APPENDIX A

STUDENT EVALUATION:

QUIZZES, FINAL EXAM,

AND SOLUTION GUIDE

CLASS A FOAM

SCORING AND EVALUATION FORM

COURSE LOCATION	INSTRUCTORS	DATES

TRAINEE NAMES	UNIT TEST	1	2	3	4	5	6	7	FINAL	TOTAL	PASS/FAIL
	POSSIBLE										
	PASSING										

CLASS A FOAM

QUIZ KEY

UNIT 1 QUIZ: **FOAM PROPERTIES**

1. What is the fire triangle? A well-defined sketch may help this and the following answers. Describe the relationship of the three parts.

   The fire triangle is a model of fire, describing the relationship of three elements necessary for fire to occur. Each leg of the triangle represents one element: fuel, heat, and oxygen. An incomplete triangle will not support fire, so the model also describes processes for extinguishment.

2. How does (untreated) water work on fire modelled by the fire triangle?

   Water works to eliminate the heat leg of the fire triangle by absorbing heat or cooling. In very specific conditions not very common to wildland fire, water can work to eliminate oxygen and separate fuel. Water is not very efficient at these functions in its pure form.

3. Explain the three things that treated water can do better to fire than regular water, as depicted by the fire triangle.

   -- **Break the heat leg by cooling. Water in the right form can absorb about 9000 btu/gallon.**
   -- **Break the fuel leg by raising fuel moisture, getting dry fuel wet.**
   -- **Break the oxygen leg by submerging burning fuels in foam bubbles.**

4. Name one property of water that reduces its efficiency as an extinguishing agent. (One of the following)

   -- **High surface tension**
   -- **Limited penetrating/wetting ability**
   -- **Resists bonding to hydrocarbons**

5. True or False. Wetting agents and foaming agents are the same thing.

   False

6. Foam is:
   a. the combination of air and water.
   b. the combination of air and foam solution.
   c. the combination of water and foam solution.

   b. the combination of air and foam solution.

7. Name the four foam types. (all of the following)

   -- **Foam solution**
   -- **Wet foam**
   -- **Fluid foam**
   -- **Dry foam**

8. Foam makes water more effective for fire extinguishment and resource protection by:

   a. adhering to most surfaces
   b. being highly visible
   c. readily absorbing heat due to increased surface area-to-mass ratio
   d. increasing the time water has to be absorbed into exposed fuels
   e. a. and d. only
   f. all of the above

   f. all of the above

CLASS A FOAM

QUIZ KEY

UNIT 2 QUIZ: **PERSONAL SAFETY AND ENVIRONMENTAL CONSIDERATIONS**

1. Identify three ways to protect the environment from excessive exposure to foam or foam concentrate.

   -- **Keep concentrates away from water sources.**
   -- **Do not apply foam into water sources.**
   -- **Contain concentrates at the proportioning site.**
   -- **Clean up spills with absorbents; do not rinse.**
   -- **Maintain functional foot valves and check valves to prevent backflushes of solution into water sources.**
   -- **Other?**

2. Name three items of personal protective equipment that can be worn to prevent eye and skin exposure to foam concentrate.

   Gloves
   Goggles
   Hard Hat
   Sunscreen
   Hand Lotion
   Rubber Boots (if permissible)

3. True or False. Class A foam concentrates are similar to household detergents and shampoos.

   True

4. A material safety data sheet will tell you about:

   a. hazardous ingredients or flammable properties
   b. what to do with a spill
   c. necessary protective measures
   d. any special precautions
   e. all of the above
   f. none of the above

   e. all of the above

CLASS A FOAM

QUIZ KEY

UNIT 3 QUIZ: **PROPORTIONERS**

1. Provide at least 2 reasons why you might use a manual proportioning method or device.

   -- **For remote operations where equipment weight is critical.**
   -- **For operations involving one mix ratio and one water flow rate.**
   -- **For getting started using foam with low initial equipment cost.**
   -- **When machines both manual and automatic break down, use batch mix.**
   -- **Other?**

2. Provide at least two reasons why you might use an automatic proportioning device.

   -- **For operations involving several mix ratios and more than one water flow rate.**
   -- **For long-term use to reduce cost of foam concentrate wasted.**
   -- **For operations when consistent foam output is critical.**
   -- **Other?**

3. Name two manual proportioning methods or devices. (any two of the following)

   -- **Batch Mix**
   -- **Suction-side proportioner**
   -- **In-line proportioner (eductor)**
   -- **Around-the-Pump proportioner**
   -- **By-pass eductor**
   -- **Manual direct injection**

4. Name one automatic proportioning device. (any one of the following or their brand names)

- **Balanced pressure bladder tank system (bladder tank, flow mix okay)**
- **Balanced pressure pump system (KK)**
- **Automatic direct injection system (Hypro)**

CLASS A FOAM

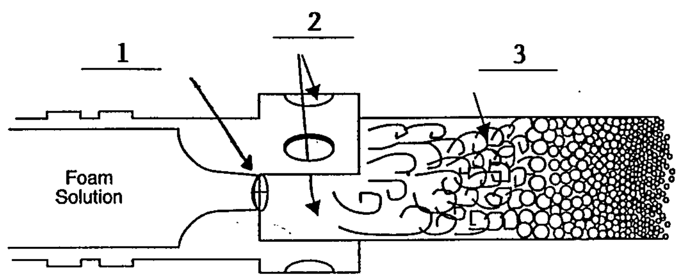
QUIZ KEY

UNIT 4 QUIZ: **ASPIRATING NOZZLE FOAM SYSTEMS**

1. Why is the aspirating nozzle described as a "Low energy system"?

   The aspirating nozzle is a low energy system because it relies entirely on the energy or power provided by the water pump for making foam.

2. On the drawing below identify the locations of the following functions:



3. Identify two important parts of a nozzle aspirating foam system.

   -- **Water pump**
   -- **Foam solution or source of, proportioner**
   -- **Aspirating nozzle**

4. Which requires more nozzle pressure, the low expansion or medium expansion aspirating nozzle?

   Low expansion. High pressure necessary to create bubbles in small space and discharge long distances. High pressure in medium expansion nozzles breaks down larger bubbles, defeating purpose of nozzle design.

5. True or False. The mix ratio of concentrate for aspirating foam solution is usually 0.5%.

True

QUIZ KEY

UNIT 5 QUIZ: **COMPRESSED AIR FOAM SYSTEMS**

1. Why is the compressed air foam system considered to be a "High energy system"?

   The compressed air foam system is called "high energy" because it uses the energy provided by the water pump and by an air compressor to generate and discharge foam.

2. Identify three important parts of a compressed air foam system.

   -- **Air compressor or other air source**
   -- **Water pump**
   -- **Foam solution or source of, proportioner**
   -- **Mixing chamber or length of hose**
   -- **Nozzle or shut-off valve**

3. Explain how the three parts of your answer to question 2 can be used to change the foam type.

   -- **Increase air flow to make dry foam, reduce air flow to make wet foam**
   -- **Increase water flow to make wet foam, reduce water flow to make dry foam**
   -- **Increase mix ratio to make dry foam, reduce mix ratio to make wet foam**
   -- **Lengthen chamber or hose to make drier foam, shorten to make wetter foam**
   -- **Adjust the nozzle or shut-off valve, more open for drier foam, more closed for wetter foam**

4. Name or describe two safety concerns when using a CAFS unit.

-- **Nozzle reaction**
-- **Slug flow**
-- **Charging a hoselay**

5. True or False. Mix ratios of concentrate for CAFS foam solution are usually 0.2% to 0.3%.

True

6. With a compressed air foam a charged hose weighs much less than hose filled with water because air has replaced much of the liquid. This lighter hose is easier to maneuver. Is this also a safety concern? Explain your answer.

Yes, due to energy stored in the hose from the compressed air.

CLASS A FOAM

QUIZ KEY

UNIT 6 QUIZ: **APPLICATIONS FROM THE GROUND**

1. Class A foams are recommended for:

   a. Fires in flammable liquids
   b. Fires in ordinary combustible solids, such as wood
   c. Fires in wood and flammable liquids

   b. Fires in ordinary combustible solids, such as wood

2. For the fuels in your answer to question 1., name three applications appropriate for Class A foam. (any three of the following)

   1. Direct attack/extinguishment/knockdown
   2. Indirect attack/barriers/ fuel breaks
   3. Mopup/overhaul
   4. Exposure protection/resource or property protection

3. Is dry foam effective for mopup? Explain your answer.

   No. Dry foam forms a lid on heat and is resistant to releasing moisture needed for penetrating and cooling.

4. Do foam concentrates contain any ingredients which will prevent or slow the spread of fire after the water has dried out of the foam?

   No.

5. The idea of Critical Application Rate suggests that:

   a. you should match the water flow to the fire situation
   b. if the fire is too big, don't waste your water
   c. if your water flow is adequate, larger flow rates will mean shorter knockdown time and smaller total water usage
   d. all of the above
   e. none of the above

   d. all of the above

6. Provide one property (not Foam Type) of foam that makes foam a good choice for each application listed below.

Direct Attack	**Helps water reach its potential for heat absorption; reduces smoke emissions.**
Indirect Attack	**Holds water in place as a barrier and to improve fuel wetting; high visibility aids efficient application.**
Mopup	**Reduced surface tension improves penetration into duff, peat, ash, etc.; reduces smoke emissions; suffocating blanket that also wets and cools over time.**
Exposure Protection	**Holds water in place on vertical and upside-down surfaces; improves wetting and moisture retention; provides physical, insulative, and reflective barrier.**

QUIZ KEY

UNIT 7 QUIZ: **APPLICATIONS FROM AIRCRAFT**

1. Name two types of aircraft that are capable of delivering foam. (any two of the following)

   Water-skimming airtankers
   Land-based airtankers
   Single-engine airtankers
   Helicopters with buckets
   Helicopters with fixed tanks

2. For the aircraft described above, name two or more factors that affect foam delivery.

   Mix ratio
   Forward air speed
   Drop Height
   Wind speed and direction
   Door or drop configuration
   Ground cover
   Aircraft attitude

3. True or False. All approved foams have been approved for use with fixed-wing land-based airtankers.

   False

4. How is foam generated when dropped from aircraft?

   Foam solution falls through the air and mixes with air on the edges of the solution mass. This mixing by air shear is influenced by air speed, drop height, aircraft attitude, and wind speed and direction. The more edge the better the mix, the greater the amount of expansion.

CLASS A FOAM

FINAL EXAM KEY

Numbers in parentheses ( ) identify the unit and objective to which the question is written. In most cases there are at least two choices for each objective. Answers are intentionally complete to include as many correct answer ideas as possible. Students are not expected to repeat this word-for-word.

1. (1-1) Identify how water affects the fire triangle. (all three of the following)

   - **Water cools by absorbing heat, as much as 9000 btu/gallon.**
   - **Fuels submerged in water are effectively separated from oxygen (but in a spray pattern, water has a limited ability to separate oxygen from free-burning fire).**
   - **Water renders fuel unburnable by raising its moisture content.**

2. (1-1) Why does untreated water wet Class A fuels poorly? (one of the following)

   - **High surface tension (72 dynes/cm) holds water molecules together, restricting their soaking into dry fuels. Water collected together by surface tension tends to fall or flow under the influence of gravity and may flow over and off fuel before it can be absorbed.**

   - **Water is more attracted to itself than to the hydrocarbon molecules that make up Class A fuels.**

3. (1-2) How do you reduce the surface tension of water?

   - **Add a surfactant or surface active agent, such as those found in wet water or foam concentrate or dish soap.**

4. (1-2) Describe two things that a foaming agent does to water that a wetting agent does not do.

IT FOAMS: Foaming agent allows bubbles. Wetting agent has defoamers which breakdown bubbles. As a foam, it holds water in place longer.

IT COOLS: Bubbles have higher surface area-to-mass ratios, enabling foam to be a more efficient form of water for heat absorption.

5. (1-2) How is foam solution made?

- **By adding foam concentrate to water.**

6. (1-2) What is necessary to equip an engine to generate foam?

- **Foam concentrate**
- **Proportioner**
- **Water pump**
- **Water**
- **Nozzle**
- **Hose**

7. (1-4) Define expansion ratio.

- **Expansion ratio is the volume of the foam created relative to the volume of the foam solution used to create the foam.**

8. (1-5) List four reasons why foam makes water more effective for fire extinguishment and resource protection. (any four of the following)

1. **Foam helps water absorb heat more efficiently**
2. **Foam helps control the flow of water at a rate similar to the fuel's ability to absorb it.**
3. **Foam helps reduce evaporation, when fuels are covered in foam.**
4. **The opaque surface reflects heat.**
5. **Foam provides insulation from heat to the treated fuel.**
6. **Foam helps water adhere to most surfaces.**
7. **Foam makes an application of water highly visible.**

9. (2-1) Why should you be interested in information on a Material Safety Data Sheet?

   An MSDS contains information that could prevent a serious accident due to mishandling, improper use, inadequate personal protection and more. An MSDS explains risks and precautions related to the use of and exposure to foam concentrate.

10. (2-2) Describe three strategies for safely handling, mixing or using foam concentrate or solution. (any three of the following)

    1. Use products approved for use by your authority having jurisdiction which have met standards for skin and eye toxicity and metal corrosion.
    2. Avoid applying solution or spilling concentrate into water sources.
    3. Regularly flush plumbing and rinse tools.
    4. Wear gloves, goggles, hard hat, sunscreen and rubber boots (if permitted) to reduce skin and eye exposure.
    5. Avoid walking where foam conceals ground.

11. (3-2) Describe two features, advantages or limitations of two manual proportioning methods or devices. (any two items from any two of the following)

    A. Batch Mixing

    1. Proportional, the first time. After that it is difficult to know exact amount of water and solution in the tank.

    2. Labor intensive.

    3. Knowledge of mix ratios.

    4. Foam solution runs through pump, over time this could wear on seals.

    5. It is very easy with no upfront equipment cost.

    6. Accurate at any water flow for a single mix ratio.

B. **Suction-side Proportioner**

1. **Proportional, but not automatic.**

2. **Works on suction of side of pump.**

3. **Dependent on pump pulling a draft, in other words, if there is a flooded suction, the pump will not pull the concentrate into the water line because it is not pulling in water.**

4. **Foam solution runs through the pump.**

5. **Accurate at a single water flow and single mix ratio.**

C. **In-Line Proportioning System (Eductor)**

1. **Proportional, but not automatic.**

2. **Situation sensitive; as soon as water flow or pressure changes, this device quits adding concentrate.**

3. **Works anywhere on the pressure side of the pump.**

4. **Must use a nozzle rated for a gallonage equal to the flow of the eductor.**

5. **Requires minimum of 200 psi inlet pressure.**

6. **Limited to a maximum of 300 feet of hose from the eductor to the nozzle.**

7. **Maximum 10 feet elevation from eductor to nozzle.**

8. **Discharge pressures reduced at least 30% at the eductor.**

9. **Accurate at single water flow and single mix ratio.**

D. By-Pass Eductor

1. **Proportional, but not automatic.**

2. **Situation sensitive; as soon as water flow or pressure changes, this device changes the mix ratio.**

3. **Works anywhere on the pressure side of the pump.**

4. **Limited water flow.**

5. **Discharge pressures reduced at least 30%.**

6. **Accurate at narrow water flow range for single mix ratio.**

E. Around-the-Pump Proportioning System

1. **Proportional, but not automatic.**

2. **Connects to both the suction and discharge sides of the pump.**

3. **Foam solution runs through the pump.**

4. **Can build up pressure on suction-side of pump when all nozzles are closed. Need a pressure relief valve.**

5. **Accurate at single water flow and any mix ratio. Will need to monitor mix ratio.**

F. Manual Direct Injection Proportioning Systems

1. **Proportional, but not automatic.**

2. **Works on pressure side of pump.**

3. **Provides knowledge of gallons per minute flowing.**

4. **Stops concentrate injection when water flow stops.**

5. **Requires additional power supply to operate the proportioner.**

6. **Shop repairable.**

7. **Accurate for single water flow at any mix ratio.**

12. (3-3) Describe two features, advantages, or limitations of one automatic proportioning device. (any two items from any one of the following)

A. **Balanced Pressure Bladder Tank Proportioning System**

1. **Proportional and automatic.**

2. **Works on the discharge side of the pump.**

3. **Can be placed anywhere in a hose lay or pump manifold.**

4. **Requires only water flow to operate proportioner.**

5. **Field or shop repairable.**

6. **No restriction to hose length/elevation.**

7. **No significant loss in pressure or flow.**

8. **Accurate at wide range of water flow for any mix ratio.**

B. **Balanced Pressure Pump Proportioning System**

1. **Proportional and automatic.**

2. **Works on the discharge side of the pump.**

3. **Can be placed anywhere in a hose lay or pump manifold.**

4. **Requires an additional power supply to operate proportioner.**

5. **Shop and manufacturer repairable.**

6. **Accurate for any mix ratios at flow ranges of 5-125 gpm or 25-250 gpm.**

C. **Automatic Direct Injection Proportioning System**

1. **Proportional and automatic.**

2. **Works on the discharge side of the pump.**

3. **Integral to pumping platform.**

4. **Requires an additional power supply to operate.**

5. **Shop and manufacturer repairable.**

6. **No restriction to hose length/elevation.**

7. **No loss in pressure or flow.**

8. **Accurate for any water flow at any mix ratio.**

13. (4-1) How does an aspirating nozzle work?

A drawing of this description would be acceptable, as well as any description that covers the following five points:

An air aspirating nozzle 1) forces foam solution through a restriction or venturi 2) creating a low pressure area which 3) draws air into a chamber where 4) the air mixes with the foam solution and 5) is discharged. Some nozzles may have screens or other mechanisms to improve bubble formation.

14. (4-1) How can the foam produced by an aspirating nozzle be changed? (at least one of the following)

    1. Change the mix ratio,
    2. Change the nozzle pressure,
    3. Change the air flow into the nozzle. This is difficult to control.

15. (4-2) Name two different expansion types of aspirating foam nozzles and define the limits of expansion for each. (any two of the following)

1.	**Low expansion nozzle**	**1:1 to 20:1**
2.	**Medium expansion nozzle**	**21:1 to 200:1**
3.	**High expansion nozzle**	**201:1 to 1000:1**

16. (5-1) What is a compressed air foam system?

    A generic term used to describe foam systems consisting of an air compressor or other air source, a water pump, and foam solution. (This is the definition from "Foam vs. Fire".

17. (5-1) True or False. Compressed air foam is made at the nozzle similar to air aspirating nozzles.

    False. Compressed air foam is made in the hose or mix chamber

18. (5-2) Why is hose lighter when using compressed air foam than aspirated foam or water?

    The hose is filled with about 1 part water and 10 parts air.

19. (5-2) Why does a compressed air foam system project foam farther than plain water when both have the same water flow and pressure?

    The extra energy provided by the air compressor is the reason.

20. (5-4) What is slug flow and how can you stop it?

Slug flow is what occurs when the mix ratio is too low to mix the water with the air in the hose. Instead, water and air move through the hose separately in "slugs" or "plugs". This can be difficult to control at the nozzle.

Slug flow can be solved by increasing the mix ratio, batch mixing immediately if necessary; or by shutting off the air flow. Bleed out the air/water slugs by cracking the nozzle just open.

21. (5-5) Match the foam generation system number to the appropriate descriptor/feature.

1. Aspirating Nozzle
2. Compressed air foam system

2	**High energy system**
1	**Mix ratio about 0.5%**
1	**Low energy system**
2	**Small, uniform bubbles**
2	**Mix ratio 0.2%-0.3%**
1	**Multiple bubble sizes**
2	**Lighter hose weight**
1	**Lower initial cost**
2	**Longer discharge per gallon**

22. (1-3)(6-2) Name the four foam types and list their applications.

1. **foam solution -- mopup, flame knockdown**
2. **wet foam -- mopup, flame knockdown, line support, resource protection, backfiring**
3. **fluid foam -- flame knockdown, line support, resource protection, backfiring**
4. **dry foam -- line support, resource protection**

23. (6-3)(6-4) Why is Class A foam a suppressant and not a retardant?

Class A foam is not a retardant because it is simply water that has been thinned and stretched. Foam has no flame inhibiting properties that remain after the water has dried. Once foam is applied, treated fuels will lose moisture at the normal drying rate.

Class A foam is a suppressant because it provides the suppressant water in an optimum form for cooling, wetting, vapor sealing, and smothering.

24. (6-5) Class A foams are not recommended for Class B fires because:

a. they do not produce a flammable vapor seal
b. they may be absorbed by many flammable liquid fuels
c. a. and b. above
d. none of the above

c. a. and b. above

25. (7-1) If you had the option of applying foam or long-term retardant on a large remote fire using one aircraft which had a 2-hour turn-around time, which would you choose?

Choose the long-term retardant, because it will still be there when the aircraft comes back. The foam will have dried up allowing fire spread through the treated fuels.

26. (7-3) How does drop height affect the type of foam delivered from aircraft and the accuracy of the drop?

Lower drop heights allow less shearing or mixing, creating a wetter foam that is more accurately placed.

Higher drop heights allow more shearing or mixing, creating a drier foam that may drift away from the target or get stuck in the canopy vegetation.

APPENDIX B

LAB DEMONSTRATIONS

CLASS A FOAM

LAB DEMONSTRATIONS

01-01-FOAM-LB: Demonstrating Water's Negative Properties

Items Needed:

1. Large glass beaker or beakers (1000 ml or equivalent)
2. Sphagnum peat moss
3. Water container
4. Water

Instruction: Make sure the glass beaker is clean and void of any soap residue. A contaminated beaker can cause the demonstration to fail.

Add sphagnum peat moss to the dry, clean beaker and pack it well at the bottom of the beaker. Use about 1/4 of the space in the beaker. Place beaker(s) where students can view them. Pour water into the beaker(s). The volume of water should fill the beaker almost to the top.

Questions/Observations:

- Is the water penetrating the moss?
- Is the water just sitting on top of the moss?
- Some of the water is flowing down the inside of the beaker.
- Why do we use hand tools?

  To push or smash water into fuel.

- Sometimes the whole clump of sphagnum moss will float to the top of the beaker.

- What causes this?

    High surface tension.

- Note that most of the time there will be three layers of substance (if the moss has not all floated to the top). At the bottom of the beaker is the peat moss, in the middle is a water layer and at the top are small quantities of peat moss floating on the water.

01-02-FOAM-LB: Demonstrating Water's Negative Properties

Items Needed:
1. 3" x 3" piece of cardboard
2. Water container
3. Water

Instructions: Place the pieces of cardboard where students can view them. Pour a small amount of the plain water onto the cardboard squares.

Questions/Observations:

- Is the water penetrating the cardboard?
- Is the water just sitting on top of the cardboard?
- Why do we use hand tools?

  To push or smash water into fuel.

- Why does the water just sit in a puddle on top of the cardboard?

  High surface tension.

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01-03-FOAM-LB: Demonstrating the Result of Surfactant Added to Water

Items Needed:
1. Overhead projector
2. Water container
3. Water
4. Soap concentrate (surfactant)
5. Eyedropper
6. Credit card or equivalent
7. Paper towels
8. Projector screen or equivalent

Instructions: Clean glass table of the projector with water so there is no soap residue or contaminates on it.

Make sure that the glass table is dry.

Set up the overhead projector so it is showing light against the screen or its equivalent.

Add a small amount of water to the middle of the glass table. Spread water around the table with an uncontaminated credit card or equivalent.

Questions/Observations:

- What is the water doing?
- Is the water clinging to itself?

- What is this force known as?

- We can not spread the water and keep it spread over the surface of the projector.

Instructions: Now add a drop of soap concentrate to the puddle of water. Spread the water (solution which will be explained later) over the glass table.

Questions/Observations:

- What is the water doing now?

- Is the water clinging to itself?

- Has the water surface tension been reduced?

- The water can now be spread and remain spread over the surface of the projector.

- Have we improved the water?

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01-04-FOAM-LB: Demonstrating Positive Properties of Solution

Items Needed:

1. Large glass beaker or beakers (1000 ml or equivalent). These beakers are in addition to the ones used in Lab Demonstration #1.
2. Sphagnum peat moss
3. Water container
4. Water
5. Soap concentrate (surfactant)
6. Two stir rods or equivalent

Instructions: Make sure the glass beaker is clean and void of any soap residue. A contaminated beaker can cause the demonstration to fail.

Add the sphagnum peat moss to the dry, clean beaker and pack it well at the bottom of the beaker. Use about 1/4 of the space in the beaker. Place beaker(s) where students can view them. Mix water and soap concentrate together to form a 1% solution. (1000 ml of water and 10 ml of soap concentrate). Pour the solution into beaker(s). The volume of the solution should fill the beaker almost to the top.

Questions/Observations:

- Is the solution penetrating the moss?
- Is the solution sitting on top of the moss?
- What are the bubbles that are forming?

  Could it be the air pockets around the moss and in the moss fibers are being displaced by solution?
- Are there three layers present as with Lab Demo. #1?

- Where has the solution gone?

- What are the implications for mopup and pre-wetting?

Instructions: Let both sets of breakers stay in view of students throughout the class. After about one hour or more stir both samples with a stir rod of their own. (Remember don't contaminate.)

Questions/Observations:

- Has the water penetrated the moss that is in the water beaker?

- Are there still a lot of dry areas in the peat moss which is in the water beaker?

- Are there still a lot of dry areas in the peat moss which is in the solution beaker?

01-05-FOAM-LB: Demonstrating Positive Properties of Solution

Items Needed:

1. 3" x 3" piece of cardboard. This piece of cardboard is in addition to the one used in Lab Demo. #2.

2. Water container

3. Water

4. Soap concentrate (surfactant)

Instructions: Place the cardboard where students can view it. Mix water and soap concentrate together to form a 1% solution. (100 ml of water and 1 ml of soap concentrate). Pour a small amount of the solution onto the cardboard.

Questions/Observations:

- Is the solution sitting on top of the cardboard?

- Is the solution penetrating the cardboard?

- What are the implications for mopup and pre-wetting fuels?

Instructions: Let both pieces of cardboard (Demonstrations #2 and #5) stay in view of students throughout the class. After about one hour look to see what is happening to both pieces of cardboard.

Questions/Observations:

- Has the water penetrated the cardboard that has just plain water on it?

- What would it take to burn each piece of cardboard?

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01-06-FOAM- LB: Showing Foam Solution, Foam Types, Expansion, and Drain Rate

OPTION #1:

Items Needed:
1. Three 1-quart, wide-mouthed jars w/lid
2. Water
3. Soap concentrate (Surfactant)

Instructions: Fill each jar about one quarter full of water. To the first jar, add 1 part foam concentrate to 400 parts water. To the second jar add 7 parts to 400 parts. To the third jar add 20 parts to 400 parts. (These ratios are chosen for demonstration purposes.)

Questions/Observations:

-- Each jar holds a different mix ratio of foam solution.

-- How are they different? The same?

-- How easily did the concentrate mix with water?

Instructions: To add air to the foam solution to make foam, (make sure the lid is on tight) shake each jar rapidly. Shake jar #1 -- 10 times, jar #2 -- 15 times, and jar #3 -- 20 times.

Questions/Observations:

-- Each jar now holds a different foam. Why?

-- How are the foams different?

-- How much of the original water is now in bubbles?

-- What is the difference, relatively, in expansion between the three jars?

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Remember, each jar started with the same amount of water.

- -- What happens to the foams over a few minutes? Why?
- -- How are the foams reacting differently?
- -- Which foam would be best for resource protection, structure protection, or building a foam line?
- -- Which foam would be better for mopup and flame knockdown?
- -- Which foam would not be as good for mopup, especially deep-seated fire?

OPTION #2: THIS IS AN OUTSIDE DEMONSTRATION

Items Needed:
1. Automatic proportioner with foam concentrate
2. Pump, hose, and aspirating nozzle or CAFS
3. Flat ground or pavement

Instructions:
- -- Set mix ratio at 0.1% and establish flow of this foam through the nozzle.
- -- Turn and loft this foam in one place until covered.
- -- Move the nozzle away.
- -- Repeat as above for 0.5% and 1.0% mix ratios, spraying each foam adjacent to the others.

Questions/Observations:
- -- How are the forms different?
- -- What happens to the foams over a few minutes? Why?

CLASS A FOAM

-- How are the foams reacting differently?

-- Which foam would be best for resource protection, structure protection, or building a foam line?

-- Which foam would be better for mopup and flame knockdown?

-- Which foam would not be as good for mopup, especially deep-seated fire?

CLASS A FOAM

APPENDIX C

HANDOUTS

CLASS A FOAM

HANDOUTS

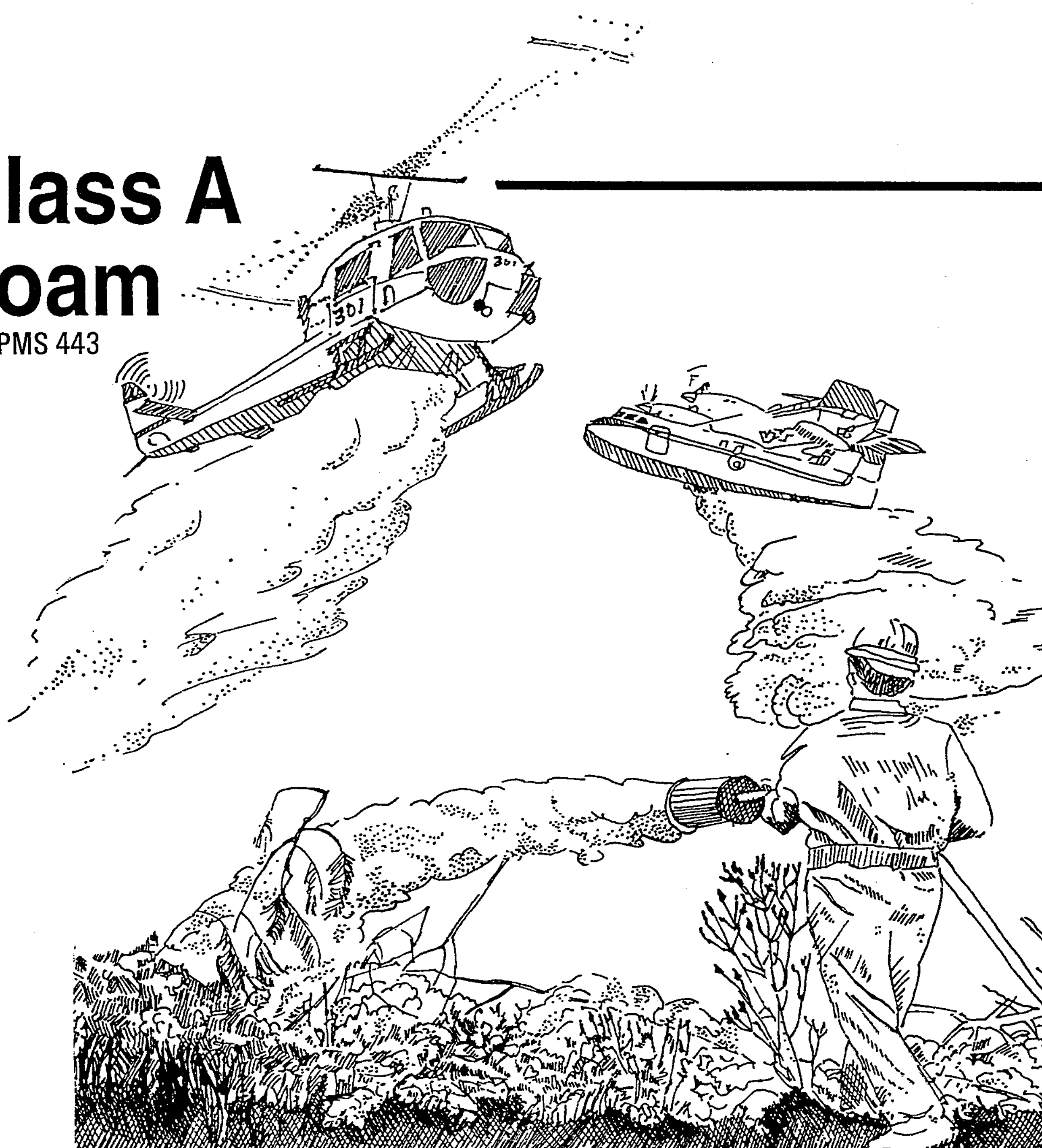
A three-ring binder is recommended to keep this material together.

00-01-FOAM-HO	Notetaking Guide
02-01-FOAM-HO	Material Safety Data Sheets
03-01-FOAM-HO	Foam Concentrate to Add Chart
03-02-FOAM-HO	A Lightweight, Inexpensive, Portable Pump Foam Induction System
04-01-FOAM-HO	A 10-cent Unbreakable Foam Nozzle for Backpack Pumps
04-02-FOAM-HO	Low-Volume, Medium Expansion Foam Nozzle From Your Workshop
05-01-FOAM-HO	In Line CAFS Instructions

The Student Notetaking Guide, the Handouts and the pamphlet, "Foam vs Fire Class A Foam for Wildland Fires" may be put into a three-ring binder. If the instructor chooses to provide the binders, a "Student Workbook" cover/spine master are provided at the end of the Handouts which may be used to reproduce covers and spines for the binders.

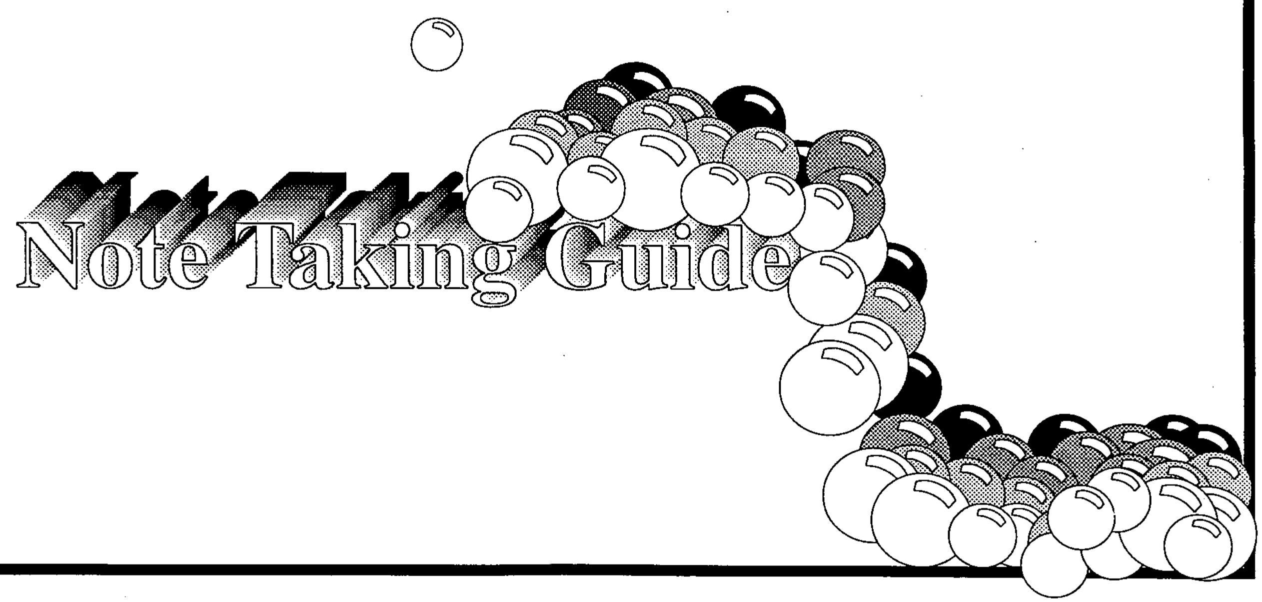
Class A Foam

PMS 443



Student Note Taking Guide
November 1995
NFES 1302

Class A Foam



Course Purpose

To provide the student with the skills necessary to use Class A foam on fires in wildland fuels in a safe and efficient manner.

Course Objectives

Upon completion of this course the student will:

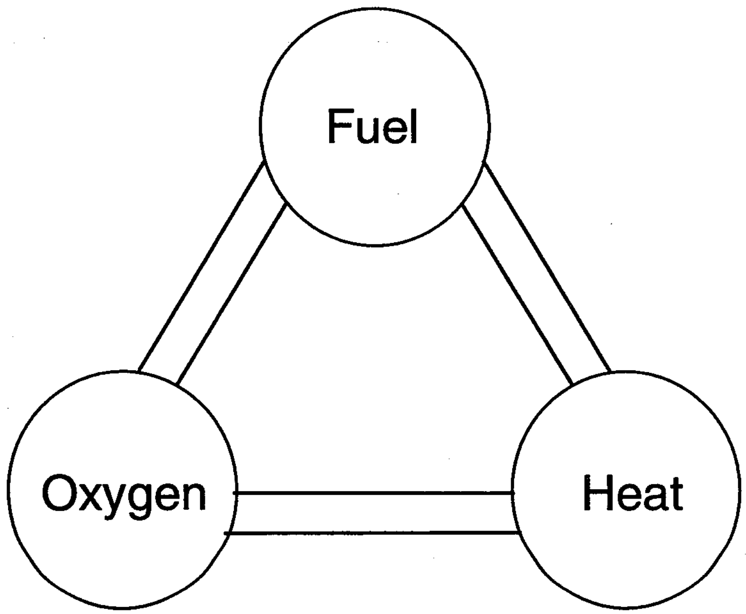
1. Explain the effects of water and foam on fire.
2. Describe safe handling procedures and environmental considerations when using Class A Foam.
3. Describe some of the equipment that is needed to produce a foam solution.
4. Describe an aspirating foam system and give two advantages and two disadvantages of the system.
5. Define a compressed air foam system and provide two advantages and two disadvantages of that system.
6. Explain when, where, and how to use Class A Foam.
7. Describe some types of aircraft that deliver foam to fires.

Unit 1 Objectives

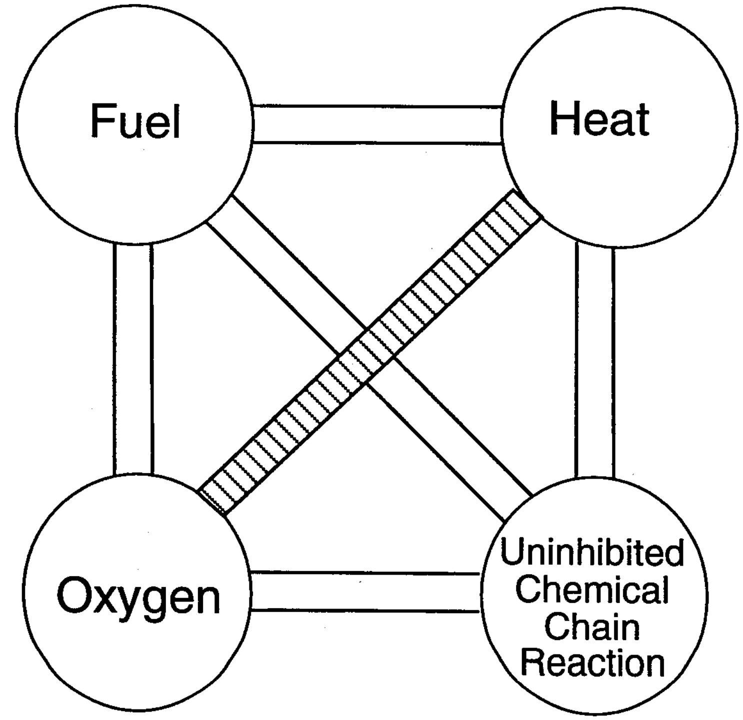
Foam Properties

1. Explain why water can be an excellent extinguishing agent.
2. Define foam
3. Describe the four types of foam.
4. Explain expansion ratio and draintime
5. List four reasons why foam makes water more effective

The Fire Triangle



The Fire Tetrahedron

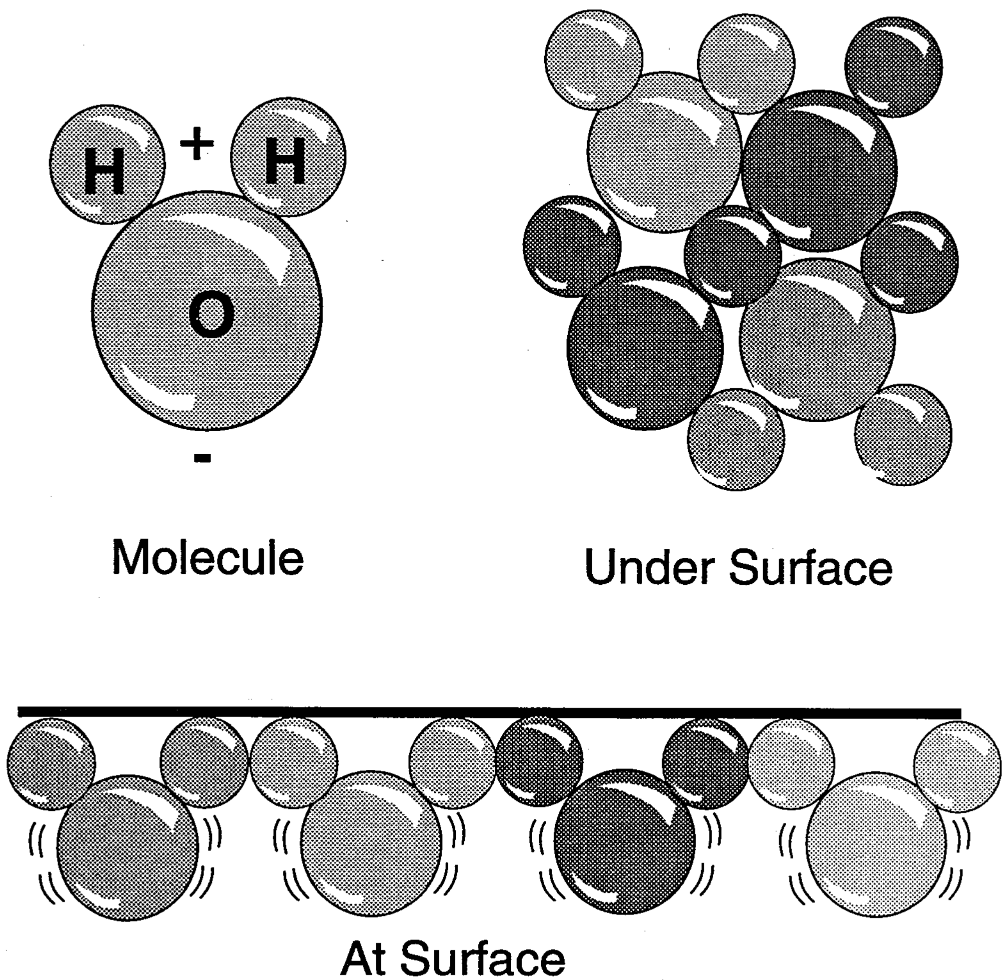


Properties of Water

Advantages of Water

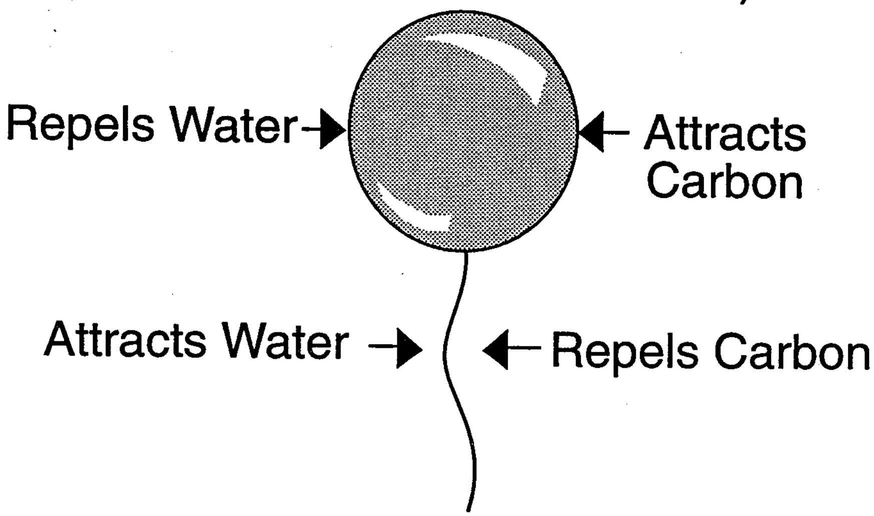
Disadvantages of Water

Water

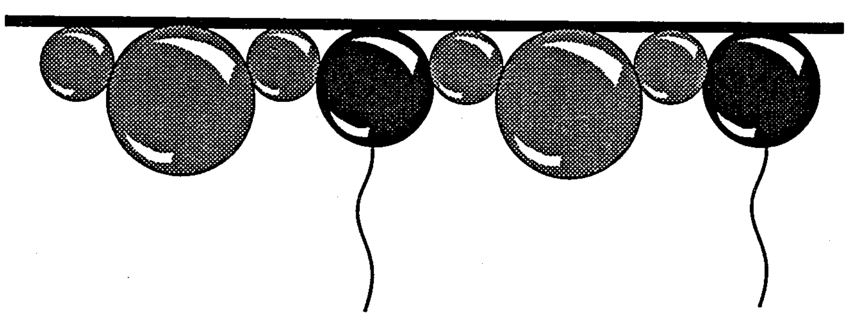


Hydrocarbon Surfactant Molecule

(Class A Foam, Wet Water)

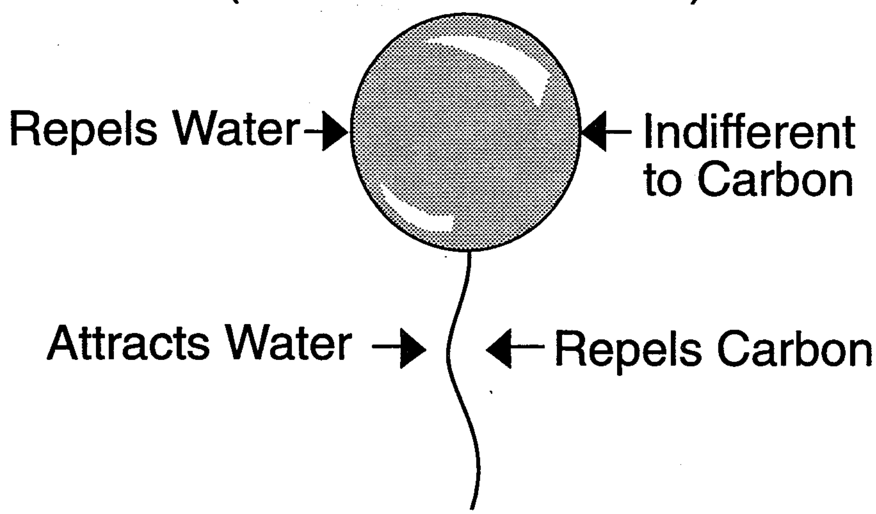


The surface of water with surfactants

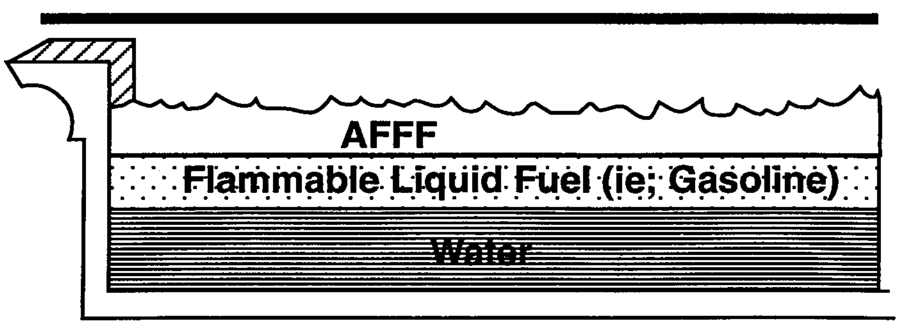


Benefits of Hydrocarbon Surfactants

Fluorocarbon Surfactant Molecule
(Class B Foam: AFFF)



AFFF on liquid fuel



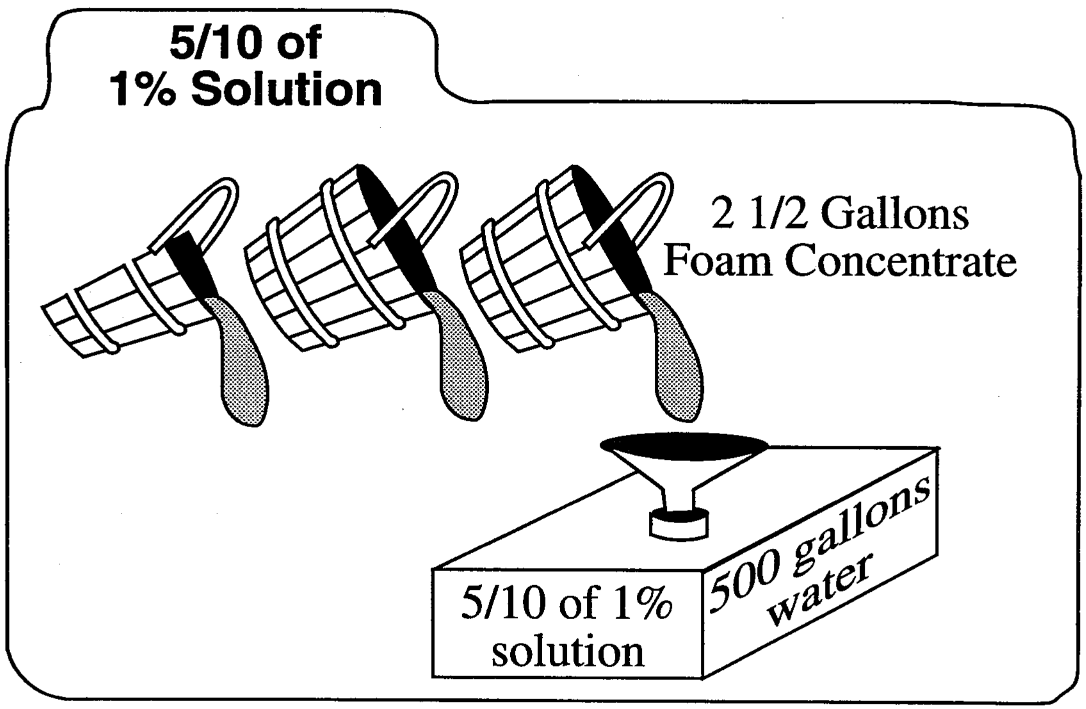
Fluorocarbon Surfactant

Wetting Agents

Foaming Agents

Foam Concentrate + Water = Foam Solution	Foam Solution + Air = Foam

Foam Solution



Mix Ratios:

Expansion Ratio

$$\textbf{Expansion Ratio} = \frac{\textbf{VOLUME OF FOAM}}{\textbf{VOLUME OF FOAM SOLUTION}}$$

Low = 1:1 to 20:1

Medium = 21:1 to 200:1

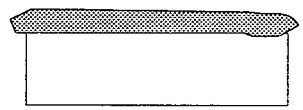
High = 201:1 to 1000:1

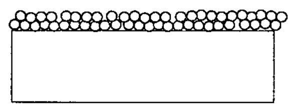
Drain Time

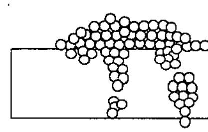
Foam Type

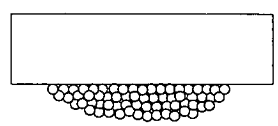
A measure of the durability and viscosity of foam

Used for:

Foam Solution  ____________________

Wet Foam  ____________________

Fluid Foam  ____________________

Dry Foam  ____________________

Foam Enhancements to Water

Unit 2 Objectives

Personal Safety and Environmental Concerns

1. Explain what a Material Safety Data Sheet (MSDS) is.
2. Describe three safety concerns or environmental procedures when handling foam concentrate.

Safety Concerns

Material Safety Data Sheet Information

International Foam Specification

Procedures/Guides When using Foam

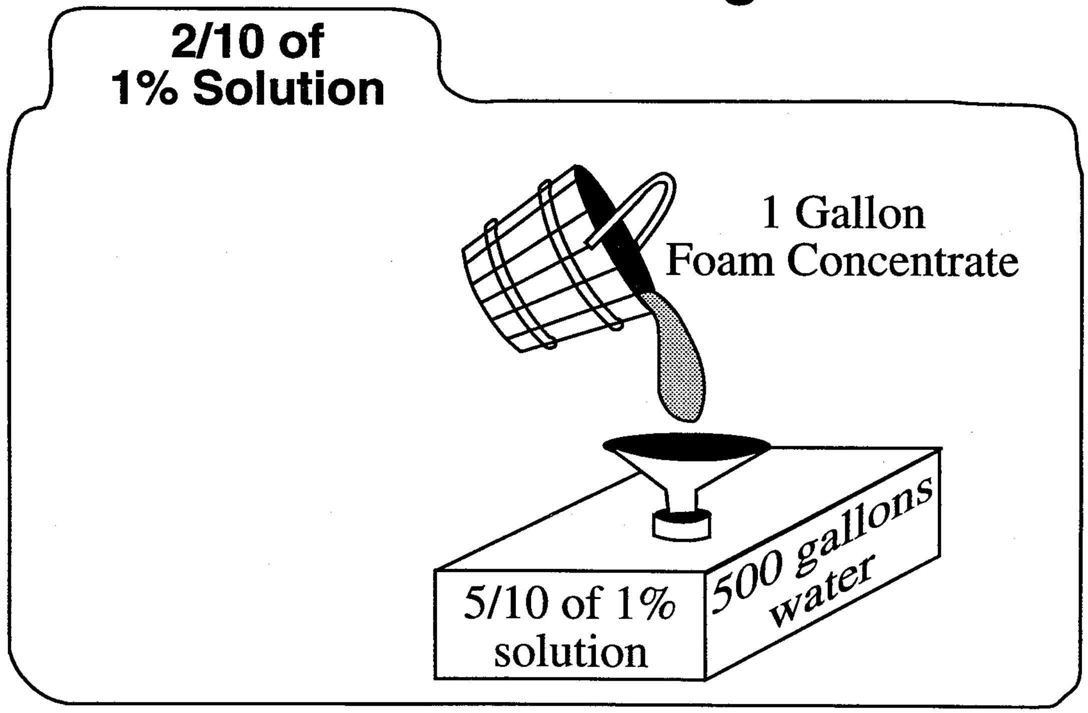
Studies of Effects Indicate:

Unit 3 Objectives

Proportioning

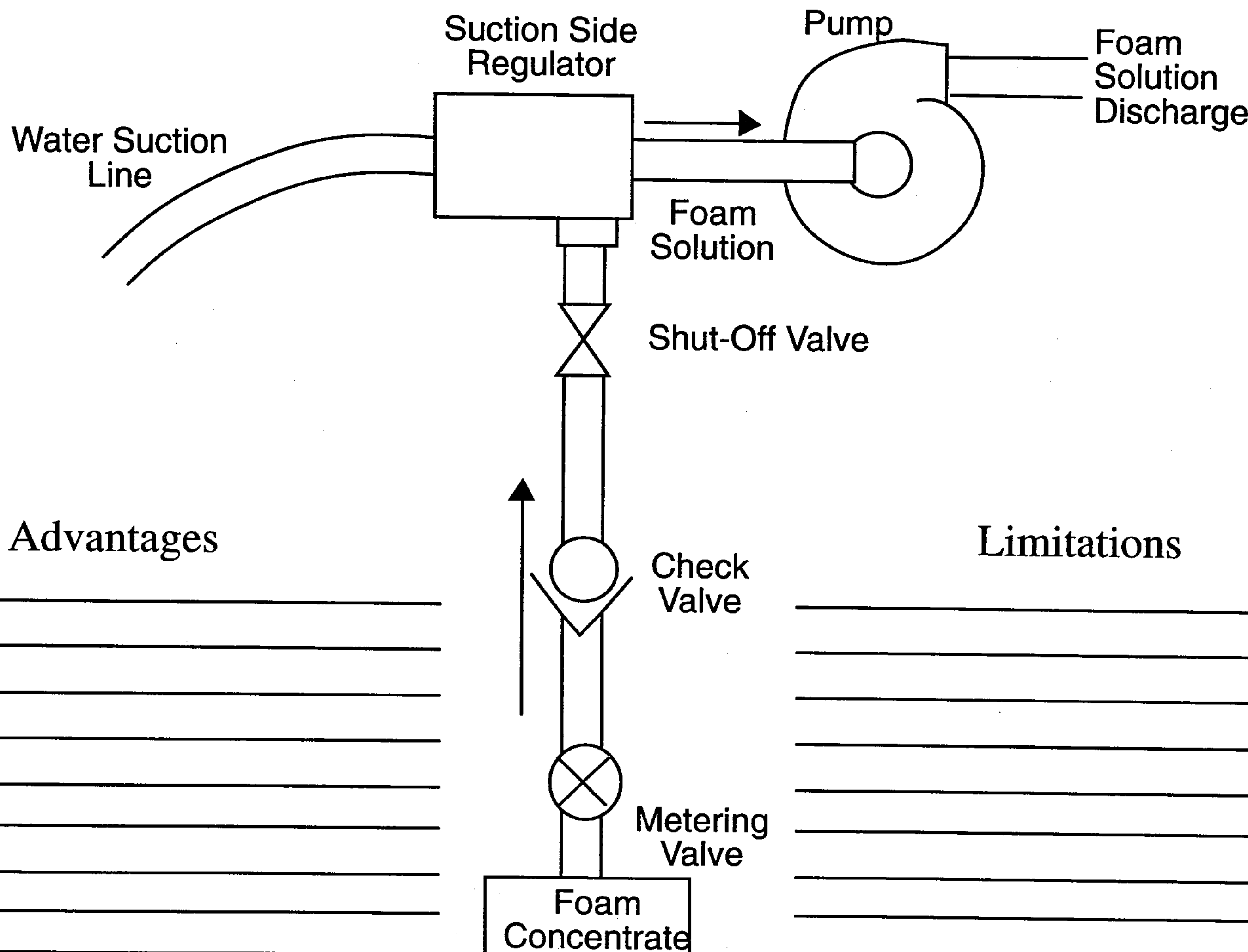
1. List two manual proportioning methods or devices.
2. Describe the advantages and disadvantages of two manual proportioners.
3. Name one automatic proportioner and describe its advantages and limitations

Batch Mixing



Advantages	Disadvantages

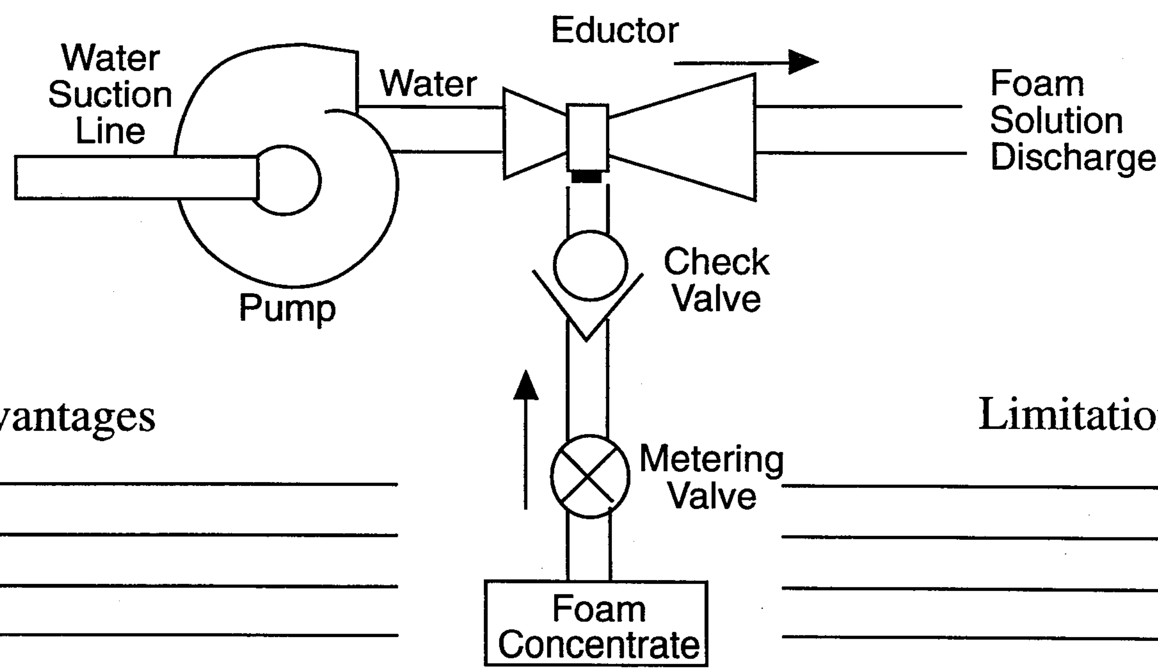
Suction Side Proportioner



Advantages

Limitations

In-line Proportioner (Eductor)



Advantages

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Limitations

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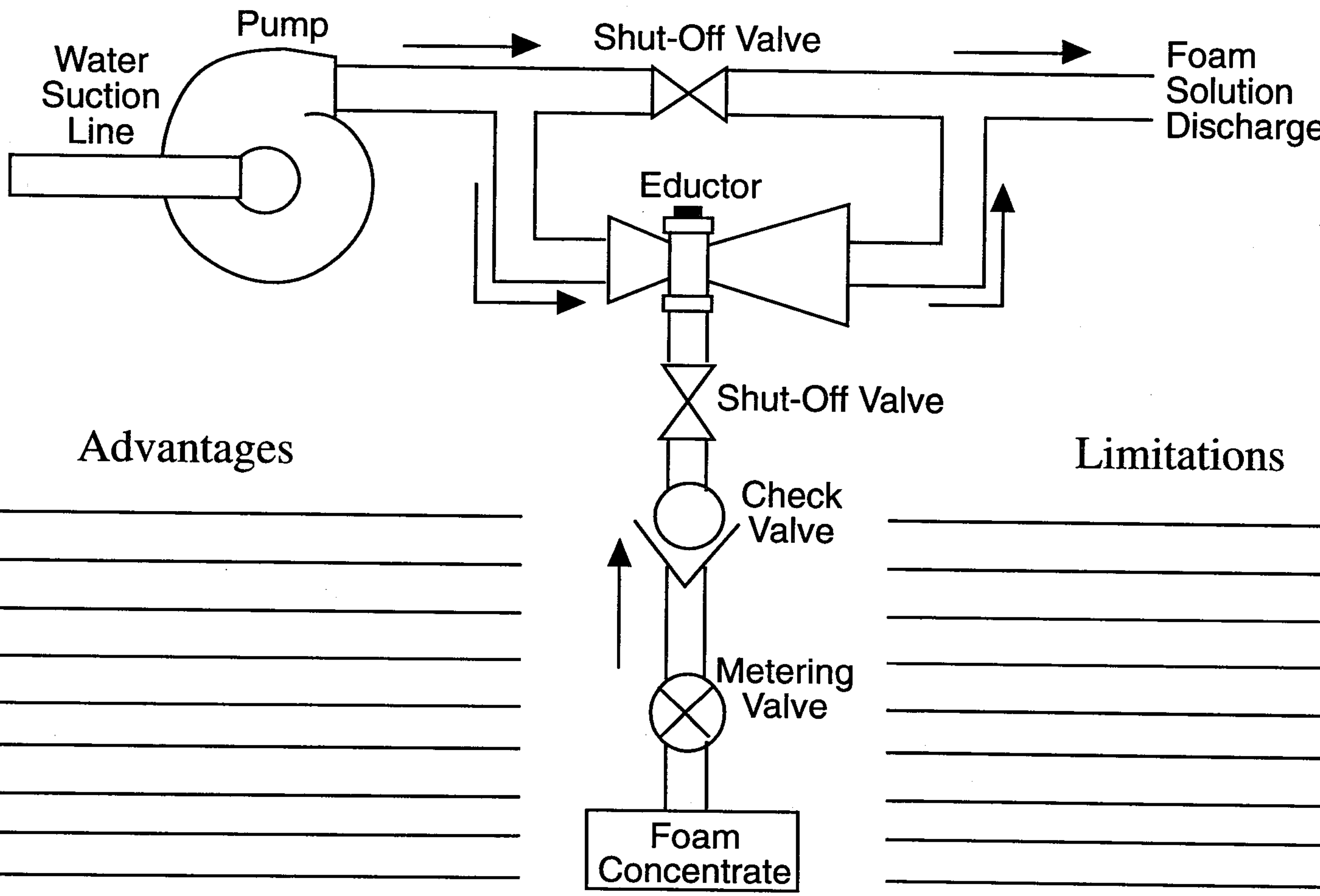
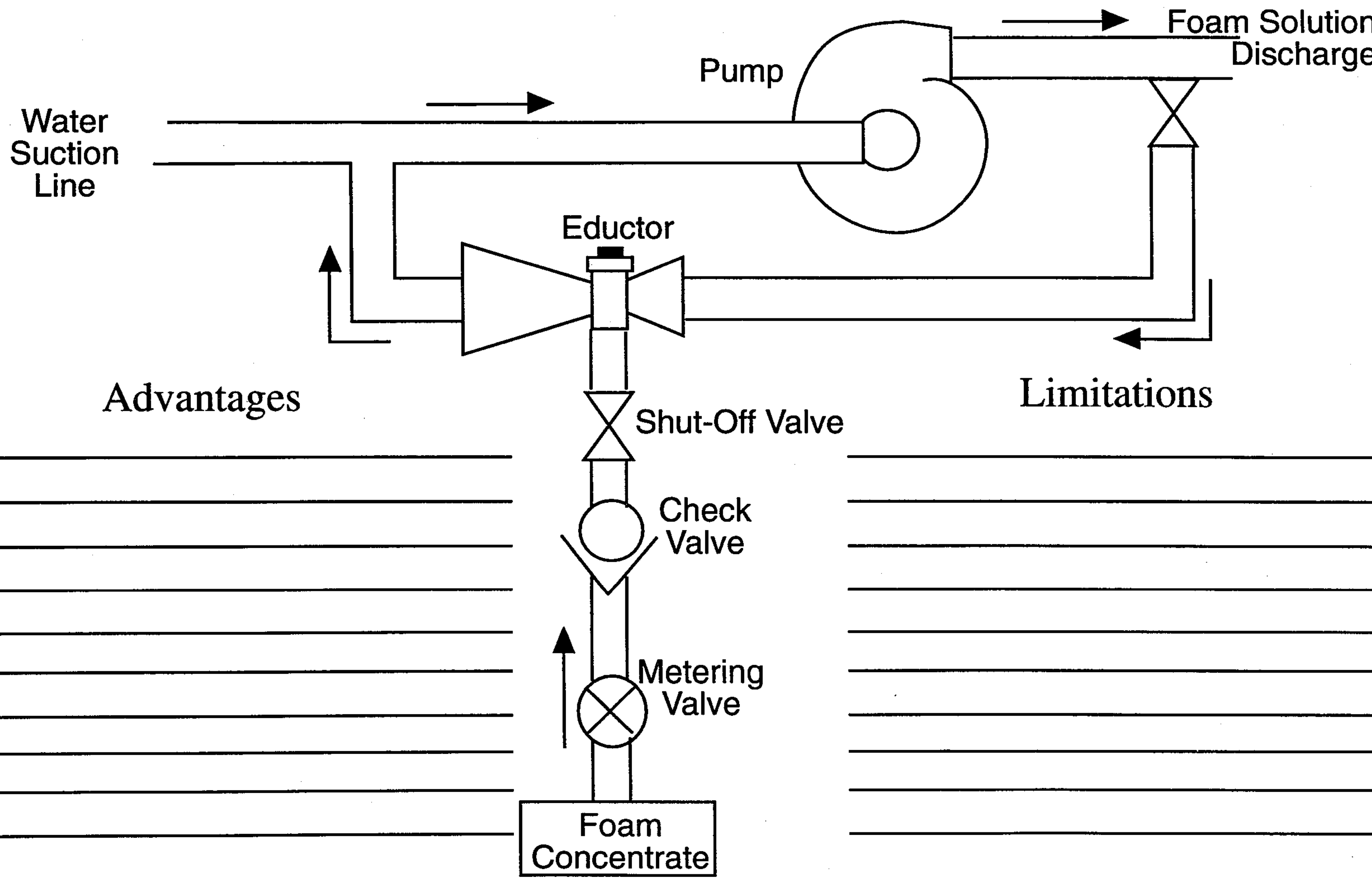
By-Pass Eductor



Advantages

Limitations

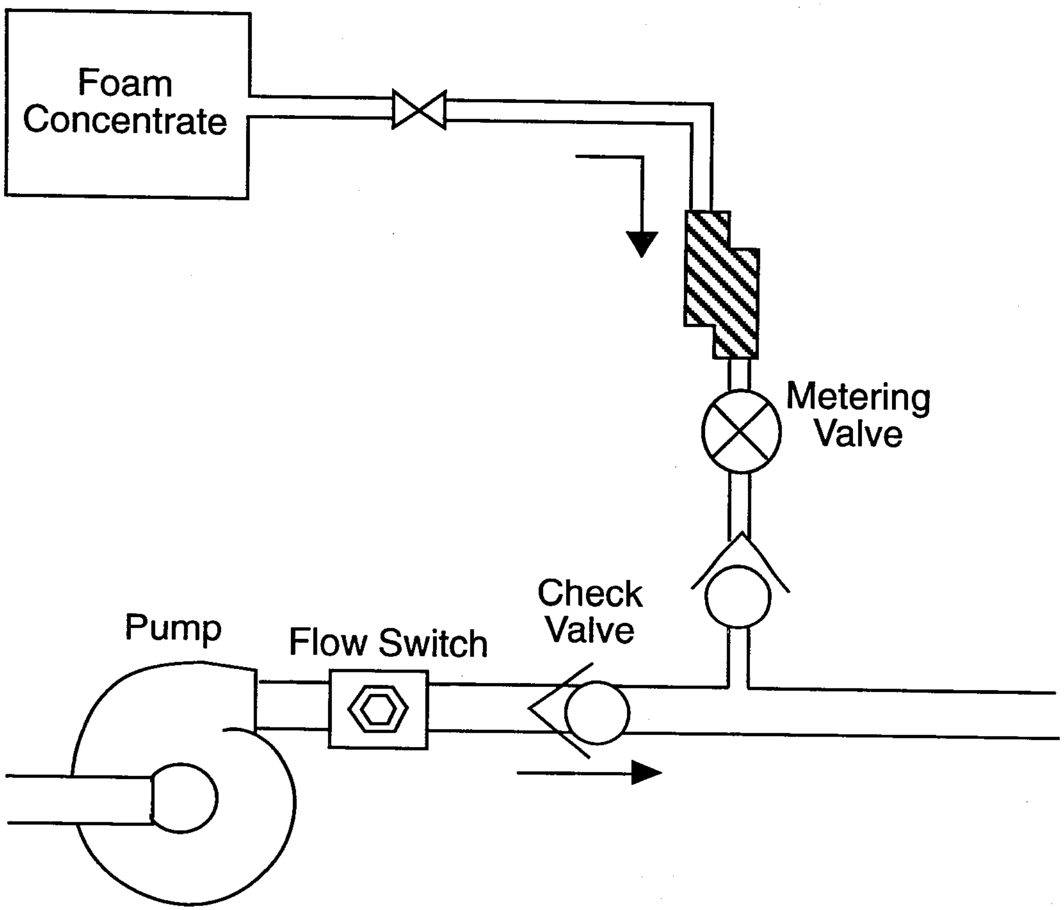
Around the Pump Proportioner



Advantages

Limitations

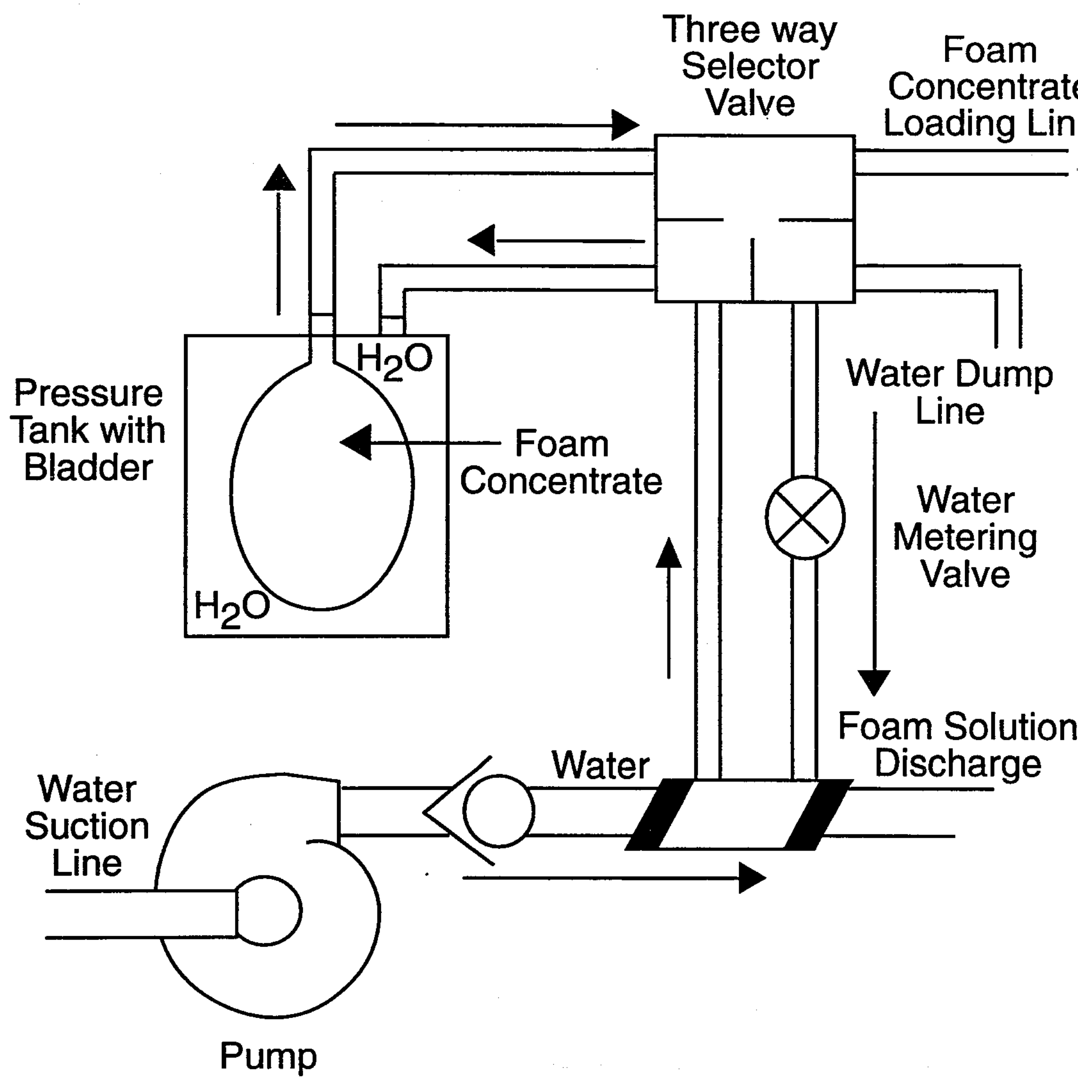
Manual Direct Injection Proportioner



Advantages

Limitations

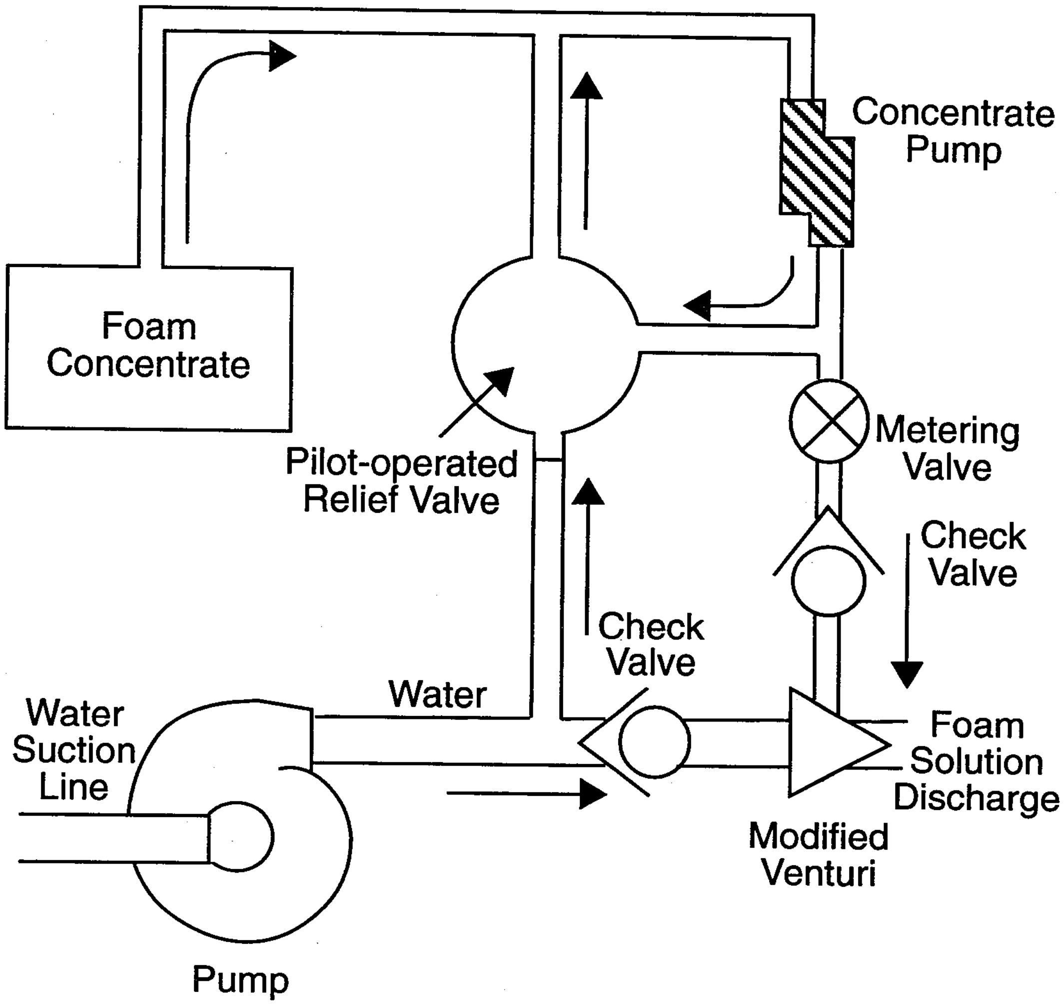
Balanced Pressure Bladder Tank Proportioner



Advantages

Limitations

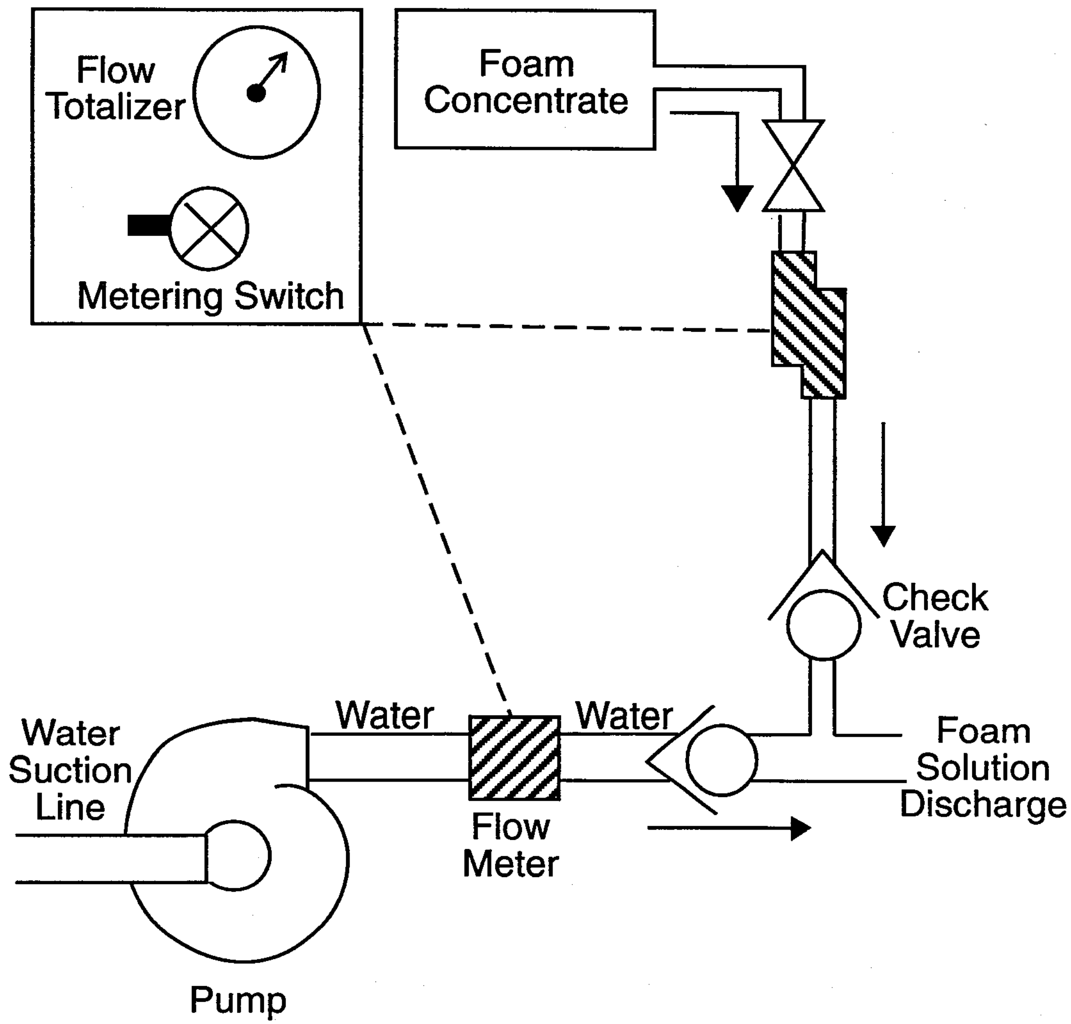
Balanced Pressure Pump Proportioner



Advantages

Limitations

Automatic Direct Injection Proportioner



Advantages

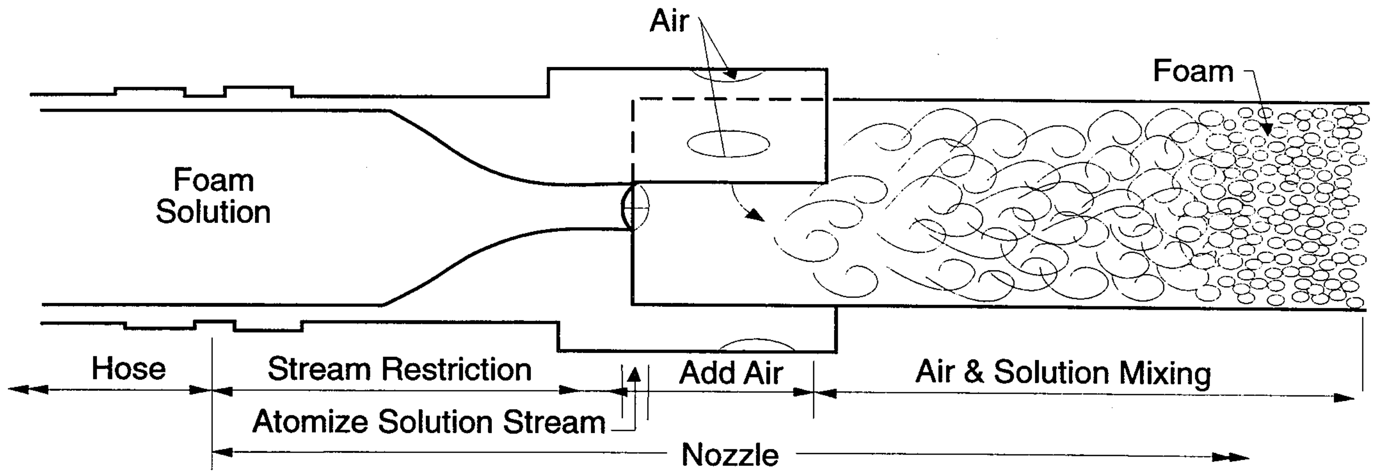
Limitations

Unit 4 Objectives

Nozzle Aspirating Foam Systems

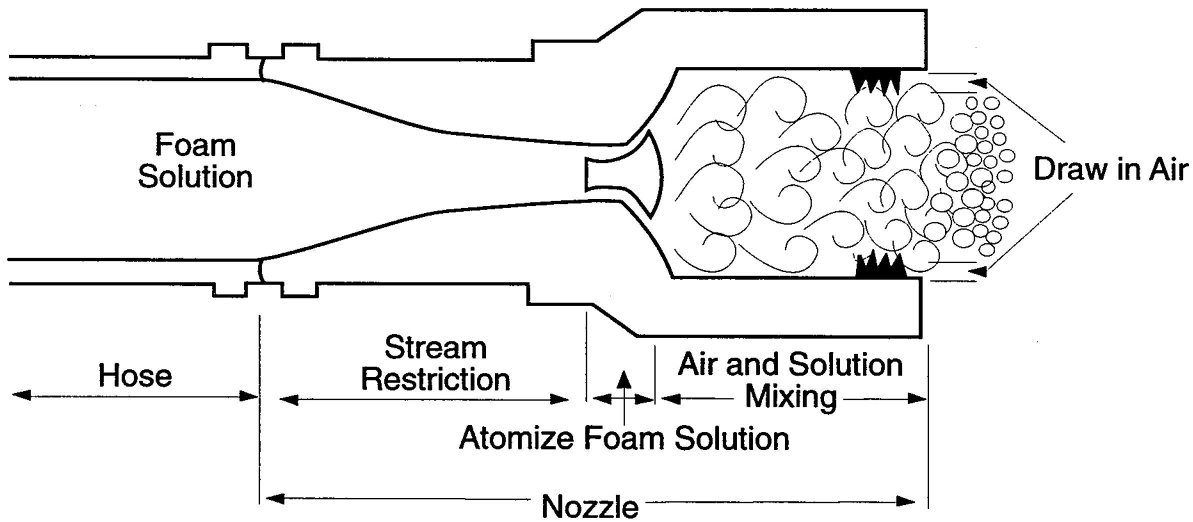
1. Define a nozzle aspirating foam system.
2. List two types of nozzles used in an aspirating system.

Aspirating Nozzle



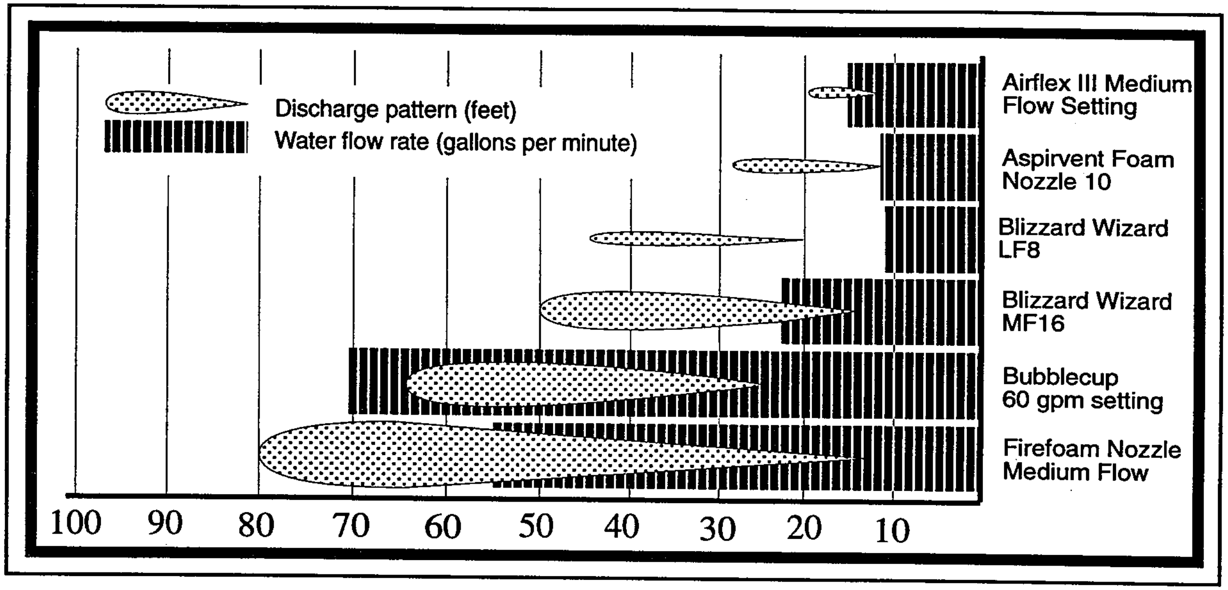
Notes:

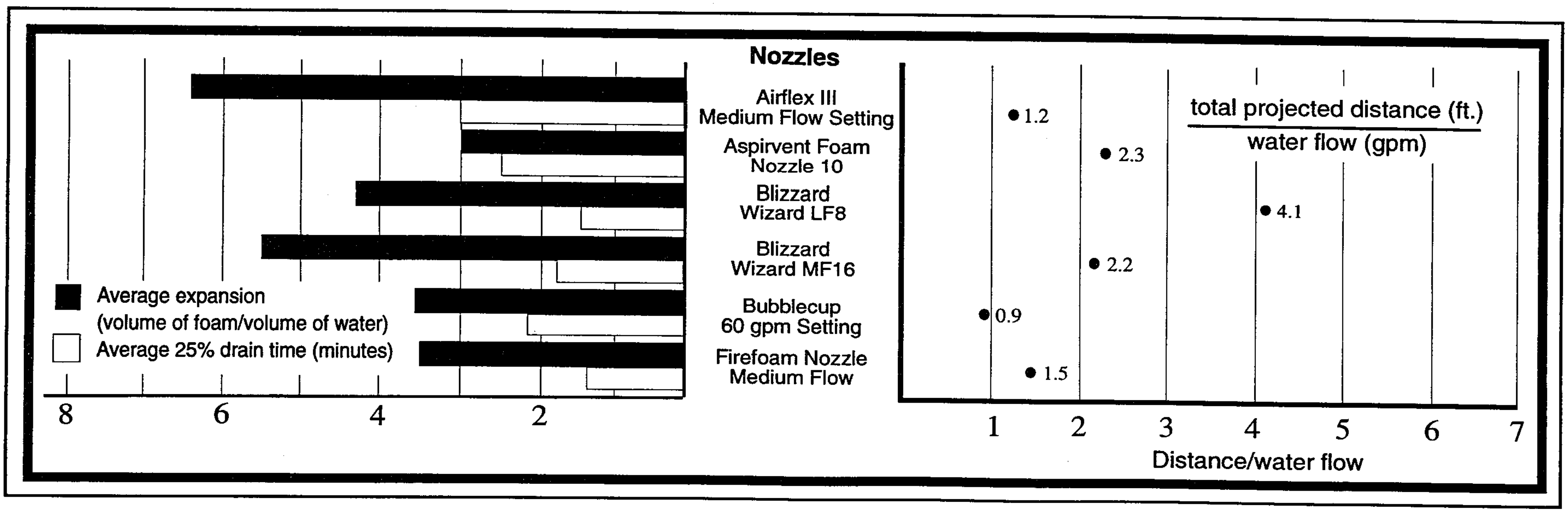
Aspirating Nozzle



Notes:

Aspirating Nozzle Performance





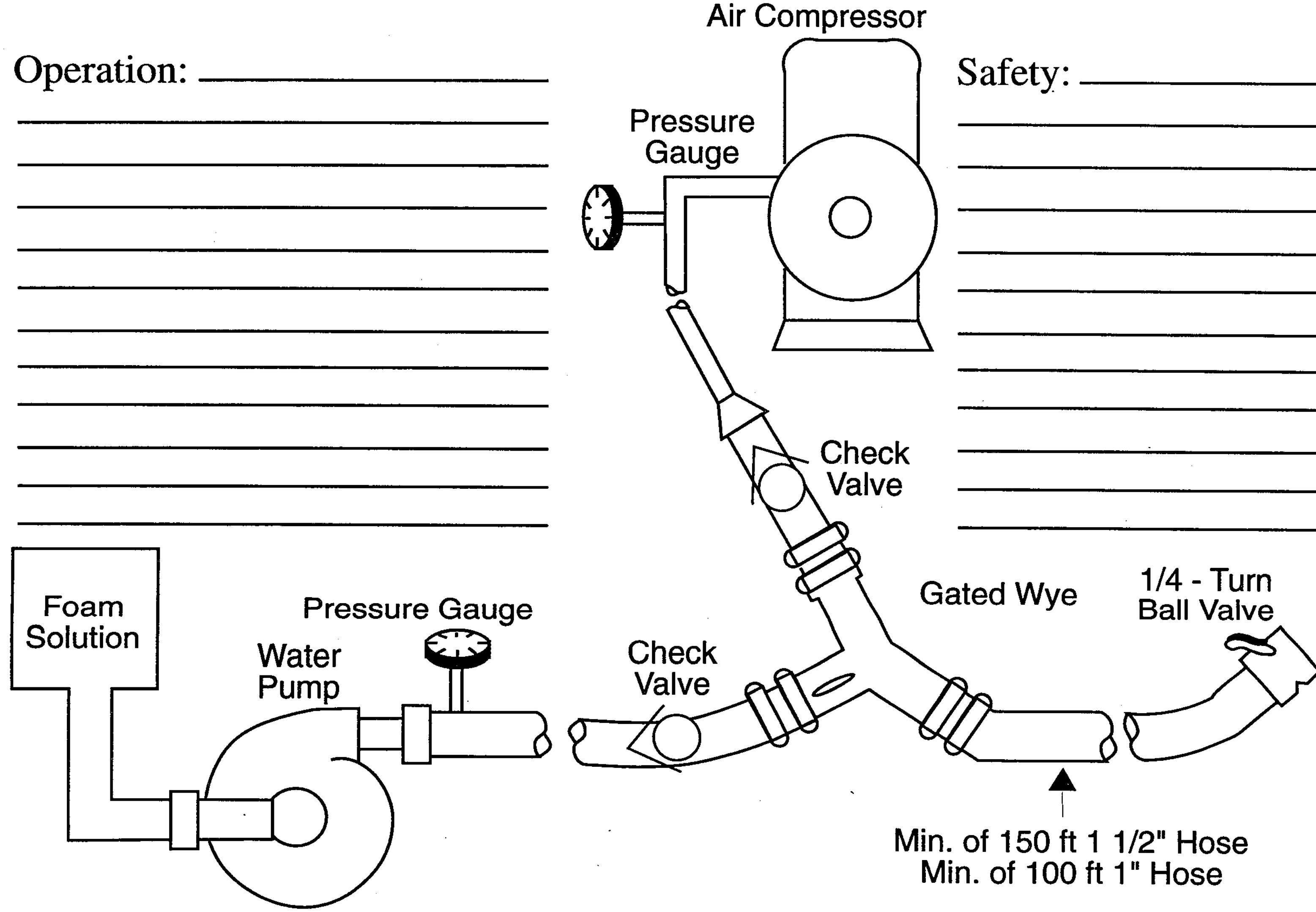
Unit 5 Objectives

Compressed Air Foam Systems

1. Define a compressed air foam system.
2. Explain why a compressed air foam system is a high energy system.
3. List two ways to change the type of foam projected from a CAFS unit.
4. List three safety concerns with a CAFS unit.
5. Describe two differences between CAFS and aspirating nozzle foam systems.

Compressed Air Foam System

Operation: ______________________



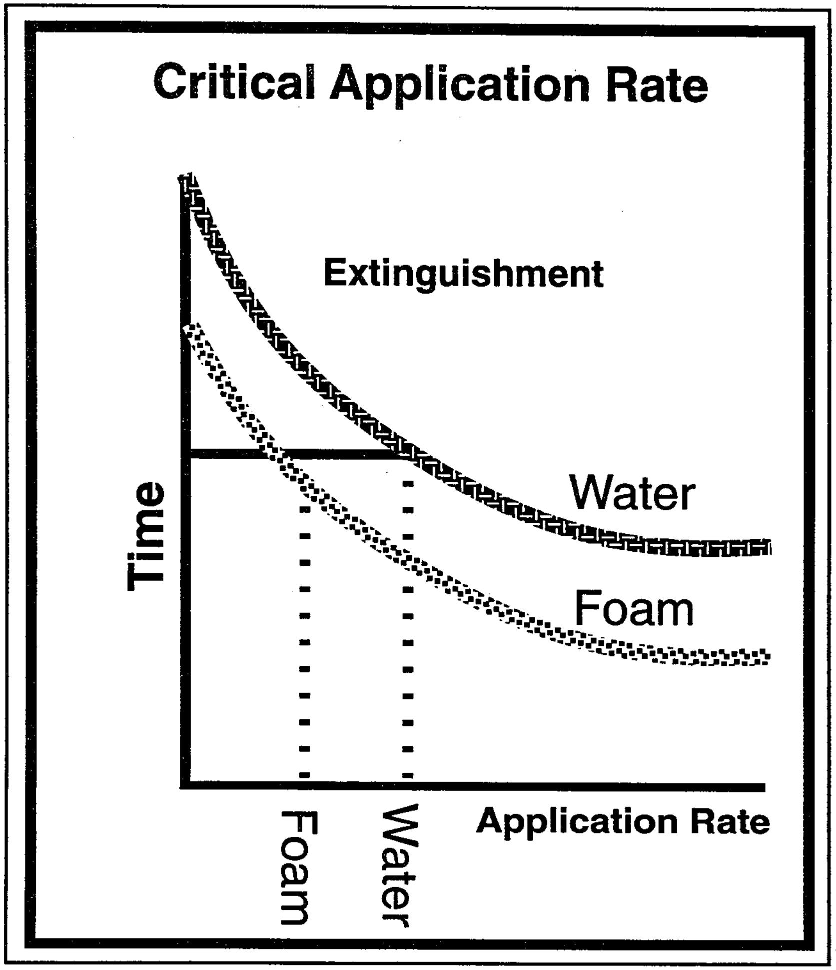
Safety: ______________________

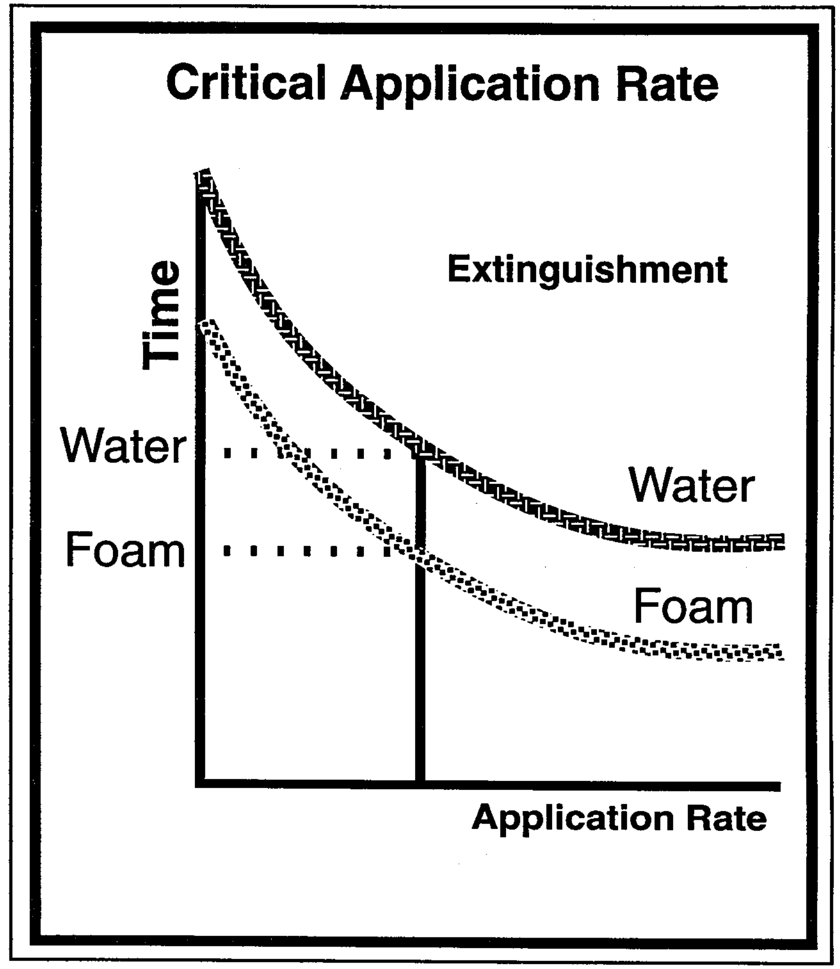
Compressed Air Foam	VS.	Aspirated Foam

Unit 6 Objectives

Applications from the Ground

1. Define Critical Application Rate.
2. List four applications for foam generating systems.
3. Explain why foam is a suppressant rather than a retardant.
4. Explain why foam is a short term protection tool.
5. Explain why Class A foams are not used on Class B fires.


Critical Application Rate
Extinguishment
Time
Water
Foam
Application Rate
Foam
Water


Critical Application Rate
Extinguishment
Time
Water
Foam
Water
Foam
Application Rate

Notes:

Applications for:

Foam Solution

Wet Solution

Fluid Foam

Dry Foam

What to use on:

Mop-up

Direct Attack

Indirect Attack

Exposure Protection

Class A Foam

VS.

Class B Foam

Unit 7 Objectives

Applications from Aircraft

1. Explain why foam dropped from the air is only a suppressant.
2. Name two types of aircraft that can deliver foam.
3. Name two factors that affect quality of foam delivered from aircraft.

Suppressant

Retardant

Aircraft Used to Drop Foam:

Factors Affecting Foam Delivered:

Notes:

Notes:

Notes:

APPENDIX D

OUTLINE FOR OUTDOOR EXERCISES

CLASS A FOAM

OUTLINE FOR OUTDOOR EXERCISES

The purpose of these exercises is to supplement lecture and discussion of Units 3, 4, and 5. Several exercises are outlined here to be used at the discretion of the cadre. It is recognized that equipment availability and interest, and adequate demonstration grounds vary. This outline should be used as a guide to demonstrating the foam equipment of most importance to the students.

These non-fire exercises should be conducted with adequate consideration for personal safety. Participants should wear at a minimum gloves, goggles, hard hats, and boots.

A. Manual Proportioners

1. Suction-side Proportioner

   a. Equipment
      -- Portable pump, hose, fuel
      -- Garbage can or portable water tank
      -- Suction-side proportioner of choice
      -- Foam concentrate
      -- Aspirating foam nozzle

   b. Operation
      -- Begin with proportioner plumbed and ready.
      -- Start pump, open nozzle, open valve on proportioner.
      -- Change concentrate flows, water flows, water pressure, note effects if any.
      -- Shut down nozzle with pump on, note effect on concentrate flow.

   c. Discussion
      -- Function and use
      -- Advantages/disadvantages
      -- What to do with a flooded suction?
      -- How do you make it work for your situation?

2. Around-the-Pump Proportioner

a. Equipment
- -- Portable pump, hose, fuel, pressure relief valve
- -- Garbage can or portable water tank
- -- Around-the-pump proportioner of choice
- -- Foam concentrate
- -- Aspirating foam nozzle

b. Operation
- -- Begin with proportioner plumbed and ready.
- -- Start pump, open nozzle, open valve on proportioner.
- -- Change concentrate flows, water flows, water pressure, note effects if any.
- -- Shut down nozzle with pump on, note effects on concentrate flow and pump pressure.

c. Discussion
- -- Function and use
- -- Advantages/disadvantages
- -- What happened when nozzle was shut?
- -- What might happen without a pressure relief valve?
- -- How do you make it work for your situation?

3. Eductor

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose, at least 300 feet
- -- Water supply: portable water tank or engine water tank
- -- Eductor of choice
- -- Pressure gauges plumbed on both sides of eductor
- -- Foam concentrate
- -- Nozzle matching gallonage required for eductor

b. Operation
- -- Begin with proportioner plumbed and ready.
- -- Start pump, open nozzle, open valve on proportioner
- -- Change concentrate flows, water flows, water pressure, note effects if any.

c. Discussion
- -- Function and use
- -- Advantages/disadvantages
- -- How does eductor respond to changes in water flow, hose length, etc?
- -- How do you make it work for your situation?

4. <u>By-pass eductor</u>

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose, at least 300 feet
- -- Water supply: portable water tank or engine water tank
- -- By-pass eductor of choice
- -- Pressure gauges plumbed on both sides of by-pass eductor
- -- Foam concentrate
- -- Variable flow nozzle matched to flow range of proportioner

b. Operation
- -- Begin with proportioner plumbed and ready.
- -- Start pump, open nozzle, open valve on proportioner,
- -- Change concentrate flows, water flows, water pressure, note effects if any.

c. Discussion
-- Function and use
-- Advantages/disadvantages
-- How does by-pass eductor respond to changes in water flow, hose length, etc?
-- For what range of flow and pressure is the unit proportional?
-- How do you make it work for your situation?

5. <u>Manual Direct Injection Proportioner</u>

a. Equipment
-- Pump, portable or engine-mounted, fuel
-- Hose
-- Water supply: portable water tank or engine water tank
-- Manual direct injection proportioner of choice
-- Foam concentrate
-- Foam nozzle

b. Operation
-- Begin with proportioner plumbed and ready.
-- Start pump, open nozzle, open valve on proportioner,
-- Change concentrate flows, water flows, water pressure, note effects if any.

c. Discussion
-- Function and use
-- Advantages/disadvantages
-- How does proportioner respond to changes in water flow?
-- For what range of flow and pressure is the unit proportional?
-- How do you make it work for your situation?

B. Automatic Proportioners

1. Balanced pressure bladder tank (Robwen Flow-mix 500)

   a. Equipment
      - -- Pump, portable or engine-mounted, fuel
      - -- Hose
      - -- Water supply: portable water tank or engine water tank
      - -- Flowmix 500 or equivalent, portable 5 gal. or engine mounted
      - -- Foam concentrate
      - -- Foam nozzle

   b. Operation
      - -- Begin with proportioner plumbed and ready.
      - -- Start pump, open nozzle, open selector and metering valves on proportioner.
      - -- Change concentrate flows, water flows, water pressure, note effects if any.
      - -- Demonstrate flushing the system.
      - -- Demonstrate refilling the bladder.
      - -- Disconnect from hose and disassemble and reassemble unit.

   c. Discussion
      - -- Function and use
      - -- Advantages/disadvantages
      - -- How does proportioner respond to changes in water flow?
      - -- For what range of flow and pressure is the unit proportional?
      - -- How do you make it work for your situation?
      - -- How do you replace a bladder?
      - -- Why might there be foam solution on the outside of the bladder?

2. Balance Pressure Pump Proportioner (KK Pro/portioner)

a. Equipment
-- Pump, portable or engine-mounted, fuel
-- Hose
-- Water supply: portable water tank or engine water tank
-- KK Pro/portioner or equivalent, portable or engine mounted.
-- Foam concentrate
-- Foam nozzle

b. Operation
-- Begin with proportioner plumbed and ready.
-- Start pump, open nozzle, open selector and metering valves on proportioner
-- Demonstrate priming and starting the proportioner pump.
-- Change concentrate flows, water flows, water pressure, note effects if any.
-- Demonstrate flushing the system
-- Demonstrate refill

c. Discussion
-- Function and use
-- Advantages/disadvantages
-- How does proportioner respond to changes in water flow?
-- For what range of flow and pressure is the unit proportional?
-- How do you make it work for your situation?

3. Automatic Direct Injection (Hypro 2001)

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose
- -- Water supply: portable water tank or engine water tank
- -- Hypro 2001 or equivalent, portable or engine mounted
- -- Foam concentrate
- -- Foam nozzle

b. Operation
- -- Begin with proportioner plumbed and ready.
- -- Start water pump, open nozzle
- -- Start proportioner pump, set mix ratio.
- -- Change concentrate flows, water flows, water pressure, note effects if any.
- -- Demonstrate flushing the system.
- -- Demonstrate refill.

c. Discussion
- -- Function and use
- -- Advantages/disadvantages
- -- How does proportioner respond to changes in water flow?
- -- For what range of flow and pressure is the unit proportional?
- -- How do you make it work for your situation?

C. Aspirating Nozzles

1. Comparison of 3 nozzles

a. Equipment

- -- Pump, portable or engine-mounted, fuel
- -- Hose
- -- Water supply: portable water tank or engine water tank
- -- Automatic proportioner of choice, portable or engine mounted
- -- Foam concentrate
- -- Foam nozzles: 16 gpm bubble cup, 16 gpm Blizzard Wizard, Wajax Airflex III, any other with equal flow characteristics

b. Operation

- -- Provide each nozzle with equal mix ratio and water flow.
- -- Students should operate the nozzles.

c. Discussion

- -- At equal flow rates compare foam generation, discharge distance, cost, etc.
- -- Are all foam nozzles the same?
- -- Does higher cost equal better performance?
- -- For what application would each nozzle be best suited for?

2. <u>Demonstration of all low expansion nozzles</u>

a. Equipment

- -- Pump, portable or engine-mounted, fuel
- -- Hose
- -- Water supply: portable water tank or engine water tank
- -- Automatic proportioner of choice, portable or engine mounted
- -- Foam concentrate
- -- Foam nozzles: All low-expansion nozzles available except those in nozzle exercise #1., depending on how many nozzle exercises are conducted

b. Operation

- -- Provide each nozzle with equal mix ratio and recommended water flow and pressure.
- -- Students should operate the nozzles.

c. Discussion

- -- Compare foam generation, discharge distance, water flow and pressure, mix ratio, cost, etc.
- -- Are all foam nozzles the same?
- -- Does higher cost equal better performance?
- -- For what application would each nozzle be best suited?
- -- Notice how nozzles are constructed and how this influences foam created.

3. <u>Medium and High expansion nozzles</u>

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose
- -- Water supply: portable water tank or engine water tank
- -- Automatic proportioner of choice, portable or engine mounted
- -- Foam concentrate
- -- Foam nozzles: All medium- and high-expansion nozzles available

b. Operation
- -- Provide each nozzle with equal mix ratio and recommended water flow and pressure.
- -- Students should operate the nozzles.

c. Discussion
- -- Compare foam generation, discharge distance, cost, water flow, water pressure, mix ratio required, etc.
- -- Does higher cost equal better performance?
- -- For what application would each nozzle be best suited?
- -- Notice how nozzles are constructed and how this influences foam created.

4. <u>Build your own nozzle</u>

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose
- -- Water supply: portable water tank or engine water tank
- -- Automatic proportioner of choice, portable or engine mounted
- -- Foam concentrate
- -- Foam nozzles: All custom and home-made nozzles available

b. Operation
- -- Provide each nozzle with equal mix ratio and recommended water flow and pressure.
- -- Students should operate the nozzles.

c. Discussion
- -- Compare foam generation, discharge distance, cost, water flow, water pressure, mix ratio required, etc.
- -- Discuss features required to make foam: restriction, divided stream, air inlets, tube
- -- Notice how nozzles are constructed and how different dimensions of parts affect foam created: tube length, tube diameter, air intake design, atomized stream design, screen mesh size and placement, other
- -- Does higher cost equal better performance?
- -- For what application would each nozzle be best suited?

D. Compressed Air Foam Systems

1. <u>Manifold</u>

a. Equipment
- -- Pump, portable or engine-mounted, fuel
- -- Hose, 1-inch and 1.5 inch
- -- Water supply: portable water tank or engine water tank
- -- Automatic proportioner of choice, portable or engine mounted
- -- Foam concentrate
- -- Air compressor or compressed air source, trailer or engine mounted
- -- Manifold components:
  - (1) Gated Wye, 1.5 inch
  - (2) 2 pressure gauges on 1.5 inch in-line tees
  - (3) 2 check valves

(4) double female, double male 1.5-inch
(5) double female 1-inch
(6) 1.5 inch to 1 inch reducer

-- 1/4-turn ball shut-off with pistol grip

b. Operation

-- Begin with manifold disassembled.
-- Following the operation described in "In-line CAFS Instructions," 05-01-FOAM-HO, work students through construction of manifold at least once, being careful to note sequential placement of pressure gauge, check valve, gated wye in reverse.
-- Students operate the discharge line and adjust flows of air and foam solution.

c. Discussion

-- Compare foam generation, discharge distance, cost, water flow, water pressure, mix ratio required, etc. with aspirated foam.
-- What happens to the pressure of air and water after foam is flowing?
-- What would happen if check valves were not installed?
-- What would happen if check valves were installed between the water and air sources and their pressure gauges?

2. Slug Flow

a. Equipment

-- CAFS as described in 1. or CAFS-equipped fire engine equipped as in 1.

b. Operation

-- Demonstrate slug flow from monitor or hose line. With hose line, use 50-75 psi static pressure. Flow compressed air foam at normal settings including mix ratio about 0.3%. Gradually reduce mix ratio until discharge pulses in slugs of water and air. Students should operate the equipment and nozzle.

c. Discussion

-- Why does slug flow happen? What might cause this?

-- How do you solve the problem? (Add concentrate, shut off air)

-- How does the nozzle operator handle the pulsing? (Crack the nozzle)

3. Nozzle operation and safety

a. Equipment

-- CAFS as described in 1. or CAFS-equipped fire engine equipped as in 1.

b. Operation

-- Demonstrate safe stance and opening procedure of ball shut off. Allow students to perform this. Operate at 100 psi or less.

-- Demonstrate discharge distance, foam qualities produced, weight of hose filled with compressed air foam, etc.

-- Apply foam to ground, vegetation, and vertical surfaces.

c. Discussion

-- What happens if nozzle operator is not prepared?

-- What causes the initial surge of foam?

-- Is there a value in light hose?

CLASS A FOAM

APPENDIX E

COURSE EQUIPMENT NEEDS

CLASS A FOAM

EQUIPMENT LIST: Class A Foam

Foam concentrate	15-20 gallons
Portable water tank	1
Water pump, portable or built-in	1
Proportioners, portable or built-in	at least 1 of any kind
Low and Medium expansion nozzles	at least 1 of each and all locally used
Compressed air foam system	1 unit, if used locally
Fire hose, all diameters normally used	200 feet
1/4-turn ball shut-off, fits CAFS hose	1
Foam-equipped fire engine	at least 1

Cardboard, 3" x 3"	2 per 3 students
Large-mouthed, see-through container, such as a glass beaker or equivalent, 100 ml (about 1 quart) size or larger.	4
Sphagnum peat moss, dry	about 10 lbs.
Large-mouthed container, 1 gallon size	2
Paper towels	1 roll
Stir rods, or equivalent	2

Overhead projector	1
VHS video player	1
Slide carousel projector	1

APPENDIX F

PRE-COURSE

INFORMATION AND WORKSHEET

CLASS A FOAM

PRECOURSE WORKSHEET KEY

1. What was one of the recent developments in foam technology that has made use of foam in wildland firefighting possible today?

    -- **Development of the compressed air foam system.**
    -- **Development of new foaming agents blended for mix ratios less than 1%.**

2. Why is it important to know if the foam being used has a fast or slow draintime?

    Foams with fast draintimes release water and "disappear" sooner than foams with slow draintimes. Each foam is appropriate for different applications and may not be effective on the same application.

3. List four practices to minimize the impact of foam products on the environment.

    -- **Avoid application of foam directly into bodies of water.**
    -- **Inform personnel of the potential problems of excessive environmental exposure.**
    -- **Locate mixing and loading areas to minimize contact with natural bodies of water.**
    -- **Avoid spills.**
    -- **Be cautious around fish hatcheries.**
    -- **Notify authorities of fish kill or spills.**
    -- **Use caution with helicopters dipping buckets from rivers and lakes.**

4. What is the difference between manually- and automatically-regulated proportioners?

   Manually-regulated proportioners must be adjusted by hand to maintain a constant mix ratio when water flow changes, or they may only work at one water flow. Automatically-regulated proportioners will adjust the flow of concentrate independently to maintain a constant mix ratio when water flow changes.

5. List three advantages of aspirating nozzles as compared to compressed air foam systems.

   -- **Requires minimal equipment**
   -- **Simple to operate**
   -- **Inexpensive to develop and initiate**
   -- **Adapts to any system capable of pumping foam solution.**
   -- **A variety of expansions are possible with different nozzles.**

6. List three advantages of compressed air foam systems as compared to aspirating nozzles.

   -- **Requires less water flow**
   -- **Provides greater discharge distance per gallon flowed**
   -- **Converts more water to bubbles**
   -- **Requires less concentrate**
   -- **Produces a rope effect, placing more output on the target**
   -- **Produces all types of foams**
   -- **Provides a lighter hose weight**
   -- **Reduces head pressure in hose**
   -- **Provides stored energy in the hose**
   -- **Produces most stable foam**

7. Which type(s) of foam are recommended for mopup? Which type(s) is not?

   Foam solution, wet foam, fluid foam are recommended. Dry foam is not.

APPENDIX G

COURSE ANNOUNCEMENT

AND

TRAINEE PROFILE

CLASS A FOAM

TRAINING ANNOUNCEMENT

Course Title: CLASS A FOAM

Course Dates:

Location:

Nominations Due At: By Date:

Notification of Selection Date:

Target Group: Prospective wildland firefighters who work on or around water handling equipment in all geographic areas of the United States.

Prerequisites:

- S-130 Firefighter Training
- S-190 Introduction to Wildland Fire Behavior
- S-211 Portable Pumps and Water Use

Description: An interactive course combining short lectures, lab demonstrations, and videos to introduce students to Class A Foam.

Other Information: Attendees will be provided a written evaluation which will also be sent to their supervisor.

CLASS A FOAM

TRAINING PROFILE

Course Title: CLASS A Foam

Name of Student:

Agency:

Unit:

ICS Qualifications ______________________________
____

Water Handling Experience:

Fire Training: (check appropriate boxes)

- ☐ S-130 Firefighter Training
- ☐ S-190 Introduction to Wildland Fire Behavior
- ☐ S-211 Portable Pumps and Water Use

Class A Foam Application and Generating Equipment Experience:

CLASS A FOAM

CLASS A FOAM

LOGISTICAL INFORMATION

The following information is provided to assist you in making necessary arrangements to attend the course. We would like to make everyone's stay as comfortable as possible.

COURSE COORDINATOR:

Name ______________________________
Location ______________________________
Phone # ______________________________

If you have any questions concerning the logistical information provided below, please contact the course coordinator.

TRAVEL ARRANGEMENTS: (Agency information pertaining to driving, flying, etc.)

Travel to and from the training site will be the responsibility of the benefitting unit.

PER DIEM: The per diem rate for is $_____ per day.

LODGING: Upon receipt of this information, you should make reservations for your stay.

MOTEL: Name

Location

Phone #

Government Credit Card accepted? (check one) YES __ NO __

Our motel is located _____ miles from the training site.

MEALS: All meals are the participants' responsibility. A list of local restaurants will be furnished at the beginning of class.

MEETING PLACE: We will be meeting at ________________________.

CLASS A FOAM

DRESS AND WEATHER: Field and/or casual dress is recommended for the classroom session and outdoor events. Hardhat, gloves, and goggles are also necessary for the outdoor events.

TELEPHONE MESSAGES: Telephone messages will be received by ____________

LOGISTICAL ITEMS: The benefitting unit must provide students with the following items to be brought to class.

SPIKE CAMP: If applicable.

APPENDIX H

SLIDE LIST

CLASS A FOAM

SLIDE LIST

SLIDE NUMBER	TITLE
00-01-FOAM -SL	Course Purpose
00-02-FOAM-SL	Course Objectives
00-03-FOAM-SL	Course Objectives (continued)
00-04-FOAM-SL	Course Objectives (continued)
01-01-FOAM-SL	Unit 1 Objectives
01-02-FOAM-SL	Unit 1 Objectives (continued)
01-03-FOAM-SL	Water (Title)
01-04-FOAM-SL	Flaming Front
01-05-FOAM-SL	Cheat Grass Fire Engine Attack
01-06-FOAM-SL	The Water Molecule
01-07-FOAM-SL	Under the Surface
01-08-FOAM-SL	At the Surface
01-09-FOAM-SL	Surfactants (Title)
01-10-FOAM-SL	Surfactant = Surface Active Agent
01-11-FOAM-SL	Hydrocarbon Surfactant Molecule
01-12-FOAM-SL	Surfactant at the Surface of Water
01-13-FOAM-SL	Fluorocarbon Surfactant Molecule

CLASS A FOAM

SLIDE NUMBER	TITLE
01-14-FOAM-SL	Wetting Agent
01-15-FOAM-SL	Different Foaming Agents
01-16-FOAM-SL	Foam Solution (Title)
01-17-FOAM-SL	Foam Concentrate + Water = Foam Solution
01-18-FOAM-SL	Mix Ratio Class A Foam
01-19-FOAM-SL	Metering Value Showing Range of Mix Ratios
01-20-FOAM-SL	Foam (Title)
01-21-FOAM-SL	Foam Solution + Air = Foam
01-22-FOAM-SL	Expansion Ratio
01-23-FOAM-SL	Milky Bubbles
01-24-FOAM-SL	Nozzle and Fire, Showing Foam Solution
01-25-FOAM-SL	Log Deck Foamed
01-26-FOAM-SL	Log Deck Fire
01-27-FOAM-SL	Foam on Fence
01-28-FOAM-SL	Exposure Protection
01-29-FOAM-SL	Canadian With Medium Nozzle on a Log Deck
01-30-FOAM-SL	Foam Covering Live as well as Down and Dead Fuels
01-31-FOAM-SL	Fire Burning Against a Foam Line

CLASS A FOAM

SLIDE NUMBER	TITLE
01-32-FOAM-SL	Fire Being Reflected by Foam in Slash Pile
01-33-FOAM-SL	Foam Insulating an Old House
01-34-FOAM-SL	Applying the Foam to a Car
01-35-FOAM-SL	Foam Adhering to a Fir Tree
01-36-FOAM-SL	Unit 1 Objectives
01-37-FOAM-SL	Unit 1 Objectives (continued)
02-01-FOAM-SL	Unit 2 Objectives
02-02-FOAM-SL	Safety Equipment
02-03-FOAM-SL	Foam in the Lake
02-04-FOAM-SL	Helicopters Dipping in a River
02-05-FOAM-SL	Unit 2 Objectives
03-01-FOAM-SL	Unit 3 Objectives
03-02-FOAM-SL	Proportioner Schematic
03-03-FOAM-SL	Manual Proportioners (Title)
03-04-FOAM-SL	Batch in Collapsible Tank
03-05-FOAM-SL	Schematic of Suction Side Proportioner
03-06-FOAM-SL	Picture of Suction Side Proportioner

CLASS A FOAM

SLIDE NUMBER	TITLE
03-07-FOAM-SL	Schematic of Eductor
03-08-FOAM-SL	Eductor
03-09-FOAM-SL	Schematic of By-Pass Eductor
03-10-FOAM-SL	By-Pass Eductor
03-11-FOAM-SL	Schematic of an Around the Pump Proportioner
03-12-FOAM-SL	Around the Pump Proportioner
03-13-FOAM-SL	Manual Direct Injection Proportioner
03-14-FOAM-SL	Accufoam Unit
03-15-FOAM-SL	Automatic Proportioners (Title)
03-16-FOAM-SL	Schematic of a Balanced Pressure Bladder Proportioner
03-17-FOAM-SL	Balance Pressure Bladder Proportioner (Flow-Mix)
03-18-FOAM-SL	Schematic of a Balanced Pressure Pump Proportioner
03-19-FOAM-SL	Balanced Pressure Pump Proportioner (KK)
03-20-FOAM-SL	Schematic of a Automatic Direct Injection Proportioner
03-21-FOAM-SL	Automatic Direct Injection Proportioner (Hypro 2001)
03-22-FOAM-SL	Unit 3 Objectives
04-01-FOAM-SL	Unit 4 Objectives
04-02-FOAM-SL	Schematic of a Nozzle-Aspirating Foam System

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SLIDE NUMBER	TITLE
04-03-FOAM-SL	Schematic of a Standard Single-Pattern Aspirating Nozzle
04-04-FOAM-SL	Schematic of a Multiple Pattern Aspirating Nozzle
04-05-FOAM-SL	Medium Expansion Aspirating Nozzle Discharge
04-06-FOAM-SL	Back Pack Pump Aspirating Nozzles
04-07-FOAM-SL	Mark 26 Pump
04-08-FOAM-SL	Tracked Engine
04-09-FOAM-SL	State of Montana Engine
04-10-FOAM-SL	Assorted Nozzles
04-11-FOAM-SL	Medium Expansion Nozzle Application
04-12-FOAM-SL	High Expansion Nozzle Application
04-13-FOAM-SL	High Expansion Nozzle Flow
04-14-FOAM-SL	Homemade Nozzle -- Side Mounted on Engine
04-15-FOAM-SL	Shooting Foam With a Low Expansion Nozzle
04-16-FOAM-SL	Medium Expansion Foam Application Demonstration
04-17-FOAM-SL	Low and Medium Expansion Foams on Slope-Aerial View
04-18-FOAM-SL	Low Expansion Foam on Blazer
04-19-FOAM-SL	Unit 4 Objectives

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SLIDE NUMBER	TITLE
05-01-FOAM-SL	Unit 5 Objectives
05-02-FOAM-SL	Unit 5 Objectives (continued)
05-03-FOAM-SL	Schematic of CAFS Setup
05-04-FOAM-SL	Picture of Gated Wye Setup
05-05-FOAM-SL	Shooting CAFS Foam 80 ft. into the Air
05-06-FOAM-SL	Firefighter Batch Mixing
05-07-FOAM-SL	CAFS Bubbles
05-08-FOAM-SL	CAFS Applied to Side of Structure
05-09-FOAM-SL	CAFS Foam on Log Deck
05-10-FOAM-SL	CAFS Discharge onto Wildlife Snag
05-11-FOAM-SL	Ball Valves
05-12-FOAM-SL	Conventional Nozzle CAFS
05-13-FOAM-SL	Nozzle Operation
05-14-FOAM-SL	Unit 5 Objectives
05-15-FOAM-SL	Unit 5 Objectives (continued)

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SLIDE NUMBER	TITLE
06-01-FOAM-SL	Unit 6 Objectives
06-02-FOAM-SL	Unit 6 Objectives (Continued)
06-03-FOAM-SL	Critical Application Rate Chart -- Flow Rate as Function of Time
06-04-FOAM-SL	Critical Application Rate Chart -- Time as a Function of Flow Rate
06-05-FOAM-SL	Mopup (Title)
06-06-FOAM-SL	Foam on PJ Tree
06-07-FOAM-SL	CAFS Foam Misting a Log
06-08-FOAM-SL	Medium Expansion Nozzle Working on a Fire
06-09-FOAM-SL	Aerial View of Foam-Treated Area
06-10-FOAM-SL	Mopup Wand
06-11-FOAM-SL	Indirect Attack and Protective Barriers (Title)
06-12-FOAM-SL	Burnout Operation in Sagebrush/Grass
06-13-FOAM-SL	Fire Against Foam Line
06-14-FOAM-SL	Foam Line Through Logging Slash
06-15-FOAM-SL	Texas Burnout
06-16-FOAM-SL	Texas Burnout
06-17-FOAM-SL	Foam on Matted Fine Fuels

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SLIDE NUMBER	TITLE
06-18-FOAM-SL	Fireproofing a Telephone Pole
06-19-FOAM-SL	Prescribed Fire Perimeter Foam Treatment
06-20-FOAM-SL	Foam Barrier From Pump and Roll
06-21-FOAM-SL	Foam on Ground Obscuring Safe Footing
06-22-FOAM-SL	Grass Fire
06-23-FOAM-SL	Direct Attack (Title)
06-24-FOAM-SL	Firefighter Working in Slash Pile
06-25-FOAM-SL	Applying Foam to Unburned Edge
06-26-FOAM-SL	Direct Attack with CAFS
06-27-FOAM-SL	Structural firefighter with CAFS
06-28-FOAM-SL	CDF Attack With Bubble Cup
06-29-FOAM-SL	CDF Attack With Bubble Cup
06-30-FOAM-SL	Exposure Protection (Title)
06-31-FOAM-SL	House Covered With Foam
06-32-FOAM-SL	Log Cabin and CAFS Discharge
06-33-FOAM-SL	Log Garage
06-34-FOAM-SL	Foam-Treated Cabin Losing its Foam Blanket
06-35-FOAM-SL	Hazardous Materials (Title)

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SLIDE NUMBER	TITLE
06-36-FOAM-SL	Car Fire Medium Nozzle
06-37-FOAM-SL	Petroleum Fire
06-38-FOAM-SL	Unit 6 Objectives
06-39-FOAM-SL	Unit 6 Objectives (continued)
07-01-FOAM-SL	Unit 7 Objectives
07-02-FOAM-SL	CL215 Dropping
07-03-FOAM-SL	B24 Dropping Retardant
07-04-FOAM-SL	Single Engine Agricultural Spray Plane Ship Dropping
07-05-FOAM-SL	Helicopter With Bucket Dropping
07-06-FOAM-SL	Helicopter With Fixed Tank Dropping
07-07-FOAM-SL	Unit 7 Objectives
07-08-FOAM-SL	Course Objectives
07-09-FOAM-SL	Course Objectives (continued)
07-10-FOAM-SL	Course Objectives (continued)

CLASS A FOAM

APPENDIX I

VIDEOTAPE LIST

CLASS A FOAM

VIDEOTAPE LIST

01-01-FOAM-VT	"INTRODUCTION TO CLASS A FOAM" NFES #2073 Time 13:00 minutes
01-02-FOAM-VT TAPE 1	"CLASS A FOAM VIDEO DATABASE" NFES #1304 53 Segments:Average Time 2.5 minutes
01-02-FOAM-VT TAPE 2	"CLASS A FOAM VIDEO DATABASE" NFES #1305 58 Segments: Average Time 1.5 minutes
01-03-FOAM-VT	"PROPERTIES OF FOAM" NFES #2219 Time 15:00 minutes
03-01-FOAM-VT	"CLASS A FOAM PROPORTIONERS" NFES #2245 Time 23:00 minutes
04-01-FOAM-VT	"ASPIRATING NOZZLES" NFES #2272 Time 10:00 minutes
05-01-FOAM-VT	"COMPRESSED AIR FOAM SYSTEMS" NFES #2161 Time 20:00 minutes
06-01-FOAM-VT	"TACTICAL APPLICATIONS WITH CLASS A FOAM" NFES #2404 Time 7:30 minutes

APPENDIX J

VIDEOTAPE CROSS REFERENCE TABLE

APPENDIX K

SUBJECT INDEX FOR

CLASS A FOAM VIDEO DATABASE

CLASS A FOAM VIDEO DATABASE
GENERAL SUBJECT INDEX:

Tape No.1 *Total Tape Time:* *120:00*

<u>INTRODUCTION</u> *Total Segment Time:* *3:00*
TWO PRIMARY TACTICAL OBJECTIVES

<u>INDIRECT WILDLAND TACTICS</u>
RESOURCE PROTECTION *17:00*
<u>Surface exposures</u>
<u>Aerial exposures</u>
<u>Snag protection</u>
LINE CONSTRUCTION
<u>Hose applications</u> *33:00*
Class A synthetic foam
High expansion
Medium expansion
Low expansion
Durable foam
<u>Pump and Roll</u> *35:00*
CAFS
High expansion
Medium expansion
Low expansion aspirated
<u>Downhill</u> *22:00*
Understory/slash
Brush/grass

Tape No. 2 *Total Tape Time:* *101:00*

<u>DIRECT WILDLAND TACTICS</u>
CONTROL/KNOCKDOWN *Total Segment Time:* *18:00*
MOP-UP *30:00*
<u>Low expansion</u>
Aspirated
CAFS

CLASS A FOAM

Medium expansion
High expansion

WILDLAND/URBAN INTERFACE	*12:00*
AERIAL DELIVERY	*9:00*
FIXED WING	
Single Engine	
Water Scoopers	
Airtanker	
ROTOR WING	
Helitank	
Helibucket	
VEHICLE FIRE	*6:00*
EXTERIOR ATTACK OF STRUCTURE FIRE	*10:00*
FLAMMABLE LIQUID FIRE	*13:00*
FOAM PROPERTIES	*2:00*
DRAINTIME	

CLASS A FOAM VIDEO DATABASE
SPECIFIC SUBJECT INDEX:

Tape No. 1
(Minutes from start) (Scene number) (Description)

00:00 INTRODUCTION

02:00 TWO PRIMARY TACTICAL OBJECTIVES

INDIRECT WILDLAND TACTICS

RESOURCE PROTECTION

Surface exposures

03:40 1 High expansion foam applied to protect understory brush.

06:30 2 High expansion foam applied to protect surface fuels within a prescribed burn area.

07:20 3 High expansion foam used on ground fuels under canopy to protect intermittent (and dry) stream bed.

09:40 4 High expansion nozzle (fan) in grass, wide application for ground exposure protection.

12:00 5 Medium expansion foam applied to protect slash and understory fuels.

13:10 6 Medium expansion foam used as a heat sink on fuels under thinned pine canopy.

14:20 7 Low expansion aspirated foam is used to demonstrate wetting dry fuels.

15:20 8 Foam on fuels exposed to flame showing wetting, insulating, and drying.

CLASS A FOAM

Aerial exposures

16:00 1 Compressed air foam applied to sapling canopy above intermittent (and dry) stream bed inside a prescribed fire unit boundary. Surface fuels were blanketed with high expansion foam.

17:40 2 Compressed air foam applied to thinned pine canopy above surface fuels treated with medium expansion foam.

18:30 3 Compressed air foam used to protect trees adjacent to burning slash piles.

Snag protection

19:45 1 Compressed air and high expansion foam are applied for snag protection inside a burn unit.

21:00 2 Compressed air foam is applied for snag protection inside burn unit.

LINE CONSTRUCTION

Hose applications *Class A synthetic foam*

High expansion

22:30 1 High expansion foam applied below road at top of burn unit.

Medium expansion

23:20 1 Medium expansion barrier to burn against in sage/pine; flames against this line.

25:10 2 Medium expansion application in grass with ignition immediately following.

27:10 3 Custom low/medium expansion application, low for reach, medium for ground fuels.

30:45 4 Flames between two foam lines - blacklining in slash.

CLASS A FOAM

32:15 5 Discussion of merits of medium expansion application to cheat grass fuels; seed heads are dry.

Low expansion

33:20 1 Compressed air foam used to pretreat forest edge and slash at burn unit boundary.

35:10 2 CAFS line in grass, boring to mineral surface for wetting; ignition against.

37:20 3 CAFS line construction in grass/fern: lofting, then boring techniques, poor on safety.

39:50 4 Burning against and away from CAFS line .

41:40 5 Rockwood low/medium combo line construction in grass/fern with three foot wide line.

Hose applications *Durable foam*

43:30 1 CAFS terra foam line construction for purpose of 24-hr protection.

52:00 2 CAFS terra foam line to burn against later the same day.

54:30 3 CAFS terra foam on brush and grass in circle, burn out.

56:10 4 CAFS terra foam at 2% treating engine and vegetation. Then two days later: wet underneath.

Pump and Roll *CAFS*

59:40 1 CAFS engine monitor pump and roll to support road as control line at top of burn unit.

62:00 2 CAFS pump and roll with three large engines at NE entrance to Yellowstone NP: canopy treatment to support road as fire break.

63:40 3 CAFS 1-inch spray nozzle applying foam to support tire track with fire approaching.

65:00 4 CAFS 1-inch spray off rear of engine onto tire track.

66:50 5 CAFS 1-inch barrier application ten feet from approaching grass fire. Fire burns to this line, stops at wet fuel, burns through dry or untreated fuel. (Straight-stream and spray foam patterns were successful, but at the point of changing from one to the other, a gap of untreated fuel remained.)

Pump and Roll *High expansion*

70:30 1 High expansion pump and roll operation in grass.

72:50 2 High expansion foam applied in a circle in brush. 41 gallons of solution applied. Ignite next to foam as would do in Rx fire or burning out.

74:50 3 High expansion applied with ignition following developing into burn-through and holding against long flamelengths.

77:40 4 High expansion applied from an engine.

Pump and Roll *Medium expansion*

78:45 1 Medium expansion applied in grass as barrier: spotty application leaves untreated fuels.

79:50 2 Medium expansion applied off rear of engine in sage.

81:00 3 Medium expansion applied from engine in brush. Application in circle uses 40 gallons. Burnout to follow.

83:40 4 Medium expansion applied from Hummer during indirect uphill initial attack.

86:30 5 Medium expansion applied from Hummer: ignite against and burn into fire flank.

89:00 6 Medium expansion applied from two nozzles on rear of hummer: follow ridgetop, ignite between (instead of dozer).

92:00 7 Medium expansion applied from two nozzles on rear of Hummer: circle, ignite between.

Pump and Roll *Low expansion*

95:15 1 Low expansion 32 gpm nozzle from heavy engine in grass/brush: burn out circle.

Downhill *understory or slash*

98:10 1 High expansion (tube) foam applied downhill under canopy (nozzle hung from tree).

100:30 2 High expansion applied downhill on forest floor.

101:00 3 High expansion (fan) downhill next to fire edge and CAFS together supporting cut trail. Burning jackpot threatens.

Downhill *Brush/grass*

102:30 1 Medium expansion applied downhill into chaparral burn area, edited with ground and air views.

109:00 2 Medium expansion applied downhill through grass and brush fuels, edited.

118:15 3 High expansion applied downhill to burn against. Medium expansion foam applied parallel top and bottom. Ignite between.

CLASS A FOAM

Tape No. 2
(Minutes from start) (Scene number) (Description)

DIRECT WILDLAND TACTICS

CONTROL/KNOCKDOWN

00:00	1	Foam solution applied by backpack pump on grass fire.
01:30	2	CAFS applied to slash pile fire.
04:30	3	Medium expansion application to same slash pile fire as in 2. Almost complete smoke elimination as a result
06:40	4	Water on slash pile fire: could compare end result to foam applications on similar pile in 2 and 3.
12:45	5	Medium expansion flame knockdown in grass/brush.
14:30	6	CAFS 1-inch knockdown on flank of small grass fire.
15:30	7	Vapor mist with CAFS - mostly air on small grass fire flank.
16:00	8	Vapor mist with CAFS - mostly air on small grass fire.
17:20	9	Low expansion knockdown in heavy grass, forcing foam through the grass.

MOPUP

Low expansion *Aspirated*

18:40	1	Foam solution mop-up in rocky area with tool.
20:00	2	Low expansion backpack pump application.
20:40	3	Low expansion backpack pump application.

21:30 4 Low expansion mop-up with tool on stump.

23:00 5 5 gpm nozzle used for rapid mop-up: quick coverage of hot spots, long nozzle reach.

25:15 6 8 gpm nozzle used for rapid mop-up: quick coverage of hot spots, long nozzle reach.

26:40 7 8 gpm nozzle creating wet foam on char, blanketing ground, and working with tool.

Low expansion *CAFS*

28:10 1 CAFS 1-inch hose using forester tips and other variable spray tips.

29:20 2 CAFS 1-inch wand with tool on stump hole, wet CAFS on wood, use of residual foam with tool.

30:40 3 CAFS wet foam with wand on white ash hole; wetting scenes.

31:50 4 CAFS rapid mop-up in brush.

33:30 5 CAFS wet foam and tool in rocky area.

34:50 6 CAFS 1-inch hose with wand on pile.

35:30 7 CAFS mopup of stump.

Medium expansion aspirated

36:20 1 Comparison of water and tool vs medium expansion blanketing.

38:40 2 After medium expansion blanket application, using tool to stir in residual.

39:40 3 Downhill rapid blanketing in grass.

40:50 4 Rapid mopup/securing in grass/brush.

42:20 5 Handline blanketing applying without walking in foam.

44:30 6 Custom low/medium expansion foam applied below road at top of burn unit.

46:00 7 Medium expansion rapid mopup; note smoke abatement.

47:20 8 Smoke reduction using medium expansion foam vs using water.

High expansion aspirated

48:50 1 High expansion (tube) mopup, not much smoke reduction initially.

WILDLAND\URBAN INTERFACE

51:00 1 CAFS terrafoam applied to brushpile and small shed. Adjacent structure fully involved. Foam treated structure withstanding heat pulse.

52:10 2 CAFS engine pretreating structures with monitor at Canyon Corral, Yellowstone in advance of fire.

53:50 3 CAFS engine pretreating structures in advance of fire at Canyon Village, Yellowstone, including post office.

56:15 4 CAFS dual monitor application demonstration.

57:30 5 CAFS monitor and 1-inch hose application to structures.

58:10 6 CAFS applied to trailer home. CAFS applied to large cabin.

60:40 7 CAFS applied to barn from hoselay.

61:30 8 Foam solution applied to mobile home.

CLASS A FOAM

AERIAL DELIVERY

FIXED-WING

Single Engine

62:50 1-4 AgCat test drops: trail, salvo; four drops.

Water Scoopers

65:40 1 Martin Mars foam drops including 4 acre drop in timber.

67:00 2 CL 215 dropping foam on fire in Alberta.

Airtanker

68:20 1 ORE Program footage of airtanker foam drop.

ROTOR-WING

Helibucket

69:00 1 Sikorsky S58 bucket drop.

69:20 2 CDF 205 bucket drops (2).

70:00 3 Boeing Vertol bucket drops (2).

Helitank

71:00 1 LADS fixed tank drop.

VEHICLE FIRES

71:50 1 Low/Medium combo nozzle extinguishment of car fire, demo.

CLASS A FOAM

EXTERIOR ATTACK OF STRUCTURE FIRE

77:20 1 Foam on fully involved house, Watsonville, California.

79:20 2 Foam on fully involved house, Eddyville, Oregon.

80:00 3 Foam on fully involved house, Napavine, Washington.

81:00 4 Foam on fully involved house, Boise, Idaho.

83:15 5 Foam knockdowns of fully involved homes.

FLAMMABLE LIQUIDS

87:30 1 CAFS attack of pool, barrel, flammable liquid demo/training fires.

90:10 2 Water attack of pool, barrel, and tanker flammable liquid demo/training fires.

96:40 3 CAFS: two 1-inch hoselines apply to pool and dock applications.

FOAM PROPERTIES

DRAINTIME

101:10 1 Solution draining from foam through oil allows you to "see" drainage.

CLASS A FOAM

VIDEOTAPE CROSS REFERENCE TABLE

This table describes the location in the lesson outline at which time the videotapes can be shown. It is highly recommended the instructor views the videotapes prior to the course.

The listed videotapes are often used in foam training. The videotapes are available through the Publication Management System (PMS). See Appendix L - Material Ordering Information.

VIDEOTAPE		IG
01-01-FOAM-VT	"INTRODUCTION TO CLASS A FOAM"	Unit 1, pg. 15
01-02-FOAM-VT TAPE 2	"CLASS A FOAM VIDEO DATABASE, TAPE 2"	Unit 1, pg. 24
01-03-FOAM-VT	"PROPERTIES OF FOAM"	Unit 1, pg. 27
03-01-FOAM-VT	"CLASS A FOAM PROPORTIONERS"	Unit 3, pg. 41
04-01-FOAM-VT	"ASPIRATING NOZZLES"	Unit 4, pg. 46
05-01-FOAM-VT	"COMPRESSED AIR FOAM SYSTEMS"	Unit 5, pg. 52
06-01-FOAM-VT	"TACTICAL APPLICATIONS OF CLASS A FOAM"	Unit 6, pg. 60
01-02-FOAM-VT TAPES 1, 2	"CLASS A FOAM VIDEO DATABASE TAPE 1 AND / OR TAPE 2"	Unit 6, pg. 60
01-02-FOAM-VT TAPE 2	"CLASS A FOAM VIDEO DATABASE TAPE 2"	Unit 7, pg. 64
OPTIONAL	AMERICAN HEAT: "CLASS A FOAM TESTS: SIKESTON, MO"	Unit 6, pg. 55

APPENDIX L

MATERIAL ORDERING INFORMATION

CLASS A FOAM

MATERIAL ORDERING INFORMATION

The following items may be ordered from the National Interagency Fire Center, ATTN: Supply, 3833 S. Development Ave., Boise ID 83705. Check the current NWCG NFES Catalog Part 2: Publications for ordering procedures.

Items necessary to present "Class A Foam":

NFES 1301 Class A Foam Instructor's Guide

NFES 1303 Class A Foam slide set

NFES 1304 Class A Foam Video Database, Tape 1

NFES 1305 Class A Foam Video Database, Tape 2

NFES 1302 Class A Foam Student Notetaking Guide (order 1 per student)

NFES 2246 Foam vs. Fire: Class A Foam for Wildland Fires (order 1 per student)

Additional videos needed for course presentation:
NFES 2073 Introduction to Class A Foam
NFES 2219 Properties of Foam
NFES 2245 Class A Foam Proportioners
NFES 2272 Aspirating Nozzles
NFES 2161 Compressed Air Foam Systems
NFES 2404 Tactical Applications of Class A Foam

Optional for the Course Coordinator:
NFES 2226 Course Coordinator's Guide

Optional for each student:
NFES 2068 1", 3-ring binder

The following optional video for Unit 6 is available from Fire & Emergency Television Network, 1303 Marsh Lane, Carrollton, TX 75006. 1-800-624-2272.

American Heat, Volume 5, Program #4 (1990), "Class A Foam Tests: Sikeston, Mo."

APPENDIX M

UNIT EVALUATIONS AND NWCG COURSE SUMMARY

CLASS A FOAM

INSTRUCTOR & UNIT EVALUATION

LOCATION: ______________________ DATE: ________________
INSTRUCTOR: ____
UNIT: ____

		EXCELLENT		AVERAGE		POOR
1.	Instructor knew subject matter. (Knowledgeable)	5	4	3	2	1
2.	Clearly stresses what information is important to learn and understand.	5	4	3	2	1
3.	Stimulated student's interest and increased motivation to learn.	5	4	3	2	1
4.	Encouraged input from students. (Participation in class and exercises)	5	4	3	2	1
5.	Explained concepts clearly.	5	4	3	2	1
6.	Conveys enthusiasm and interest for the subject.	5	4	3	2	1
7.	Well organized (presentation).	5	4	3	2	1
8.	Made good use of lecture, visual aids/videotape and hands on demonstrations.	5	4	3	2	1
9.	Clarity of presentation (instructor made it easy to understand).	5	4	3	2	1

COMMENTS: Feel free to add any comments, suggestions, reactions, etc., pertaining to the unit and/or instructor.

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____
____

NAME: ______________________

CLASS A FOAM

EVALUATION SUMMARY QUESTIONNAIRE

This form is intended for use by the course coordinator or lead instructor.

Course Number and Title: ______________________________
Date and Location: ______________________________
Lead Instructor: ____________________ Telephone Number: ____________
Instructors: ____________________ ____________________
____________________ ____________________

1. Did instructors meet the required instructor prerequisites? Were course instructional and performance objectives achieved?

____
____

2. Were any modifications made to the published course package? If so, describe modifications and why they were needed.

____
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____
____

3. List any specific problems with course materials identified by the students related to content, exercises, visual aids, tests, delivery method, etc., during their evaluation of the course.

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4. List any specific problems with course materials identified by the instructors or cadre related to the content, exercises, visual aids, delivery method, etc., of the course.

____
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____

5. What recommendations can you offer that would improve the ability to learn and/or teach the objectives of this course?

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Please use additional pages as needed to complete your comments, then return to:

National Interagency Fire Center
National Fire & Aviation Training Support Group
Training Standards Team
3833 S. Development Avenue
Boise, Idaho 83705-5354

APPENDIX N

REFERENCE LIST

CLASS A FOAM

REFERENCE LIST

Fire Protection Handbook, 1986 or more current edition, National Fire Protection Association, Quincy, Massachusetts. (Unit 1: Water properties, extinguishment, fire theory, fire triangle, fire tetrahedron)

Daniel Madrzykowski, Study of the Ignition Inhibiting Properties of Compressed Air Foam, 1988, USDC, National Institute of Standards and Technology, Center for Fire Research, Gaithersburg, MD. (Unit 1: Foam effectiveness. Unit 5: Compressed air foam)

The MSDS - Your Guide to Chemical Safety Order No. #200-039, published by Business and Legal Reports, Inc., Madison, Connecticut.

OR

MSDS Pocket Dictionary, 1994, Genium Publishing Corp., Schenectady, New York or equivalent. (Unit 2: Material Safety Data Sheets)

Labat-Anderson Incorporated, Chemicals Used in Wildland Fire Suppression. A Risk Assessment, 1994, Arlington, Virginia. (Unit 2: Human and environmental effects of foams)

Susan E. Finger (ed), Toxicity of Fire Retardant and Foam Suppressant Chemicals to Plants and Animal Communities, Progress report #2, National Biological Survey, Dec. 1994. (Unit 2: Environmental effects)

Cecilia W. Johnson/Charles W. George, Relative Corrosivity of Currently Approved Wildland Fire Chemicals, USDA Forest Service, INT-437, DEC. 1990. (Unit 2: Corrosion)

International Specification Class "A" Foam for Wildland Fires, Aircraft or Ground Application, USDA Forest Service Interim Specification 5100-00307, 1993. (Unit 2: Product acceptability)

Qualified or Approved Wildland Fire Foam Products List, current year, USDA Forest Service, Washington, DC. (Unit 2 and Unit 7: Product approval)

CLASS A FOAM

Foam Chemicals for Wildland Fire Control, NFPA Standard 298, National Fire Protection Association, Quincy, Massachusetts, 1994. (Unit 2: Product acceptability)

Ronald Rochna/Paul Schlobohm/Al Olson, Foam Proportioner Evaluation, USDI Bureau of Land Management, National Interagency Fire Center, Boise, Idaho, 1993. (Unit 3: Proportioners)

Dan McKenzie, Proportioners for Use in Wildland Fire Applications, USDA Forest Service, Technology & Development Center, San Dimas, California, 1992. (Unit 3: Proportioners)

Paul Schlobohm/Ron Rochna, A Performance Test of Low Expansion Nozzle Aspirated Systems and Class A Foam, 2nd edition, USDI Bureau of Land Management, Boise, Idaho, 1990. (Unit 4: Nozzle aspirated foam devices)

Dan McKenzie, Compressed Air Foam Systems for use in Wildland Fire Applications, USDA Forest Service, Technology & Development Center, San Dimas, California, 1992. (Unit 5: Compressed air foam systems)

"Class A Foam Tests: Sikeston, Missouri," in American Heat: Vol.#5, Program #4, 1990 (video). (Unit 6: Critical Application Rate, Effectiveness comparison)

Ron Rochna, Quantitative Production Rate Study: Water, Foam Solution, Aspirated Foam, CAFS, USDI Bureau of Land Management, National Interagency Fire Center, 1994. (Unit 6: Application rates, techniques)

Foam vs Fire, Aerial Applications,1995, National Wildfire Coordinating Group, NFES 1845, Boise, Idaho. (Unit 7: Aircraft, aerial foam generation)

Foam Applications for Wildland and Urban Fire Management, Vol 1-6. National Wildfire Coordinating Group, San Dimas Technology and Development Center, San Dimas, California. (Miscellaneous)

Foambib: A bibliography of Wildland Fire Foam Evaluation and Use, prepared by National Wildfire Suppression Technology for NWCG Fire Equipment Working Team, Dec. 1992, plus Supplement Number 1, Sept. 1993, and Supplement Number 2, September 1994. (Miscellaneous)

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIREQUIP
blm fire equipment technical notes

BOISE INTERAGENCY FIRE CENTER Vol. 8 No. 1, 1992

Low-volume, medium-expansion foam nozzle

...from your workshop

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

Introduction

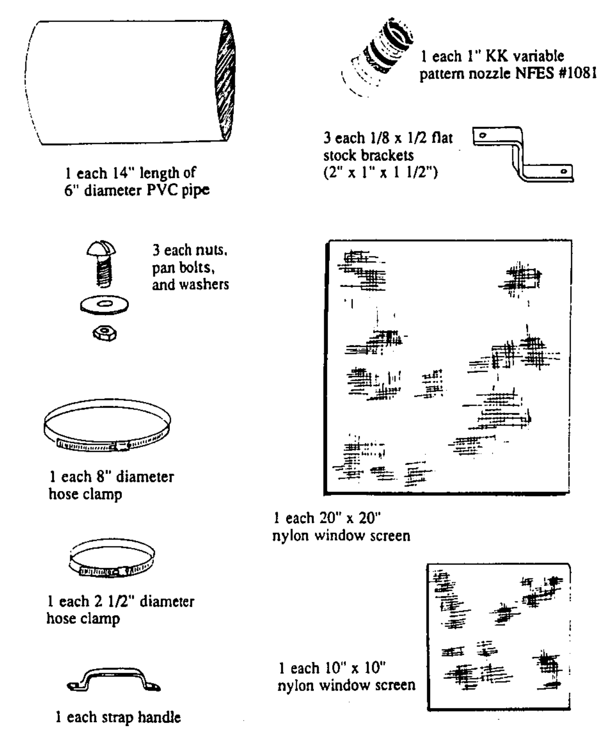
Class A wildland foam is a very useful tool for both fire suppression and prescribed fire operations. A particularly useful version is medium expansion foam. It can be used in direct attack, blanketing fuels in mop-up, protecting selected resources and anchoring and building wetlines for backfiring,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

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

The U.S. Fish and Wildlife Services (FWS) actively manages over 91 million acres of wildlife habitat as the national Wildlife Refuge System. Prescribed fire is a primary tool. Most refuges are equipped with small slip-on packages varying in capacity from 75 to 200 gallons. The small water tank capacities of most FWS engines combined with limited funding suggested that an alternative to current nozzles be developed. Most other resource agencies, including the Bureau of Land Management (BLM), also experience this problem. All are looking to minimize costs of equipment, yet still accomplish the tasks of the job.

The BLM program at the Boise Interagency Fire Center includes a Foam Technology Development group. As part of the many foam workshops this group presents, one demonstration shows the basics behind generating aspirating medium-expansion foam. The demonstration is done with a 4-

(See FROM YOUR SHOP..., p. 2)



Equipment and parts needed

Because of the simplicity of the design of the medium nozzle, all parts and supplies should be readily available in even the most remote stations. The equipment list is as follows:

- •PVC pipe, 6-inch diameter, 12 to 14 inch length
- •One piece 1/8" thick by 1/2" flat stock, 15-3/4 inches long
- •Nylon window screen — 20" X 20"
- •Nylon window screen — 10" X 10"
- •1-inch KK variable pattern type nozzle (NFES #1081; GSA 4210-01-165-6603)
- •Hose clamp, 7 to 8 inches in diameter
- •Hose clamp, 2-1/2 inches in diameter
- •Three each — 1/4" diamenter 1-inch long bolts, washers, and nuts
- •Cabinet or strap handle

FROM YOUR workshop..., from p. 1

inch stove pipe with screening taped over the end and a KK variable pattern type nozzle found in NFES caches. The results are crude, but low- to medium-expansion foam is generated.

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

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

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

Assembling the nozzle

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

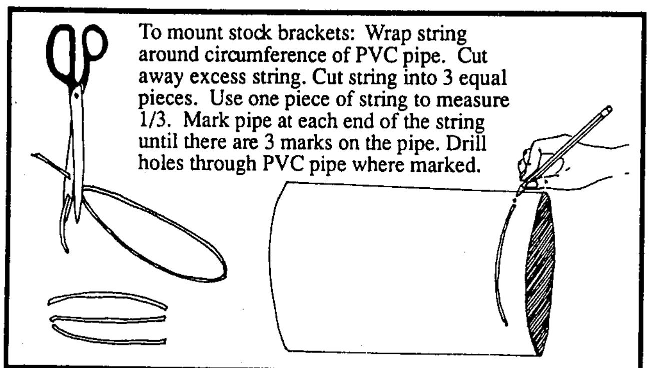


Figure 1: Locating the drilling points

To determine the three places to mount the brackets, place a piece of string around the PVC pipe's circumference. Mark the spot where the string meets itself and cut off the excess string. Next, divide and cut the string into three equal parts. One piece of string will be the "measuring tool." Place the measuring tool in an arc on the PVC pipe edge, and mark the beginning and ending point. At the ending point, place the measuring tool in another arc and mark. *(See Figure 1).*

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

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

Measure two inches along the strap. This is the location of the first 90-degree bend. Now measure another 1-3/4 inches. This is the next point to make a 90-degree bend. The two bends made to the finished bracket will look somewhat like a "Z" (with 90-degree corners). The ending run, or "tang," which is about 1-1/2 inches long, is where the KK nozzle will be attached. It should be the

(see ASSEMBLY, p. 5)

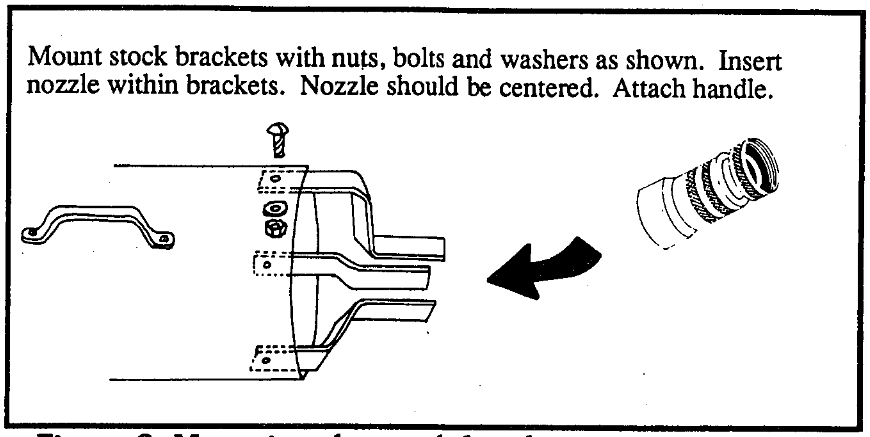


Figure 2: Mounting the stock brackets

ASSEMBLY..., from p. 2

Place the KK nozzle between the tangs with the KK nozzle tip pointing towards the front of the medium nozzle. Place the small hose clamp over the tangs and nozzle, then screw tight. This action will compress the tangs against the KK nozzle and secure it in a centered position. Make sure the tangs do not interfere with the twist open/close action of the nozzle. *(See Figure 3)*

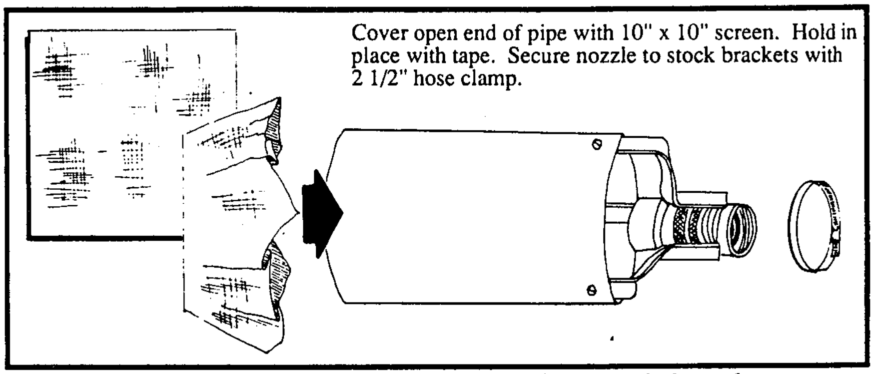


Figure 3: Positioning the nozzle in the stock brackets

Next comes the nylon window screening, used to fracture the foam solution stream that is flowing through the PVC pipe. Building the two fracturing screens is simple. Take the 20" screen, and fold two opposite corners together to form a triangle. Sew up (with an ordinary sewing machine) one side of the triangle-shaped screen, forming a conical screen. *(Figure 4)*.

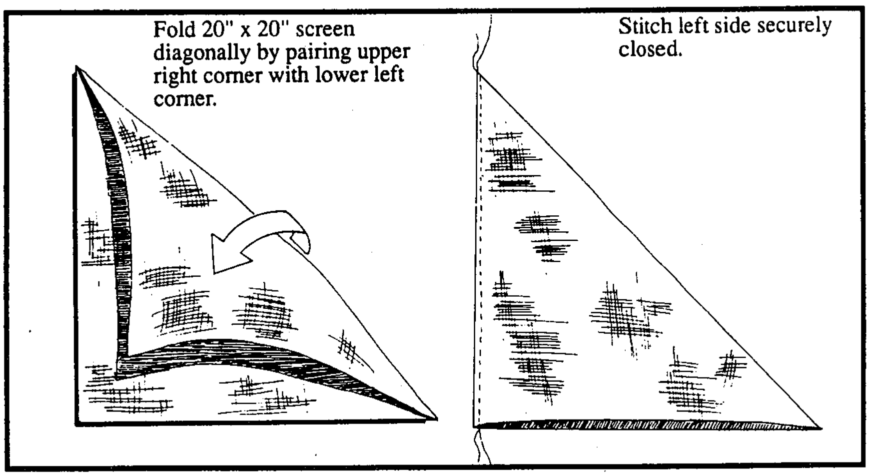


Figure 4: Preparing the nylon screen

Place the 10" screen over the non-drilled end of the PVC pipe, and then the conical-shaped screen over the 10" screen. The 10" screen should be flat across the end of the pipe. The conical screen should be pulled down tightly over the pipe *and* the flat screen, with the point centered in the circle of the pipe projecting outward. Secure both screens to the PVC pipe with the large hose clamp. The 10" screen should be flush with the PVC pipe opening and the conical-shaped screen should form a cone (big to small) from the front end of the PVC pipe. Cut off excess screening around the hose clamp. *(Figure 5)*.

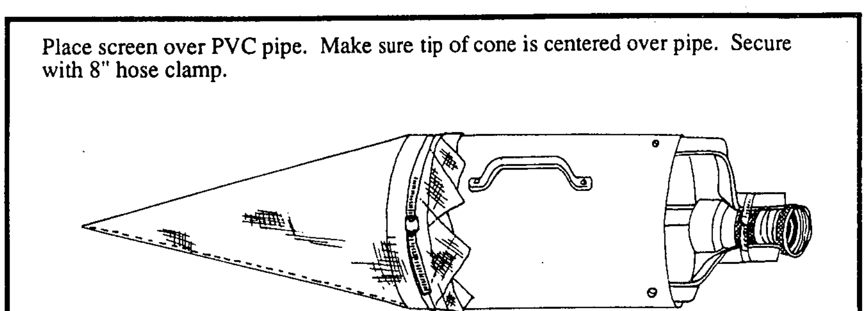


Figure 5: Attching the screen to the foam nozzle

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

Adjusting the nozzle

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

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

On Page 6 — Conclusions and a Chart

Now you've made your own low-volume, medium-expansion foam nozzle, here are

....Test results

The resulting nozzles were tested to measure their flow rates and foam-expansion ratios. By using an automatic regulated proportioner, we were able to monitor and set both flow rates and concentrate mix ratios. The concentrate mix ratio was set at five-tenths (0.5) per cent and remained constant during all flow volumes. Expansion ratios were determined by collecting the foam generated from a timed volume of solution flow at a set nozzle pressure of 70 psi, and then measuring the volume of foam.

The two nozzles were compared to the **Angus MEX225** medium-expansion nozzle, the closest performing commercially available nozzle. The results are by no means to be considered scientific. They are rough field evaluations, but they do give a feel for the nozzle's performance.

(See Chart this page)

Nozzle Discharge and Expansion Rates

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

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

(1) "Expansion Ratio" compares the Gallons of Foam produced to each Gallon of Water. "Medium-expansion" foam falls in the range of 20/1 to 80/1. There is no one "best" or "preferred" ratio, since the various tasks — direct attack, mop-up, wetlines, etc. — have their own requirements.

Conclusion

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