CHAPTER 17
Fire Attack and Foam

CHAPTER OVERVIEW

Consider a fire in a one-story, woodframe residential structure with one room fully engulfed in flames. Two engines arrive, followed closely by a ladder truck. Each apparatus carries an officer, an engineer, and three fire fighters decked out in full personal protective equipment (PPE), ready to make quick work of this routine fire. While the truck company prepares to ventilate and begins forcing entry for search-and-rescue, the success of this operation rests with the engine companies’ ability to deploy hose quickly and efficiently and apply an adequate stream to extinguish the fire.

After students complete this chapter and the related course work, they will understand the basic concepts of attack hoses and nozzle functions, selection, and construction. Students will also have the skills to advance lines, load hose, and use different nozzles and foam systems.

OBJECTIVES AND RESOURCES

FIRE FIGHTER I

Knowledge Objectives

After studying this chapter, you will be able to:

- List the standard sizes of attack hoses. (NFPA 5.3.10.A, 5.3.13.A, p 552-553)
- Describe the characteristics of booster hose. (NFPA 5.3.10.A, p 553)
- Describe the general procedures that are followed during attack line evolutions. (NFPA 5.3.10.A, p 553)
- Describe the types of loads used to organize attack hose. (p 553-559)
- Describe the procedures to follow when advancing attack hose. (NFPA 5.3.10.A, p 559-562)
- Describe where to position an attack line for a transitional fire attack, an offensive interior fire attack, and a defensive fire attack. (p 559)
- Describe the uses of large diameter hose as an attack line. (p 552)
- Describe how to extend an attack line. (NFPA 5.3.10.A, p 566-567)
- Describe how to advance an attack line from a standpipe. (NFPA 5.3.10.A, p 566)
- Describe how to replace a defective section of attack hose. (NFPA 5.5.2.A, p 567-568)
- List the three classifications of nozzles. (NFPA 5.3.10.A, p 568-570)
- Describe the characteristics of smooth-bore nozzles. (NFPA 5.3.10.A, p 569)
- Describe the characteristics of fog-stream nozzles. (NFPA 5.3.10.A, p 569-570)
- List the three types of fog-stream nozzles. (NFPA 5.3.10.A, p 570)
- Describe the specialized nozzles that may be used during fire suppression operations. (NFPA 5.3.10.A, p 570-572)
- Describe how to maintain nozzles to ensure proper operation. (p 572)
- Describe how to inspect nozzles. (p 572)
Skill Objectives

After studying this chapter, you will be able to:

- Perform a minuteman hose load. (NFPA 5.5.2.B, p 554-555)
- Advance a minuteman hose load. (NFPA 5.3.10.B, p 554, 556)
- Perform a preconnected flat load. (NFPA 5.5.2.B, p 556-557)
- Advance a preconnected flat hose load. (NFPA 5.3.10.B, p 557-558)
- Perform a triple-layer hose load. (NFPA 5.5.2.B, p 558, 560)
- Advance a triple-layer hose load. (NFPA 5.3.10.B, p 558-559, 561)
- Unload and advance wyed lines. (NFPA 5.3.10.B, p 559, 562)
- Advance a hose line up a stairway. (NFPA 5.3.10.B, p 563)
- Advance a hose line down a stairway. (NFPA 5.3.10.B, p 563-564)
- Advance an uncharged hose line up a ladder. (NFPA 5.3.10.B, p 563, 566)
- Operate a hose stream from a ladder. (NFPA 5.3.10.B, p 566-567)
- Connect and advance an attack line from a standpipe outlet. (NFPA 5.3.15.B, p 567-568)
- Replace a defective section of hose. (NFPA 5.3.10.B, p 568)
- Operate a smooth-bore nozzle. (NFPA 5.3.10.B, p 569, 571)
- Operate a fog-stream nozzle. (NFPA 5.3.10.B, p 570, 572)

Knowledge Objectives

After studying this chapter, you will be able to:

- Describe how foam suppresses fire. (NFPA 6.3, 6.3.1.A, p 573)
- Describe the characteristics of Class A foam. (NFPA 6.3.1.A, p 573-574)
- Describe the characteristics of Class B foam. (NFPA 6.3.1.A, p 574)
- List the major categories of Class A foam concentrate. (NFPA 6.3.1.A, p 574)
- Describe the characteristics of compressed air foam (CAF). (NFPA 6.3.1.A, p 575)
- List the major categories of Class B foam concentrate. (NFPA 6.3.1.A, p 575)
- Describe the characteristics of protein foam. (NFPA 6.3.1.A, p 575)
- Describe the characteristics of fluoroprotein foam. (NFPA 6.3.1.A, p 575)
- Describe the characteristics of aqueous film–forming foam. (NFPA 6.3.1.A, p 575)
- Describe the characteristics of alcohol-resistant foam. (NFPA 6.3.1.A, p 575)
- Describe how foam proportioner equipment works with foam concentrate to produce foam. (NFPA 6.3.1.A, p 575-576)
- Describe how foam is applied to fires. (NFPA 6.3.1.A, p 576-578)

Skill Objectives

After studying this chapter, you will be able to perform the following skills:

- Place an eductor foam line in service. (NFPA 6.3.1.B, p 576)
- Apply foam using the sweep method. (NFPA 6.3.1.B, p 577)
- Apply foam using the bankshot method. (NFPA 6.3.1.B, p 577-578)
- Apply foam using the rain-down method. (NFPA 6.3.1.B, p 577)

Additional NFPA Standards

- NFPA 1962, Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose

Reading and Preparation

- Review all instructional materials, including Fundamentals of Fire Fighter Skills, Chapter 17 and all related presentation support materials.
- Review local firefighting protocols for Chapter 17.
- Review Chapter 6, Fire Behavior; Chapter 11, Response and Size-Up; Chapter 13, Ladders; Chapter 16, Water Supply; and Chapter 22, Fire Suppression.
Support Materials

- Dry erase board and markers or chalkboard and chalk
- LCD projector, slide projector, overhead projector, and projection screen
- PowerPoint presentation, overhead transparencies, or slides
- Various quantities of 1½” (38 mm), 1¾” (45 mm), 2½” (65 mm), and supply hose
- Samples of forestry hose, booster hose, supply hose
- Spanner wrenches for each size of hose
- Wye, gated wye, Siamese, water thief, four-way valve, hose jacket, reducers, double male, double female
- Spare swivel gaskets
- Fire hydrant
- Engine
- Available set of stairs
- Ladder(s)
- Fire department connection
- Smooth-bore nozzles of various sizes
- Fog nozzles of various types and sizes
- Foam eductor system and nozzle
- Foam of various types (may substitute liquid dish soap if needed)

Enhancements

- Review and assign the prebuilt activities and assessments within Jones & Bartlett Learning’s Navigate 2 online course materials for *Fundamentals of Fire Fighter Skills: Evidence-Based Practices, Enhanced Third Edition*. These activities include:
  - eBook chapter quizzes, embedded videos, and skill evaluation sheets (Advantage Package)
  - Chapter-specific practice activities (Advantage Package)
  - Navigate Test Prep practice and final examinations in preparation for course assessments (Preferred Package)
  - Interactive lectures (Premier Package)
- Add instructor voice notes and text notes to the eBook found in Jones & Bartlett Learning’s Navigate 2 online course.

Teaching Tips and Activities

- Be sure to include plenty of time for hands-on practice of each of the evolutions for each participant. This information is so basic that instructors often forget that this is completely new to students and will require practicing each evolution more than once.
- Having samples of all of the various types of hose, nozzles, and appliances will help students visually understand them. After the information is covered, consider identifying each with a number and laying them out on a table for the students to write what they are during a break.

PRESENTATION OVERVIEW

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### Chapter 17  •  Fire Attack and Foam

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PRE-LECTURE

I. You Are the Fire Fighter

Time: 5 Minutes
Small-Group Activity/Discussion

Purpose
To allow students an opportunity to explore the significance and concerns associated with using fire hose, nozzles, and hose load.

Instructor Directions
1. Direct students to read the “You Are the Fire Fighter” scenario found in the beginning of Chapter 17.
2. You may assign students to a partner or a group. Direct them to review the discussion questions at the end of the scenario and prepare a response to each question. Facilitate a class dialogue centered on the discussion questions.
3. You may also assign this as an individual activity and ask students to turn in their comments on a separate piece of paper.

LECTURE

I. Introduction

Time: 13.5 Minutes
Slides: 2-10
Lecture/Discussion

1. **Slides 2-9** Review the Knowledge Objectives with the class.
2. **Slide 10** Fire hoses are used for two main purposes:
   1. As supply hoses
   2. As attack hoses
3. **Slide 10** Attack lines discharge water from an attack engine onto the fire.
   1. Most attack hoses carry water directly from the attack engine to a nozzle.
   2. They operate at higher pressures than supply lines.
   3. Nozzles at the end of attack lines give fire streams shape and direction.
   4. Foam can be a valuable tool in suppressing certain types of fires.
II. Attack Hose

A. **Introduction to Attack Hoses**
   1. A 1½” (38-mm) or 1¾” (45-mm) hose is commonly used to attack interior fires.
      a. Some departments use 2½” (65-mm) attack lines
      b. Each section is usually 50 ft (15 m) long
   2. Medium-diameter hose.
      a. Diameter of 2½” (65 mm) or 3” (76 mm)
         i. 2½” (65-mm) attack handlines are used to extinguish larger fires.
         ii. 3” (76-mm) lines are more often used to deliver water to a master stream device or a fire department connection.
      b. Usually come in 50-ft (15-m) lengths
   3. Large-diameter hose.
      a. Limited role as a fire-attack tool
      b. Used to supply portable monitors or is mounted on an aerial ladder
   4. Attack hose must withstand high pressure and high temperatures.
      a. Must be tested annually

B. **Sizes of Attack Lines**
   1. 1½” (38-mm) and 1¾” (45-mm) attack hose
      a. Most fire departments use either 1½” (38-mm) or 1¾” (45-mm) hose as the primary attack line for most structure fires.
         i. Both sizes of hose use the same 1½” (38 mm) couplings.
      b. Handlines of this size can usually be operated by one firefighter.
      c. Often stored on fire apparatus as a preconnected attack line in lengths of 150 to 350 ft (45-106 m), ready for immediate use.
      d. The primary difference between 1½” (38-mm) or 1¾” (45-mm) hose is the amount of water that can flow through the hose.
         i. 1½” (38-mm) hose can generally flow between 60 and 125 gal (273-568 L) of water per minute.
         ii. 1¾” (45-mm) hose can flow between 120 and 180 gal (545-818 L) per minute.
   2. 2½” (65-mm) attack hose
      a. Can be used as an attack line for fires that are too large to be controlled by a 1½” (38-mm) or 1¾” (45-mm) hose line.
      b. Flows about 250 gallons (946 L) of water per minute.
      c. It takes at least two firefighters to safely control a 2½” (65-mm) handline hose if it is being operated inside a building due to the weight of the hose and the water and the nozzle reaction force.
         i. When the hose is charged and filled with water it weighs as much as 140 lb (64 kg) per length.
      d. Higher flows can be achieved with higher pressures and larger nozzles; however, it is difficult to operate a handline hose at these high flow rates.
   3. Booster hose
      a. Usually carried on a hose reel that holds 150 or 200 ft (45-61 m) of rubber hose.
      b. Contains a steel wire that gives it a rigid shape, which allows it to flow water without pulling all the hose off the reel.
      c. It is light in weight and can be advanced quickly by one person.
      d. Limited flow, approximately 40 to 50 gal (182-227 L) per minute.
         i. Not adequate for structure fires.
4. Forestry lines
   a. Small-diameter hoses, typically 1" (25 mm) or 1½" (38 mm) in diameter
   b. Large volumes of water are typically not needed
   c. Better maneuvering
   d. May be extended for hundreds of feet

III. Attack Line Evolutions

A. **Slide 15** Attack lines used to deliver water from an attack engine to a nozzle, which discharges the water onto the fire.
   1. Evolutions are standard methods of working with attack lines to accomplish different objectives in a variety of situations.
   2. Most departments set up equipment and conduct regular training.
   3. Evolutions involve specific actions assigned to crew members, depending on their position.
   4. Every fire fighter should know how to perform standard evolutions quickly and proficiently.
   5. Attack lines are usually stretched from an engine or an apparatus that is functioning as an attack engine to the fire.
   6. Most engines are equipped with preconnected attack lines, which provide a predetermined length of attack hose that is already equipped with a nozzle and connected to a pump discharge outlet.
   7. An additional supply of attack hose is usually carried in a hose bed that is not preconnected.
   8. The attack hose is loaded so that it can be quickly and easily deployed.

B. **Slide 16** Preconnected Attack Lines
   1. Intended for immediate use as attack lines.
   2. A preconnected hose line has a predetermined length of hose with the nozzle already attached and is connected to a discharge outlet on the fire engine.
   3. The most commonly used attack lines are 1¾" (45-mm) hose, generally from 150 to 250 ft (46-76 m) in length.
   4. Many engines are also equipped with a preconnected 2½" (65-mm) hose line for quick attack on larger fires.
   5. Attack lines should be loaded in the hose bed so they can be quickly stretched from the attack engine to the fire.
      a. First, the hose is laid out from the attack engine to the building entrance or to the location where the fire attack will begin.
      b. When performing a transitional attack, the hose should be positioned in a location to cool the fire environment from a safe location, where the hose stream will be directed as a straight or solid stream, as an indirect attack, to the ceiling of the room, or as close to the body of the fire as possible.
      c. When performing an interior fire attack, the hose is advanced into the building to reach the fire.
      d. The hose should not get tangled as it is being removed from the bed and advanced.
      e. Laying out the hose should not require multiple trips between the engine and the attack point, and it should be easy to lay the hose around obstacles and corners.
      f. It should also be possible to repack the hose quickly and with minimal personnel.
   6. The three most common hose loads for preconnected attack lines are the minuteman load, the flat load, and the triple-layer load.
   7. Because they face different types of fire situations, most departments load attack lines of different lengths.
   8. Preconnected hose lines can be placed in several different locations on a fire engine.
   9. Many engines include a special compartment in the front bumper that can store a short preconnected hose line.
      a. Line often used for vehicle fires and dumpster fires
   10. Booster hose is another type of preconnected attack line.
Fire Attack and Foam

Chapter 17  ▪  Fire Attack and Foam

- Not used for structure fires and has limited applications

11. Performing the minuteman hose load will be practiced in Skill Drill 17-1.

12. Advancing the minuteman load will be practiced in Skill Drill 17-2.

13. Performing the preconnected flat hose load will be practiced in Skill Drill 17-3.

14. Advancing the preconnected flat hose load will be practiced in Skill Drill 17-4.

15. Performing the triple layer hose load will be practiced in Skill Drill 17-5.

16. Advancing the triple layer hose load will be practiced in Skill Drill 17-6.

C. Slide 17  Wyed lines

1. To reach a fire that may be some distance from the engine, it may be necessary to first advance a larger diameter line, such as 2½” (65-mm) hose line, and then split it into two 1½” (45-mm) attack lines.
   a. This is accomplished by attaching a gated wye or a water thief to the end of the 2½” (65-mm) line and then attaching the two attack lines to the gated outlets.
   b. Unloading and advancing wyed lines will be practiced in Skill Drill 17-7.

D. Slides 18-25  Advancing Attack Lines

1. Attack lines are used for three different types of evolutions.
   a. Transitional fire attack
      i. Aggressive offensive exterior attack that occurs in coordination with entry, search, and tactical ventilation
      ii. Transitional attack line helps to temporarily darken the fire down and reduces the production of hot gases
         a) Helps to provide a safer environment for the fire fighters entering the building and makes the environment more survivable for an occupant trapped in the fire building
   b. Offensive interior fire attack
      i. Requires the hose line to be placed in position in front of the door where the firefighters will make entry into the fire building
   c. Defensive fire attack
      i. Used when it is unsafe to enter the fire building and the goal of the fire fighters is to contain the fire to the building of origin

2. To attack an interior fire, an attack line is usually advanced in two stages.
   a. The first stage involves laying out the hose to the building entrance.
   b. The second stage is to advance the line into the building to the location where it will be operated.

3. When the attack line has been laid out to the entry point, the extra hose that will be advanced into the building should be flaked out in a serpentine pattern so that it will not become tangled when it is charged.

4. Make sure that you flake out the hose before it is charged with water.

5. Once the hose is ready, prepare to enter the building.
   a. Signal the driver/operator to charge the line.
   b. Open the nozzle slowly to bleed out any trapped air and to make sure the hose is operating properly.
   c. If you are using an adjustable nozzle, make sure the nozzle is set to deliver the appropriate stream.
   d. Once this is done, slowly close the nozzle.
   e. This is the time to quickly recheck all parts of your and your partner’s PPE and get ready for action.
   f. Be ready to start breathing air from your self-contained breathing apparatus (SCBA) and to advance the charged hose line as soon as your officer directs you.
   g. When you are given the command to advance the hose, keep safety as your number one priority.
   h. Make sure the other members of the nozzle team are ready.
   i. Do not stand in front of the door as it is opened.
   j. As you move inside, stay low to avoid the greatest amount of heat and smoke.
   k. If you cannot see because of the dense smoke, use your hands to feel the pathway in front of you.
   l. Feel in front of you so you do not fall into a hole or opening.
   m. Look for the glow of fire, and check for the sensation of heat coming through your face piece.
   n. Communicate with the other members of the nozzle team as you advance.

6. Advancing an attack line up a stairway.
   a. When advancing a hose line up stairs, arrange an adequate amount of extra hose close to the bottom of the stairs.
b. Make sure all members of the team are ready to move on command.
c. It is hard to move a charged hose line up a set of stairs while flowing water through the nozzle.
d. Shutting down the hose line while moving up the stairs will often allow you to get to the top of the stairs more quickly and safely.
e. Advancing an uncharged hose line up a stairway will be practiced in Skill Drill 17-8.

7. Advancing an attack line down a stairway.
   a. The smoke and flames from the fire tend to travel up the stairway of a residential structure.
     i. This means fire fighters will be operating in the exhaust portion of the flow path of a basement fire.
   b. Fire officers should consider cooling the fire environment from the safest location possible, the exterior.
   c. Applying a straight or solid stream into a basement window prior to entry will cool the fire environment, limit fire damage to the floor system, and reduce the thermal assault to the operating members.
   d. If the application of an exterior line is not possible and an interior attack must be made, get down the stairway and position yourself below the heat and smoke as quickly as you can.
   e. Keep as low as possible to avoid the worst of the heat and smoke.
   f. Gravity is working to bring the hose line down the stairs.
   g. Never advance toward a fire unless your hose line is charged and ready to flow water.
   h. If you try to crawl down a stairway headfirst, you are likely to find yourself tumbling head over heels.
     i. Move down the stairway feet first, using your feet to feel for the next step.
     j. Move carefully but as quickly as possible to get below the worst of the heat and smoke.
   k. Advancing a hose line down a stairway will be practiced in Skill Drill 17-9.

8. Advancing an attack line up a ladder.
   a. If a hose line has to be advanced up a ladder, this should be done before the line is charged.
   b. Additional fire fighters should pick up the hose about every 25 ft (7 m) and help to advance it up the ladder.
   c. The nozzle is passed over the top rung of the ladder and into the fire building.
   d. Additional hose should be fed up the ladder until sufficient hose is inside the building to reach the fire.
   e. The hose should be secured to the ladder with a hose strap to keep it from becoming dislodged.
   f. Advancing a hose line up a ladder will be practiced in Skill Drill 17-10.

9. Operating an attack line from a ladder.
   a. A hose stream can be operated from a ladder and directed into a building through a window or other opening.
   b. Operating a fire hose from a ladder will be practiced in Skill Drill 17-11.

E. Extending an Attack Line
   1. There are two basic ways to extend a hose line.
      a. The first way is to disconnect the hose from the discharge gate on the attack engine and add the extra hose at that location.
         i. This requires advancing the full length of the attack line to take advantage of the extra hose, which could take time and considerable effort.
      b. The alternative is to add the hose to the discharge end of the hose.
         i. This can be done easily if the nozzle is a breakaway type that can be separated between the shut-off and the tip.
         ii. A standpipe kit can be used to supply the added section of hose.

F. Advancing an Attack Line from a Standpipe Outlet
   1. The standpipe outlets inside a building are provided for fire fighters to connect attack hose lines.
   2. The standpipe outlets are often located in stairways, and standard operating procedures generally require attack lines to be connected to an outlet one floor below the fire.
      a. Before opening the door, it is important to properly flake out the hose line so it will be ready to advance into the fire floor.
      b. Before charging the hose line, the hose should be flaked out on the stairs going up from the fire floor.
      c. When the hose line is charged and advanced into the fire floor, gravity will help to move the line forward.
      d. Connecting and advancing an attack line from a standpipe outlet will be practiced in Skill Drill 17-12.

G. Replacing a Defective Section of Hose
1. Every fire fighter should know how to quickly replace a length of defective hose and restore the flow.
2. A burst hose line should be shut down as soon as possible.
3. If the line cannot be shut down at the pump or at a control valve, a hose clamp can be used to stop the flow in an undamaged section of hose upstream from the problem.
4. After the water flow has been shut off, quickly remove the damaged section of hose and replace it with two sections of hose.
5. Using two sections of hose will ensure that the replacement hose is long enough to replace the damaged section.
6. Replacing a hose section will be practiced in Skill Drill 17-13.

FIRE FIGHTER I

IV. Nozzles

Time: 15 Minutes
Slides: 29-38
Lecture/Discussion/Demonstration

A. **Slide 29** Nozzles are attached to the discharge end of attack lines to give fire streams shape and direction.
   1. Nozzles are used on all sizes of handlines as well as on master stream devices.

B. **Slide 25** Nozzles can be classified into three groups:
   1. Low-volume nozzles
      a. Flow 40 gal (182 L) per minute or less
   2. Handline nozzles
      a. Used on hose lines ranging from 1½” (38 mm) to 2½” (65 mm) in diameter
      b. Usually flow between 60 and 350 gal (273-1591 L) per minute
   3. Master stream nozzles
      a. Used on deck guns, portable monitors, and ladder pipes that flow more than 350 gal (1591 L) per minute

C. **Slide 30** Nozzle Shut-offs
   1. The nozzle shut-off enables a person at the nozzle to start or stop the flow of water.
      a. The handle that controls this valve is called a bale.
      b. Some nozzles incorporate a rotary control valve operated by rotating the nozzle in one direction to open and the opposite direction to shut off the flow of water.
   2. Two different types of nozzles are manufactured for the fire service.
      a. Smooth-bore nozzles produce a solid column of water.
      b. Fog-stream nozzles separate the water into droplets.
   3. Nozzles must have an adequate volume of water and an adequate pressure to produce a good fire stream.

D. **Slides 31-33** Smooth-Bore Nozzles
   1. The simplest smooth-bore nozzle consists of a shut-off valve and a smooth-bore tip that gradually decreases the diameter of the stream to a size smaller than the hose diameter.
   2. Smooth-bore nozzles are manufactured to fit both handlines and master stream devices.
   3. Stacked tips allow different sizes of streams to be produced under different conditions.
   4. A good smooth-bore has a longer reach than a combination fog nozzle operating at a straight stream setting.
   5. Smooth-bore nozzles also operate at lower pressures than adjustable-stream nozzles.
      a. Most smooth-bore nozzles are designed to operate at 50 psi (344 kPa), whereas adjustable-stream nozzles generally require 75 to 100 psi (516-689 kPa).
      b. Lower nozzle pressure makes it easier for a fire fighter to handle the nozzle.
   6. A smooth-bore straight stream extinguishes a fire with less air movement and less disturbance of the thermal layering than a fog stream.
   7. Smooth-bore nozzles are not as effective for hydraulic ventilation.

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8. A fire fighter cannot change the setting of a smooth-bore nozzle to produce a fog pattern; however, a fog nozzle can be set to produce a straight stream.

9. Operating a smooth-bore nozzle will be practiced in Skill Drill 17-14.

E. **Slides 34-36 Fog-Stream Nozzles**
   1. Produce fine droplets of water.
      a. The smaller droplets will absorb more heat per gallon than water from a straight stream nozzle.
   2. The straight stream from a fog stream nozzle breaks up faster and does not have the reach of a solid stream.
   3. Fog streams are effective at absorbing heat and can be used to create a water curtain to protect fire fighters from extreme heat.
   4. A fog stream can be used to exhaust smoke and gases through hydraulic ventilation.
   5. Fog nozzles move large volumes of air along with the water.
      a. Can result in a sudden heat inversion that pushes hot steam and gases onto fire fighters.
      b. If used incorrectly, it can push fire into unaffected areas.
   6. To produce an effective stream, nozzles must be operated at the pressure recommended by the manufacturer.
      a. For many years, the standard operating pressure for fog stream nozzles was 100 psi (689 kPa).
      b. In recent years, some manufacturers have produced low-pressure nozzles that are designed to operate at 50 or 75 psi (344-517 kPa).
   7. Operating a fog nozzle will be practiced in Skill Drill 17-15.
   8. There are three types of fog stream nozzles:
      a. A fixed-gallongage fog nozzle will deliver a preset flow in gallons per minute at the rated discharge pressure.
      b. An adjustable-gallongage fog nozzle allows the operator to select a desired flow from several settings.
         i. This is done by rotating a selector bezel to adjust the size of the opening.
         ii. Once the setting is chosen the nozzle will only deliver the rated flow as long as the rated pressure is provided at the nozzle.
      c. An automatic adjusting fog nozzle can deliver a wide range of flows.
         i. The amount of water flowing through the nozzle is adjusted to maintain the rated pressure and produce a good stream.
         ii. A typical automatic nozzle could have an operating range of 90 to 225 gal (409-1023 L) per minute while maintaining a 100-psi (689-kPa) discharge pressure.

F. **Slide 37 Other Types of Nozzles**
   1. Piercing nozzles are used to make a hole in automobile sheet metal, aircraft, or building walls to extinguish fires behind these surfaces.
   2. Cellar nozzles and Bresnan distributor nozzles are used to fight fires in cellars and other inaccessible places.
      a. These nozzles discharge water in a wide circular pattern as the nozzle is lowered vertically through a hole into the cellar.
      b. They work like a large sprinkler head.
   3. Water curtain nozzles are used to deliver a flat screen of water that then forms a protective sheet (curtain) of water on the surface of an exposed building.

G. **Slide 38 Nozzle Maintenance and Inspection**
   1. Nozzles should be inspected on a regular basis, along with all of the equipment on every fire department vehicle.
      a. They should be checked after each use before being placed back on the apparatus.
   2. They should be kept clean and clear of debris.
   3. A light grease on the valve ball will keep it operating smoothly.
   4. On fog nozzles, make sure all fingers are present and the finger ring can spin freely.
A. Slide 39 Introduction to Foam
1. Firefighting foam can be used to fight several different types of fires and also to prevent the ignition of materials that could become involved in a fire.
2. Firefighting foam is produced by mixing foam concentrate with water to produce a solution that can be used as an effective extinguishing agent.
3. There are several different types of foam used for fires involving different types of fuels.
   a. Each type of foam requires the appropriate type of concentrate, the proper equipment to mix the concentrate with water in the required proportions, and the proper application equipment and techniques.
   b. It is particularly important to learn where and when to use each type of foam that is available in your department.

B. Slides 40-41 Foam Classifications
1. Class A foam is used to fight fires involving ordinary combustible materials, such as wood, paper, and textiles.
   a. It is effective on organic materials, such as hay and straw.
   b. Class A foam is particularly useful for protecting buildings in rural areas during forest and brush fires when the supply of water is limited.
   c. Class A foam increases the effectiveness of water as an extinguishing agent by reducing the surface tension of water.
   d. This allows the water to penetrate dense materials instead of running off the surface and allows more heat to be absorbed.
   e. The foam also keeps water in contact with unburned fuel to prevent ignition.

2. Class B foam is used to fight Class B fires—flammable and combustible liquids.
   a. There are several different types of Class B foam that are formulated to be effective on different types of flammable liquids.
   b. Some liquids are incompatible with different foam formulations and will destroy the foam before the foam can control the fire.
   c. In a flammable-liquid fire, only the flammable vapors that are evaporating from the surface of the liquid and mixing with air can burn.
   d. Foam extinguishes flammable-liquid fires by separating the fuel from the fire.
   e. Once a foam blanket has been applied, it must not be disturbed.
   f. If the foam blanket is disturbed by wind, by someone walking through the liquid, or by hose streams breaking up the foam blanket, flammable vapors will be released and could be easily reignited.
   g. When using foam to extinguish a flammable-liquid fire, it is critically important to apply enough foam to fully cover the liquid surface.
   h. Class B foam can also be applied to a spill of flammable-liquid product to prevent a fire.
   i. It is important to use the proper foam for the situation that is encountered.

C. Slides 42-43 Foam Concentrates
1. Class A foams are usually formulated to be mixed with water in ratios from 0.1% (1 gal of concentrate to 999 gal of water, or 1 liter of concentrate to 999 liters of water) to 1.0% (1 gal of concentrate to 99 gal of water, or 1 liter of concentrate to 99 liters of water).
   a. The end product can be produced with different properties by varying the percentage of foam concentrate in the mixture and the application method.
   b. It is possible to produce “wet” foam that will have good penetrating properties or “drier” foam that is more effective for applying a protective layer of foam onto a building.

2. Most Class B foam concentrates are designed to be used in strengths of either 3% or 6%.
   a. The compatibility of foam agents with other extinguishing agents needs to be considered.
b. It is important not to mix different types of foam concentrate or even different brands of the same type unless they are known to be compatible.

c. Some constituents in Class B foam concentrates that have been widely used in the past are being phased out because of environmental concerns.

d. Newer concentrates have been developed that are equally effective without the undesirable properties.

3. There are four major categories of Class B foam concentrate.
   a. Protein foams are made from animal by-products.
      i. They are effective on Class B hydrocarbon fires and are applied in 3% or 6% delivery rates.
   b. Fluoroprotein foams are made from the same base materials as protein foam along with fluorochemical surfactant additives.
      i. The additives allow this foam to produce a fast-spreading film.
   c. Aqueous film–forming foam (AFFF) is a synthetic-based foam that is particularly suitable for spill-related fires that involve gasoline and light hydrocarbon fuels.
      i. It can form a seal across a surface quickly and has excellent vapor suppression capabilities.
   d. Alcohol-resistant foam has properties that are similar to AFFF; however, it is formulated so that alcohols and other polar solvents will not dissolve the foam.

   e. Standard PPE provides protection when working with foam.
   f. Fire fighters should rinse their skin after coming in contact with foam.
      i. Flush equipment with clear water
      ii. Rinse protective clothing with plain water

D. Slides 44-45 Compressed Air Foam System

1. A compressed air foam system (CAFS) is a relatively new method of making class A foam.
   a. CAF is produced by injecting compressed air into a stream of water that has been mixed with 0.1% to 1.0% foam.
      i. Results in a small, highly compacted structure.
      ii. Provides a much larger surface area for heat absorption than aspirated foams.
      iii. Produces rapid knockdown of a fire and a rapid cooling of the atmosphere.
      iv. Adheres to most surfaces and absorbs more heat than water because it provides a greater surface area for absorption than an equal amount of water.
      v. Decreases the amount of fuel available to ignite by isolating the fuel.
      vi. Seems to decrease the amount of smoke in an enclosed fire.

2. CAFS is produced by a combination of a centrifugal fire pump, a foam metering device to provide a 0.1% to 1.0% concentration of foam that is injected on the discharge side of the pump, and an air compressor to inject compressed air bubbles into the water-foam combination.

3. Foams of different consistencies can be produced by adjusting the ratios of air to water.
   a. Drier foams are produced by increasing the ratio of air to water.
   b. Wetter foams are produced by decreasing the ratio of air to water.
   c. Drier foams have longer drain times.

4. The use of CAF requires special training, including instruction for pump operators and theoretical and practical training for other fire fighters.
   a. This training should include practice with live burn situations.

E. Slides 46-47 Foam Equipment

1. Foam-proportioning equipment
   a. A foam proportioner is the device that mixes the foam concentrate into the fire stream in the proper percentage.
      i. The two types of proportioners, eductors and injectors, are available in a wide range of sizes and capacities.
      ii. An eductor can be built into the plumbing of an engine or a portable eductor can be inserted in an attack hose line.
      iii. A foam eductor is usually designed to work at a predetermined pressure and flow rate.
      iv. A metering valve can be adjusted to set the percentage of foam concentrate that is educted into the stream.
      v. The most common type of portable in-line eductor used by fire departments is sized to work with a 1½" (38-mm) or 1¾" (45-mm) attack line.
   b. Foam injectors add the foam concentrate to the water stream under pressure.
      i. Most injector-based proportioning systems will work across a range of flow rates and pressures.
      ii. A metering system measures the flow rate and pressure of the water and adjusts the injector to add the proper amount of foam concentrate.
      iii. This type of system is often installed on special foam apparatus.
iv. Placing an eductor foam line in service will be practiced in Skill Drill 17-16.

2. Batch mixing
   a. Foam concentrate can be poured directly into an apparatus booster tank to produce foam solution. This technique is called batch mixing.
   b. If the booster tank has a capacity of 500 gal (1893 L), 15 gal (56 L) of 3% foam concentrate should be added.
   c. If 6% foam concentrate is used, 30 gal (113 L) of foam concentrate should be added to the booster tank.
   d. It may be necessary to drain sufficient water from the tank first to make room for the foam concentrate.
   e. After the concentrate has been added, the solution should be mixed by circulating the water through the pump before it is discharged.

3. Premixing
   a. Premixed foam is commonly used in 2½-gal (9.5-L) portable fire extinguishers.
   b. Foam fire extinguishers are filled with premixed foam solution and pressurized with compressed air or nitrogen.
   c. Some vehicles are equipped with a large tank holding 50 or 100 gal (190-380 L) of premixed foam, which operate in the same manner.

F. Slides 48-49 Foam Application
   1. Foam can be applied to a fire or spill through portable extinguishers, handlines, master stream devices, or a variety of fixed systems for special applications.
      a. Foam can be applied with a wide range of expansion rates, depending on the amount of air that is mixed into stream and the size of the bubbles that are produced.
      b. Low-expansion foam has little entrained air and a small bubble structure.
         i. Often produced with standard adjustable fog nozzles.
         ii. Air is entrained by the flowing stream and mixed into the foam solution.
         iii. Often used to apply AFFF or Class A foam.
      c. Medium-expansion foam is produced with special aerating nozzles that are designed to introduce more air into the stream and produce a consistent bubble structure (aeration).
         i. Generally used with protein and fluoroprotein foams to produce a thicker blanket of foam.
         ii. Recommended for use with alcohol-resistant foams to produce a thicker foam blanket.
      d. High-expansion foam has a much greater proportion of air and large bubbles.
         i. Uses a high-expansion foam generator to introduce large quantities of air into the discharge stream.
         ii. Sometimes used in automatic systems that are designed to completely fill a large space with foam.

G. Slide 50 Foam Application Techniques
   1. The sweep (or roll-on) method should only be used on a pool of flammable product that is on open ground.
      a. The sweep method of applying foam will be practiced in Skill Drill 17-17.
   2. The bank shot (or bank-down) method is used at fires where there is an object that can be used to deflect the foam stream and let it flow down onto the burning surface.
      a. The bank shot method will be practiced in Skill Drill 17-18.
   3. The rain-down application method consists of lofting the foam stream into the air above the fire and letting it fall down gently onto the surface.
      a. The rain-down method will be practiced in Skill Drill 17-19.

H. Slide 51 Backup Resources
   1. If the flow of foam has to be interrupted while additional foam supplies are obtained, the fire will destroy the foam that has already been applied.
   2. It is better to wait until an adequate supply of foam concentrate is on hand than to waste the limited supply that is immediately available.
   3. There are specific formulas provided by the foam manufacturers to calculate how much foam is required to extinguish fires of a certain size.
   4. Most fire departments have contingency plans to deliver quantities of foam to the scene of a major incident.
   5. The manufacturers of foam products also have emergency programs to deliver large quantities of foam to the scene of exceptionally large-scale incidents.

I. Slide 52 Foam Apparatus
   1. Some fire departments operate apparatus that is specifically designed to produce and apply foam.
      a. The most common examples are used at airports for aircraft rescue and firefighting.
      b. These are large vehicles that carry the foam concentrate and water on board and are designed to quickly apply large quantities of foam to a flammable-liquids fire.
      c. Remote-control monitors can be used to apply foam while the vehicle is in motion.
      d. Fire fighters should practice with local airports and know the best access.
VI. Summary

Lecture/Discussion

1. Slide 53 Attack hoses carry water from the attack engine to a nozzle used to direct water onto the fire.
2. Slide 53 Attack hoses operate at high pressure.
3. Slide 53 Hoses used to attack interior fires are 1½” (38 mm) to 1¾” (45 mm) in diameter.
4. Slide 53 Attack hoses must be tested annually.
5. Slide 54 A 1½” (38-mm) hose can flow between 60 and 125 gal (273-568 L) per minute.
6. Slide 54 A 2¼” (65-mm) hose is used on large fires.
7. Slide 54 Booster hoses contain a steel wire giving it a rigid shape.
8. Slide 54 Attack lines are stretched from the attack engine to the fire.
9. Slide 55 Attack lines are loaded so they can be quickly and easily deployed.
10. Slide 55 Preconnected hose lines can be placed in several different locations on a fire engine.
11. Slide 55 Hoses may need to be split into two attack lines to reach a fire that is far away from the attack engine.
12. Slide 55 Attack evolutions have a specific structure.
13. Slide 55 Nozzles give fire streams shape and direction.
14. Slide 55 Nozzle shut-off enables the fire fighter to start or stop the flow of water.
15. Slide 55 Smooth-bore and fog-stream are the two different types of nozzles.
16. Slide 55 There are three specialized nozzles.
17. Slide 57 Foam can be used to fight multiple types of fire.
18. Slide 57 Foams are either Class A or Class B.
19. Slide 57 Foam extinguishes flammable-liquid fires by separating the fuel from the fire.
20. Slide 57 Foam concentrate is mixed with water in different ratios to produce a foam solution.
21. Slide 57 There are five categories of Class B foam.
22. Slide 58 Compressed air foam systems (CAFSs) are a way to make Class A foam.
23. Slide 58 A foam proportioner mixes foam concentrate into the fire stream in the proper percentage.
24. Slide 58 Foam solution can be produced by batch mixing or premixing.
I. Wrap-Up Activities

Time: 40 Minutes
Individual Activity/Small-Group Activity/Discussion

Fire Fighter in Action and/or Fire Fighter II in Action

This activity is designed to assist the student in gaining a further understanding of fire hose, nozzles, streams, and foam. The activity incorporates both critical thinking and the application of fire fighter knowledge.

Purpose

This activity allows students an opportunity to analyze a firefighting scenario and develop responses to critical thinking questions.

Instructor Directions

1. Direct students to read the “Fire Fighter in Action” and/or “Fire Fighter II in Action” located in the Wrap-Up section at the end of Chapter 17.
2. Direct students to read and individually answer the quiz questions at the end of the scenario. Allow approximately 10 minutes for this part of the activity. Facilitate a class review and dialogue of the answers, allowing students to correct responses as needed. Use the answers noted below to assist in building this review. Allow approximately 10 minutes for this part of the activity.
3. You may also assign these as individual activities and ask students to turn in their comments on a separate piece of paper.

Answers to Multiple Choice Questions

1. What steps will you take to pull a minuteman load?
   A. While facing the engine, pull the hose one-third of the way out, place the hose on your shoulder, turn, and then walk toward the proper location.
   B. While facing away from the engine, pull the hose one-third of the way out, turn, place the hose on your shoulder, and then walk toward the proper location.
   C. Place your arm through the larger loop, and then grasp the smaller loop with that hand. Pull the hose and walk toward the proper location.
   D. Place your arm through the larger loop, and then grasp the smaller loop with the opposite hand. Pull the hose and walk toward the proper location.

2. Hose with a diameter of 2½” or 3” (65 or 76 mm) is considered ____________.
   A. small diameter
   B. medium diameter
   C. intermediate diameter
   D. large diameter

3. A nozzle that can deliver a wide range of water stream flows and that operates by means of an internal spring-loaded piston is called a/an ____________.
   A. adjustable-gallonage fog nozzle
   B. Bresnan distributing nozzle
   C. fog nozzle stream
   D. automatic-adjusting fog nozzle
4. What is a device placed in the hose line that draws foam concentrate from a container and introduces it into the fire stream called?
   A. Foam injector  
   B. Aerator  
   C. Foam eductor  
   D. Batch mixer

5. What is the method that applies the stream onto a nearby object, such as a wall, instead of directly aiming at the fire called?
   A. Roll-on  
   B. Sweep  
   C. Rain-down  
   D. Bank-down

6. ______ foam increases the effectiveness of water as an extinguishing agent by reducing the surface tension of water.
   A. Class A  
   B. Class B  
   C. Class C  
   D. Class D

Fire Fighter II in Action Questions

1. How will you protect the exposed buildings?
2. Do you have the proper foam to extinguish the fire?
3. Will CAFs be of any value in this scenario?
4. What concerns do you have with this incident?

II. Lesson Review

Time: 15 Minutes

Discussion

Note: Facilitate the review of this lesson’s major topics by using the review questions as direct questions or PowerPoint slides. Answers are found throughout this lesson plan.

FIRE FIGHTER I

1. Describe the characteristics of an attack hose.
2. What size hose constitutes a small-diameter, medium-diameter, and large-diameter hose?
3. What is the purpose of a preconnected attack line?
4. What are the two stages of advancing an attack line?
5. What is the purpose of a gated wye?
6. Describe the two basic ways to extend a hose line.
7. Name three different types of hose loads.
8. Describe the basic procedure for replacing a defective hose.
9. List the advantages and disadvantages of smooth-bore nozzles and fog-stream nozzles.
10. Name the three types of fog-stream nozzles.

FIRE FIGHTER II

1. How is firefighting foam produced?
2. What are the different types of foam classifications?
3. What are the different types of Class B foams?
4. What is a foam proportioner?
5. How does a foam eductor draw foam concentrate?
6. What are the different types of foam application techniques?
7. Why is it crucial to have enough foam concentrate available to complete a job?

III. Assignments

Time: 5 Minutes
Lecture

A. Advise students to review materials for a quiz (determine the date/time).
B. Direct students to read the next chapter in Fundamentals of Fire Fighter Skills: Evidence-Based Practices, Enhanced Third Edition, as listed in your syllabus (or reading assignment sheet), to prepare for the next class session.