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.
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.
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 (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?
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)
• 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
• Class B foams
  – Used on hydrocarbon, combustible fuels, and polar solvent fires
  – Categories:
    • Protein foams
    • Fluoroprotein foams
    • Alcohol-resistant film-forming fluoroprotein foam (AR-FFF P)
# Foam Classifications

## Table 11-1  Class B Foams and Their Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Protein</th>
<th>Fluoroprotein</th>
<th>AFFF</th>
<th>FFFP</th>
<th>AR-AFFF</th>
</tr>
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<tbody>
<tr>
<td>Knockdown</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Heat Resistance</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Fuel Resistance</td>
<td>Fair</td>
<td>Excellent</td>
<td>Moderate</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Vapor Suppression</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Alcohol Resistance</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

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
• 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
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.
• 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.
• 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
• 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.
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.