

INSTRUCTOR GUIDE

TOPIC: FOAM OPERATIONS FOR FIREFIGHTERS

LEVEL OF INSTRUCTION:

TIME REQUIRED: THREE HOURS

MATERIALS: FOAM NOZZLES
FOAM EDUCTORS
FOAM SOLUTION
HOSE AND APPARATUS (OPTIONAL)

REFERENCES: ESSENTIALS OF FIRE FIGHTING, FOURTH EDITION, IFSTA
PUMPING APPARATUS DRIVER/OPERATOR HANDBOOK, FIRST EDITION,
IFSTA
A FIREFIGHTER'S GUIDE TO FOAM, NATIONAL FOAM
HAZARDOUS MATERIALS FOR FIRST RESPONDERS, SECOND EDITION, IFSTA

PREPARATION:

MOTIVATION:

OBJECTIVE (SPO): 1-1

The individual will demonstrate an understanding of the various types of foam, foam equipment, and foam applications.

OVERVIEW:

FOAM OPERATIONS FOR FIREFIGHTERS

- Foam and Foam Equipment
- Foam Operations
- Foam Application

FOAM OPERATIONS FOR FIREFIGHTERS

- SPO 1-1 The individual will demonstrate an understanding of the various types of foam, foam equipment, and foam applications.
- EO 1-1 Identify the various types of foam, the characteristics of each, and the equipment required to apply them.
- EO 1-2 Identify the items required to make foam.
- EO 1-3 Identify the methods of applying foam.

This drill is designed to provide the firefighter and fire officer with some basic knowledge of foam and foam operations. It also provides basic information that the pump operator should know to apply foam using an in-line educator. It is suggested that manufacturer literature be consulted for specific information on the foam solution and foam equipment within the department. The department may want to conclude the lesson with a practical demonstration of their foam equipment and application techniques. At a minimum the foam-making equipment should be reviewed. Training foam can be made by mixing a pint of concentrated liquid dish detergent with five gallons of water. It is assumed that the audience is familiar with how foam prevents ignition or extinguishes a fire.

I. FOAM AND FOAM EQUIPMENT (EO 1-1)

A. Definitions

1. Expansion ratio – amount by which foam solution expands when mixed with air. Low expansion foams have an expansion ratio of about 10:1. Medium expansion foams have an expansion ratio of between 20:1 and 200:1. High expansion foams have an expansion ratio of between 200:1 and 1,000:1.
2. Finished foam – foam solution mixed with air or aerated
3. Foam concentrate – foam in the container before it is mixed with anything
4. Foam eductor – device used to mix water and foam concentrate; also serves as the proportioning device
5. Foam nozzle – special nozzle with openings to allow air to be introduced into the foam solution
6. Foam solution – foam concentrate mixed with water

B. Characteristics of an Effective Foam

1. Knockdown speed and flow characteristics – the time required for a foam blanket to spread across a fuel surface or around an obstacle and wreckage in order to achieve complete extinguishment
2. Heat or burnback resistance – the ability to resist the destructive effects of heat radiated from any remaining fire from the liquid's flammable vapor or any hot metal wreckage or other objects in the area
3. Fuel resistant – tolerance and the ability to minimize fuel pick-up so that the foam does not become saturated and burn
4. Vapor suppression – the vapor-tight blanket produced must be capable of suppressing the flammable vapors and minimize the risk of reignition
5. Alcohol tolerance – due to alcohol's affinity to water and because a foam blanket is more than 90% water, foam blankets that are not protected will be destroyed

C. Types of Foam

1. Protein
 - a. May be used in 3% or 6% mixture
 - b. Protein based
 - c. Low expansion
 - d. Good re-ignition (burn-back) resistance
 - e. Excellent water retention
 - f. High heat resistance and stability
 - g. May be used with fresh or salt water
 - h. Performance can be affected by freezing and thawing
 - i. Concentrate can be freeze protected with anti-freeze
 - j. Not as mobile or fluid on fuel surface as other low-expansion foams
 - k. Primary use on Class B fires involving hydrocarbons
 - l. Used to protect flammable and combustible liquids in storage, transport, and processing

2. Fluoroprotein
 - a. May be used in 3% or 6% mixture
 - b. Protein and synthetic based; derived from protein foam
 - c. Fuel shedding
 - d. Long-term vapor suppression
 - e. Good water retention
 - f. Excellent, long-lasting heat resistance
 - g. Performance not affected by freezing and thawing
 - h. Maintains low viscosity at low temperatures
 - i. Can be freeze protected with anti-freeze
 - j. May be used with fresh or salt water
 - k. Non-toxic and biodegradable after dilution
 - l. Good mobility and fluidity on fuel surface
 - m. Pre-mixable for short periods of time
 - n. Primary used for hydrocarbon vapor suppression
 - o. Used for subsurface application to hydrocarbon fuel storage tanks and extinguishing in-depth crude petroleum or other hydrocarbon fuel fires

3. Aqueous Film Forming (AFFF)
 - a. May be used in 1%, 3% or 6% mixture
 - b. Synthetic based
 - c. Good penetrating capabilities
 - d. Spreads vapor-sealing film over and floats on hydrocarbon fuels
 - e. Can be used through non-aerating nozzles
 - f. Performance may be adversely affected by freezing and storing
 - g. Has good low-temperature viscosity
 - h. Can be freeze protected with anti-freeze
 - i. Can be used with fresh or salt water

- j. Can be premixed
 - k. Primary use in controlling and extinguishing Class B fires
 - l. Used in handling land and sea crash rescues involving spills, extinguishing most transportation-related fires, wetting penetrating Class A fuels, and securing un-ignited hydrocarbon spills
4. Aqueous Film Forming – Alcohol Resistant (AFFF-ATC or AFFF-ARC)
- a. May be used in 3% or 6% mixture
 - b. AFFF concentrate to which polymer added
 - c. Can be used on both polar solvents and hydrocarbon fuels (used on polar solvents at 6% solution and on hydrocarbon fuels at 3% solution)
 - d. Forms a membrane on polar solvent fuels that prevents destruction of the foam blanket
 - e. Forms same aqueous film on hydrocarbon fuels as AFFF
 - f. Fast flame knockdown
 - g. Good burn-back resistance on both fuels
 - h. Not easily premixed
 - i. Primary use on fires or spills of both hydrocarbon and polar solvent fuels
5. High Expansion
- a. Synthetic detergent based
 - b. Proportioned at 1-1/2% with water
 - c. Special purpose, low water content
 - d. High air-to-solution ratios: 200:1 to 1,000:1
 - e. Performance not affected by freezing or thawing
 - f. Poor heat resistance
 - g. Prolonged contact with galvanized or raw steel may attack these surfaces
 - h. Primary use in extinguishing Class A and some Class B fires, flooding confined spaces, volumetrically displacing vapor, heat, and smoke, reducing vaporization from liquefied natural gas spills, extinguishing pesticide fires, suppressing fuming acid vapors, suppressing vapors in coal mines and other subterranean space, suppressing vapors in concealed spaces in basements, as an extinguishing agent in fixed extinguishing systems for industrial use
 - i. Not recommended for outdoor use
6. Class A
- a. Synthetic
 - b. Wetting agent that reduces surface tension of water and allows it to

- soak into combustible materials
- c. Rapid extinguishment with less water use than other foams
- d. Can be used with regular water stream equipment
- e. Can be premixed with water in booster tank
- f. Mildly corrosive
- g. Requires lower percentage of concentration (0.2 to 1.0) than other foams
- h. Outstanding insulating qualities
- i. Good penetrating capabilities
- j. Primary use in extinguishing Class A combustibles only
- k. Can be used with compressed-air foam systems (does not require aeration)

II. FOAM OPERATIONS (EO 1-2)

A. Application Rates

1. Dependent on type of foam concentrate used, whether or not fuel is on fire, type of fuel (hydrocarbon/polar solvent) involved, and whether fuel is spilled or in a tank
2. Hydrocarbon fuel spill fires (non-diked) – protein and fluoroprotein foams: 0.16 gpm/sq. ft. of surface area for 15 minutes; AFFF foams: 0.10 gpm/sq. ft. of surface area for 15 minutes
3. Polar solvent fuel spill fires – range is between 0.10 and 0.20 gpm/sq. ft. or surface area, depending on manufacturer's UL listing
4. Hydrocarbon fuel fires in fixed roof storage tanks – 0.16 gpm/sq. ft. of surface area. Combustible liquids require a 50-minute application time; flammable liquids and crude petroleum require a 65-minute application time
5. The application rate for Class A foam is the same as the minimum critical flow for water
6. Example of application rate for hydrocarbons:
 - a. An area of 2,000 square feet of regular gasoline burning and 3%/6% AFFF foam is available
 - b. Application rate per square foot times the number of square feet of surface area (0.10 gpm per sq. ft. X 2,000 sq. ft.) equal amount of foam solution (200 gpm) required
 - c. Proportion percentage times application rate (3% X 200 gpm) equals amount of concentrate (6 gallons of 3%) required per minute
 - d. Concentrate requirements per minute times application period (6 gallons X 15 minutes) equals amount of concentrate (90 gallons of 3% AFFF) of required to control, extinguish, and initially secure the 2,000 sq. ft. hydrocarbon fire
 - e. Application rate also tells what hardware is required for a given size fire

B. Water and Concentrate Requirements

1. A 5-gallon container of 3% foam concentrate requires 161.7 gallons of water and will produce 166.7 gallons of foam solution
2. A 5-gallon container of 6% foam concentrate requires 75.2 gallons of water and will produce 80.2 gallons of foam solution
3. In the example above, the 90 gallons of 3% foam concentrate will require 2,917.6 gallons of water and will produce 3,000.6 gallons of foam solution

III. FOAM APPLICATION (EO 1-3)

A. Methods

1. Roll-On
 - a. Foam stream is directed on ground near front edge of burning liquid pool
 - b. Foam then rolls across surface of fuel
 - c. Application continues until it spreads across entire surface of fuel and fire is extinguished
 - d. May be necessary to move stream to different positions along edge of liquid spill to cover entire pool
 - e. Method only used on pool of liquid fuel (either ignited or unignited) on open ground
2. Bank-Down
 - a. Employed when elevated object (wall, tank shell, etc.) is near or within area of burning pool of liquid or unignited liquid spill
 - b. Foam stream is directed off object, allowing foam to run down onto surface of fuel
 - c. May be necessary to direct stream to various points around fuel area to achieve total coverage and extinguishment of fuel
 - d. Method used primarily in dike fires and fires involving spills around damaged or overturned transport vehicles
3. Rain-Down
 - a. Used when roll-on and bank-down methods are not feasible because of either size of spill area or lack of an object from which to bank foam
 - b. Primary manual application technique used on above ground storage tank fires
 - c. Method directs stream into air above fire or spill and allows foam to float gently down onto surface of fuel
 - d. On small fires, sweep stream back and forth over entire surface of fuel until fuel is completely covered and fire is extinguished
 - e. On large fires, it may be more effective to direct stream at one location to allow foam to take effect there and then work its way out from that point

B. Proportioning

1. In-line eductors work on venturi principle with water at high pressure (approximately 200 psi) being forced into a reducing orifice where it mixes with foam concentrate
2. Six percent concentrates are mixed with water at a ratio of 94 parts water to 6 parts concentrate
3. Three percent concentrates are mixed with water at a ratio of 97 parts water to 3 parts concentrate
4. Once mixed with water, the resulting foam solutions of a 3% foam or a 6% foam are virtually the same with regard to performance characteristics
5. By switching from a 6% foam to a 3% foam, you can either double your firefighting capacity by carrying the same number of gallons of concentrate, or cut your foam supply in half without compromising suppression capacity
6. As an emergency measure, 15 gallons of foam concentrate poured into a 500-gallon booster tank will produce an adequate 3% foam solution with the pump serving as the eductor

C. Shortfalls

1. Foam concentrates require large quantities of water to produce foam solution
2. The nozzles and eductors must be matched in terms of flow rates
3. Partially closed nozzle controls can result in a higher nozzle pressure
4. Too long a hose layout on the discharge side of the eductor can result in poor quality foam
5. Kinks in hose can result in back pressure and affect ability to produce foam solution or reduce the foam quality
6. Nozzle too far above eductor can affect foam discharge
7. Different types of foam concentrates should not be mixed because the mixture may be too viscous
8. A regular combination nozzle can be used to discharge foam solution; however, since it has no way for air to be introduced, the expansion rate will be low. Aeration can be greatly enhanced by the addition of a clip-on foam tube to the nozzle
9. You need to have an adequate supply of foam concentrate and water in place to meet the application rate requirements along with the equipment to apply the foam at the required rate before starting the foam operation. If you begin your operation without all the required supplies and equipment in place and the fire is not extinguished, you may have to start over at the beginning.

REVIEW:

FOAM OPERATIONS FOR FIREFIGHTERS

- Foam and Foam Equipment
- Foam Operations
- Foam Application

REMOTIVATION: Foam and foam-making equipment are among those items of firefighting equipment that are carried on most engines but seldom used. When the need arises where foam must be used, it must be applied quickly and efficiently. Regular practice with the foam and foam-making equipment is important to maintaining knowledge and skills. The emergency scene is not the time to become reintroduced to the foam and foam equipment.

ASSIGNMENT:

EVALUATION: