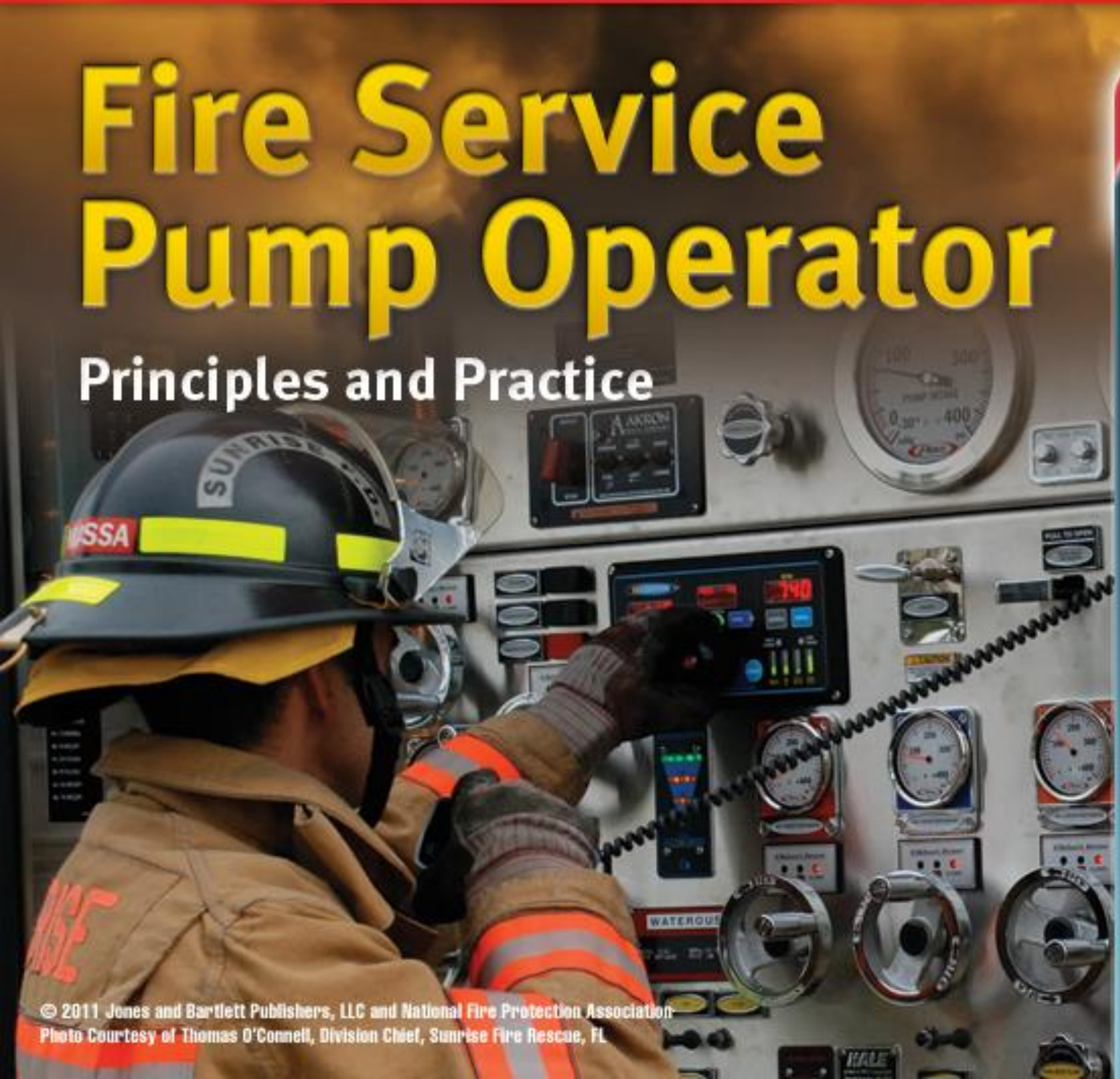
International Association of Fire Chiefs

National Fire Protection Association



Chapter 11

Foam

Knowledge Objectives (1 of 2)

- Describe how foam works.
- Describe the foam tetrahedron.
- Describe foam characteristics.
- Describe the different types of foam concentrates.
- Describe foam expansion rates.
- Describe foam percentages and their importance.

Knowledge Objectives (2 of 2)

- Describe foam guidelines and limitations.
- Describe the different types of foam application systems.

Skills Objectives (1 of 2)

- Batch-mix foam.
- Operate an in-line eductor.
- Operate the around-the-pump proportioning system.
- Operate a balanced-pressure proportioning system.
- Operate an injection foam system.

Skills Objectives (2 of 2)

- Operate a compressed-air foam system (CAPS).
- Apply Class A foam on a fire.
- Apply foam with the roll-on method.
- Apply foam with the bankdown method.
- Apply foam with the raindown method.

Introduction (1 of 3)

- Water: main means of suppressing fires for many years
  - Effective, bountiful, and relatively inexpensive
- Foams added a new dimension to fighting fires.
  - Successful control and extinguishment requires proper application of foam on a fuel surface plus an understanding of the physical characteristics of foam.

Introduction (2 of 3)

- A full understanding of foam and its application is imperative to a safe and successful suppression operation.
- An unfamiliarity with the chemical characteristics of foam and its application causes problems.

Introduction (3 of 3)

- Improvements in and a greater simplicity of application techniques and versatility of foam concentrates makes foam use more common for all types of fires.
  - NIST determined foam more effective than plain water in extinguishing fires

History (1 of 5)

- Foam has been available for firefighting for many years.
  - 1800s: Foam was introduced as an extinguishing agent for flammable liquid fires
  - It was produced by mixing two powders (aluminum sulfate and sodium bicarbonate) with water in a foam generator.

History (2 of 5)

- 1940s: Introduction of foam concentrate based on liquid protein
  - Made from natural animal protein by-products
  - Produced by mechanically mixing protein foam concentrate with water in a foam proportioner
  - Protein-based foam used to fight flammable liquid fires on Navy ships.

History (3 of 5)

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History (4 of 5)

- 1960s: Introduction of FP and AFFF
  - More versatile, better than protein foam
  - Knocks down fires faster
  - Longer blanket life
- 1970s: Introduction of alcohol-resistant foams
  - Used for hydrocarbon and polar solvent fuels
  - Allowed flexibility in dealing with fuels that fire fighters encounter daily

History (5 of 5)

- Use of foam is limited, but technological improvements have made them more common and acceptable.
  - More apparatus equipped with foam systems means operation and maintenance of systems are important skills for the driver/operator.
  - The knowledge necessary to operate and maintain systems properly comes from learning about and training with them.

Overview (1 of 8)

- Why is foam used for firefighting?
  - What are the reasons for equipping apparatus with foam systems?
  - What benefits make firefighting with foam so popular that departments spend thousands to add the equipment to their apparatus?
  - Is it a fad, or does firefighting with foam truly make a difference?

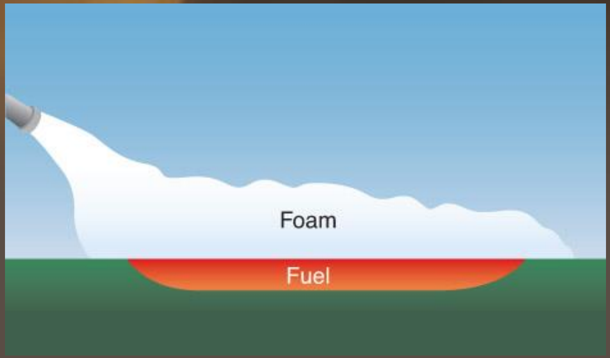
Overview (2 of 8)

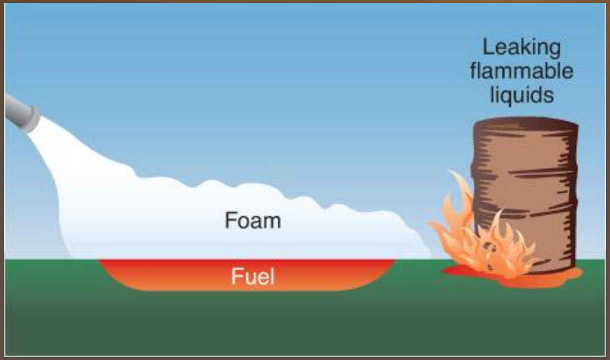
- Introduction of automobile and use of petroleum products proved water is not effective for extinguishing these fires.
  - Water is heavier than petroleum so application to petroleum-fueled fires caused more problems than it solved.
  - Water spreads fire, making the situation worse.
  - Firefighting foam became available to deal with these issues.

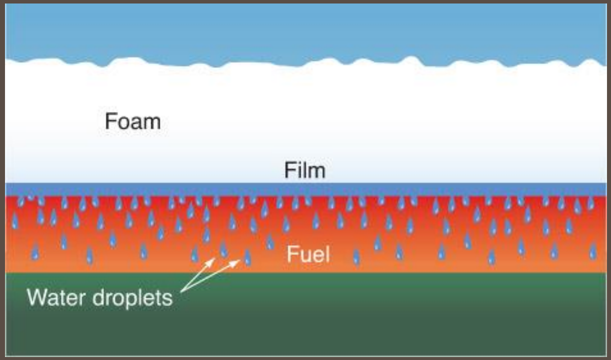
Overview (3 of 8)

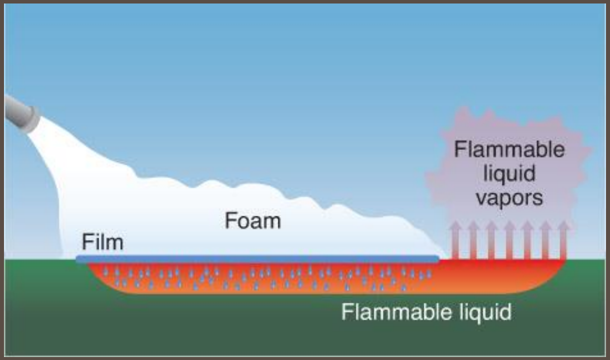
- What is foam?
  - Stable mass of small, air-filled bubbles
  - Foam is created through the application of water, foam concentrate, mechanical agitation, and air.
  - Expansion of foam solution depends on the process of introducing air into it.

Overview (4 of 8)





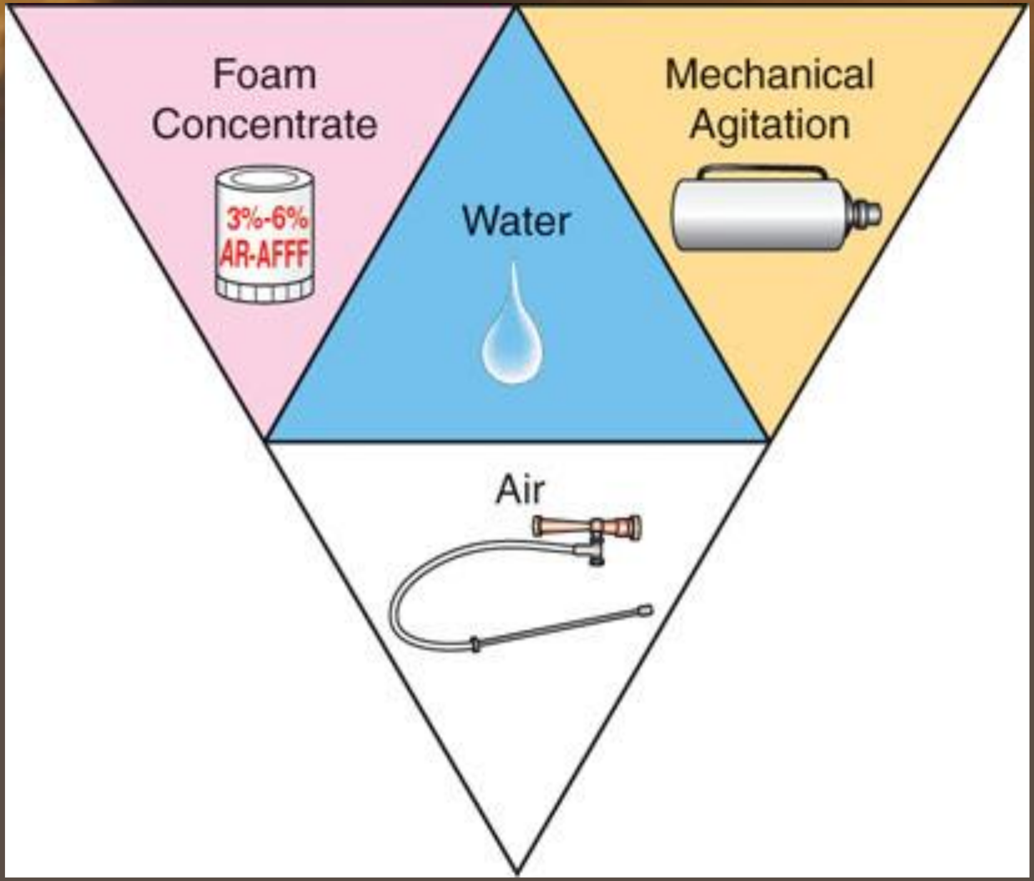




Overview (5 of 8)

- Foam tetrahedron
  - Elements needed to produce finished foam
  - Any side missing or not at proper mixture affects the foam production
  - Chemical foam is produced through a reaction between two chemicals.
  - Mechanical foam is produced when water is mixed with a foam concentrate in appropriate amounts.

Overview (6 of 8)



Overview (7 of 8)

- Foam characteristics
  - Good foam needs the right physical characteristics to be effective.
  - Knockdown speed and flow: time required for foam blanket to spread across fuel surface
  - Foam needs good heat resistance to avoid breakdown from direct flame contact with burning fuel vapors or heat from metal objects.
  - Foam produces a good vapor-suppressing blanket.

Overview (8 of 8)

Foam Classifications (1 of 11)

- Class A foams
  - Used on ordinary combustible materials (wood, textiles, paper)
  - Effective on organic materials (straw, hay)
  - Referred to as wetting agents
  - Effective because they improve penetrating effect of water and allow greater heat absorption

Foam Classifications (2 of 11)

- Class A foams (continued)
  - Manufacturers say these foams extinguish fire in Class A materials 20 times faster than water.
  - Useful for protecting buildings in rural areas during forest or brush fires with limited water supply
  - Used as an obstruction to the spread of fire

Foam Classifications (3 of 11)

- Class A foams (continued)
  - Used by many departments while performing initial fire attack and overhaul
  - Increases effectiveness of water as an extinguishing agent by reducing water’s surface tension

Foam Classifications (4 of 11)

- Class B foams
  - Used on hydrocarbon, combustible fuels, and polar solvent fires
  - Categories:
    - Protein foams
    - Fluoroprotein foams
    - Alcohol-resistant film-forming fluoroprotein foam (AR-FFFP)

Foam Classifications (5 of 11)

Table 11-1 Class B Foams and Their Properties

Property	Protein	Fluoroprotein	AFFF	FFFP	AR-AFFF
Knockdown	Fair	Good	Excellent	Good	Excellent
Heat Resistance	Excellent	Excellent	Fair	Good	Good
Fuel Resistance	Fair	Excellent	Moderate	Good	Good
Vapor Suppression	Excellent	Excellent	Good	Good	Good
Alcohol Resistance	None	None	None	None	Excellent

Notes: AFFF = aqueous film-forming foam; FFFP = film-forming fluoroprotein foam; AR-AFFF = alcohol-resistant aqueous film-forming foam.

Foam Classifications (6 of 11)

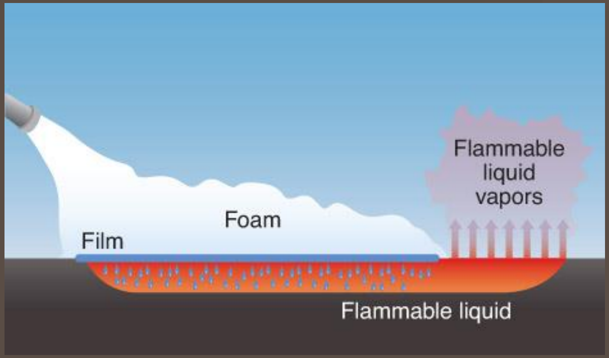
- Protein foams
  - Used for extinguishment of Class B fires involving hydrocarbons
  - Contain animal by-products as foaming agent
  - May be created using fresh or salt water

Foam Classifications (7 of 11)

- Fluoroprotein foam
  - Consists of hydrolyzed protein, stabilizers, preservatives, and synthetic fluorocarbon surfactants
  - Intended for use on hydrocarbon fuels and some oxygenated fuel additives
- AR-FFFP
  - Used on hydrocarbon and water-soluble fuels

Foam Classifications (8 of 11)

- Synthetic foams: AFFF
  - Based on combinations of fluorochemical surfactants, hydrocarbon surfactants, and solvents
  - Very fluid, flows around obstacles and across fuel surface
  - Apply using aspirating foam nozzles



Foam Classifications (9 of 11)

- AR-AFFF
  - Contain synthetic detergents, fluorochemicals, and high-molecular-weight polymers
  - When a non-alcohol-resistant foam is applied to the surface of polar a solvent, the foam blanket breaks down into a liquid and mixes with the fuel.
  - One of the most versatile types of foam

Foam Classifications (10 of 11)

- Synthetic detergent foams (high-expansion foams)
  - Effective in confined-space firefighting operations and areas with limited access or dangerous entry
  - Used on Class A or B fires
  - Achieve fire control, extinguishment by rapid smothering, and cooling of fire

Foam Classifications (11 of 11)

Foam Concentrates (1 of 3)

- Foam concentrates are designed to be mixed with water at specific ratios.
- Must be proportioned at the percentage listed by the manufacturer
  - Foam is tested and approved for certain fires at specific ratios, so follow the manufacturer's guidelines.
  - Foam concentrates are manufactured at different percentages.

Foam Concentrates (2 of 3)

- Industry trend is to reduce foam concentrate percentages as low as possible.
  - Less bulk in storage for departments
  - Firefighting capacity can be doubled by carrying the same volume of foam concentrate or cut the foam supply in half without reducing fire suppression capabilities
  - Reduce cost of fixed foam system components and concentrate transportation costs

Foam Concentrates (3 of 3)

- Alcohol-resistant foams are used effectively on hydrocarbon and polar solvent fuel.
  - AR-AFFF is the most commonly used concentrate for this.
- Many foam concentrates are available, so selecting the right concentrate is critical to safe and effective handling of an incident.
  - Knowledge of foam types and systems assists IC in mitigating the incident

Foam Expansion Rates (1 of 3)

- Ratio of finished foam to foam solution after the concentrate is mixed with water, agitated, and aspirated through a foam-making appliance
  - Air inside the bubbles makes up expanded part of finished foam
  - NFPA 11 classifies foam concentrates into three expansion ranges.

Foam Expansion Rates (2 of 3)

- Low-expansion foam
  - Foam expansion ratio of up to 20:1
  - For use on flammable and combustible liquids
  - Effective in controlling and extinguishing most Class B fires
  - Special low-expansion foams are used on Class A fires where a penetrating and cooling effect of the foam solution is important.

Foam Expansion Rates (3 of 3)

- Medium-expansion foam
  - Foam expansion ratio of 20:1 to 200:1
  - Used to suppress vapors from hazardous chemicals
- High-expansion foam
  - Foam expansion ratio of 200:1 to 1000:1
  - Designed for confined-space firefighting
  - Consists of synthetic and detergent-type foam used in confined spaces

Foam Proportioning (1 of 2)

- Foam cannot be produced if not proportioned properly.
  - Several foam application systems are available, from basic to more advanced.

Foam Proportioning (2 of 2)

- Proportioning foam concentrate
  - Applying foams at a proper percentage depends on foam concentrate mixed at the proper percentage with water
  - Driver/operator has a responsibility to produce effective foam streams.
  - To produce a finished foam, mix water, air, and foam concentrate at the proper ratio.

Foam Proportioning Systems (1 of 3)

- Foam proportioner
  - Device that mixes foam concentrate into fire stream in proper percentage
  - Available in a range of sizes and capabilities
  - Two types: eductors and injectors

Foam Proportioning Systems (2 of 3)

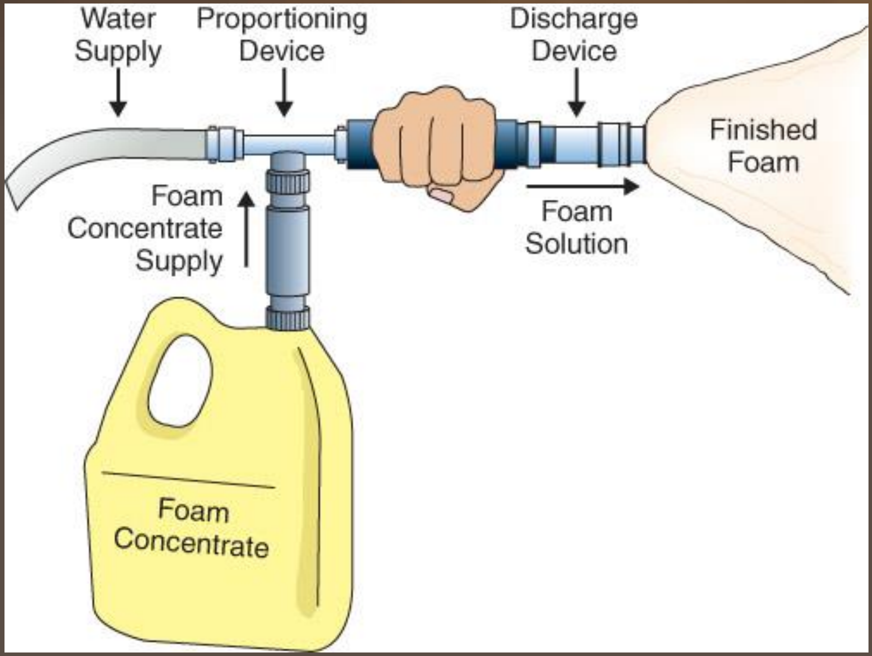
- Batch mixing
  - Process of pouring foam concentrate directly into the apparatus tank and mixing a large amount of foam at once
  - Problems with batch mixing:
    - Foam mixture is corrosive to the apparatus's pipe, pump, and water tank
    - Difficult to adjust and maintain the correct application rate
    - Adding the foam solution causes gauges to be inaccurate and overflow the water tank

Foam Proportioning Systems (3 of 3)

- Batch mixing (continued)
  - Batch-mixed Class A foam concentrates must be used within 24 hours to be effective.
- Premixing
  - Technique reserved for portable fire extinguishers
  - Quick and easy to deploy but have limited foam
  - Should be applied only to small fires or fuel spills

Foam Eductors (1 of 2)

- Induction
  - Uses an eductor to introduce the appropriate amount of foam concentrate into the water stream flowing from discharge
- Foam eductor is designed to work at a predetermined pressure and flow rate
- Two types
  - Inline
  - Bypass



Foam Eductors (2 of 2)

- Use Venturi effect to mix the foam concentrate into the water stream
- Most are calibrated to a flow rated capacity at 200 psi (1379 kPa) inlet pressure.
- Deliver flow rates of 30, 60, 95, 125, and 250 GPM (114, 227, 360, 473, and 946 L/min)
- A metering device controls the flow of concentrate into the eductor.

Around-the-Pump Proportioning System (1 of 2)

- Operates on the same principle as in-line or bypass eductor systems
- Advantages over other methods
  - Process for engaging pump is the same as for water or foam operations.
  - Allows for adjustment of foam depending on application
  - Variable pressure operations are possible.
  - No backpressure or nozzle restrictions

Around-the-Pump Proportioning System (2 of 2)

- AP system limitation
  - Not able to supply some lines with water and others with foam simultaneously
- Maximum inlet pressure to the water pump cannot be more than 10 psi (69 kPa)

Balanced-Pressure Proportioning Systems (1 of 2)

- Versatile and accurate means to deliver foam
- Separate foam concentrate pump supplies foam concentrate to pressure control valve and ratio controller
  - Device required for each outlet to proportion correct amount of concentrate into water stream over range of flows, with minimal pressure loss

Balanced-Pressure Proportioning Systems (2 of 2)

- Metering valves receive concentrate from foam pump and discharge concentrate to individual ratio controllers
- Duplex gauge at pump panel lets driver/operator monitor foam concentrate and water pressures
- Many balanced-pressure systems are equipped with a foam heat exchanger.

Injection Systems (1 of 2)

- Use electrically operated, variable-speed foam concentrate pump to directly inject concentrate into discharge side of pump manifold
- Depend on water flow for operation
- Unaffected by changes in suction or discharge pressure

Injection Systems (2 of 2)

- Direct injection systems are very user friendly.
- Can adjust foam concentrate percentage while system is in operation
- Can be used with standard nozzles, aspirating nozzles, and CAFS

Compressed-Air Foam System (CAFS) (1 of 3)

- Combines compressed air and foam solution to create finished foam
- Production of finished foam depends on the correct mixture of water, foam concentrate, and air
  - The system allows for a more uniform bubble structure and a better finished foam.

Compressed-Air Foam System (CAFS) (2 of 3)

- Benefits
  - Foam quality greatly improved
  - Works four to five times faster than water
  - Uses less water, reducing water damage
  - Reach of fire stream is improved
  - Weight of the attach line is less
  - Can be used for water rescue or as a temporary barrier to contain spills since the hose floats
  - Friction loss is insignificant

Compressed-Air Foam System (CAFS) (3 of 3)

- Issues
  - Driver/operator needs to know about air compressor operation.
  - Water and air are incompressible, so the foam solution has to be in the water stream before injecting the compressed air.
  - Burst hose lines react more erratically.
  - Nozzles open slowly.

Nozzles (1 of 3)

- Nozzles are an important part of foam operations.
  - The proper nozzle is needed to produce a good-quality foam blanket.
- Medium- and high-expansion foam generators
  - Mechanical generators operate similarly to water-aspirating generator.
  - High-expansion foams produce large volumes of foam that exclude oxygen from the incident area.

Nozzles (2 of 3)

- Master stream foam nozzles
  - Let operators deal with large incidents where handline nozzles cannot handle demands for foam suppression
- Air-aspirating foam nozzles
  - Mix air with foam solution while discharged
  - Designed to aspirate the foam solution to produce a good-quality finished foam

Nozzles (3 of 3)

- Smooth-bore nozzles
  - Nozzle of choice when using CAFS
- Fog nozzles
  - Used to produce finished foam
  - Do not provide the best aeration of foam solution

Foam Supplies (1 of 2)

- Foam concentrate is stored in containers from 5-gal (19-L) pails to 55-gal (208-L) drums.
  - Standard size is 5-gal (19-L) pail
  - Totes and trailers of foam concentrate available in different sizes
  - Can store foam in container without changing physical or chemical characteristics

Foam Supplies (2 of 2)

- Shelf life varies depending on the type of concentrate.
  - Protein concentrate has a shelf life of 7 to 10 years.
  - Synthetic, high expansion concentrate has a shelf life of 20 to 25 years
- Environmental impact has been a concern.

Foam Application (1 of 6)

- Knowing the accepted methods for foam application is important for driver/operators.
  - May use handline to apply foam or assist others in application
  - Driver/operator should be an expert on foam operation.

Foam Application (2 of 6)

- Class A foam
  - Use becoming more common
  - Similar to using water; same application methods but better results
  - Training or experimentation in fire situations is not recommended.

Foam Application (3 of 6)

- Class B foam
  - Methods differ from when applying Class A foam
  - Three methods
    - Sweep (roll-on) method
    - Bankshot (bankdown) method
    - Raindown method

Foam Application (4 of 6)

- Sweep (roll-on) method
  - Use only on a pool of flammable product on open ground.
  - Direct the foam stream onto the ground in front of the product involved.
  - May need to move the hose line or use multiple lines to cover the material
  - If multiple lines are used, be aware of other fire fighters in the area.

Foam Application (5 of 6)

- Bankshot (bankdown) method
  - Fire fighter uses an object to deflect the foam stream so it flows down the burning surface.
  - Application should be as gentle as possible.
  - Direct the foam at a vertical object.
  - Allow the foam to spread over the material and form a foam blanket.

Foam Application (6 of 6)

- Raindown method
  - Used when unable to employ the bankshot method or the roll-on method
  - Loft the foam stream into the air above the material and let it fall gently onto the surface.
  - Effective as long as the foam stream completely covers the material
  - Might not be effective if wind conditions are unfavorable

Foam Compatibility (1 of 2)

- Class A and Class B concentrates are not compatible.
  - Mixing different classes of concentrate may make the concentrate gel, hindering equipment operation.
  - Class B foam concentrates are not compatible with each other.
  - Check with the manufacturer for information on compatibility of foam types.

Foam Compatibility (2 of 2)

- Make sure onboard tanks on the apparatus are properly marked.
  - Many apparatus carry onboard water, Class A foam concentrate, and Class B foam concentrate tanks.
  - Concentrate can be poured into the wrong tank with undesirable results.

Summary (1 of 2)

- Water is effective in suppressing fires, but foams added a new dimension to firefighting strategies.
- Foam components: water, foam concentrate, mechanical agitation, and air
- Firefighting foams are classified as either Class A or Class B.

Summary (2 of 2)

- Foam is not produced if not proportioned properly.
- Several foam application systems are available from basic to more advanced systems.
- Knowing the accepted methods for applying foam is important for the driver/operators.
- Class A and Class B concentrates are not compatible.