Apparatus Foam Tanks Full!

- Foam concentrate sloshing around in a foam tank will turn concentrate into a froth. The greater the air space the the worse it gets. AR-AFFF concentrate may take weeks to unfroth, if at all. This condition will cause VERY lean proportioning.



Concentrate supply plumbing

AR-AFFF foam users

Supply plumbing from foam concentrate tank to foam pump or foam eductor must be at least 3/4" for 1/2 to 3 GPM.

3 to 8 gpm One inch

10 to 15 GPM 1.25"

20 GPM to 30 GPM 1.5"

30 gpm + 2"

NO AIR HOSE!



My pet peeves:

System failures caused by back pressure and plumbing mistakes.



Your Foam Is Jelled-up!
NO WAY!



In the class B world, everything depends on proportioning accuracy.





Foam Eductors
Line Proportioners
Ratio Controllers
Foam Inductors

Apparatus Specification & Vehicle Maintenance Symposium 2006



No Moving Parts

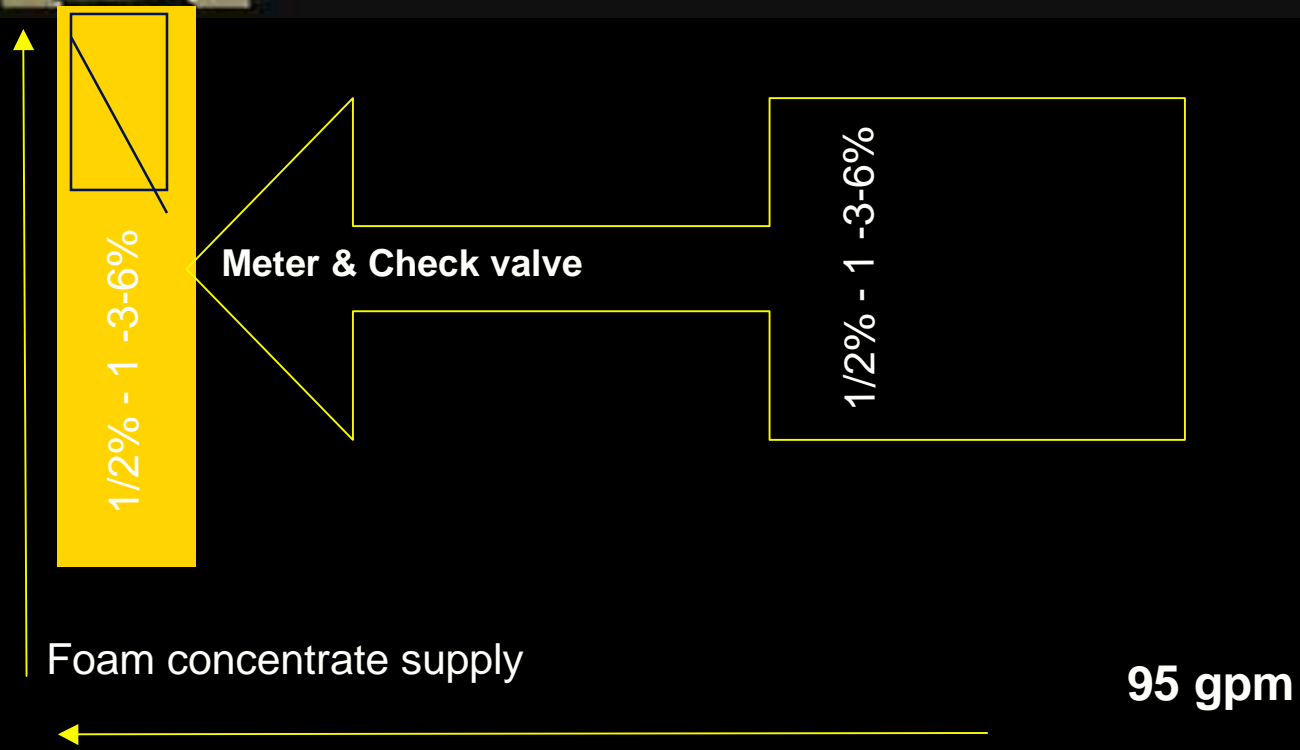
Rugged

Inexpensive

Back Pressure Limits

Eductors are all about speed and back pressure.

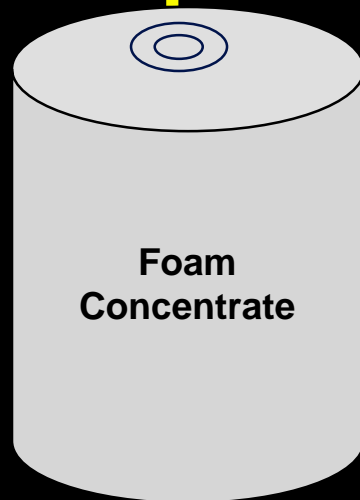
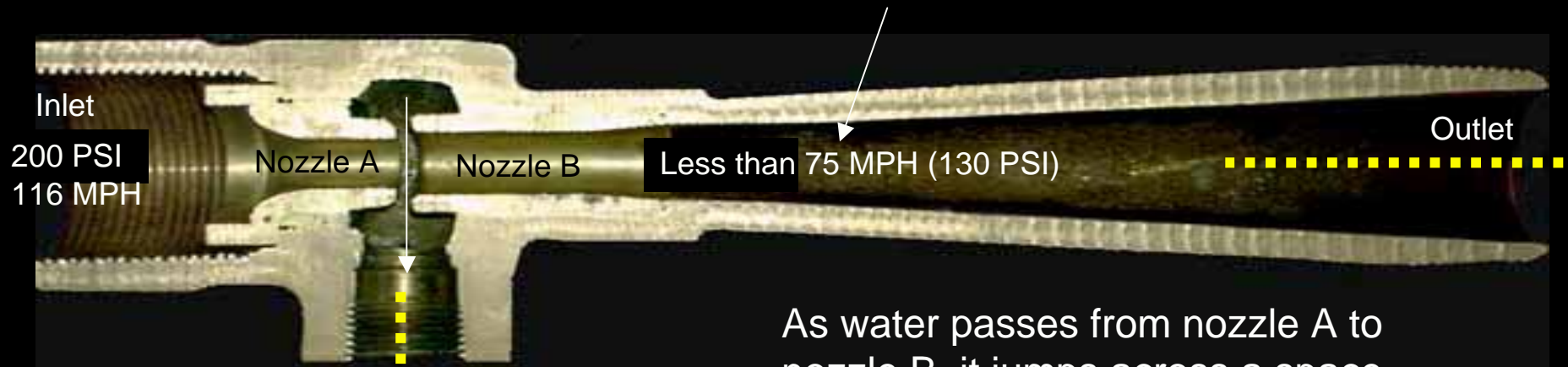
0.47" nozzle @ 200 psi = 95 gpm



Eductors are all about speed...

0.47" nozzle @ 200 psi = 95 gpm

SHUT DOWN!



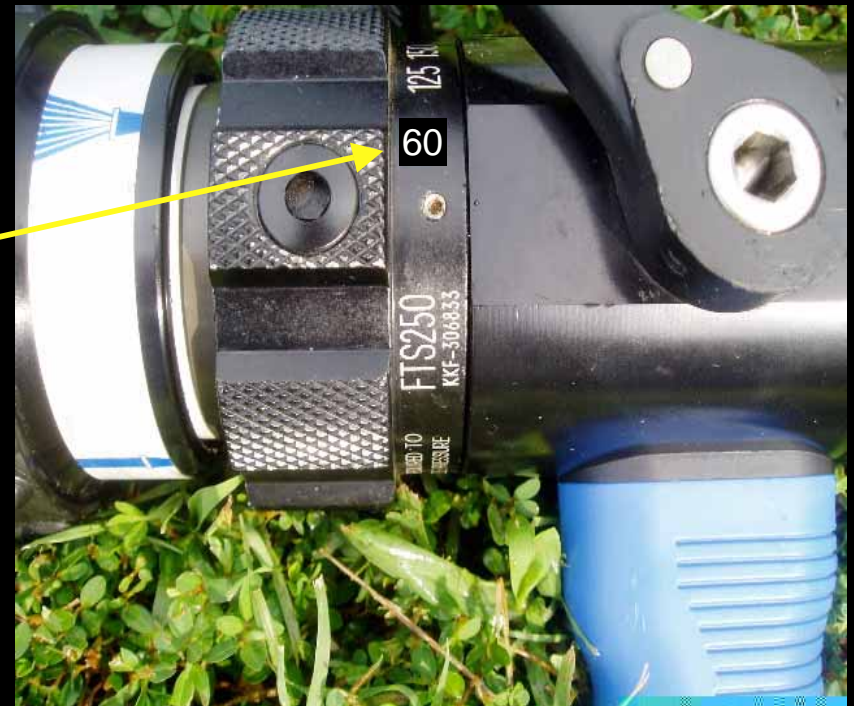
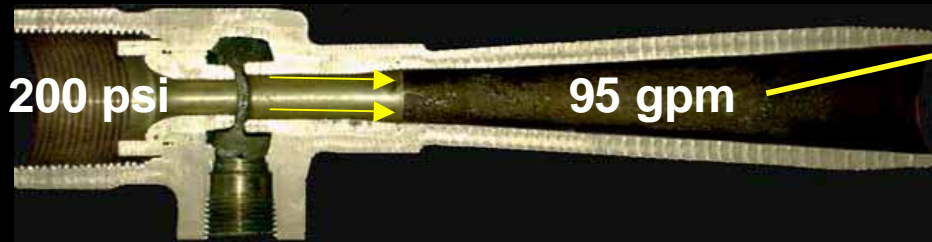
As water passes from nozzle A to nozzle B, it jumps across a space that's vented to the pick up tube. As long as water speed does not slow below 65% of the eductor's inlet speed, it will continue to draft foam concentrate into its stream.

If a downstream hose is kinked, or a nozzle partially closed, the back pressure created slows the outlet speed. If outlet speed drops below 65% of inlet speed it will begin to lean-out and eventually shut down.

Foam eductor must be a hydraulic match for the nozzle.

This is why a 60 GPM nozzle setting will shut down a 95 GPM eductor. Too much back pressure.

125 GPM setting or higher is OK... Nozzle outlet pressure may be too low though.



1/2% - 1 - 3-6%

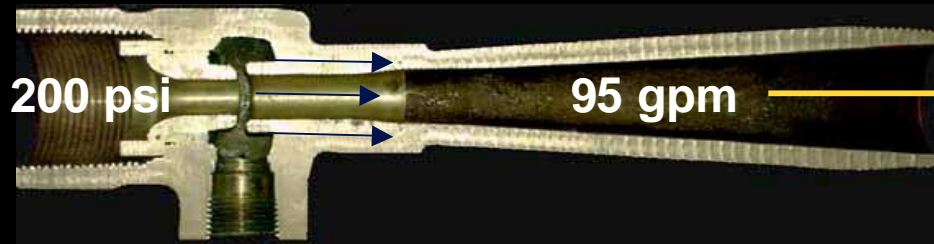
Metering / Check valve

Foam concentrate supply

Foam eductor must be a hydraulic match for the nozzle.

Automatic nozzles will stay in hydraulic balance with foam eductors.

No nozzle settings to worry about.



1/2" - 1 - 3-6%

Metering / Check valve

Foam concentrate supply

Foam Eductors Work Best With Automatic Nozzles

Automatics will be in hydraulic balance with eductors

200 psi at inlet to make 95 gpm

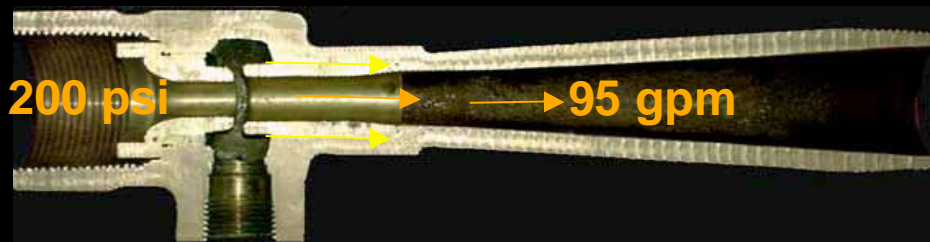
65% of inlet is available for back pressure

30 psi for hose @ 95 gpm

100 psi for nozzle pressure

=130 psi. More than 130 - eductor shuts down.

130 psi max. back pressure



1/2% - 1 - 3-6%

Metering / Check valve

Foam concentrate supply

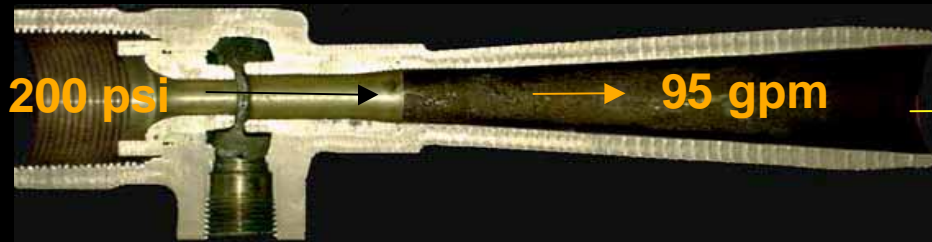


Foam Eductors & Low Pressure Automatics

200 psi at inlet to make 95 gpm
65% of inlet is available for back pressure
80 psi for hose @ 95 gpm
50 psi for nozzle

=130 psi - More, and eductor shuts down.

130 psi max. back pressure



1/2% - 1 - 3 - 6%

Metering / Check valve

Foam concentrate supply

50 psi, low pressure nozzle setting...



900 ft. with 2" hose

450 ft. W/ 1.75" hose

250 ft. W/1.5" hose

Medium Expansion setting 40 :1 expansion

Big Eductors & Deck Guns

500 GPM+

200 psi at inlet to make 500 gpm

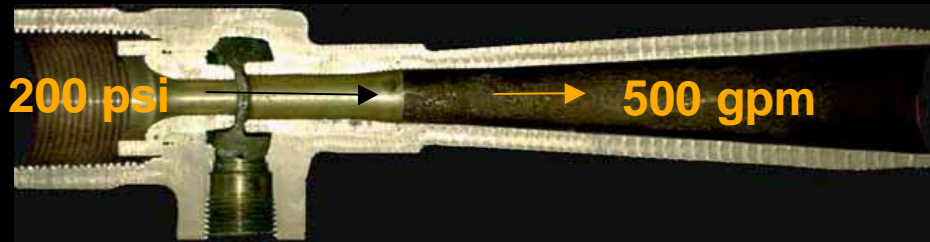
65% of inlet is available for back pressure

30 psi for hose @ 500 gpm

100 psi for nozzle

=130 psi - More, and eductor shuts down

130 psi max. back pressure



1/2% - 1 - 3 - 6 %

Metering / Check valve

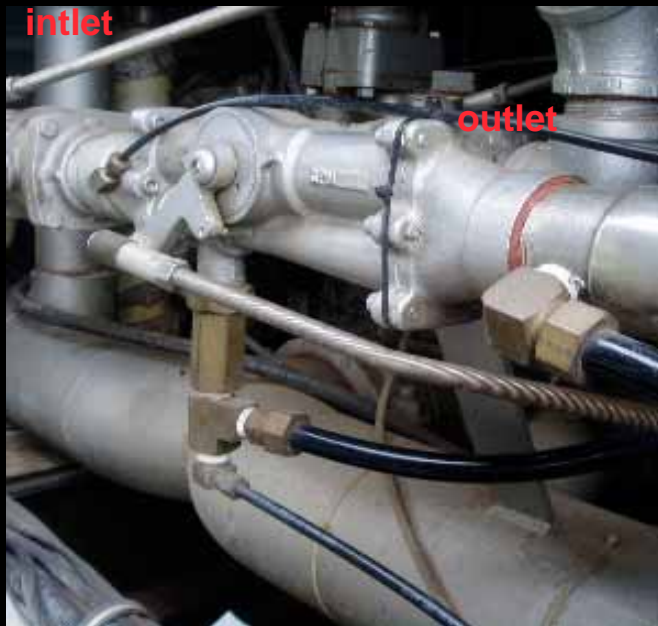
Foam concentrate supply

100 ft. to device w/ 3" hose FL = 25/100'
Wyed 3" lines to a two-port deck gun will allow 500 ft.

600 ft. to device w/ 4" hose FL = 5/100'

2000 ft to device w/ 5" hose FI = 1.5/100

Bi-Pass Foam Eductor System



Reliable (usually)
Several moving pts.
All foam concentrates
Inexpensive (relatively)
Plumbing sensitive
Back pressure restricted

Portable Proportioning Equipment, Aerated.



Reliable - No moving parts - Versatile

Gladiator Tri-Flow

- Adjustable Gallon
- Self inducting
- Aerating



500 - 750 - 1000 GPM



Portable Proportioning Equipment



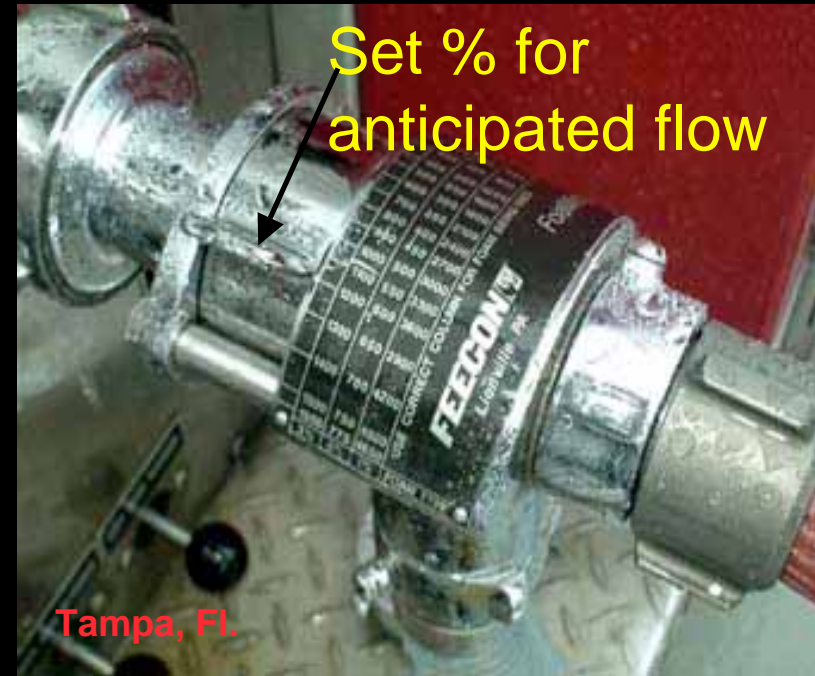
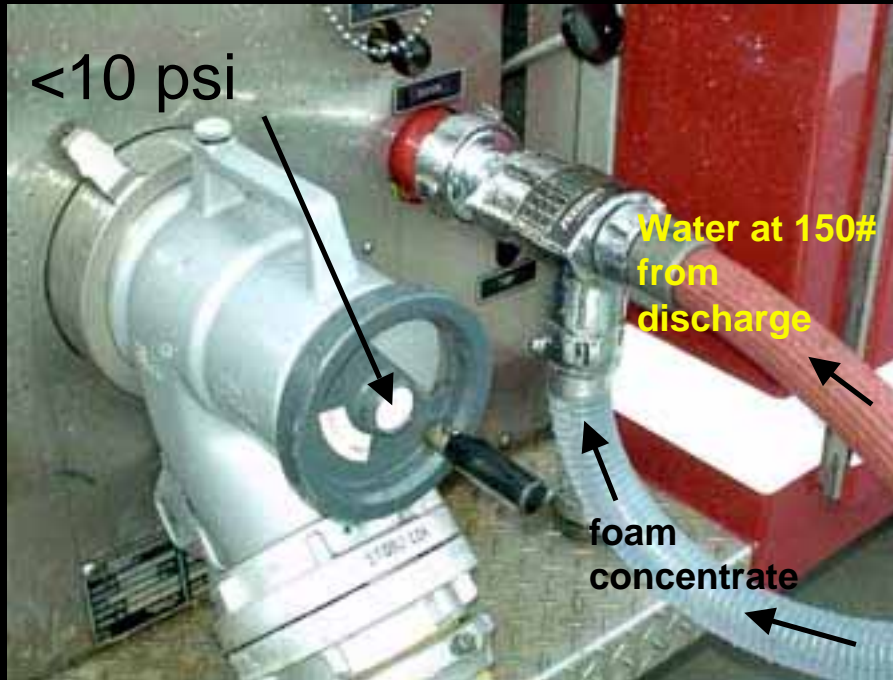
suction side eductor



Reliable - No moving parts - Versatile
Turns your pumper into a crash truck!

Portable ATP - Around The Pump System

(portable crash truck)



Hydrant ops... Throttle engine to 150 psi. Open aux. suction. Throttle incoming pressure to <10 psi. Keep inlet and discharge pressure in balance with throttles.

500 gpm @ 1% uses 5 gallons foam per minute
500 gpm @ 3% uses 15 gallons foam per minute
500 gpm @ 6% uses 30 gallons foam per minute

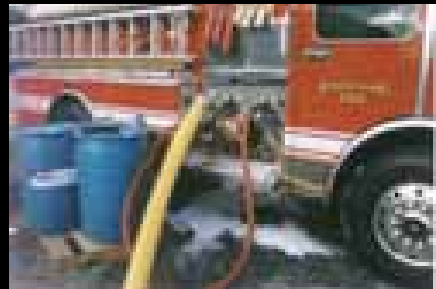
Portable Around The Pump System

All discharges foam...

FoaMidget



Chilhowie VFD, Va.



Bristol, Va.



Fought fire for seven hours
@ 1300 gpm in Aug. of '97



Apparatus Foam Systems

Onboard storage (NFPA 1901)

- Firefighting foam should not be stored at temperatures greater than 120 deg. F. (see caution on all foam containers)
- Flush lines often do not purge concentrate supply hoses from tank to eductor, or foam pump.
- Foam concentrate trapped in system supply hoses will tend to dry and harden over time. This is particularly true where foam supply lines reside in the hot spaces found in fire pump compartments. Temperatures in these spaces can easily exceed 190 deg.
- **It is strongly recommended** that you run your foam system (produce foam) for about thirty seconds at least once every two months. Perhaps once a month during summer months in warmer latitudes. Military and FAA require system cycling on ARFF truck systems for this reason. Concentrate supply hoses should be 3/4" or larger.



AR-AFFF concentrate supply hoses should be 3/4" (i.d.) or larger.



1/2" - plastic air hose, N/G

Fire apparatus system question...

Question 6. Foam-Pro says they do not guarantee proper system performance, and discourage the use of foam concentrates like National Foam's Universal Gold 1x3% AR-AFFF due to its thickness. Have you heard of this limitation with using the Universal Gold 1x3% with the FoamPro, or any other system for that matter?

A: Yes, the FoamPro®-1600, 2001 and 2002 series systems are the only foam systems that I know of that have difficulty with AR-AFFF (Alcohol Resistant- Aqueous Film Forming Foam). The reason is that they use a chemical pump to proportion fire fighting foam concentrates and water which are of the self-priming variety and are designed to move fluids having the viscosity of water or slightly thicker. Class A foam concentrate and simple AFFF's are water-like in viscosity and therefore are not a proportioning problem for the FoamPro® as they tend to gravity feed from the tank quite well. The Pierce, Husky® foam system, Hale Products, FoamMaster® system and Foam-Pro's® series 3000 foam systems do a fine job of proportioning AR-AFFF foams because they use foam concentrate pumps that are designed for use with the more viscous, AR-AFFF foams. The down side is that these systems are at the higher end of the food chain in terms of price. Proportioning accuracy with these systems is dependent on whether the flow meter is feeding the computer-driven pump, accurate speed information.

In the end, I'd use a simple foam eductor for Class B, AR-AFFF. Screw it to a pump outlet and connect the pick-up tube to a pump panel foam tank connection. Small fire, small eductor. Big fire, big eductor.

With 2" hose and a 95 gpm eductor you can go 400' from the rig to a 100 psi nozzle. With 1.75" hose and a 75 psi nozzle you can go 350 feet.



Class handout

Fire apparatus system question...

In the end, I'd use a simple foam eductor for AR-AFFF screwed to a pump outlet and connect the pick-up tube to a pump panel foam tank connection.



Foam concentrate line from foam tank should be 1" where eductor flow is 95 GPM or greater.

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