

COURSE NUMBER 55-0505-2
5/18/2005
1 HOUR
FOAM CONCENTRATE TECHNOLOGY

Lesson Plan for Foam Concentrate Technology
Chapter 2 of IFSTA Manual: Principles of Foam
Fire Fighting

Prepared By Rick Wagner

Objectives:

At the completion of this lesson student will have the information that will assist in meeting the following job performance requirements for:

NFPA 1001

6.3.1

- (a) Requisite knowledge: Methods by which foam prevents or controls a hazard; principles by which foam is generated; causes for poor foam generation and corrective measures; difference between hydrocarbon and polar solvent fuels and the concentrates that work on each; the characteristics, uses, and limitations of fire-fighting foams; the advantages and disadvantages of using fog nozzles versus foam nozzles for foam application; foam stream application techniques; hazards associated with foam usage; and methods to reduce or avoid hazards.

NFPA 1002

3-2.3

- (a) Requisite knowledge: Proportioning rates and concentrations, equipment assembly procedures, foam systems limitations

NFPA 472

5.4.4

- (2) Identify the characteristics and applicability of the following foams:
 - (a) Protein
 - (b) Fluoroprotein
 - (c) Special purpose
 - 1. Polar solvent alcohol-resistant concentrates
 - 2. Hazardous materials concentrates
 - (d) Aqueous film-forming foam (AFFF)
 - (e) High expansion

Level of instruction: Basic firefighter

Materials needed: lesson plan, video, foam containers representing types of foam used by department. Foam eductors, foam nozzles and equipment used by department. IFSTA Principles of Foam Fire Fighting manual. Student manuals.

Instructor: One fire service instructor knowledgeable in foam fire fighting.

References:

IFSTA PRINCIPLES OF FOAM FIRE FIGHTING-SECOND EDITION

NFPA 1001

NFPA 1002

NFPA 472

Presentation:

Time to complete class: 1 hour

Take roll and have students complete training paperwork

Motivation: Even though most of the fires we respond to can be effectively and safely extinguished with plain water there are incidents that cannot be safely handled with water alone. Incidents such as flammable or combustible liquids, deep seated below grade fires that are inaccessible by standard techniques, or wildland fires that are complicated by rugged terrain, dry ground cover, or high winds.

So if we have a thorough knowledge of foam concentrates we can use this technology to bring these incidents to a safe and expedient end.

This lesson will explain mechanical foam components, their characteristics, how they are proportioned or mixed, and how they are stored for both class A and class B foams.

Lesson blocks:

1. How foam concentrates work:
 - A. Separating
 - B. Cooling
 - C. Suppressing

Instructor Note - explain how the foams work and give definitions of the 3 methods.

2. Mechanical Foam Components:

a. foam concentrate

- b. foam solution
- c. foam proportioner
- d. finished foam

Instructor Note - discuss the class A and class B fuels, define the foam components, and explain how the proper foam must be used on different types of fuel.

3. Foam Concentrate Characteristics:

- a. Foam Expansion
- b. Shelf or Storage Life
- c. Corrosiveness
- d. Health Risks
- e. Compatibility with Other Extinguishing Agents
- f. Environmental Impact
- g. Foam Drainage

Instructor Note - explain expansion factors and low, medium, and high expansion foams. Review storage and shelf life factors. Discuss corrosiveness and how to clean equipment to prevent corrosion. Discuss health and environmental factors. Explain why drain time is important.

4. Foam Concentrate Types:

- a. Class A Foam Concentrates

Instructor Note - discuss fuel it is to be used on, characteristics, proportioning, application rates, operations. Show example of Class A foam.

- b. Class B foam concentrates

Instructor Note - discuss fuels it is to be used on, characteristics, proportioning, application rates. Show example of Class B foam.

5. Specific Foam Concentrates:

- a. Regular Protein Foam
- b. Fluoroprotein Foam
- c. Film Forming Fluoroprotein Foam
- d. Aqueous Film Forming Foam
- e. Alcohol- Resistant AFFF
- f. Vapor-Mitigating Foam
- g. High-Expansion Foam
- h. Emulsifiers

Instructor Note - on all of above foam concentrates review specific applications, proportioning ratios, storage factors. Show examples of all types of foam used by department.

6. Foam Proportioning Methods:
 - a. Eduction (induction)
 - b. Injection
 - c. Batch mixing
 - d. Premixing

Instructor Note - define proportioning and how to select proper proportioner. Discuss 4 types of proportioning.

7. Foam Concentrate Storage:
 - a. Pails
 - b. Barrels
 - c. Intermediate Bulk Containers
 - d. Foam Tenders
 - e. Apparatus Tanks
 - f. Fixed Fire-Suppression System Tanks
 - g. On-Site Storage Tanks

Instructor Note - discuss all methods of foam storage and show examples if possible.

8. Take questions from students and give answers.

9. Give summary and dismiss

Summary: Foam firefighting concentrates and delivery systems have been available since the early 1900s. They have provided fire and emergency services personnel with methods of controlling flammable liquid spills and fires, hazardous chemical incidents, maritime and aviation incidents, and transportation incidents. In recent years, advancements in the development of foam concentrates for use with class A fires have given fire and emergency services personnel a new tool to effectively and efficiently combat structural and wildland fires. These advances have not come without costs. Environmental issues have caused some departments to rethink the use of such concentrates that may damage sensitive ecosystems. Fire and emergency services personnel must continue to work with manufacturers and standard writing organizations to create the best foam firefighting concentrates possible.

Fire and emergency services responders who are required to use foam concentrates and equipment must have a basic understanding of mechanical foam components, how they work, and their characteristics, proportioning methods, and storage limitations. From this basic knowledge, a full and complete understanding of foam concentrates and their uses can be developed.

STUDENT MANUAL FOR FOAM CONCENTRATE TECHNOLOGY

1. How foam concentrates work:

As discussed previously, water alone is not always effective as a fire extinguishing agent. Under certain circumstances, foam is needed as an extinguishing agent. The resulting finished foam extinguishes and/or prevents fire by the following methods.

- a. Separating-creates a barrier between the fuel and burning vapors
- b. Cooling- lowers the temperature of the fuel and adjacent surfaces
- c. Suppressing- prevents the release of additional flammable vapors, access to oxygen in the atmosphere, and therefore reduces the possibility of ignition or reignition

2. Mechanical Foam Components: divided into two general categories: those intended for use on Class A fuels (ordinary combustibles) and those for use on Class B fuels (flammable and combustible liquids). Mechanical type foam concentrates must be proportioned and aerated before they can be used. Foam concentrate, water, air, and mechanical aeration are needed to produce a foam blanket. These elements must be present and blended in the correct ratios. Removing any element results in either no foam production or poor quality foam.

- a. foam concentrate: liquid found in a foam storage container before the introduction of water
- b. foam solution: mixture in the proper ratio of foam concentrate and water before the introduction of air
- c. foam proportioner: device that mixes foam concentrate in the proper ratio with water

d. finished foam: completed product after air is introduced into the foam solution and after it leaves the nozzle of aerator

3. Foam Concentrate Characteristics:

- a. foam expansion: refers to the increase in volume of a foam solution when it is aerated. Expansion is a key factor to consider when choosing a foam concentrate for a specific application. Depending on its purpose, foam concentrates can be described as one of three types: low expansion foam with up to 20 parts finished foam for one part of solution. Medium expansion foam- 20:1 up to 200:1 ratios. High expansion foam- 200:1 to 1000:1 ratios.
- b. Shelf or Storage Life: most can be stored for long periods of time(in excess of ten years). Manufacturers recommendations should be followed for maximum storage time. UL listed foam concentrates have storage temperature requirements of not less than 35 F and not higher than 120 F.
- c. Corrosiveness: both class A and B concentrates may be mildly corrosive. To prevent corrosion on metal parts, pumps, hoselines, proportioners, and nozzles, flush with clean water following each use of foam. Always lubricate moving parts of proportioners, pumps, and nozzles after using foams.
- d. Health Risks: foam concentrates at full or diluted strength pose minimal health risks. It may be mildly irritating to skin and eyes, so flush affected areas with water. And may be harmful if ingested or inhaled. Consult MSDS for info on specific concentrates.
- e. Compatibility with Other Extinguishing Agents: AFFF, FFFP and fluoroprotein foams are all compatible with carbon dioxide, halon substitutes, and dry chemical agents and may be simultaneously discharged with them.
- f. Environmental Impact: Impact varies between concentrates. Generally causes harm by excluding or using

oxygen. Try to avoid the direct discharge of foam concentrates or finished foam into rivers, streams, lakes, and other bodies of water if possible.

- g. **Foam Drainage:** drainage or quarter drain time plays a role in finished foam effectiveness. The bubbles formed in the foaming process begin breaking down as soon as they are applied. Longer drain times mean the foam blanket holds water and insulates for longer periods. Drain time is affected by fuel temperature, heat of the fire, size of the flame front, and to a lesser extent, ambient air temperature and wind.

4. **Foam Concentrate Types:**

- a. **Class A Foam Concentrates:** is a formulation of hydrocarbon surfactants. It helps to reduce the water's surface tension in the foam solution which provides better fuel penetration of the water. May be used with fog nozzles, aerating foam nozzles, medium and high expansion devices, and compressed air foam systems using almost any nozzle. Shelf life is indefinite. Class A foams are proportioned at ratios of 0.1 to 1 percent.
- b. **Class B Foam Concentrates:** used to extinguish fires involving flammable or combustible liquids and suppresses vapors from unignited spills from these liquids. May be applied with either standard fog nozzles or with air-aspirating foam nozzles of all types. They are made from either a synthetic or protein base. They are mixed at ratios from 1 to 6 percent. Consult labels on container for proper proportioning.

5. **Specific Foam Concentrates:** numerous types of foam concentrates are selected for specific applications according to their properties and performance.

- a. **Regular Protein Foam:** use started before World War II. It is derived from naturally occurring sources of protein such

as hoof, horn, or feather meal. Then hydrolyzed in lime and converted to protein liquid. It is only used on hydrocarbon fuels. Rarely used today.

- b. Fluoroprotein Foam: a combination protein based and synthetic based concentrate. 3 or 6 percent concentrations. Not affected by freezing and thawing.
- c. Film Forming Fluoroprotein Foam: has added AFFF capabilities.
- d. Aqueous Film Forming Foam: completely synthetic, the surfactants reduce the surface tension of the water to a degree less than the surface of the hydrocarbon so that a thin aqueous film can spread across the fuel, 1,3,6 percent concentrates, premixable. It is affected by fuel temperatures above 140F.
- e. Alcohol Resistant AFFF: has added ability of being used on polar solvents.
- f. Vapor-Mitigating Foam: advances in technology of hazardous material foam concentrates have produced AR-AFFF foam concentrates that can help stop acidic or alkaline reactions. Designed solely for use on unignited spills of hazardous liquids.
- g. High Expansion Foam: have low water content and minimizes water damage. Has 3 basic applications: concealed spaces, fixed extinguishing systems for specific industrial uses such as bulk paper storage, and class A fire applications.
- h. Emulsifiers: a type of concentrate for use with class A or B fires. Unlike finished foam that blankets the fuel, the emulsifier is designed to mix with the fuel, breaking it into small droplets and encapsulating them. The resulting emulsion is rendered nonflammable. Main drawback is that should only be used on fuels one inch or less in depth. If it is deeper it is almost impossible to mix emulsifier thoroughly with fuel.

6. Foam Proportioning Methods: proportioning is the mixing of water with foam concentrate to form a foam solution. Foam concentrates must be proportioned at the specific percentages for which they are designed. Failure to do so may produce no or poor foam. The selection of a proportioner depends on the foam solution flow requirements, available water pressure, cost, type of delivery system, and the foam concentrate. There are four basic methods.

- a. **Eduction(induction):** uses a foam eductor, inductor, line proportioner, or ratio controller.
- b. **Injection:** uses a foam concentrate pump or bladder proportioner to pump foam concentrate at the appropriate ratio into a water stream.
- c. **Batch Mixing:** uses a "dump and pump" or one time use process.
- d. **Premixing:** stores in a solution ready to use.

7. Foam Concentrate storage:

- a. **Pails:** most common used by fire services, usually a 5 gallon pail.
- b. **Barrels:** 55 gallon plastic or plastic lined barrels or drums.
- c. **Intermediate Bulk Containers:** usually 250 to 450 gallons. Designed to fit on fork lift pallets or on trailers.
- d. **Foam tenders:** a specialty apparatus similar to water tankers.
- e. **Apparatus Tanks:** a special tank on fire apparatus ranging from 20 to 200 gallons piped directly to foam delivery system.
- f. **Fixed Fire-Suppression System Tanks:** industrial and shipboard facilities equipped with fixed fire suppression foam systems have large concentrate tanks that supply these systems. Usually located near the proportioning equipment. Sizes vary but tanks over 3000 gallons are common.

g. **On-Site Storage Tanks:** storage tanks for large quantities of concentrate may be found at airports and hazardous materials facilities. Usually have permanent transfer pumps and overhead piping that permit the refilling of apparatus tanks from above.