Chapter 11 Forcible Entry

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Lesson Goal

After completing this lesson, the student shall be able to explain, as well as perform, forcible entry into a structure or structural components. Students shall also be able to explain and perform forcible entry methods and breaching operations.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain the basic principles of forcible entry. [NFPA[®] 1001, 5.3.4]
- 2. Describe the basic construction of locksets. [NFPA[®] 1001, 5.3.4]
- 3. Describe considerations a firefighter must take when using forcible entry tools. [NFPA[®] 1001, 5.3.4]
- 4. Indicate steps needed to care for and maintain forcible entry tools. [NFPA[®] 1001, 5.5.1]
- 5. Explain the ways to force entry through various types of doors. [NFPA[®] 1001, 5.3.4]
- 6. Identify considerations that need to be taken when forcing entry through locks, padlocks, overhead doors, and fire doors. [NFPA[®] 1001, 5.3.4]
- 7. Describe forcible entry methods used for windows. [NFPA[®] 1001, 5.3.4]
- 8. Explain considerations firefighters must take when forcing entry through miscellaneous types of windows and covers. [NFPA[®] 1001, 5.3.4]
- 9. Describe forcible entry methods for breaching walls. [NFPA[®] 1001, 5.3.4]
- 10. Explain forcible entry methods for breaching floors. [NFPA[®] 1001, 5.3.4]
- 11. Indicate methods for forcing fences and gates. [NFPA[®] 1001, 5.3.4]
- 12. Clean, inspect, and maintain hand tools and equipment. [NFPA[®] 1001, 5.5.1]
- 13. Clean, inspect, and maintain power tools and equipment. [NFPA[®] 1001, 5.5.1]
- 14. Force entry through an inward-swinging door Two-firefighter method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 15. Force entry through an inward-swinging door Cutting the lock out of the door method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 16. Force entry through an outward-swinging door Removing hinge-pins method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 17. Force entry though an outward-swinging door Wedge-end method. [NFPA[®] 1001, 5.3.4, 5.3.]



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- 18. Force entry using the through-the-lock method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 19. Force entry using the through-the-lock method using the K-tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 20. Force entry using the through-the-lock method using the A-tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 21. Force entry through padlocks. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 22. Use a bam-bam tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 23. Cut a padlock with a rotary saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 24. Force entry through a window (glass pane). [NFPA[®] 1001, 5.3.4, 5.3.14]
- 25. Force entry through a double-hung window. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 26. Force a Lexan[®] window using a rotary saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 27. Force entry through a wood-framed wall. (Type V construction) with hand tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 28. Force entry through a wood wall. (Type V construction) with a rotary saw or chain saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 29. Breach a wall using a battering ram. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 30. Force entry through a masonry wall with hand tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 31. Force entry through a metal wall with power tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 32. Breach a hardwood floor. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 33. Bridge a fence with a ladder. [NFPA[®] 1001, 5.3.4, 5.3.14]

Instructor Information

This is the lesson covering forcible entry. This lesson describes the basic principles of forcible entry. The lesson also covers the operation of structural parts and the dangers associated with forcibly entry methods/tools.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. BASIC PRINCIPLES OF FORCIBLE ENTRY

pp. 573-575

Objective 1 — Explain the basic principles of forcible entry.



- Forcible entry Technique used to gain access into compartment, structure, facility, or site when normal means of entry is locked or blocked
 - a. Should only cause minimal damage to structure or structural components when applied properly
 - b. Provides quick access to emergency
 - i. Determine if alternative means of access are practical before forcing entry in building
 - ii. Do not use if normal means of access is available
- 2. Can also be applied to
 - a. Vehicles
 - b. Railway passenger cars
 - c. Aircraft
 - d. Ships
- 3. All types require effective size-up and situational awareness
- 4. Supervisor or Incident Commander (IC) determines where to perform based on
 - a. Tactics that must be fulfilled
 - b. Location of the fire or hazard
 - c. Stage of the fire
 - d. Effect on ventilation
 - e. Amount of effort required to force entry
- 5. Example Easier to force open basement window than to force entry through a door and advance hoseline down stairway
- 6. Location of opening can affect fire behavior by adding fresh air to a ventilation-controlled fire









THE GENERAL CONSIDERATIONS FOR FORCIBLE ENTRY INCLUDE THREE AREAS.					
Doors and locks					
Proper tools	Security barriers				
	A station the				



- 7. Never force entry without orders to do so
 - a. First "Try before you pry" at every door or window

Ask Students: What is meant by "Try before you pry?"

Briefly discuss answers with students. Suggested answer: The door or window may be unlocked and can be opened in a normal manner.

- b. Second Look for lockbox near the main entrance on commercial and industrial occupancies
 - i. Using a door key or numeric keypad combination in a lockbox avoids unnecessary damage to property
 - ii. May be quicker than having to force a door or window
- 8. General considerations
 - a. Doors and locks
 - i. Construction
 - ii. Direction of opening (inward or outward)
 - iii. Type of frame
 - iv. Type of lock
 - v. Mounting of lock
 - b. Proper tools
 - i. Know correct tools needed for particular job
 - ii. Adjust entry activity based upon available tools
 - iii. Use tools for their intended purposes to make entry
 - c. Security barriers
 - i. Could include
 - (a) Bars
 - (b) Grilles
 - (C) Lexan[®] windows
 - (d) Others

- ii. Require specialized
 - (a) Training
 - (b) Tools
 - (C) Knowledge
- iii. Block escape routes for both firefighters and occupants
- iv. May necessitate making multiple openings for entry

Review Question: What are the basic principles of forcible entry? *See pp. 573-575 of the textbook for answers.*

II. LOCKSETS

Objective 2 — Describe the basic construction of locksets.



pp. 575-581



A. Locksets

- 1. Used to describe all types of door latches, locks, and locking devices
- 2. Purpose
 - a. Secures doors
 - b. Prevents unauthorized entry into room or structure
- 3. To perform adequate size-up Understand types of locks and locking devices that may be encountered during fire or other emergency
- B. Door locks/latches Hardware found on all exterior doors and many interior doors
 - 1. Latches
 - a. Keeps doors closed
 - b. Consist of a handle on both sides and springloaded bar that extends into receiver in door frame
 - c. May or may not have lock

- 2. Locks are divided into three basic types
 - a. Mortise lock
 - b. Cylindrical lock
 - c. Rim lock
- 3. Nontraditional types of locks provide higher level of security
 - a. Multiple bolts
 - b. Keyless
 - c. Electromagnetic locks
- 4. Mortise latch and lock
 - a. Mounted into cavity in door edge
 - b. Older assemblies have only latch to hold the door closed
 - c. Newer units consist of both latch and a keyoperated dead bolt
 - d. When in locked position Bolt protrudes from lock into receiver that is mortised into jamb
 - e. Operated with doorknob or lever
 - f. Used on exterior wood and metal doors
 - g. Found on
 - i. Private residences
 - ii. Commercial buildings
 - iii. Industrial buildings
- 5. Cylindrical lock
 - a. Most common type of lockset
 - b. Found in residential applications
 - c. Installation involves boring two holes at right angles to one another
 - i. One through face of door to accommodate main locking mechanism
 - ii. Other in edge of door to receive latch or bolt mechanism







- d. Two types
 - i. Key-in-knob lock
 - (a) Has keyway in outside doorknob
 - (b) Inside knob may contain either keyway or button
 - (c) May be push or turn button
 - (d) Equipped with latch mechanism that locks and unlocks by both key and, if present, knob button
 - (e) Unlocked position Turn knob to retract spring-loaded beveled latch bolt
 - (f) Easiest to pry open because of short length of latch
 - (g) Latch clears if door and frame are pried far enough apart
 - ii. Tubular dead bolt lock
 - (a) Mounted above doorknob
 - (b) May have single cylinder or double-action cylinder
 - (c) Single cylinder Has keyway on outside of door and thumb turn knob on inside
 - (d) Double cylinder Has keyway on both sides of door

Note: The easiest way to breach modern dead bolts in a wood residential door is to force the door itself.



THE EASIEST WAY TO BREACH MODERN DEAD BOLTS

- 6. Rim lock
 - a. Mounted on interior door surface
 - b. Used as supplemental lock for doors with or without other types of locks
 - c. Operate by turning thumb turn knob on inside of door

- d. Found in all types of occupancies
 - i. Houses
 - ii. Apartments
 - iii. Some commercial buildings
- e. Not all doors have a keyway in a cylinder on exterior door
- f. Variety available
 - i. Night latch
 - (a) Has spring-loaded bolt with beveled edge facing door frame
 - (b) Allows door to lock when it is closed
 - ii. Dead bolt
 - (a) Rectangular bolt must be manually retracted before door can be closed and bolt engaged with receiver
 - (b) If bolt is extended, door cannot be closed
 - iii. Vertical dead bolt
 - (a) Slides vertically into receiver and does not cross door opening
 - (b) Makes it impossible to open by spreading door from doorjamb
- g. Higher security locks include
 - Multiple bolt locks Dead bolt lock that engages and projects bolts 1 inch (25.4 mm) into two or more points on one edge of the door
 - (a) Some versions extend hardened steel bolts into all four edges of the door frame
 - (b) May have a thumb turn knob or keyway on the inside of the door as well as a keyway on the exterior
 - (C) Surface mounted version may be encountered



- ii. Electronic keyless or digital locks Found on exterior and interior doors
 - (a) May have a key pad, card reader, or fingerprint activated screen
 - (b) Battery powered
 - (C) May have a keyway
 - (d) Used for areas that require continuous security and controlled access
- iii. Electromagnetic Consists of an electromagnet attached to the door frame and an armature plate mounted on the door
 - (a) Held shut by an electric current passing through the electromagnet and the armature plate
 - (b) Shutting off power will release door

C. Locking Devices

- 1. May be supplemental to door lock or used in place of it
 - a. Padlocks are best
 - b. Door chains or drop bars impede entry but are not locks in the traditional sense
- 2. Padlocks are portable or detachable locking devices Two types
 - a. Standard
 - i. Hackles of ¼ inch (6 mm) or less in diameter
 - ii. Are not case-hardened steel
 - b. Heavy duty
 - i. Have case-hardened steel shackles
 - ii. More than ¼ inch (6 mm) in diameter
 - iii. Toe and heel locking
 - (a) Both ends of shackle are locked when depressed into lock mechanism
 - (b) Shackles will not pivot if one side is cut
 - (c) Both sides must be cut in order to remove





- iv. May be key or combination operated
- 3. Other locking devices
 - a. Drop bar Brackets are bolted or welded to door and wood or metal bar rests in brackets and extends across the door frame
 - b. Door chain
 - i. Classic supplemental locking device for residential doors
 - ii. Permits door to be opened wide enough to see and speak to visitor but restrict access
 - c. Door limiter
 - i. Similar to supplemental security locks found in hotel rooms
 - ii. Door limiter consists of a frame-mounted plate with shaft and knob and hinged u-shaped shackle that mounts on the door
 - iii. Restricts opening of door
 - d. Surface bolt
 - i. Manually operated supplemental locking device
 - ii. Can be mounted on most doors and some windows
 - e. Internal-mounted bolt
 - i. Flush bolts are installed in edge of one side of set of double doors
 - ii. Permits one side to remain locked while other door is used for entry and exit
 - iii. Bolts can be retracted and both doors opened
 - f. Most devices are easy to force open, except drop bars and mounted bolts
 - g. It is difficult to tell if devices are mounted prior to attempted entry

Review Question: What types of locksets may firefighters encounter during forcible entry operations? *See pp. 576-580 of the textbook for answers.*

III. FORCIBLE ENTRY TOOLS

pp. 581-593

Objective 3 — Describe considerations a firefighter must take when using forcible entry tools.

Caution: Always wear appropriate PPE when using forcible entry tools.



A. Cutting Tools

- 1. Powered manually or with other source
- 2. Specific to types of materials they cut and how fast
- 3. No single cutting tool will safely and efficiently cut all materials
- 4. Damage can occur if tool is used on material for which it is not designed for
- 5. Axes Most common type of cutting tool; two basic types
 - a. Pick-head axe 6-pound or 8-pound head (2.7 kg or 3.6 kg)
 - i. Uses
 - (a) Versatile
 - (b) Cutting, prying, and digging
 - (c) Structural fire fighting operations
 - ii. Construction
 - (a) Head is hardened steel
 - (b) Handles are wood or fiberglass
 - (c) Comes in variety of sizes
 - (d) Effective in chopping wooden structural components, shingles and other roof coverings, aluminum siding, and other natural and lightweight materials
 - (e) Pick end can be used to penetrate materials that blade cannot cut easily
 - (f) Side of the pick-head axe can be used for striking and prying

- b. Flat-head axe
 - i. Construction
 - (a) Same as pick-head axe in size, design, and construction
 - (b) Flat striking face replaces pick end
 - (C) Blade can be used for all the same purposes as pick-head axe
 - ii. Uses
 - (a) Can be used with other tools to force entry
 - (b) Face is used to strike the other tool, forcing bit end in doorjamb or windowsill
 - (C) Used in both structural and ground cover fire fighting operations
- 6. Metal cutting devices
 - a. Cut through
 - i. Heavy-duty locks
 - ii. Metal-clad doors
 - iii. Window security bars and grilles
 - iv. Similar items to gain access into buildings
 - b. Bolt cutters
 - i. Used to cut bolts, iron bars, pins, cables, hasps, chains, and some padlock shackles
 - To prevent fragments striking operator's face, always wear face shield and eye protection during use
 - iii. Limitations
 - (a) Less practical as they once were
 - (b) Cannot cut Modern high-security chains, hasps, and padlock shackles
 - (c) Some locks are designed to prevent insertion into the shackle
 - (d) Should not be used to cut case-hardened materials



- (e) Do not use to cut energized cables unless insulated
- c. Cutting torches
 - i. Needed to cut security bars, grilles, or gates that cannot be easily cut using bolt cutters, rebar cutters, or rotary saws
 - ii. Oxyacetylene cutting torches, oxygasoline cutting torches, burning bars, and plasma cutters are commonly used
 - For safe efficient use Train based on manufacturer's specific cutting and burning instructions
 - iv. Charged hoseline must be in place during the cutting operation to cool the metal and control any sparks
- d. Rebar cutters
 - i. Available in both powered and manual versions
 - (a) Manual version requires more energy to use
 - (b) Can be used in areas beyond the reach of hydraulic supply hose on powered units
 - ii. Firefighters can use to cut steel reinforced bars (rebar) in concrete walls or cut door or window security bars
- 7. Handsaws
 - a. Power saws are used more often in fire service
 - b. May be useful when power saws are not available
 - c. Most common Hacksaws, drywall saws, and keyhole saws
- 8. Power saws
 - a. Includes circular saw, rotary saw, reciprocating saw, and chain saw
 - b. Power comes from self-contained battery pack, gasoline engine, or electricity from a generator or electrical outlet
 - c. Firefighters should always use eye, hearing, and hand protection when operating saw
 - d. Misuse can lead to property damage and injury







- e. Never use in flammable atmosphere
- f. Sparks can cause a fire or explosion

Caution: Wear eye, hearing, and hand protection when operating any power saw.

Caution: Never force a power saw beyond its design limits. Follow the manufacturer's recommendations.

Caution: Do not use a power saw in a flammable atmosphere.

- 9. Circular saw
 - a. Used in fire fighting, rescue, and overhaul operations
 - b. Useful where electrical power is readily available
 - c. Small battery-powered units are available
- 10. Rotary saw
 - a. Usually gasoline powered with changeable blades for cutting
 - i. Wood
 - ii. Metal
 - iii. Masonry
 - b. When using, have charged hoseline or portable fire extinguisher nearby for sparks

Caution: Sparks from cutting operations can cause additional fires. Have a charged hoseline or portable fire extinguisher close at hand during cutting.

WARNING!: Never use a rotary saw to cut the shell of any storage tank that might contain flammable vapors.

- c. Blades may spin at more than 6,000 rpm
 - i. Large-toothed blades are for quick and rough cuts
 - ii. Fine teeth are for a more precise cut
 - iii. Some are made to cut metal or concrete

CAUTION

ACCIPROCATING SAWS AND CHAIN SAWS BOTH H ADVANTAGES IN SPECIFIC CIRCUMSTANCES. iv. Blades with carbide-tipped teeth are superior to standard blades because they are less prone to dulling after heavy use

Caution: The blade guards on some rotary saws are not designed for use with carbide-tipped blades. Be sure that the saw is designed for the blades used.

11. Reciprocating saw

- a. Powerful, versatile, and easy to control
- b. Has short, straight blade that moves in and out like handsaw
- c. Can cut different materials with variety of blades
- d. Ideal for cutting sheet metal body panels when using a metal-cutting blade
- 12. Chain saw
 - a. Used in forcible entry, ventilation, rescue, and overhaul operations
 - b. Can be powered by gasoline engines, electricity, compressed air, or hydraulic power
 - c. Cutting chain types
 - i. Wood
 - ii. Concrete
 - iii. Stone
 - iv. Brick building materials
 - d. Useful during natural disasters to clear trees, limbs, and debris
 - e. Should be equipped with kickback protection and chain brakes for safety
 - f. Add carbide-tipped chains and depth gauges for better control

B. Prying Tools

- 1. Useful for opening doors, windows, locks, and moving heavy objects
- 2. Mechanical advantage
 - a. Principle of lever and fulcrum provide



C TOOLS HELP OPEN DOORS, WINDOWS, ND MOVE HEAVY OSJECTS BY PROVIDING

- b. Force applied to the tool's handle is multiplied at working end based upon distance between fulcrum and working end
- c. Longer the handle, greater the force produced at working end
- 3. Manual prying tools
 - a. Most common
 - i. Crowbar
 - ii. Halligan tool
 - iii. Pry (pinch) bar
 - iv. Hux bar
 - v. Claw tool
 - vi. Kelly tool
 - vii. Pry axe
 - viii. Flat bar (nail puller)
 - ix. Rambar
 - b. Constructed from single-piece high-carbon steel, approximately 30 to 36 inches (762 mm to 900 mm)
 - i. One end is beveled into a single wedge or fork
 - ii. Opposite end may have a hook, pike tip, or adz
 - c. Rambars have sliding weight on shaft that is used to drive wedge or fork into opening
 - d. Miniature versions of tools are available
 - e. Some can be used effectively as striking tools, but most cannot
 - f. Firefighters should be familiar with capabilities and limitations of each
 - g. Only use tool for its intended purpose
- 4. Hydraulic prying tools
 - a. Receive power from hydraulic fluid pumped through special high-pressure hoses
 - i. Pumping mechanism can be powered or manual
 - ii. Compressed air can be used







- iii. Electric motors or two- or four-cycle gasoline engines are more common
- b. Manual tools require more labor to operate
- c. Manual tools operate slowly
 - i. Smaller
 - ii. Lighter
 - iii. Easier to carry
- d. Tools can be used to
 - i. Pry
 - ii. Push
 - iii. Pull
- e. Rescue tools
 - i. Hydraulic spreaders
 - (a) Can exert force to spread something apart or pull heavy objects
 - (b) Tip can be spread as much as 32 inches (800 mm)
 - ii. Hydraulic rams
 - (a) Can spread from 36 inches (900 mm) to 63 inches
 (1 600 mm)
 - (b) Can be used for pushing and pulling
 - (C) Can be placed inside door frame and used to spread frame far enough apart for door to swing open
 - iii. Hydraulic door opener
 - (a) Lightweight and consists of a hand pump and spreader device
 - (b) Intermeshed teeth easily slip into a narrow opening such as a door frame
 - (c) Pumping handle spreads the device open
 - (d) Pressure can cause locking mechanism or door to fail
 - (e) Valuable when more than one door must be forced



C. Pushing/Pulling Tools

- 1. Limited use for forcible entry
- 2. Can break glass and open walls or ceilings
- 3. Tools
 - a. Pike pole
 - b. Clemens hook
 - c. Plaster hook
 - d. Drywall hook
 - e. San Francisco hook
 - f. Multipurpose hook
 - g. Roofman's hook
 - h. Rubbish hook
- 4. Pike poles and hooks give firefighters a reach advantage
 - Should only be used for pushing or pulling, except for roofman's hook because it is all metal
 - b. Handles are made of wood or fiberglass and may break when used as lever
- 5. Plaster hook has two knifelike wings that depress as head is driven through
 - a. Spreads out under pressure of self-contained springs
 - b. If lever is needed, select the appropriate prying tool

D. Striking Tools

- 1. Basic hand tool with weighted head attached to handle
- 2. Examples
 - a. Sledgehammer (8, 10, and 16 pounds [3.6, 4.5, and 7.3 kg])
 - b. Maul
 - c. Battering ram



- d. Pick
- e. Flat-head axe
- f. Mallet
- g. Hammer
- h. Punch
- i. Chisel
- 3. May be the only tool required
- 4. Also used with another tool to gain entry
- 5. Can crush fingers, toes, and other body parts when used improperly
- 6. Use proper eye protection when striking surfaces may cause metal chips or splinters to fly into air
- 7. Battering ram
 - a. Used to make wall and door openings
 - b. Construction
 - i. Weighs 30 to 40 pounds (13.6 to 18.1 kg)
 - ii. Made of steel with installed handles and hand guards
 - iii. One end is forked for breaking ordinary brick and concrete blocks
 - iv. Other end is rounded and smooth for battering doors and other types of walls
 - v. Breach can be created by one to four firefighters swinging ram back and forth into wall

E. Tools Used in Combination

- 1. No single forcible entry tool handles all situations
- 2. Tool combinations vary based on
 - a. Building construction
 - b. Security concerns
 - c. Tool availability
 - d. Other factors within fire department and area served

3. Irons are a combination of flat-head axe and Halligan tool

Ask Students: What is the most important factor to consider before performing forcible entry?

Briefly discuss answers with students. Suggested answer: Selecting the proper tools to do the job.

- 4. It is dangerous to use tools not equipped for situations
- 5. Preincident surveys help determine which tools are required to force entry to particular building or door, window, or wall

F. Tool Safety

- 1. Improper use of power and hand tools can result in
 - a. Strains
 - b. Sprains
 - c. Fractures
 - d. Abrasions
 - e. Lacerations
- 2. To prevent injury
 - a. Wear full PPE including hand and eye protection
 - b. Use only undamaged tools
 - c. Select the right tool for the type of opening to be made
 - d. Use tools only for their intended purpose
 - e. Position yourself so that your weight is balanced on both feet
 - f. Ensure that you have room to operate the tool properly
 - g. Be aware that there will be a sudden release of energy when the door, window, or wall is opened
 - h. Ensure that other personnel are out of the immediate area





- i. Be aware of the environment to prevent possible gas or vapor ignitions
- j. Become familiar with all tools used
- k. Read and follow manufacturer's guidelines as well as department SOPs
- I. Keep tools in properly designated places on apparatus when not in use
- m. Check location to make sure they are secured in brackets
- n. Repair or replace damaged tools immediately
- 0. Prying tools used incorrectly create a safety hazard
- p. Use larger tool if job cannot be completed with a particular tool
- q. Do not use prying tool as striking tool

Instructor Note: Discuss the Safety Alert Box titled "Unacceptable Practice: Cheater Bars" on page 592 of the textbook. Briefly cover the information on cheater bars and the safety concerns of using them. Additional force can cause the tool to slip, break or shatter causing serious injury.

- 3. Use rotary saws, power saws, and chain saws with extreme care to prevent injury
 - a. Match the saw or saw blades to the task and material to be cut
 - b. Never force a saw beyond its design limitations
 - c. Always wear full PPE, including gloves, hearing protection, and eye protection
 - d. Fully inspect the saw before and after use
 - e. Do not use any power saw when working in a flammable atmosphere or near flammable liquids
 - f. Maintain situational awareness
 - g. Keep unprotected and nonessential people out of the work area
 - h. Follow the manufacturer's guidelines for proper saw operation





- i. Keep blades and chains sharpened— Dull saw is more likely to cause an accident
- j. Be aware of hidden hazards such as electrical wires, gas lines, and water lines
- k. Remember that the rotating blade on rotary saw continues to spin after throttle has been released
- I. Use only blades that are manufacturer approved for saw Blades may not be interchangeable
- m. To maintain control of saw, account for the twisting (gyroscopic or torsion effect) caused by spinning blade
- n. Start all cuts at full revolutions per minute (rpm) to prevent blades from binding into material
- o. Store blades in clean, dry environment
- p. Store composite blades in compartments where gasoline fumes will not accumulate
 - i. Hydrocarbons can attack bonding material in these blades
 - ii. Causing to deteriorate and violently shatter during use

Review Question: What are some basic tool safety tips firefighters should follow during forcible entry operations? *See pp. 591-593 of the textbook for answers.*



G. Carrying Tools

- 1. Take care to protect yourself, other firefighters, and bystanders
- 2. Always lift with legs and not back when lifting heavy tools or other objects
- 3. Get help when transporting heavy tools
- 4. Safety practices for carrying specific tools
 - a. Axes If not in a scabbard, carry the axe with blade away from the body
 - i. Pick-head axes Grasp pick with hand to cover it

- ii. Never carry axe on shoulder
- b. Prying tools Carry with any pointed or sharp edges away from the body
 - i. Can be difficult when carrying tools with multiple cutting or prying surfaces
 - ii. Example Bit on one end and an adz on the other
- c. Combinations of tools
 - i. Strap tool combinations together
 - ii. Halligan tools and flat-head axes can be nested together and strapped
- d. Pike poles and hooks
 - i. Carry with the tool head down
 - ii. Close to the ground
 - iii. Ahead of the body when outside a structure
 - iv. When entering a building, carefully reposition tool and carry it with head upright
 - (a) Keep it close to body to facilitate prompt use
 - (b) Especially dangerous because they are somewhat unwieldy
 - (c) Can severely injure anyone accidentally jabbed with working end of tool
- e. Striking tools Keep the heads of these tools close to the ground
 - i. Maintain a firm grip
 - ii. Mauls and sledgehammers are heavy and may slip
- f. Power tools Never carry more than 10 feet (3 m) when operating
 - i. Running tools are potentially lethal weapons
 - ii. Transport the tool to area where work will be performed and start it there
 - iii. Carry saw with blade forward and toward ground
 - iv. Ensure that gas cap is tight and gasket is in place to prevent leaking

pp. 593-596



Objective 4 — Indicate steps needed to care for and maintain forcible entry tools.

H. Care and Maintenance of Forcible Entry Tools

- 1. If maintained properly, tools will function as designed
- 2. Tool failure can result in
 - a. Delays
 - b. Injury
 - c. Death
- 3. Read manufacturer's recommended maintenance guidelines
- 4. Follow department procedures to report tools/equipment needing repair
- 5. Remove damaged tools from service
- 6. Wooden handles Care and maintenance
 - a. Inspect the handle for cracks, blisters, or splinters
 - b. Sand the handle if necessary to eliminate splinters
 - c. Wash the handle with mild detergent, rinse, and wipe dry
 - d. Soaking a handle in water can cause wood to swell
 - e. Apply coat of boiled linseed oil to handle to preserve it and prevent roughness and warping
 - f. Do not paint or varnish handle
 - g. Check the tightness of the tool head
 - h. Limit amount of surface area used for tool marking
 - i. Unit designations can be applied on strips of tape or self-adhesive bar codes on handle
- 7. Fiberglass handles
 - a. Easier to maintain

- b. Care includes
 - i. Wash the handle with mild detergent, rinsing, and wiping dry
 - ii. Check for damage or cracks
 - iii. Check the tightness of the tool head
- 8. Cutting edges Care and maintenance
 - a. Inspect cutting edge for chips, cracks, or spurs
 - b. Replace axe head when required
 - c. File cutting edges by hand; grinding weakens tool
 - d. Sharpen blade as specified in departmental SOP
 - i. Some axe blades are intentionally left semisharp to make them less prone to chipping
 - ii. Pieces of blade will break if it is extremely sharp and ground too thin when cutting gravel or striking nails
 - iii. It is difficult to drive a thick axe head through ordinary objects

Note: Paint should never be applied to the cutting surface of an axe head; this may cause the cutting surface to stick and bind.

9. Plated surfaces

- a. Protected by chromium or another metal applied by electroplating process
- b. Wipe surfaces or wash using mild detergent and water, rinse, and wipe dry
- c. Inspect for damage
- 10. Unprotected metal surfaces
 - a. Components that have not been protected from rust or corrosion
 - b. Instructions for care
 - i. Remove dirt and rust with an emery cloth or steel wool
 - ii. Remove burrs from cutting edge and body with metal file
 - iii. Do not make blade edge too sharp Can cause it to chip or break

- iv. Do not use a mechanical grinder to sharpen blades – Can cause a loss of temper through overheating
- v. Oil metal surface lightly
 - (a) Light machine oil works best
 - (b) Metal protectant that contains 1-1-1trichloroethane can damage and weaken handle
- vi. Do not apply oil to the striking surface of tools
- vii. Do not paint metal surfaces paint hides defects
- viii. Inspect metal for chips, cracks, burrs, or sharp edges, and file them off when found

11. Power equipment

- a. Each tool has its own set of instructions for care and maintenance
- b. Even minor damages can cause potential hazards
- c. General care and maintenance
 - i. Read and follow manufacturer's instructions
 - ii. Ensure that rechargeable battery packs are fully charged and ready for immediate use
 - iii. Inspect power tools periodically and ensure they will start manually
 - iv. Check blades for damage or wear
 - v. Replace blades that are damaged or worn
 - vi. Check all electrical components (cords, etc.) for cuts or other damage
 - vii. Ensure that grounding prong has not been removed from three-prong plugs
 - viii. Ensure that all guards are functional and in place
 - ix. Ensure that fuel, engine oil, and hydraulic fluid is fresh and at proper level
 - x. Check condition of all hydraulic hoses and connections



Chapter 11 Forcible Entry

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Forcible Entry	
Module 2	
Chapter 11	
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Lesson Goal

After completing this lesson, the student shall be able to explain, as well as perform, forcible entry into a structure or structural components. Students shall also be able to explain and perform forcible entry methods and breaching operations.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain the basic principles of forcible entry. [NFPA[®] 1001, 5.3.4]
- 2. Describe the basic construction of locksets. [NFPA[®] 1001, 5.3.4]
- 3. Describe considerations a firefighter must take when using forcible entry tools. [NFPA[®] 1001, 5.3.4]
- 4. Indicate steps needed to care for and maintain forcible entry tools. [NFPA[®] 1001, 5.5.1]
- 5. Explain the ways to force entry through various types of doors. [NFPA[®] 1001, 5.3.4]
- 6. Identify considerations that need to be taken when forcing entry through locks, padlocks, overhead doors, and fire doors. [NFPA[®] 1001, 5.3.4]
- 7. Describe forcible entry methods used for windows. [NFPA[®] 1001, 5.3.4]
- 8. Explain considerations firefighters must take when forcing entry through miscellaneous types of windows and covers. [NFPA[®] 1001, 5.3.4]
- 9. Describe forcible entry methods for breaching walls. [NFPA[®] 1001, 5.3.4]
- 10. Explain forcible entry methods for breaching floors. [NFPA[®] 1001, 5.3.4]
- 11. Indicate methods for forcing fences and gates. [NFPA[®] 1001, 5.3.4]
- 12. Clean, inspect, and maintain hand tools and equipment. [NFPA[®] 1001, 5.5.1]
- 13. Clean, inspect, and maintain power tools and equipment. [NFPA[®] 1001, 5.5.1]
- 14. Force entry through an inward-swinging door Two-firefighter method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 15. Force entry through an inward-swinging door Cutting the lock out of the door method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 16. Force entry through an outward-swinging door Removing hinge-pins method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 17. Force entry though an outward-swinging door Wedge-end method. [NFPA[®] 1001, 5.3.4, 5.3.]



- 18. Force entry using the through-the-lock method. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 19. Force entry using the through-the-lock method using the K-tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 20. Force entry using the through-the-lock method using the A-tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 21. Force entry through padlocks. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 22. Use a bam-bam tool. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 23. Cut a padlock with a rotary saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 24. Force entry through a window (glass pane). [NFPA[®] 1001, 5.3.4, 5.3.14]
- 25. Force entry through a double-hung window. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 26. Force a Lexan[®] window using a rotary saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 27. Force entry through a wood-framed wall. (Type V construction) with hand tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 28. Force entry through a wood wall. (Type V construction) with a rotary saw or chain saw. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 29. Breach a wall using a battering ram. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 30. Force entry through a masonry wall with hand tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 31. Force entry through a metal wall with power tools. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 32. Breach a hardwood floor. [NFPA[®] 1001, 5.3.4, 5.3.14]
- 33. Bridge a fence with a ladder. [NFPA[®] 1001, 5.3.4, 5.3.14]

Instructor Information

This is the lesson covering forcible entry. This lesson describes the basic principles of forcible entry. The lesson also covers the operation of structural parts and the dangers associated with forcibly entry methods/tools.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. FORCING ENTRY THROUGH DOORS

pp. 596-608 Objective 5 — Explain the ways to force entry through various types of doors.

Objective 6 — Identify considerations that need to be taken when forcing entry through locks, padlocks, overhead doors, and fire doors.

A. Forcing Entry through Doors

- 1. Most conventional method in fire service
- 2. After sizing up door, forcible entry can be performed
- 3. Door construction determines what type of entry to use
- 4. Opening the door
 - a. Begin with minimum damage and proceed to maximum
 - b. Start by trying to open in normal fashion
 - c. Look for lockbox with key if normal fashion does not work
 - d. Look for door window or sidelight panel for access to lock
- 5. If the door must be forced determine if quicker to
 - a. Force the lock
 - b. Remove hinge pins
 - c. Force the door
 - d. Pry the door from jamb
- 6. Damage can be justified by severity of emergency and speed needed for entry
- 7. Rapid-entry lockbox systems provide a means to open locked doors
 - a. Keys or numeric keypad combinations are kept in lockbox in high-visibility location
 - b. Only the fire department possesses master key that opens all boxes in its jurisdiction



Instructor Note: Discuss the Safety Alert Box titled "Maintaining Door Control" on page 597 of the textbook. Briefly cover the information on door control. Explain the change in ventilation and the adverse effects on the fire.

- 8. Breaking door glass
 - a. One of the fastest and least destructive techniques
 - b. Gives ability for firefighter to reach inside and unlock door
 - c. Tempered glass can be more difficult and costly
 - i. Will shatter into sharp fragments when broken
 - ii. Firefighters should wear full protective equipment to prevent injury
 - d. SCBA should be worn if gaining access to burning building
 - e. Techniques for breaking door glass and window glass are similar
- 9. Forcing swinging doors
 - a. Doors that swing 90 degrees are most common
 - i. Hinges are mounted on one side that permits swinging in both directions
 - ii. Swing direction can be determined by looking at hinges
 - iii. If you can see hinges of door, it swings toward you
 - iv. If you cannot see hinges, door swings away from you
 - b. Inward-swinging doors
 - i. Examples
 - (a) Single firefighter using rambar can open most standard swinging doors
 - (b) Two firefighters are required to use Halligan tool or flat-head axe
 - ii. Use other techniques if door is
 - (a) Metal or metal-clad
 - (b) In metal frame in concrete or masonry wall



OK FOR THE PLACEMENT OF THE HINGE WHEN FORCING SWING DOORS.



- iii. Rabbit tool Hydraulic door opener used to force open door
- iv. Cutting around lock is another way to open resisting door
 - (a) First option Make two intersecting cuts with metal cutting blade and isolate locking mechanism to allow door to swing
 - (b) Second option Use three intersecting cuts
- c. Outward-swinging doors
 - i. Also known as flush fitting doors
 - ii. Hinges are mounted on outside
 - (a) Possible to use nail set and hammer to drive pins out and remove door
 - (b) Break hinges off if pins cannot be driven out using rambar or Halligan
 - (c) Placing blade to pry between door and doorjamb will open space wide enough for lock bolt to slip
- d. Double-swinging doors
 - i. If secured by mortise lock, doors can be pried to let bolt slip past receiver
 - ii. Using rambar or Halligan between doors can pry apart allowing bolt to clear receiver
 - iii. Rotary saw blade can also be used to cut dead bolt
 - iv. Double doors may have security molding or weather strip
 - (a) Remove the molding
 - (b) Then insert blade
- e. Doors with drop bars
 - i. Located on single- or double-swinging doors for locking
 - ii. To force entry
 - (a) Use rambar or Halligan tool to spread space between double doors





- (b) Insert blade of handsaw or other narrow tool into opening and lift bar up and out of stirrups
- (c) Use a rotary saw to cut exposed bolt heads that are holding stirrups on the outside of door
- (d) Allows drop-bar to fall away and door to be opened
- (e) Insert blade of rotary saw into space between halves of double doors and cut security bar
- f. Tempered plate glass doors
 - i. Located in commercial, light industrial, and institutional occupancies
 - (a) Heavy and very expensive
 - (b) Difficult to break
 - (C) Heat resistant
 - (d) Shatters into thousands of tiny cube-like pieces when broken
 - ii. How to break
 - (a) Strike at bottom corner with pick end of pickhead axe
 - (b) Firefighter should wear complete PPE including faceshield or goggles
 - (c) Shield may be used to take the blow from striking glass
 - (d) Glass can be scraped from frame
 - iii. Only break as last resort
 - iv. Through-the-lock method may be used as well
- 10. Forcing sliding doors
 - a. Consist of
 - i. Glass panels mounted in wood, aluminum, or vinyl-clad material
 - ii. One panel is stationary and the other slides on a track

DETERMINE THE METHOD FOR FORDING SLIDING DODRS OR SECURITY DODRS/GATES BY DENTIFYING THE TYPE.
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- iii. Also known as patio doors
- iv. Found in single-family residential structures and apartments
- v. Lock by latches on inside of door and security bars placed in track
- b. For forcible entry
 - i. Break glass with axe or lift sliding panel up and out of track
 - ii. Door will shatter if spread from frame
- c. Second type Interior pocket door
 - i. One or two panels that slide into adjacent wall
 - ii. Can be forced with same technique used for swinging door
- 11. Forcing security doors and gates
 - a. Different forms
 - i. Rollup doors, both manual and power operated
 - ii. Doors with open steel bars
 - iii. Doors that consist of multiple slats that can be closed to form solid panel
 - b. Delay entry and require planning for entry
 - c. Padlocks may be located outside while others may lock inside
 - d. If inside, look for second means of entry
 - e. Forcible entry can be done by
 - i. Cutting the padlock
 - ii. Make opening near lock with rotary saw
 - iii. Cut section out of panel as overhead door
 - f. Practice on security doors and gates in your area
- 12. Through-the-lock forcible entry
 - a. Preferred for
 - i. Commercial doors
 - ii. Residential security locks
 - iii. Padlocks
 - iv. High-security doors



- b. Requires good size-up of door and lock mechanism
- c. Can be used if opening with conventional forcible entry does not work
- d. Cylinder can be unscrewed from some doors
- e. Storefront doors have locks that can be unscrewed
- f. Key tool must be inserted to open lock just like a key
- g. K-tool
 - i. When to use
 - (a) Pulling all types of lock cylinders
 - (b) With Halligan-type tool
 - ii. How to use
 - (a) Forced behind ring and face of cylinder until wedge blades bite into cylinder
 - (b) Metal loop on face provides slot to insert one end of prying tool
 - (c) Strike top of prying tool with flat-head axe or other to set – Use to pull lock cylinder from door
 - (d) Usually still fits behind ring when lock cylinder is located close to threshold or jamb
 - iii. Only ¹/₂-inch (13 mm) is needed for clearance
 - iv. Can be inserted into hole moving lock bolt to open once removed
- h. A-tool
 - i. Can rapidly accomplish same job as K-tool
 - ii. Can cause more damage
 - iii. Developed to force entry on locks with collars
 - (a) Has protective cone-shaped covers
 - (b) Prevent lock cylinder from being unscrewed
 - iv. Prying tool with sharp notch with cutting edges machined into it Resembles the letter "A"

- (a) Designed to cut behind protective collar of lock cylinder and maintain a hold so lock cylinder can be pried
- (b) Curved head and long handle are used to provide leverage for pulling the cylinder
- (C) Chisel head is used to gouge out wood around cylinder for better bite of working head
- i. J-tool
 - i. Construction
 - (a) Device made of rigid, heavy gauge wire
 - (b) Designed to fit through space between double-swinging door equipped with panic hardware
 - ii. Use
 - (a) Inserted between doors far enough to rotate 90 degrees either direction
 - (b) Firefighter can pull tool until it makes contact with panic hardware
 - (C) Firefighter makes sharp pull and tool should operate panic hardware allowing door to open
- j. Shove knife
 - i. Flat steel tool
 - ii. Resembles wide-bladed putty knife with a notch cut in one edge of blade
 - iii. Provides firefighters rapid access to outward swinging latch doors
 - iv. Blade of tool depresses latch, allowing door to open when used properly
- 13. Forcing Padlocks
 - a. Conventional forcible entry tools can be used to break padlock or detach hasp to gain access
 - b. Additional tools
 - i. Duck-billed lock breaker Wedge-shaped tool that will widen and break the shackles of padlocks



- (a) Similar to hook of Halligan-type tool
- (b) Insert tool into lock shackle and strike tool with maul or flat-head axe until padlock shackles break
- ii. Bam-bam tool Uses a case-hardened screw that is screwed into keyway of padlock
 - (a) Once screw is firmly set, few firm, quick pulls on sliding hammer will pull lock tumbler out of padlock body
 - (b) Firefighters can insert flat end of key tool or screwdriver into lock to trip lock mechanism

NOTE: This method will not work on Master Locks, American Locks, and other high-security locks. These locks have a case-hardened retaining ring in the lock body that prevents the lock cylinder from being removed.

- c. Rotary saw with metal-cutting blade or cutting torch may be quickest removal method
- d. High-security is designed with heel and toe shackles Will not pivot if only one side of shackle is cut
- e. Cutting with power saw or torch can be dangerous
 - i. One firefighter should
 - (a) Stabilize lock with set of locking pliers and chain
 - (b) Pull lock straight away from hasp
 - ii. Second firefighter should cut both sides of padlock with saw or torch
- 14. Forcing overhead doors
 - a. Best to use rotary saw
 - i. Cut square or rectangular opening
 - ii. About 6 feet (1.8 m) high and nearly full width of door
 - b. Use lift mechanism to open fully on interior
 - c. Cribbing or shoring blocks prevent unintentional closing


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d. Vice grips on door rail can prevent closing as well

WARNING: All overhead doors should be blocked in the up or open position to prevent injury to firefighters if the built-in control device fails.

- 15. Forcing fire doors
 - a. Movable assemblies
 - b. Cover doorway openings in rated separation walls
 - c. Types
 - i. Horizontal and vertical sliding
 - ii. Single and double swinging
 - iii. Overhead rolling

Ask Students: Where are fire doors generally encountered in a structure?

Briefly discuss answers with students. Suggested answers: Inside of the structure, Separating one area from another, Enclosing hazardous process or storage area, Protecting means of egress

- d. Exterior doors are only found where structure must be protected from adjacent exposure
 - i. Will probably be locked
 - ii. Forcible entry would be similar to overhead or sliding door
- e. Interior doors will be manually or automatically activated when fire is detected
 - i. Only work during fire
 - ii. Will not lock when closed
 - Precautionary measure Block door open to prevent it from closing and blocking means of egress
 - iv. Water supply can be cut off in hoselines from closed doors

pp. 609-616

Review Question: How do the considerations that must be taken when forcing entry through swinging and sliding doors compare?

See pp. 598-602 of the textbook for answers.

II. FORCING ENTRY THROUGH WINDOWS

Objective 7 — Describe forcible entry methods used for windows.

Objective 8 — Explain considerations firefighters must take when forcing entry through miscellaneous types of windows and covers.

- A. Forcing Entry through Windows
 - 1. Not the best entry point into burning building
 - 2. Used as entry to unlock door
 - 3. Size-up is also critical to successful forced entry
 - 4. Opening wrong one can
 - a. Disrupt ventilation
 - b. Intensify fire growth
 - c. Draw fire to uninvolved sections

B. Breaking Window Glass

- 1. Most common, but creates hazards and obstacles
 - a. Slows entry to structure due to glass shards
 - b. Glass shards may be pushed great distance
 - c. Floor covered with glass shards makes footing treacherous for firefighters
 - d. Could shower glass on victims inside the structure causing additional injury

Note: When using a pike pole to break a window, position yourself upwind and higher than the window so that falling glass will not slide down the handle toward you.

- e. Can contribute to fire spread
- f. Wet canvas tarps or fire retardant tarps can be used to limit effect of wind



- 2. Wire glass is more difficult to break and remove
 - a. Prevents glass from shattering and falling out of frame
 - b. Use sharp tool to remove from frame
- 3. Two and three layers of glass are expensive
 - a. Weigh the expense of breaking against replacing
 - b. Multi-pane windows are time-consuming to remove

Note: Chapter 4, Building Construction, provides information on the various window types, functions, and materials that firefighters may encounter.



C. Forcing Fixed Windows

- 1. Found in
 - a. Single family residences
 - b. Mercantile occupancies
 - c. Office buildings
- 2. Consist of
 - a. Large solid glass pane
 - b. Multiple panels
 - c. Individual glass blocks formed into wall
- 3. Broken as last resort
 - a. Breaking causes a air in and out
 - b. Affecting ventilation
- 4. Forcing block windows or walls is the last resort
 - a. Walls are 2 to 4 inches (50.8 mm to 101.6 mm)
 - b. Held together with mortar or vinyl strips or panels
 - C. Panels up to 47 inches (1 193.8 mm) square



D. Forcing Double-hung Windows

- 1. Found in
 - a. Residential structures
 - b. Small office buildings
 - c. Manufactured houses
 - d. Older educational buildings
- 2. Manufactured in
 - a. Wood
 - b. Metal
 - c. Vinyl
- 3. Made up of two sashes
 - a. Top and bottom are fitted and operate by sliding up or down
 - b. May contain
 - i. Glass (single-, double-, or triple-pane)
 - ii. Wire glass
 - iii. Plexiglas™
 - iv. Acrylic plastic
 - v. Lexan[®] plastic
 - c. One or two thumb-operated locking devices located where top and bottom sashes meet — Used to secure double-hung windows
 - d. Surface-mounted window bolts may be used to fasten windows more securely
- 4. Forcible entry depends on what lock and material are made of
- 5. Metal-frame windows Difficult to pry
 - a. Lock mechanism will not pull out of sash and may jam
 - b. Use same technique for wood-frame
 - c. If lock does not yield with pressure Breaking glass may be quicker



E. Forcing Single-hung Windows

- 1. Identical to double-hung Except the bottom panel only moves
- 2. Locks and locking devices are same
- 3. Forcible entry procedures are same

F. Forcing Casement Windows

- 1. Construction
 - a. Hinged with wooden or metal frames
 - b. Crank out window Opens with a small hand crank
 - c. Consist of one or two sashes mounted on side hinges that swing outward
 - d. Locking devices vary from simple thumboperated to latch-type mechanisms
 - i. Can only be opened using crank on inside even if lock is open
 - ii. Single can have one or more locking devices and single crank
 - iii. Double can have at least four locking devices and two crank devices
- 2. Force open by
 - a. Breaking lowest pane of glass and clear shards
 - b. Cut screen behind same area
 - c. Unlock and then operate crank to open
 - d. Remove screen
- 3. One full pane does not require cranking once glass is removed

Note: Casement windows should not be confused with awning or jalousie windows (see Awning and Jalousie Windows section), some of which are operated with a hand crank.

G. Forcing Horizontal Sliding Windows

- 1. Made with fixed panel and sliding panel
- 2. Same technique to force entry as a sliding door

H. Forcing Awning Windows

- 1. Awning windows
 - a. Large sections of glass 1 foot (300 mm) high
 - b. As long as window width
 - c. Constructed with metal or wood frame around glass panels Double-strength glass
 - d. Hinged along top rail
 - e. Unlatching and pushing mechanical window crank makes bottom rail swing out
- 2. Hopper window Hinges at bottom and opens at top
 - a. Used for interior ventilation
 - b. Located above a door or window
- 3. Forcible entry requires breaking glass or prying window up from frame

Review Question: How does the process for forcing entry through fixed windows compare to forcing entry through awning windows?

See pp. 610-611 of the textbook for answers.



I. Forcing Jalousie Windows

- 1. Jalousie Windows
 - a. Consist of small sections about 4 inches (100 mm) high and width of window
 - b. Individual glass panes are held in movable frame only at ends
 - c. Operating crank and gear housing are located at bottom of window
 - d. Entry requires removal of several panes
 - i. Small in space
 - ii. Restricts access even when glass is removed
- 2. Cutting through wall around window may be faster for access

J. Forcing Projecting Windows

- 1. Found in
 - a. Factories
 - b. Warehouses
 - c. Other commercial and industrial buildings
- 2. Projecting windows
 - a. Metal sashes with wire glass
 - b. Function by pivoting on hinges at upper corners of the panel
 - c. Pivoting out while sliding down track makes opening at bottom and top
 - d. Forcible entry may be limited to breaking glass or cutting out panel

K. Forcing Pivoting Windows

- 1. Hinge pins in middle of window
- 2. Permits equal opening at top and bottom
- 3. Latches are at bottom
- 4. Forcible entry is same as projecting window

L. Forcing Miscellaneous Types of Windows and Covers

- 1. Hurricane windows
 - a. Resist hurricane force winds
 - b. Use laminated glass and advanced polymer
 - c. Ionoplast layer is sandwiched between two layers of glass producing laminated glass
 - d. 100 times rigid, five times as tear resistant as commonly used high-impact glass
 - e. Five times as tear resistant
 - f. Identify during preincident planning for most effective tool and technique selection
 - g. To break
 - i. Use axe or adz end of Halligan
 - ii. Aluminum window frame may be cut to remove



- iii. Labor intensive and time consuming to remove
- h. Shutters Exterior coverings mounted over windows and patio doors to protect structure from hurricane-force winds
 - i. Could be permanently mounted
 - ii. Not only in hurricane areas
 - iii. Being used for burglary prevention
 - iv. Blend into architecture of house
 - v. Remove with
 - (a) Rotary saw with aluminum oxide blade
 - (b) Break lag bolts holding rail with adz of Halligan tool
- 2. High-security windows
 - a. Break-resistant plastic panes instead of glass
 - b. Most effective when forcing entry through high-security windows
 - c. Identify barriers during preincident planning
 - d. One plastic used is Lexan[®]
 - i. Strengths
 - (a) 250 times stronger than safety glass
 - (b) 30 times stronger than acrylic
 - (c) Self-extinguishing
 - (d) Impossible to break
 - ii. Identified by
 - (a) Tapping with tool to produce dull plastic sound compared to glass sound
 - (b) Scratch easier
 - (c) Wavy surface and distortion on sides
 - (d) Bolted or riveted to frame to prevent punchthrough
 - e. Guidelines to force entry with rotary saw
 - i. Use a carbide-tipped, medium-toothed blade (approximately 40 teeth)





- Large-toothed blades will skid off the surface, and smaller toothed blades will melt the Lexan[®] and cause blade to bind
- iii. If a chain saw is used, it must be equipped with a carbide-tipped cutting chain
- iv. Start all cuts at full rpm to avoid bounce and vibration of the saw
- v. Wear full PPE including goggles or other eye protection to reduce injury from chips and shards
- vi. Cut as rapidly as possible without forcing the saw
- vii. Make the horizontal cuts first, then the vertical cuts
- f. Other striking or impact tools can be effective if entire pane is removed through frame
- 3. Housing and Urban Development (HUD) windows
 - a. Plywood installed in vacant buildings to prevent vandalism or break-ins
 - i. One sheet of 2 x 4 inch (50 mm by 100 mm) plywood is secured to boards on inside of frame
 - ii. This is connected to similar boards on outside
 - iii. Strongbacks Two-boards connected with long carriage bolts
 - b. Two ways to force entry
 - i. Use a rotary saw to cut the heads off the carriage bolts
 - ii. Then use a pickhead or punch to push the bolt through the plywood
 - iii. Knock the board on the inside loose
 - iv. Use an axe or Halligan to split wood away from bolt head
 - v. Then push the bolt through the plywood
- 4. Vacant protection systems (VPS)
 - a. Prevents unauthorized entry and vandalism of buildings
 - b. Used by
 - i. Banks
 - ii. Mortgage companies

- iii. Building owners
- c. Consist of
 - i. Metal grates that are secured to exterior of window openings
 - ii. Cables are used to pull grate to structure and metal strongbacks on interior
 - iii. Remove grates by cutting mounting tabs or bolt heads off frame with rotary saw or adz
- 5. Barred or screen windows and openings
 - a. Security bars and grilles
 - i. Prevent unauthorized entry but create unintended hazard for occupants and firefighters
 - ii. Prevent access and escape
 - iii. Remove all bars from building when crews are operating inside
 - b. Forcible entry methods
 - i. Remove mounting bolt heads with adz of Halligan tool
 - ii. Cut bolt heads with rotary saw with aluminum oxide blade
 - iii. Use pick end of Halligan to chip away masonry around bar
 - iv. Strike end of Halligan with sledgehammer or maul
 - v. Cut bars or grille frame using rebar cutter
 - (a) May be permanently fixed
 - (b) Hinged at the top or side
 - (C) Fitted into brackets and locked
 - (d) Hinged can be opened easily if lock is accessible and can be cut from frame
 - (e) Rotary saw can cut screen fabric
 - (f) Window must be forced after screen is removed

Review Question: What dangers may be present when forcing entry through miscellaneous types of windows and covers? *See page 613 of the textbook for answers.*

III. BREACHING WALLS

pp. 616-619

Objective 9 — Describe forcible entry methods for breaching walls.

- A. Breaching Walls
 - 1. Breaching Creating hole in wall
 - 2. Requires thorough knowledge of
 - a. Building construction
 - b. Accurate size-up of situation
 - c. Determine if wall is safe and will accomplish purpose
 - 3. Exterior are more difficult to breach than interior

B. Exterior Walls

- 1. When working with exterior walls
 - a. Firefighters must consider possible collapse and safety hazards
 - b. Fire can weaken structure and could cause partial or total collapse
- 2. Conceal
 - a. Electrical wires
 - b. Water pipes
 - c. Gas pipes
 - d. Other building utilities
- 3. Firefighters are unable to determine if there are concealed components from outside structure
- 4. Wood frame walls
 - a. Construction
 - i. Consist of vertical 2 x 4 or 2 x 6 inch (50 mm by 100 mm or 50 mm by 150 mm) studs



- ii. Covered on inside with gypsum sheets or lathand-plaster
- iii. Outside is covered with
 - (a) Wood
 - (b) Composite boards
 - (c) Other materials
- iv. Studs are placed 16, 20, and sometimes 24 inches (400 mm, 500 mm, or 600 mm) apart
- v. Spaces may be void or contain some form of insulation material
- vi. Wood siding may be
 - (a) Hardwood boards
 - (b) Shake shingles
 - (c) Panels made of plywood
 - (d) Composite materials
- b. Firefighters can
 - i. Cut wood with axe
 - ii. Shatter using a sledgehammer before prying with crow bar
 - iii. Interior is penetrated once exterior is opened
- 5. Brick or concrete block walls
 - a. Using a battering ram is the traditional approach to breaching
 - i. Breaching with battering ram can be slow and labor-intensive
 - ii. Breaching is best suited for opening small hole for water to be supplied to other side
 - iii. It is impractical to create large opening for firefighters to pass through
 - b. Power tools such as rotary saws with masonry blades or pneumatic or electric jackhammers are best for breaching
 - i. Faster
 - ii. Require only one person to operate

- c. Penetrating (drive-in) nozzle can be driven though to apply water to other side if tools are not available
- 6. Concrete walls
 - a. Slower and more labor-intensive
 - b. Often reinforced with steel rebar

Ask Students: When should a concrete wall be breached?

Briefly discuss answers with students. Suggested answer: Only when it is absolutely necessary and no other alternative is available.

- c. To breach
 - i. Use chain saw equipped with diamond-tipped chain The fastest and most efficient power tool to use
 - ii. Pneumatic jackhammer can also be used
- 7. Metal walls
 - a. Common in
 - i. Commercial and industrial occupancies
 - ii. Rural and urban settings
 - b. Constructed of
 - i. Overlapping light-gauge sheet metal panels
 - ii. Fastened to metal or wooden studs
 - c. Attach panels by
 - i. Nails
 - ii. Rivets
 - iii. Bolts
 - iv. Screws
 - v. Other fasteners
 - d. Forcible entry
 - i. Conventional tools cut thin metal panels
 - ii. Make sure that no building utilities are located in area selected for cutting
 - iii. Have charged hoseline or fire extinguisher available when cutting metal with rotary saw in case of sparks



- iv. Cut square or rectangular opening that is large enough for firefighters to pass through easily
- v. Opening should be at least 6 feet (1.8 m) tall and as wide as needed
- vi. If breaching to allow water to be applied to fire on other side of wall — Penetrating nozzle can be driven through metal siding

C. Interior Walls

- 1. May be load-bearing or non-load-bearing
- 2. Construction materials may be
 - a. Masonry
 - b. Poured concrete
 - c. Glass block
 - d. Lath-and-plaster
 - e. Sheetrock[®]
- 3. May contain
 - a. Electrical wires
 - b. Water or gas pipes
 - c. Heating and cooling ducts
- 4. Supervisors must determine what effect breaching will have on making opening in the structural integrity
- 5. Plaster or gypsum partition walls
 - a. Designed to limit fire spread
 - b. Fire-resistance is provided by
 - i. Gypsum wallboard
 - ii. Lath-and-plaster over wooden or metal studs and framing
 - iii. Easy to penetrate with forcible entry tools
- 6. Reinforced gypsum walls
 - a. In newer buildings where public access areas are covered
 - i. Hallways
 - ii. Lobbies
 - iii. Restrooms

- b. Reinforced with Lexan[®]
 - i. Reinforced wallboard is attached to the wall frame using drywall nails, or screws
 - ii. Appears identical to other wallboard because the Lexan $^{\circ}$ reinforcement is installed on back of wallboard
 - iii. Designed to resist breaching using forcible entry tools
- c. Power saws are needed to breach material
- d. Precident planning survey must determine reinforced wallboard

Review Question: How do forcible entry operations for exterior walls compare to those for interior walls? *See pp. 616-619 of the textbook for answers.*

IV. BREACHING FLOORS

pp. 619-621 Objective 10 — Explain forcible entry methods for breaching floors.

A. Breaching Floors

- 1. May be necessary to
 - a. Ventilate an area
 - b. Apply water to fire
 - c. Rescue occupants trapped by structural collapse
- 2. Floor construction
 - a. Determines what tools and methods should be used
 - b. Subfloor construction is limited to either wood or concrete
 - c. There is a variety of covering materials
 - d. Concrete slab floors are in
 - i. Residential
 - ii. Commercial
 - iii. Industrial occupancies

BRACHING FLOORS MAY BE DONE FOR SEVERAL REAGONS AND NETHODS WAY BY HOWA FLOORIS CONTRACTOR (CONTRACTOR)

- e. Upper floors may be finished with lightweight concrete
- f. Upper floors of multistory residences are usually wooden subfloors over wooden joists or I-beams
- g. Floor may be classified according to its covering instead of material
- 3. Opening floor during operations depends on
 - a. How it was constructed
 - b. Material of construction
- 4. Preincident planning survey should determine floor construction

B. Wooden Floors

- 1. Joists can be spaced from 12 to 24 inches (300 mm to 600 mm)
 - a. Depending upon distance spanned
 - b. Dimensions of lumber
- 2. I-beams are generally spaced 24 inches (600 mm) apart regardless of span
- 3. Joists are covered by subfloor consisting of
 - a. Tongue-and-groove planks
 - b. Sheets of plywood attached to joists
- 4. Plywood subflooring is generally laid perpendicularly to joists
 - a. Some are laid diagonally to joists
 - b. Finished floor is perpendicular to joists
- 5. Before cutting
 - a. Remove carpets and rugs before cutting
 - b. Rotary or circular saws make clean cuts
 - c. Chain saws make faster and rougher cuts
 - d. Use axe if power saws are not available
 - e. Use piercing nozzle to apply water through floor assembly





- 6. Cut a larger opening for
 - a. Cellar nozzles
 - b. Bresnan distributors
 - c. Ventilating space

C. Concrete Floors

- 1. Reinforced to some degree
- 2. Depending upon
 - a. Where floor is located
 - b. Supported loads
- 3. To open use
 - a. Sledgehammers, other hand tools Slow and labor-intensive
 - b. Concrete-cutting blades
 - c. Pneumatic or hydraulic jackhammer
 - i. Faster at opening
 - ii. Stitch drill
 - (a) Opens concrete floor rapidly
 - (b) Used to create opening for penetrating nozzle

Review Question: What does the feasibility of opening a floor during a fire fighting operation depend on? *See pp. 620 of the textbook for answers.*

V. FORCING ENTRY THROUGH FENCES AND GATES

pp. 621-623

Objective 11 — Indicate methods for forcing fences and gates.

- A. Forcing Fences
 - 1. Made of
 - a. Wood
 - b. Plastic
 - c. Masonry



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- d. Barbed wire
- e. Chain-link wire fabric
- f. Ornamental metal
- g. Some are topped with barbed wire or razor ribbon
- 2. Used To contain livestock, pets, or guard dogs
- 3. Size-up determines most efficient tools and techniques for forcing entry
- 4. Rural areas may contain electrified
 - a. De-energize before cutting
 - b. Take insulation precautions to avoid electric shock
 - c. Find other means of entry if needed
- 5. Material that is stretched tight can recoil when cut and cause injury
 - a. Stand beside fence post and cut where it joins post
 - b. Recoils direction of next post
- 6. Wire fence
 - a. Cut near posts for repair after incident
 - b. Provide adequate space for fire apparatus
 - c. Reduce danger of injury from recoil
- 7. Various fences can be forced
 - a. Cut barbed wire fences with bolt cutters
 - b. Cut chain-link fences with a rotary saw
 - i. Bolt cutters may be used but are slower
 - ii. Fence fabric may also be used alternatively on posts then lay fabric on ground

Caution: Wire will recoil in the direction of the next post on the fence when it is cut.

Caution: Cutting electrified fences before deenergizing the fence may result in electric shock.





- 8. Masonry and ornamental metal fences
 - a. May be easier and faster to go over than through it
 - b. A-frame ladders can be used to bridge

B. Forcing Gates

- 1. Security gates are used in
 - a. Residential housing
 - b. Industrial sites
 - c. Construction sites
 - d. Agricultural sites
 - i. Staff may be needed during hours of operation at industrial sites
 - ii. Chains, padlocks, or other locking devices may be used
- 2. Residential complexes
 - a. Gates are controlled by electronic locks activated by
 - i. Remote opener
 - ii. Barcode reader
 - iii. Keypad
 - b. Lockbox may also contain opener or keypad code
 - c. If allowed by departmental SOP, entry may be forced by
 - i. Prying on gate
 - ii. Using apparatus bumper to force gate open
 - d. Often secured with padlocks or chains
 - e. Can be accessed using same techniques
 - f. Personal gates secure
 - i. Patios
 - ii. Swimming pools
 - iii. Backyards
 - g. Gain access through-the-lock and rim technique

h. Avoid prying or cutting because of damage

Note: Some gates on commercial sites may be provided with special padlocks and/or electronic key switches that are operated with the same key used to access lockboxes.

Review Question: What techniques can be used to force entry through fences or gates *See pp. 621-623 of the textbook for answers.*

VI. SKILLS

рр. 624-625	Objective 12 — Clean, inspect, and maintain hand tools and equipment.
p. 626	Objective 13 — Clean, inspect, and maintain power tools and equipment.
p. 627	Objective 14 — Force entry through an inward-swinging door – Two-firefighter method.
p. 628	Objective 15 — Force entry through an inward-swinging door – Cutting the lock out of the door method.
p. 629	Objective 16 — Force entry through an outward- swinging door – Removing hinge-pins method.
p. 630	Objective 17 — Force entry though an outward-swinging door – Wedge-end method.
p. 631	Objective 18 — Force entry using the through-the-lock method.
р. 632	Objective 19 — Force entry using the through-the-lock method using the K-tool.
р. 633	Objective 20 — Force entry using the through-the-lock method using the A-tool.
p. 634	Objective 21 — Force entry through padlocks.
p. 635	Objective 22 — Use a bam-bam tool.
р. 636	Objective 23 — Cut a padlock with a rotary saw.

p. 637	Objective 24 — Force entry through a window (glass pane).
р. 638	Objective 25 — Force entry through a double-hung window.
р. 639	Objective 26 — Force a Lexan [®] window using a rotary saw.
рр. 640-641	Objective 27 — Force entry through a wood-framed wall (Type V construction) with hand tools.
рр. 642-643	Objective 28 — Force entry through a wood wall (Type V construction) with a rotary saw or chain saw.
р. 644	Objective 29 — Breach a wall using a battering ram.
р. 645	Objective 30 — Force entry through a masonry wall with hand tools.
р. 646	Objective 31 — Force entry through a metal wall with power tools.
p. 647	Objective 32 — Breach a hardwood floor.
р. 648	Objective 33 — Bridge a fence with a ladder.

VII. SUMMARY AND REVIEW



A. Chapter Summary

- 1. When normal means of entry is locked or blocked, forcible entry techniques are used to gain access into a structure or area.
- 2. Forcible entry efforts can do minimal damage to a structure or structural components and provide quick access.
- 3. Tools and techniques are used to breach walls and floors to advance hoselines, apply extinguishing agents, access trapped victims, or ventilate an area.

B. Review Questions

- 1. What are the basic principles of forcible entry? (pp. 573-575)
- 2. What types of locksets may firefighters encounter during forcible entry operations? (*pp. 575-580*)
- 3. How can a firefighter know when it is appropriate to use cutting tools and pushing/pulling tools during forcible entry operations? (*pp. 582-589*)
- 4. What are some basic tool safety tips firefighters should follow during forcible entry operations? (pp. 591-593)
- 5. Who cares for and performs maintenance on forcible entry tools? (*p. 593*)
- 6. How do the considerations that must be taken when forcing entry through swinging and sliding doors compare? (*pp. 598-602*)
- 7. What precautionary methods can be used when forcing entry through overhead or fire doors? (pp. 606-608)
- 8. How does the process for forcing entry through fixed windows compare to forcing entry through awning windows? (*pp. 610-611*)
- 9. What dangers may be present when forcing entry through miscellaneous types of windows and covers? (p. 613)
- 10. How do forcible entry operations for exterior walls compare to those for interior walls? (*pp. 616-619*)
- 11. What does the feasibility of opening a floor during a fire fighting operation depend on? (*p. 620*)
- 12. What techniques can be used to force entry through fences or gates? (*pp. 621-623*)

Chapter 12 Ground Ladders



Lesson Goal

After completing this lesson, the student shall be able to recognize ground ladders used in the fire service and select the appropriate ladder for the task presented. Students will also be able to carry and deploy fire service ground ladders.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- Describe different construction types of ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 2. Identify the parts of a ladder including markings and labels. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 3. Recognize the types of ladders used in the fire service. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 4. Explain the considerations addressed by ladder inspection, cleaning, and maintenance. [NFPA[®] 1001, 5.5.1]
- 5. Describe safety guidelines used when handling ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 6. Explain considerations taken when selecting, lifting, and lowering a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 7. Describe various methods for ladder carries. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 8. Identify basic considerations and requirements for ground ladder placement. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 9. Describe various methods for ladder raises. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 10. Compare procedures for moving ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 11. Explain the methods used to secure ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 12. Describe ladder climbing considerations. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 13. Indicate what methods can be used to work from a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 14. Explain methods used for assisting a victim down a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 15. Clean, inspect, and maintain a ladder. [NFPA[®] 1001, 5.5.1]

- 16. Carry a ladder One-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 17. Carry a ladder Two-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 18. Carry a ladder Three-firefighter flat-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 19. Carry a ladder Three-firefighter flat-arm's length method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 20. Carry a ladder Two-firefighter arm's length on-edge method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 21. Tie the halyard. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 22. Raise a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 23. Raise a ladder Two-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 24. Raise a ladder Two-firefighter beam raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 25. Raise a ladder Three- or four-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 26. Deploy a roof ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 27. Pivot a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 28. Shift a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 29. Shift a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 30. Heel a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 31. Leg lock on a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 32. Assist a conscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]
- 33. Assist an unconscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]

Instructor Information

This is the lesson covering ground ladders. This lesson describes ground ladder construction, ladder types, and inspection and maintenance. The lesson also covers ladder deployment and procedures for working from a ladder.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. GROUND LADDER CONSTRUCTION

pp. 654-659

Objective 1 — Describe different construction types of ground ladders.

Objective 2 — Identify the parts of a ladder including markings and labels.

- A. Ground Ladder Construction
 - 1. Fire service ladders similar to ladders for private industry or general use
 - a. Similar construction, shape, and design
 - b. Capable of supporting heavier loads
 - c. Provide greater margin of safety
 - 2. NFPA[®] 1931 Contains design, construction, and testing specifications
 - a. Folding ladders must be designed to support maximum of 300 lbs. (136 kg)
 - Single, roof, combination, and extension ladders must support maximum of 750 lbs. (340 kg)
 - 3. NFPA[®] 1932 Requirements for use, care, maintenance, and service testing

B. Parts of a Ladder

- 1. Beam Main structural member supporting rungs, rung blocks
- 2. Bed section (base section, main section)
 - a. Lowest, widest section of extension ladder
 - b. Always maintains contact with ground, supporting surface
- 3. Butt (heel, base) Bottom end of ladder placed on ground or supporting surface
- 4. Butt spurs Metal plates, spikes, and cleats attached to butt end to prevent slippage
- 5. Fly section Upper section of extension or some combination ladders, section that moves







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- 6. Footpads (shoes) Swivel plates attached to butt of ladder
- 7. Guides Wood or metal strips, slots, and channels on an extension ladder that guide the fly section
- 8. Halyard (fly rope) Rope, cable used for hoisting, lowering fly sections
- 9. Heat-sensor label Label affixed to inside of each beam, color change indicates ladder exposed to heat, should be tested before further use
- 10. Hooks Curved metal devices near top end of roof ladders to secure to highest point on peaked roof
- 11. Pawls (dogs, ladder locks) Devices attached to inside of beams on fly section, hold fly section in place after extended
- 12. Protection plates Strips of metal attached at chafing points, areas in contact with apparatus mounting brackets
- 13. Pulley Small, grooved wheel through which halyard drawn on extension ladder
- 14. Rails Two lengthwise members of trussed ladder beam separated by truss, separation blocks
- 15. Rungs Cross members that provide foothold for climbing, extend from one beam to the other
- Stops Wooden, metal pieces prevent fly section from being extended too far
- 17. Tie rods Metal rods located beneath rungs extending from one beam to the other of a wood ladder
- 18. Tip (top) Extreme top of ladder
- 19. Truss block Spacers set between rails of trussed ladder, sometimes used to support rungs

Review Question: What are the basic parts of fire service ladders? See pp. 655-657 of the textbook for answers.





C. Construction Materials

- 1. All material must meet design and testing specifications of NFPA[®] 1931
 - a. Each material has advantages, disadvantages
 - b. Weight will vary depending on material, length
 Heavier ladders require more personnel
- 2. Metal Heat-treated aluminum
 - a. Aluminum most common currently in fire service use
 - b. Not heat resistant exposure to heat can cause ladder to warp, fail
 - c. Metal ladder advantages
 - i. Least expensive construction material
 - ii. Easy to repair
 - iii. Wide range of sizes
 - iv. Many styles and types
 - d. Metal ladder disadvantages
 - i. Conduct heat, cold, and electricity
 - ii. Can fail suddenly when exposed to heat in excess of 200° F (93.33° C)
 - iii. Accumulate ice on rungs in cold weather, creating slipping hazard
- 3. Wood Oldest construction material used
 - a. Metal parts plated for protection, wood parts coated with marine grade spar varnish
 - b. Wooden ladder advantages
 - i. Less likely to conduct electricity, heat
 - ii. Retain strength when exposed to heat
 - iii. Better resistance to flexing, bouncing when climbed
 - iv. Durable
 - c. Wooden ladder disadvantages
 - i. Highest cost of all ladders
 - ii. May require refinishing of damaged finish
 - iii. Can be very heavy

- 4. Fiberglass Newest, least common material
 - a. Cost less than wood ladders, more than aluminum ladders
 - b. Fiberglass ladder advantages
 - i. Will not conduct heat, cold, and electricity
 - ii. Rails strong and rigid
 - c. Fiberglass ladder disadvantages
 - i. Can suddenly crack and fail when overloaded
 - ii. Can burn when exposed to flame

NOTE: Refer students to the NOTE on page 658 of the textbook. Discuss with students the importance of being familiar with the manufacturer's cautions and warnings.

Review Question: How does a fire service ladder constructed of metal differ from one constructed of fiberglass? *See page 658 of the textbook for answers.*

D. Ladder Markings and Labels

- 1. All fire service ladders required to have markings and warning labels
 - a. Factory applied
 - b. Locally required may be applied
- 2. NFPA[®] 1931 requires
 - a. Designated ladder length on each beam within 12 inches (305 mm) of butt plate
 - b. Manufacturer's name plate with month, year of manufacture
- 3. Authority having jurisdiction (AHJ) may require
 - a. Apparatus designation
 - b. Locally assigned inventory number
- 4. Tip may be painted white, strip of reflective tape to make top visible in smoky and dark conditions
- 5. Butt may be painted black and balance point indicated with stripe



NOTE: Refer students to the NOTE on page 659 of the textbook. Discuss with students the type of damage that may be hidden by painting a wooden ladder.

- Certification label indicating ladder meets NFPA[®] 1931
- 7. Warning labels
 - a. Electrical hazard warning label
 - b. Ladder positioning label
 - i. Climbing angle
 - ii. Side of ladder that must be away from building
 - C. Heat sensor labels
 - i. Required on metal and fiberglass ladders
 - ii. Placed on inside of each beam and below second rung from tip of each section
 - iii. Sensor preset to 300° F (149° C), must have expiration date

Review Question: What types of markings and labels do fire service ladders have? See page 659 of the textbook for answers.

II. LADDER TYPES

pp. 660-663

SINGLE LADDERS ARE ALSO CALLED WALL OR

Objective 3 — Recognize the types of ladders used in the fire service.

- A. Single Ladders (wall ladder, straight ladder)
 - 1. One section, nonadjustable, fixed length Length of beams defines length of ladder
 - 2. Used for quick access to windows, roofs of one-and two-story buildings
 - 3. Trussed type design maximize strength while reducing weight
 - 4. Lengths 6 to 32 feet (2 m to 10 m), more common 12 to 24 feet (4 m to 7 m)









B. Roof Ladders

- 1. Single ladders equipped with folding hooks that anchor the ladder over ridge of pitched roof, other roof part
- 2. Roof ladders lie flat on roof surface so firefighter can stand on ladder while working
- 3. Ladder distributes firefighter's weight and helps prevent slipping
- 4. May be used as wall or straight ladders
- 5. Lengths 12 to 24 feet (4 m to 7 m)

C. Folding Ladders

- 1. Single ladders often used for interior attic access
- 2. Hinged rungs allow ladder to be folded so one beam rests against the other
- 3. When folded, can be carried in narrow passageways, used in attic scuttle holes, small rooms, and closets
- 4. Length 8 to 16 feet (2.5 m to 5 m), most common 10 feet (3 m)
- 5. Footpads attached to butt to prevent slipping on floor surfaces NFPA[®] 1931 requirement
- 6. Wear gloves when closing to prevent pinching between moving metal parts

D. Extension Ladders

- Base (bed) section and one or more fly sections that travel in guides or brackets, permit length adjustment
- 2. Full length to which it can be extended indicates size
- 3. Can be adjusted to specific length needed to access windows, roofs
- 4. Lengths 12 to 39 feet (4 m to 11.5 m)



E. Combination Ladders

- 1. Designed to be used as self-supporting step-ladder (A-frame) and as single or extension ladder
- 2. Lengths 8 to 14 feet (2.5 m to 4.3 m), most common 10 feet (3 m)
- 3. Must be equipped with positive locking devices to hold ladder in open position

F. Apparatus-Mounted Ground Ladders

- 1. NFPA[®] 1901 sets minimum lengths, types of ladders to be carried on fire service apparatus
- 2. Pumper apparatus
 - a. Minimum ladder requirements
 - i. One single (roof) ladder equipped with roof hooks
 - ii. One extension ladder
 - iii. One folding ladder
 - b. NFPA[®] 1901 does not specify minimum lengths of these ladders
 - C. NFPA[®] 1901 recommends engines carry 35-foot (11 m) extension ladder in areas where no ladder trucks in service
- 3. Aerial apparatus Minimum of 115 feet (35 m) of ground ladders
 - a. One folding ladder
 - b. Two single (roof) ladders equipped with roof hooks
 - c. Two extension ladders
- 4. Quint fire apparatus Aerial device mounted on pumper apparatus
 - a. Minimum of 85 feet (26 m) of ground ladders
 - b. Types same as required for pumper apparatus

Review Question: How do the five types of ladders used in the fire service compare with one another? *See pp. 660-663 of the textbook for answers.*

III. LADDER INSPECTION, CLEANING AND MAINTENANCE

pp. 663-666

Objective 4 — Explain the considerations addressed by ladder inspection, cleaning, and maintenance.

A. Inspecting and Service Testing Ladders

- 1. NFPA[®] 1932 requires inspection after each use, monthly
- 2. Elements to inspect on all ladders
 - a. For heat exposure
 - i. Heat sensor labels on metal and fiberglass for color change indicating heat exposure

NOTE: Refer students to the NOTE on page 663 of the textbook. Remind students where to look for heat sensor labels on ladder beams.

- On ladders without heat sensors, carbon (soot) deposits or blistered paint on tips indicating heat exposure
- iii. Fiberglass ladders for discoloration that could indicate heat exposure
- b. Rungs for
 - i. Damage
 - ii. Wear
 - iii. Tightness
- C. Bolts, rivets for tightness

NOTE: Refer students to the NOTE on page 663 of the textbook. Explain how to determine correct bolt tightness on wooden ladders.

- d. Welds for cracks, apparent defects
- e. Beams and rungs for cracks, splintering, breaks, gouges, checks, wavy patterns, and deformation
- f. Any points of contact with apparatus, and other ladders where vibration may cause worn areas





WARNING!: Any ladder that has been subjected to direct flame contact, has been exposed to high heat, or has a heat sensor label that has changed color is unsafe for use and should be removed from service for testing.

- 3. Wooden ladders/ladders with wooden components
 - a. Areas where finish has been chafed and scraped
 - b. Darkening (blistering or blackening) of varnish indicating exposure to heat
 - c. Dark streaks in wood indicating deterioration
 - d. Marred, worn, cracked, and splintered parts
 - e. Shoes rounded or smooth
 - f. Water damage

Caution: Any indication of deterioration of the wood is reason for the ladder to be removed from service until it can be service tested.

- 4. Roof ladders
 - a. Hook assemblies operate with relative ease
 - b. Hook assemblies should not show signs of rust
 - c. Hooks not deformed
 - d. Parts firmly attached, no signs of looseness
- 5. Extension ladders
 - a. Pawl assemblies Hook and finger move freely
 - b. Halyard If damage, wear found, halyard should be replaced
 - c. Halyard cable Taut when ladder in bedded position
 - d. Pulleys Turn freely
 - e. Ladder guides Check condition, check that fly sections move freely
- 6. If discrepancies found, remove ladder from service until repaired and tested
- 7. Ladders that cannot be repaired must be destroyed or scrapped for parts





- 8. Ladders must be service tested to ensure fit for use
 - a. NFPA[®] 1932 Guideline for ground ladder service testing
 - b. Ground ladders should be service tested
 - i. Before placed in service
 - ii. Annually while in service
 - iii. After use that exposed to high heat, rough treatment
 - c. NFPA[®] 1932 has specified tests that fire department, approved testing agency should conduct
 - d. Recommends caution used to prevent damage to ladder, injury to personnel

Review Question: What types of information do general ladder inspections look for? *See pp. 663-665 of the textbook for answers.*

B. Cleaning Ladders

- More than matter of appearance dirt or debris may collect and harden, ladder sections cannot function as designed
- 2. Ladders should be cleaned after each use
 - a. Soft bristle brush, running water
 - b. Tar, oil, and greasy residue removed with mild soap and water, environmentally safe solvents – departmental SOPs, manufacturer's recommendations
 - c. Wipe ladder dry
 - d. Look for damage, wear report defects per departmental SOPs
 - e. Lubricate where recommended by manufacturer





C. Maintaining Ladders

- 1. Maintenance Keeping in a state of usefulness, readiness
- 2. Repair Restore, replace that which is damaged, and worn out
- 3. Firefighters should be capable of routine maintenance according to departmental SOPs, manufacturer's recommendations
- 4. Ladders needing repair require trained ladder repair technician
- 5. General maintenance requirements include
 - a. Keep ground ladders free of moisture
 - b. Do not store, rest were subjected to vehicle exhaust and engine heat
 - c. Do not store where exposed to weather
 - d. Do not paint except for top and bottom 18 inches (457 mm) for identification, visibility

Review Question: What are the general maintenance requirements for ground ladders? *See page 666 of the textbook for answers.*

IV. HANDLING LADDERS

pp. 666-670

Objective 5 — Describe safety guidelines used when handling ladders.

Objective 6 — Explain considerations taken when selecting, lifting, and lowering a ladder.

A. Ladder Safety Guidelines

- 1. Develop, maintain adequate upper body strength
- 2. Wear full body harness with safety line when training on ladders
- 3. Operate ladders according to departmental training, procedures







- 4. Wear full personal protective equipment, including gloves and helmet, when handling and, working with ladders
- 5. Choose correct ladder for assigned task
- 6. Use leg muscles, not back, arm muscles when lifting ladders below the waist
- 7. Use adequate number of firefighters for each carry, raise
- 8. Do not raise any ladders within 10 feet (3 m) of electrical wires

WARNING!: Ladders coming in contact with power sources may result in electrocution of anyone in contact with the ladder.

- 9. Secure the tip and anchor the foot of the ladder when in use during training or emergency incidents
- 10. Grasp extension ladder beams when extending, retracting to prevent fingers from being pinched, and caught between sections
- 11. Check ladder placement for proper angle
- 12. Ensure hooks of pawls are seated over rungs
- 13. Ensure ladder is stable before climbing Both butts in contact with ground, roof ladder hooks firmly set
- 14. Use caution when moving ladders sideways
- 15. Climb smoothly and rhythmically
- 16. Never overload ladder
 - One firefighter every 10 feet (3 m)
 - b. One firefighter per section
- 17. Use leg lock or ladder belt when working from ground ladder
- 18. Relocate a positioned ladder only when ordered
- 19. Use ladders for intended purposes only
- 20. Inspect ladders for damage and wear after each use
21. Secure foot of unattended ladders to stationary object using ropes



WARNING!: Sliding down a ladder either feet first or head first – even in an emergency – is unsafe and may result in serious injury or death.

- 22. Important that ladders be raised safely and smoothly to avoid injury to firefighters, and damage to ladder
 - a. Movements should be smooth and controlled
 - b. More than one firefighter required, teamwork important
 - c. Individual, team proficiency developed, and maintained through repetitive training

Review Question: What are the guidelines for safely carrying, raising, lowering, and working on ladders? *See pp. 666-667 of the textbook for answers.*

B. Ladder Selection

- 1. Incident Commander (IC) and supervisor will usually tell which ladder to use, and where to place ladder
- 2. Factors to consider when deciding where to place ladder
 - a. Needs of situation
 - b. Ladders available
 - c. Assigned task
 - d. Location of overhead obstructions
 - e. Structural features
 - i. Type of roof
 - ii. Wall height
 - iii. Presence of overhangs
 - f. Wind direction, velocity
 - g. Topography of area





- 3. Personnel working on roof, upper story Must be two means of escape
 - a. Two ladders at remote locations from one another
 - b. May be ground ladders or aerial devices
- 4. Selecting ladder to reach specific point requires ability to judge distances
 - Base of ladder When placed approximately one-quarter of vertical distance from ground to point of contact on wall provides optimum climbing angle of 75 degrees
 - b. Residential story averages 10 feet (3 m) floor to windowsill averages 3 feet (1 m)
 - c. Commercial story averages 12 feet (4 m) floor to windowsill averages 4 feet (1.2 m)

Ask Students: Refer students to Table 12.1 "Ladder Selection Guide" on p. 668 of the textbook. Ask what additional factors may influence selection of a ladder for a particular situation.

Answers may include: ladders available, overhead obstructions, foundation height, and ground topography.



- 5. Guidelines for ladder length
 - a. Extend ladder minimum of three to five rungs – beyond roof edge to provide footing, handhold
 - Place tip of ladder even with top of window and to windward (upwind) side to gain access to narrow window, for opening window for ventilation
 - c. Place tip of ladder just under windowsill when rescue from window to be performed

NOTE: Refer students to the NOTE on page 668 of the textbook. Explain how to position an additional ladder to assist firefighters to and from a roof with a parapet.



- 6. Designated length is NOT ladder's reach
 - a. Ladders set at angles of 75 degrees for climbing – reach is less than designated length
 - Single, roof, and folding ladders meeting NFPA[®] 1931 required to have measured length equal to designated length
 - c. Extension ladders Maximum extended length may be as much as 6 inches (150 mm) less than designated length

Instructor Note: Refer students to Table 12.2 "Maximum Working Heights for Ladders Set at Proper Climbing Angle" on page 669 of the textbook. Discuss how maximum working reach relates to designated length of ladders.

- d. For lengths of 35 feet (11 m) or less, reach approximately one foot (300 mm) less than designated length
- e. For lengths over 35 feet (11 m) or less, reach approximately two feet (600 mm) less than designated length

Review Question: What factors must be considered when selecting a ladder placement location? *See pp. 667-669 of the textbook for answers.*

C. Lifting and Lowering Methods

- 1. To prevent personal injuries, use proper lifting and lowering techniques
- 2. Use correct number of firefighters for length, type of ladder to be lifted
- 3. Bend knees, keeping back straight, lift with legs, NOT with back, arms
- 4. Lift on command of firefighter who can see other members of team
- 5. Make it known immediately if not ready to lift when lifting with a team lifting should occur in unison



- 6. Reverse procedure for lifting if necessary to place ladder on ground before raising
 - a. Lower ladder using leg muscles
 - b. Keep body perpendicular to ladder and feet parallel to ladder – when ladder placed it does not rest on toes

Review Question: What techniques should be used to prevent personal injuries when lifting and lowering ladders? *See pp. 669-670 of the textbook for answers.*



Chapter 12 Ground Ladders

+	
Ground Ladders	
Module 2	
Chapter 12	
Supply PDL Institut Party System in Suprementional Station	CP50A

Lesson Goal

After completing this lesson, the student shall be able to recognize ground ladders used in the fire service and select the appropriate ladder for the task presented. Students will also be able to carry and deploy fire service ground ladders.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe different construction types of ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 2. Identify the parts of a ladder including markings and labels. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 3. Recognize the types of ladders used in the fire service. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 4. Explain the considerations addressed by ladder inspection, cleaning, and maintenance. [NFPA[®] 1001, 5.5.1]
- 5. Describe safety guidelines used when handling ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 6. Explain considerations taken when selecting, lifting, and lowering a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 7. Describe various methods for ladder carries. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 8. Identify basic considerations and requirements for ground ladder placement. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 9. Describe various methods for ladder raises. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 10. Compare procedures for moving ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 11. Explain the methods used to secure ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 12. Describe ladder climbing considerations. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 13. Indicate what methods can be used to work from a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 14. Explain methods used for assisting a victim down a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 15. Clean, inspect, and maintain a ladder. [NFPA[®] 1001, 5.5.1]



- 16. Carry a ladder One-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 17. Carry a ladder Two-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 18. Carry a ladder Three-firefighter flat-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 19. Carry a ladder Three-firefighter flat-arm's length method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 20. Carry a ladder Two-firefighter arm's length on-edge method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 21. Tie the halyard. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 22. Raise a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 23. Raise a ladder Two-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 24. Raise a ladder Two-firefighter beam raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 25. Raise a ladder Three- or four-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 26. Deploy a roof ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 27. Pivot a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 28. Shift a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 29. Shift a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 30. Heel a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 31. Leg lock on a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 32. Assist a conscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]
- 33. Assist an unconscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]

Instructor Information

This is the lesson covering ground ladders. This lesson describes ground ladder construction, ladder types, and inspection and maintenance. The lesson also covers ladder deployment and procedures for working from a ladder.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. LADDER CARRIES

pp. 670-675

Objective 7 — Describe various methods for ladder carries.



A. Ladder Carries

- 1. Ground ladders must be safely, and quickly carried from apparatus to point where to be used
- 2. Ladder must be properly removed from apparatus
 - a. Pumper apparatus One or two firefighters should be able to remove ladder
 - b. Aerial apparatus Three or four firefighters may be required

B. Removing Ladders from the Apparatus

- 1. Ground ladders carried on pumper apparatus may be mounted
 - a. Vertically, in racks on right side of apparatus
 - b. Vertically, in compartment between hose bed and right side of body, accessed from rear
 - c. Horizontally, in compartment under right side of hose bed, accessed from rear
 - d. In mechanically operated rack that lowers ladder from top of hose bed to right hand side
- 2. On aerial, quint apparatus, ladders may be mounted
 - a. Vertically, on left or right side of apparatus bed
 - b. Horizontally, in racks within bed, and accessed from rear
- 3. Specialized apparatus (mobile water supply, aircraft rescue and fire fighting) Generally carry ladders vertically on outside of apparatus body

Ask Students: How are the ground ladders mounted on the different apparatus in your jurisdiction? Have you observed ladders being removed from racks, compartments, or a mechanically operated rack?

Briefly discuss answers with students. Emphasize the importance of being familiar with apparatus in your jurisdiction.



PROCE	DURES FOR REMOVIN LADDERS DIFFER FR LADDERS.	G SIDE AND TOP DM FLAT MOUNTED	
	Vertically mounted	Unlatch Unlatch Unit off to connect carrying position	
	Stored internally	Open access panel Side out to proper carrying point Multiple Wellphonz -Take assigned location as ladder ls pulled out	

- 4. To assist in using ground ladders mounted on apparatus, firefighters must know
 - a. Types, length, location of ladders carried on apparatus in department
 - b. How ladders are stored (racked) Either butt toward front or rear
 - c. How ladders are nested together
 - d. How one nested ladder can be removed leaving other securely in place
 - e. Order in which nested ladders are racked
 - f. Whether extension ladder's fly is located on inside or outside when ladder is racked
 - g. Method used to secure ladders in place
 - h. Location at which mounting brackets extend through vertically mounted ladders
- 5. Procedures for removing ground ladders mounted on side, top differ from those used when mounted flat
 - a. Vertically mounted ladders
 - i. Unlatch securing devices
 - ii. Lift ladder off bracket into correct carrying position
 - b. Ladders stored internally in compartments
 - i. Open compartment access panel
 - ii. Slide ladder out to proper carrying point
 - iii. When multiple firefighters required, stand on either side of horizontally racked ladder, take assigned location as ladder is pulled out

Review Question: What information must a firefighter know in order to use ground ladders? *See page 671 of the textbook for answers.*



C. One-Firefighter Low-Shoulder Carry

- 1. One firefighter may safely carry some single, roof ladders
- 2. One firefighter may safely carry 24-foot (7 m) extension ladder two firefighters preferred

- 3. To perform carry
 - a. Rest ladder's upper beam on shoulder with arm between two rungs near midpoint of ladder
 - b. Butt of ladder is carried forward
 - c. Carry forward end slightly lowered
 - i. Provide better balance, allow to see way ahead
 - ii. If ladder strikes someone, butt spurs will contact body instead of head
 - d. Do not open hooks on roof ladder until ready to ascend roof

Caution: Carrying the forward end of a ladder at eye level impedes the carrier's balance and visibility and increases the risk of the butt spurs striking someone else in the head.

D. Two-Firefighter Low-Shoulder Carry

- 1. May be used with single, roof ladders
- 2. Most commonly used for 24-, 28-, 35-foot (7 m, 9 m, 11 m) extension ladders
- 3. Gives firefighters excellent control of ladder
- 4. Forward firefighter places free hand over upper butt spur – Prevent injury in case there is collision while ladder is carried

E. Three-Firefighter Flat-Shoulder Carry

- Typically used on extension ladders up to 35 feet (11 m)
- 2. Two firefighters, one at each end on one side of ladder
- 3. One firefighter on the other side in the middle

F. Three-Firefighter Flat Arm's Length Carry

- Begins with extension ladder on ground, fly section up
- 2. Firefighters positioned with one at each end on one side of ladder, one on other side in middle
- 3. Facing the butt while kneeling, firefighters grasp beam and stand holding ladder at arm's length





4. Four firefighters can perform carry using positions described for four-fighter flat-shoulder carry

G. Four-Firefighter Flat-Shoulder Carry

- Same flat-shoulder method used by three firefighters, change in positioning to accommodate fourth firefighter
- 2. Two firefighters positioned at each end of ladder, opposite each other

H. Two-Firefighter Arm's Length On-Edge Carry

- 1. Best performed with lightweight ladders
- 2. Firefighters positioned on bed section (widest) side of ladder when in vertical position

I. Procedures for Carrying Roof Ladders

- 1. Roof ladders may be carried either butt or tip first
 - a. Low-shoulder method used to carry roof ladder with hooks closed to extension ladder that will be climbed to access the roof
 - b. Butt-first and tip-first methods can be used by one or two firefighters
- 2. If roof ladder carried butt first from apparatus, heel at base of extension ladder
 - a. Set ladder down
 - b. Walk back to tip and open roof hooks
 - c. Raise ladder and rest on extension ladder beam
 - d. Climb extension ladder, and shoulder roof ladder at 3-4 rungs from tip (roof hooks turned out)
 - e. Carry ladder rest of the way, and deploy on roof pitch
- 3. If roof ladder carried tip first, carry to base of extension ladder
 - a. Remove from shoulder, and place butt on ground
 - b. Walk hands to tip without laying ladder down

pp. 675-677

- c. Open roof hooks outward
- d. Return to center point and shoulder ladder
- e. Proceed up extension ladder to top and deploy roof ladder

II. PLACEMENT OF GROUND LADDERS

Objective 8 — Identify basic considerations and requirements for ground ladder placement.



A. Responsibility for Placement

- 1. Normally, officer designates general location to be placed, task to be performed
- 2. Personnel carrying ladder frequently decide exact spot where butt placed
 - a. Usually, firefighter nearest butt to make decision
 - b. Two firefighters at butt, one on right side usually responsible for placement
- 3. Follow department SOPs

B. Factors Affecting Ground Ladder Placement

- 1. Two objectives to be met when placing ground ladders
 - a. Positioning the ladder properly for intended use
 - b. Placing butt proper distance from building for safe, easy climbing
- 2. Positioning a firefighter to break a window for ventilation
 - a. Alongside window on windward (upwind) side
 - b. Tip about even with top of window
 - c. Also used when firefighters climb in, out of narrow windows, or direct hose stream into them
- 3. Entry or rescue from a window, ladder tip placed slightly below sill







- a. If sill projects out, tip of ladder can be wedged under sill for additional stability
- b. If window opening wide enough, place ladder so that two or three rungs extend above sill
- 4. Other ladder placement guidelines
 - a. Place ladders at two points on different sides of building
 - Avoid placing ladders over openings windows, doors – where might be exposed to heat, direct flame contact
 - c. Take advantage of strong points in building construction when placing ladders
 - d. Raise ladder directly in front of window when used as support for smoke ejector removing cold smoke after fire extinguished – Place ladder tip on wall above window opening
 - e. Avoid placing ladders where they may come into contact with overhead obstructions
 - f. Avoid placing ladders on uneven terrain, soft spots
 - g. Avoid placing ladders in front of doors, other paths of travel Place ladder to side of opening
 - h. Avoid placing ladders on top of sidewalk elevator trapdoors or sidewalk deadlights – may give way under added weight
 - i. Do not place ladders against unstable walls, surfaces

Review Question: What are the two objectives that must be met when placing ground ladders? *See page 675 of the textbook for answers.*

- 5. Distance of butt end from building establishes angle formed by ladder and ground
 - a. If butt too close to building, stability reduced weight of person tends to cause tip to pull away from building
 - b. Desired angle of inclination is approximately 75 degrees
 - C. Benefits of 75-degree angle

- i. Good stability
- ii. Less stress placed on ladder
- iii. Optimum climbing angle
- iv. Easiest climbing position climber perpendicular to ground, arm's length from rungs
- d. If butt placed too far from building
 - i. Load-carrying capacity reduced
 - ii. More tendency to slip
- e. If placement with butt too far is necessary, tie in or heel (steady) bottom of ladder at all times
- 6. Easy way to determine proper distance between butt and building – Divide working length of ladder by 4
 - a. Only length used to reach window, not overall length, used in calculation
 - b. Exact measurements unnecessary
- 7. Experienced firefighters develop ability to visually judge proper positioning for ladder
 - a. When ladder at proper angle, firefighter standing straight on bottom rung should be able to reach straight ahead and grasp rung directly in front
 - b. Ladders also equipped with inclination marking on outside of beam – Align perfectly vertical and horizontal when ladder properly set

Review Question: How can a firefighter determine the proper distance between the heel of the ladder and the building? *See page 677 of the textbook for answers.*

III. LADDER RAISES

pp. 678-682

Objective 9 — Describe various methods for ladder raises.

- A. Ladder Raises
 - 1. Teamwork, smoothness, and rhythm necessary when raising, and lowering fire department ladders





- 2. Numerous ways to safely raise ground ladders
- 3. Methods vary depending on
 - a. Type and size of ladder
 - b. Number of personnel available to perform raise
 - c. Weather conditions
 - d. Topography conditions

NOTE: Refer students to the NOTE on page 678 of the textbook. Emphasize that all safety guidelines should be followed when lowering a ladder.

B. Transition from Carry to Raise

- 1. Methods, precautions for raising single-section, extension ladders are much the same
- 2. Not necessary to place ladder flat on ground prior to raising only butt needs to be placed on ground
- 3. Transition from carrying position to raise can/should be done in one smooth and continuous motion

C. Considerations Before Raising

- 1. Electrical hazards
 - a. Ladders, people climbing coming in contact with live electrical wires can result in electrocution – death, severe injury
 - b. Look up, check for overhead wires, equipment before making final selection on where to place ladder, method for raising
 - c. Look up again before raising ladder
 - d. Occupational Health and Safety Administration (OSHA) requires ladders must be kept distance of at least 10 feet (3 m) from all energized electrical lines, equipment
 - i. Distance must be maintained while raising, using, and lowering the ladder
 - ii. In some cases, ladder may come to rest safe distance from electrical equipment, but come too close during actual raise

iii. Alternate method of raising ladder, such as raising parallel to structure, may be required

WARNING All ladders will copecially when wet, regardless of their construction material.

WARNING!: All ladders will conduct electricity, especially when wet, regardless of their construction material.





- 2. Position of the fly section on extension ladders
 - a. Each ladder manufacturer specifies whether the ladder is to be placed with the fly in, toward structure, or out, away from structure
 - i. Based on
 - (a) Ladder design
 - (b) Construction materials
 - (c) Manufacturer's tests
 - ii. Failure to follow recommendation could void ladder's warranty
 - b. Metal, fiberglass ladders designed to be used with fly out
 - c. Wooden ladders designed with rungs mounted in top truss rail intended to be used with fly in
 - d. Consult departmental SOPs, and manufacturer to determine correct fly position
 - e. Some departments have ladders intended to be used with fly out but prefer firefighter extending halyard be on outside of ladder – Firefighters will pivot or roll ladder 180 degrees after extended
- 3. Tying the halyard
 - a. Once extension ladder resting against structure, before climbing, halyard should be tied with clove hitch, overhand safety
 - i. Prevent fly from slipping
 - ii. Prevent tripping over rope
 - b. Rescue situations, speed critical
 - i. Not necessary to wrap excess halyard before tying
 - ii. Should be placed out of way
 - c. Same tie used for closed-, open-ended halyard







D. One-Firefighter Raise

- One-firefighter single ladder raise Single, roof ladders generally light enough that one firefighter can place butt end without steadying before raising
- 2. One-firefighter extension ladder raise
 - a. From low-shoulder carry
 - b. Building used to heel ladder Prevent slipping while ladder brought to vertical position

E. Two-Firefighter Raises

- Little difference if ladder is raised parallel with or perpendicular to building – If parallel, ladder must be pivoted after in vertical position
- 2. Firefighter positioned at butt end heeler Responsible for
 - a. Placing butt at desired position from building
 - b. Determining whether ladder will be raised parallel or perpendicular to building
 - c. Giving commands during operation
- 3. Two ways for two firefighters to raise ladder
 - a. Two-firefighter flat raise
 - b. Two-firefighter beam raise

F. Three-Firefighter Flat Raise

- 1. As length of ladder increases, weight increases, requiring more personnel
- 2. Three firefighters should be used to raise ladders of 35 feet (11 m) or longer
 - a. Three-firefighter flat raise
 - b. Beam method with three firefighters
 - i. Same procedures as two-firefighter flat raise
 - ii. Third firefighter positioned along beam
 - iii. Once raised, follow procedures for flat raise



G. Four-Firefighter Flat Raise

- 1. Four firefighters better handle larger, heavier extension ladders
- 2. Flat raise, similar to three-firefighter raise
- 3. Firefighter at butt responsible for placing butt, determining whether raised parallel or perpendicular

H. Deploying a Roof Ladder

- 1. Number of ways a ladder can be deployed on pitched roof
- 2. Ladder carried up extension ladder to roof
 - a. Firefighter locks in with one leg or connects ladder belt
 - b. Remove ladder from shoulder
 - c. Slide on the beam, hooks out, up to peak
 - d. When hooks over peak, turn ladder onto both beams, and hooks over peak
 - e. Pull down to ensure hooks have engaged roof
- 3. Alternate method Slide on both beams until hooks engage peak



Review Question: What considerations must be addressed before raising a ladder? *See pp. 678-679 of the textbook for answers.*

Chapter 12 Ground Ladders

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Ground Ladders	
Module 3	
Chapter 12	
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Lesson Goal

After completing this lesson, the student shall be able to recognize ground ladders used in the fire service and select the appropriate ladder for the task presented. Students will also be able to carry and deploy fire service ground ladders.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe different construction types of ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 2. Identify the parts of a ladder including markings and labels. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 3. Recognize the types of ladders used in the fire service. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 4. Explain the considerations addressed by ladder inspection, cleaning, and maintenance. [NFPA[®] 1001, 5.5.1]
- 5. Describe safety guidelines used when handling ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 6. Explain considerations taken when selecting, lifting, and lowering a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 7. Describe various methods for ladder carries. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 8. Identify basic considerations and requirements for ground ladder placement. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 9. Describe various methods for ladder raises. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 10. Compare procedures for moving ground ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 11. Explain the methods used to secure ladders. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 12. Describe ladder climbing considerations. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 13. Indicate what methods can be used to work from a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 14. Explain methods used for assisting a victim down a ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 15. Clean, inspect, and maintain a ladder. [NFPA[®] 1001, 5.5.1]

- 16. Carry a ladder One-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 17. Carry a ladder Two-firefighter low-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 18. Carry a ladder Three-firefighter flat-shoulder method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 19. Carry a ladder Three-firefighter flat-arm's length method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 20. Carry a ladder Two-firefighter arm's length on-edge method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 21. Tie the halyard. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 22. Raise a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 23. Raise a ladder Two-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 24. Raise a ladder Two-firefighter beam raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 25. Raise a ladder Three- or four-firefighter flat raise. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 26. Deploy a roof ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 27. Pivot a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 28. Shift a ladder One-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 29. Shift a ladder Two-firefighter method. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 30. Heel a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 31. Leg lock on a ground ladder. [NFPA[®] 1001, 5.3.6, 5.3.11, 5.3.12]
- 32. Assist a conscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]
- 33. Assist an unconscious victim down a ground ladder. [NFPA[®] 1001, 5.3.9]

Instructor Information

This is the lesson covering ground ladders. This lesson describes ground ladder construction, ladder types, and inspection and maintenance. The lesson also covers ladder deployment and procedures for working from a ladder.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. PROCEDURES FOR MOVING GROUND LADDERS

pp. 682-683

Objective 10 — Compare procedures for moving ground ladders.



A. Pivoting Ladders with Two Firefighters

- Pivoting Ladders with Two Firefighters
 - If extension ladder raised with fly in incorrect position for deployment – necessary to pivot ladder
 - 2. Ladder flat-raised parallel to building also requires pivoting to align with wall
 - a. Pivot ladder on beam closest to structure
 - b. Whenever possible pivot before extended
 - 3. Two-firefighter pivot may be used on any ladder that two firefighters can raise
 - a. Ladder that must be turned 180 degrees to get fly section in proper position
 - b. Ladder flat-raised parallel to building Beam closest to building used to pivot 90 degrees

B. Shifting Raised Ground Ladders

- Because they are hard to control, shifting ground ladders in vertical position should be limited to short distances, such as aligning perpendicular to building, adjacent window
 - a. One firefighter can shift ladder 20 feet (6 m) long or less
 - b. Extension ladders require two firefighters
 - c. To shift a ladder a short distance side to side
 - i. Place ladder against building
 - ii. Slide top sideways
 - iii. Pick up butt, move into position

Review Question: What are two methods of safely moving a ground ladder after it has been raised? *See page 683 of the textbook for answers.*



II. SECURING THE LADDER

pp. 684-685

Objective 11 — Explain the methods used to secure ladders.

A. Securing the Ladder

- 1. Ground ladders must be secured whenever firefighters are climbing, and working from ladder
- 2. Two methods for securing
 - a. Heeling
 - b. Tying in
- 3. Process of securing may include
 - a. Lock extension ladder locks in place Before ladder placed against structure
 - b. Tie halyard with clove hitch and overhand safety
 - c. Prevent movement of ladder away from building by heeling and/or securing with rope to nearby firm object

B. Heeling

- 1. Several methods for heeling (footing)
- One method is for firefighter to stand beneath ladder, feet shoulder-width apart, grasp beams at eye level, and pull backward to press ladder against building
 - a. Wear complete PPE, do not look up when someone climbing
 - b. Grasp beams, not rungs
 - c. Be alert for falling debris and objects
- Another method is for firefighter to stand on outside of ladder, chock butt end with one foot, toes placed against butt spur or foot on bottom rung, grasp beams and press ladder against building – Stay alert for firefighters descending the ladder
- 4. Full PPE with faceshield must be worn when heeling ladder







C. Tying In

- 1. Whenever possible, ladder should be tied securely to fixed object
- 2. Tying in is simple, can be done quickly, strongly recommended to prevent slipping, pulling away from building
- 3. Tying in frees personnel who would otherwise be holding ladder in place
- 4. Rope hose tool, safety strap can be used between ladder and fixed object

Review Question: How do the two methods used for securing ladders compare with one another? *See pp. 684-685 of the textbook for answers.*

III. CLIMBING LADDERS

pp. 685-686

Objective 12 — Describe ladder climbing considerations.



- A. Climbing Ladders
 - 1. Should be done smoothly, rhythmically
 - 2. Ascend ladder with least amount of bounce, sway
 - a. Smoothness accomplished if knee is bent to ease weight on each rung
 - Balance will come naturally if ladder properly spaced away from building to create optimum climbing angle – body perpendicular to ground – usually 75-degree angle
 - 3. Climb starts after climbing angle checked and ladder secured
 - a. Eyes focused forward, occasional glance at tip of ladder
 - b. Keep arms straight (horizontal) during climb
 - i. Keeps body away from ladder
 - ii. Permits free knee movement during climb
 - C. Place hands on rungs

- i. Grasp rungs palms down, thumbs beneath rungs
- ii. Grasp alternating rungs while climbing
- d. Coordinate hand and foot movement right hand, left foot in contact with ladder as you move opposite hand, foot to next rungs
- e. Place feet near beams, halyard tied in center of rung
- 4. If feet slip, arms, hands are in position to stop fall
- 5. Climb using leg muscles, not arm muscles
 - a. Arms and hands should not reach above head while climbing
 - b. Will bring body too close to ladder
- 6. Practice climbing slowly to develop form rather than speed
 - a. Speed develops with repetition after proper technique mastered
 - b. Too much speed results in lack of body control
 - c. Quick movements cause ladder to bounce, sway
- 7. May be required to carry equipment up, and down ladder during emergency operation
 - a. Disrupts natural climbing motion
 - i. Added weight
 - ii. Need to use one hand to hold tool
 - b. If tool carried in one hand, may be desirable to slide free hand under beam – permits constant hand contact with ladder
 - c. Whenever possible, utility rope should be used to hoist tools and equipment, rather than carrying up a ladder

Review Question: How can a firefighter climb a ladder so that there is the least possible amount of bounce and sway? *See page 685 of the textbook for answers.*

IV. WORKING FROM A LADDER

pp. 686-687



WARNING

WARNING

Objective 13 — Indicate what methods can be used to work from a ladder.

A. Working from a Ladder

- 1. Firefighters must sometimes work with both hands while standing on ground ladder
- 2. Ladder belt or leg lock can safely secure firefighter to ladder while performing work

WARNING!: Do not exceed the rated load capacity of the ladder. To avoid overloading the ladder, allow only one firefighter on each section of a ladder at the same time. Be careful about stressing ladders laterally.

- 3. Ladder belt must be tightly strapped around waist
 - a. Hook may be moved to one side, out of the way, while climbing ladder
 - b. After reaching desired height, slide hook to center of body and attach to rung
- 4. According to NFPA[®] 1983, ladder belt rated as positioning device does not meet requirements of life safety harness

WARNING!: Use a leg lock only when working from a ground ladder. Never use a leg lock on an aerial ladder. Extending or retracting the ladder could result in serious injury.

Review Question: What methods can be used to secure a firefighter to a ladder when performing work? *See pp. 686-687 of the textbook for answers.*

V. ASSISTING A VICTIM DOWN A LADDER

pp. 687-688

Objective 14 — Explain methods used for assisting a victim down a ladder.

- A. Assisting a Victim Down a Ladder
 - 1. When ground ladder intended to be used for rescue through window
 - a. Ladder tip is raised to just below sill
 - i. Easier for conscious victim to climb onto ladder
 - ii. Easier for firefighter to lift unconscious victim onto ladder
 - b. Ladder heeled
 - c. Other loads, activity removed during rescue operations
 - d. Occupants probably unaccustomed to climbing down ladder, must be protected from slipping, falling
 - 2. To bring victims down ground ladder, at least four firefighters needed
 - a. Two inside building
 - b. One, two on ladder
 - c. One heeling ladder
 - 3. Method chosen for assisting victim depends on whether victim conscious, unconscious
 - 4. Conscious victims
 - a. Easiest to lower
 - b. Lower feet first, facing building, onto ladder
 - 5. Unconscious victim
 - a. Held on ladder in same way as conscious victim
 - i. Victim's body rests on rescuer's supporting knee
 - ii. Victim's feet must be placed outside rails to prevent entanglement
 - iii. Rescuer grasps rungs to provide secure hold, protect victim's head from hitting ladder
 - b. Alternative lowering position same hold, victim turned to face rescuer





- i. Reduces chances of victim's limbs catching between rungs
- ii. Unconscious victim facing rescuer supported at crotch by one of rescuers' arms, at chest by other arm
- iii. Rescuer may be aided by another firefighter

Instructor Note: Refer students to the Safety Box on page 688 of the textbook. Describe signs that may indicate a victim is regaining consciousness. Discuss ways a firefighter should be prepared to respond to a sudden reaction from a victim.

- 6. Victim's size a factor in lowering Large victims require more personnel, and may require more equipment
- 7. Removing heavy victims requires two rescuers
 - a. Two ground ladders placed side by side
 - b. One rescuer supports victim's waist and legs
 - c. Second rescuer, on other ladder, supports head and upper torso
- 8. Small children can be cradled across rescuer's arms

Review Question: How many firefighters are needed to bring a victim down a ladder? See page 688 of the textbook for answers.

VI. SKILLS

рр. 690-691	Objective 15 — Clean, inspect, and maintain a ladder.
p. 692	Objective 16 — Carry a ladder – One-firefighter low- shoulder method.
p. 693	Objective 17 — Carry a ladder – Two-firefighter low- shoulder method.
p. 694	Objective 18 — Carry a ladder – Three-firefighter flat- shoulder method.



p. 695	Objective 19 — Carry a ladder – Three- firefighter flat- arm's length method.
p. 696	Objective 20 — Carry a ladder – Two-firefighter arm's length on-edge method.
p. 697	Objective 21 — Tie the halyard.
рр. 698-706	Objective 22 — Raise a ladder – One-firefighter method.
рр. 707-708	Objective 23 — Raise a ladder – Two-firefighter flat raise.
рр. 709-710	Objective 24 — Raise a ladder – Two-firefighter beam raise.
рр. 711-712	Objective 25 — Raise a ladder – Three- or four-firefighter flat raise.
рр. 713-714	Objective 26 — Deploy a roof ladder – One-firefighter method.
p. 715	Objective 27 — Pivot a ladder – Two-firefighter method.
рр. 716-717	Objective 28 — Shift a ladder – One-firefighter method.
рр. 718-719	Objective 29 — Shift a ladder – Two-firefighter method.
pp. 720-721	Objective 30 — Heel a ground ladder.
рр. 722-723	Objective 31 — Leg lock on a ground ladder.
рр. 724-725	Objective 32 — Assist a conscious victim down a ground ladder.
p. 726	Objective 33 — Assist an unconscious victim down a ground ladder.

VII. SUMMARY AND REVIEW



A. Chapter Summary

- 1. Ground ladders are an essential tool used to access levels above and below ground level.
- 2. You must know the types of ground ladders your department uses, the parts and construction materials, and how to care for and maintain them.

- 3. You must be able to select, carry, and place them to effectively gain access and perform your assigned tasks.
- 4. You must know the correct methods for safely climbing, working from, and assisting victims down ground ladders.

B. Review Questions

- 1. What are the basic parts of fire service ladders? (*pp.* 655-657)
- How does a fire service ladder constructed of metal differ from one constructed of fiberglass? (p. 658)
- 3. What types of markings and labels do fire service ladders have? (*p.* 659)
- 4. How do the five types of ladders used in the fire service compare with one another? (*pp. 66o-663*)
- 5. What types of information do general ladder inspections look for? (*pp. 663-665*)
- 6. What are the general maintenance requirements for ground ladders? (*p. 666*)
- 7. What are the guidelines for safely carrying, raising, lowering, and working on ladders? (*p.* 666-667)
- 8. What factors must be considered when selecting a ladder placement location? (*pp. 667-669*)
- 9. What techniques should be used to prevent personal injuries when lifting and lowering ladders? (*pp. 669-670*)
- 10. What information must a firefighter know in order to use ground ladders? (p. 671)
- 11. What are the two objectives that must be met when placing ground ladders? (*p. 675*)
- 12. How can a firefighter determine the proper distance between the heel of the ladder and the building? (p. 677)
- 13. What considerations must be addressed before raising a ladder? (*pp. 678-679*)

- 14. What are two methods of safely moving a ground ladder after it has been raised? (*p. 68*₃)
- 15. How do the two methods used for securing ladders compare with one another? (*p. 684-685*)
- 16. How can a firefighter climb a ladder so that there is the least possible amount of bounce and sway? (*p.* 685)
- 17. What methods can be used to secure a firefighter to a ladder when performing work? (*pp. 686-687*)
- 18. How many firefighters are needed to bring a victim down a ladder? (p. 688)

13-1

Chapter 13 Tactical Ventilation

Lesson Goal

After completing this lesson, the student shall be able to apply tactical ventilation knowledge and practices following the policies and procedures set forth by the authority having jurisdiction (AHJ).

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe reasons for tactical ventilation. [NFPA[®] 1001, 5.3.11]
- 2. Identify considerations that affect the decision to ventilate. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 3. Explain the critical fire behavior indicators present during tactical ventilation. [NFPA[®] 1001, 5.3.11]
- 4. Define horizontal and vertical ventilation. [NFPA® 1001, 5.3.11]
- 5. Explain the means for achieving horizontal and vertical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 6. Describe the types of horizontal ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 7. Describe the types of vertical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 8. Recognize other types of ventilation situations. [NFPA® 1001, 5.3.11]
- 9. Explain the effects of building systems on tactical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 10. Ventilate using mechanical negative pressure in a window. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 11. Ventilate using mechanical negative pressure in a doorway. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 12. Ventilate using mechanical positive pressure. [NFPA® 1001, 5.3.11, 5.3.12]
- 13. Perform horizontal hydraulic ventilation. [NFPA® 1001, 5.3.11, 5.3.12]
- 14. Demonstrate the procedure for sounding a roof. [NFPA® 1001, 5.3.12]
- 15. Ventilate using a rotary saw to cut an opening. [NFPA® 1001, 5.3.12]
- 16. Ventilate using an axe to cut an opening. [NFPA® 1001, 5.3. 7]
- 17. Demonstrate the procedure for opening a flat roof. [NFPA® 1001, 5.3.8]
- 18. Perform the steps for opening pitched roofs. [NFPA® 1001, 5.3.12]

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19. Demonstrate the procedure for making a trench cut using a rotary saw. $[NFPA^{\ensuremath{\mathbb{R}}}\ 1001, 5.3.12]$

Instructor Information

This is the lesson covering tactical ventilation. This lesson covers types of ventilation, reasons for ventilation, and considerations that should be taken into account when performing ventilation. The lesson also covers the effects of building systems on tactical ventilation.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. REASONS FOR TACTICAL VENTILATION

pp. 732-734





Objective 1 — **Describe reasons for tactical ventilation.**

A. Reasons for Tactical Ventilation

- 1. Traditional term ventilation; more accurate tactical ventilation
- 2. Planned, systematic, and coordinated removal from a structure of
 - a. Heated air
 - b. Smoke
 - c. Gases
 - d. Other airborne contaminants
- 3. Replace with cooler, fresher air for
 - a. Life safety
 - b. Incident stabilization
 - c. Property conservation
- 4. Performed only when fire attack hoselines and teams in place, ready to advance
- 5. Success depends on
 - a. Careful planning
 - b. Knowledge of building construction
 - c. Knowledge of fire behavior
 - d. Systematic application of procedures for removing the contaminants
 - e. Coordination with other fireground activities
- 6. General reasons for performing
 - a. Reducing interior heat levels
 - b. Decreasing rate of fire spread
 - c. Reducing potential extreme fire behavior
 - d. Improving interior visibility
 - e. Improving firefighter efficiency



- f. Improving victim survival potential
- g. Reducing smoke damage and property damage
- 7. Correctly implemented achieve incident priorities
 - a. Life safety
 - b. Incident stabilization
 - c. Property conservation
- 8. Improperly applied Results can be traumatic
 - a. Occupants
 - b. Firefighters
 - c. Physical structure itself

Instructor Note: Discuss with students "The Effect of Fresh Air on an Oxygen Deprived Environment" on pp. 733 of textbook.

Discuss why it is important to effectively manage the introduction of fresh air.

B. Life Safety

- 1. Highest incident priority Applies to
 - a. Occupants who may be trapped in structure
 - b. Firefighters who must enter it to locate, rescue them
- 2. Tactical ventilation improves life safety for firefighters, occupants by
 - a. Increasing oxygen concentration
 - b. Reducing concentration of toxic products of combustion
 - c. Reducing temperature
 - d. Increasing visibility to aid in operations
 - e. Creating smoke-free paths of egress

C. Incident Stabilization

1. Tactical ventilation can be effectively combined with fire attack to stabilize incident





Fire Protection Publications Oklahoma State University

- Controlling and extinguishing fire Accomplished in stages
 - a. Locating fire
 - b. Confining fire to room, area, or structure of origin
 - c. Extinguishing fire

D. Property Conservation

- 1. When smoke, gases, and heat are removed from burning structure, fire can be confined to specific area
- If sufficient personnel on scene, salvage operations can begin outside immediate area of fire while fire control operations being conducted
- 3. Tactical ventilation Increases speed by which you can extinguish interior fires
 - a. Reduces fire damage in structure
 - b. Less water will be needed Less damage to structure, contents

Review Question: What are the reasons for tactical ventilation? *See pages 732-734 of the textbook for answers.*

II. CONSIDERATIONS AFFECTING THE DECISION TO VENTILATE

pp. 734-742 Objective 2 — Identify considerations that affect the decision to ventilate.

Objective 3 — Explain the critical fire behavior indicators present during tactical ventilation.

NOTE: The incident commander (IC) will make the decision to ventilate the structure.

A. Risks to Occupants and Firefighters

1. Occupants - Life hazards









- a. Generally lower if the occupants are awake
- b. If occupants were asleep when fire developed and are still in building, possibilities
 - i. May have been overcome by smoke and fire gases some may still be alive; others may have perished
 - ii. Might have become lost in the structure
 - iii. May be alive and taking refuge in their rooms because the doors were closed
- 2. Firefighters Hazards expected from accumulation of smoke and fire gases
 - a. Visual impairment caused by dense smoke
 - b. Lack of oxygen
 - c. Presence of toxic gases
 - d. Presence of flammable gases
 - e. Possibility of rapid fire development

B. Building Construction

- Single-family residential Drastically changed over past 50 years
 - a. Structure Increased over 150 percent between 1973 2008
 - b. Lot sizes Decreased 25 percent
 - i. Reducing firefighter access
 - ii. Increasing potential exposure risks
- 2. Residential interior layouts, and construction materials changed
 - a. Older structure construction
 - i. Composed of smaller compartments
 - ii. Windows that could be opened for ventilation
 - iii. Empty wall cavities that depended on air pockets to provide insulation
 - b. Modern single family structure features
 - i. Open floor plans
 - ii. High ceilings, atriums
- iii. Lightweight manufactured structural components
- iv. Sealed windows
- v. Wall cavities filled with synthetic insulation
- c. Construction materials, interior finish of synthetic materials, and light composite wood components
 - i. Add to fuel load of structure
 - ii. Contribute to creation of toxic gases during fire
 - Energy efficient designs tend to contain fires for longer period of time – Creating fuel rich environment
 - iv. Problems magnified in large-area residential structures
- 3. Commercial, institutional, educational, and multi-family residential structures rely on energy conservation measures that
 - a. Increase intensity of fire
 - b. Make use of tactical ventilation difficult
- 4. Open plan commercial structures have
 - a. High fuel loads in contents
 - b. No physical barriers preventing spread of fire and smoke
- Use of plastics, other synthetic materials dramatically increased fuel load in all types of occupancies
 - a. Produce large quantities of toxic, combustible gases
 - b. Heat generated escalates rapidly Can reach extreme temperatures
- Knowledge of building involved is an asset when decisions concerning tactical ventilation made; can be obtained from
 - a. Preincident plans
 - b. Inspection reports
 - c. Observation of similar types of structures







- 7. Building characteristics to be considered
 - a. Occupancy classification
 - b. Construction type
 - c. Floor area and compartmentation
 - d. Ceiling height
 - e. Number of stories above and below ground level
 - f. Number and size of exterior windows, doors, and other wall openings
 - g. Number and location of staircases, elevator shafts, dumbwaiters, ducts, and roof openings
 - h. External exposures
 - i. Extent to which building is connected to adjoining structures
 - j. Type, design of roof construction
 - k. Type, location of fire protection systems
 - I. Contents
 - m. Heating, Ventilation, and Air Conditioning (HVAC) system

C. Fire Behavior Indicators

- 1. Smoke Observations can help obtain a clear picture of interior fire conditions
 - a. Volume of smoke discharge
 - b. Location of smoke discharge
 - c. Smoke color, density, pressure
 - d. Movement of smoke
- Air flow Movement of air toward burning fuel and movement of smoke out of the compartment
 - a. Indicators of air flow
 - i. Velocity
 - ii. Turbulence
 - iii. Direction

- iv. Movement of neutral plane
- b. Air flow caused by
 - i. Pressure differentials inside and outside compartment
 - ii. Differences in density between hot smoke and cooler air
- c. Air flow follows flow path
 - i. Parts Inlet vent (where air enters), flow path, outlet or exhaust vent
 - ii. Example Single open doorway to structure fire
 - (a) Air inlet is lower portion of doorway Low pressure below neutral plane
 - (b) Smoke exhaust is upper portion of doorway – High- pressure area above neutral plane
 - iii. Other example
 - (a) Air inlet Entire open doorway
 - (b) Smoke exhaust Roof vent
 - iv. Flow path is connection between inlet and outlet
- 3. Heat
 - a. Visual indicators
 - i. Blistering paint
 - ii. Bubbling roofing tar
 - iii. Crazed glass
 - b. Thermal imager or infrared sensor Scanning buildings with can provide data on internal temperature differences
 - c. Determine presence of increased temperatures through touch, feel on skin even at a distance
- 4. Flame
 - a. Visible Provides indication of size and location of fire



- b. Effect or lack of effect of fire streams Indicates size and extent of fire
- Visible from outside structure Allows flame indicator assessment along with ventilation, air flow

CAUTION Do not rely solely on the presence or location of flamesto assess an incident.

CAUTION: Do not rely solely on the presence or location of flames to assess an incident.

Review Question: How do smoke, air flow, heat, and flame impact fire behavior in a structure? *See pages 737-738 of the textbook for answers.*



D. Location and Extent of the Fire

- 1. First arriving units must quickly determine fire size, extent, and location
- Creating tactical ventilation openings in uncoordinated manner can spread fire to uninvolved areas, cut off occupant escape routes
- Severity and extent of fire Dependent on factors
 - a. Type of fuel
 - b. Amount of time it has been burning
 - c. Activation of fire detection and suppression systems
 - d. Degree of confinement
- Phases and burning regime to which fire has progressed – Primary consideration in determining tactical ventilation procedures

E. Type of Ventilation

- To be safe and effective tactical ventilation must be coordinated with other tactical operations
- 2. Before orders given
 - a. IC must consider effects on fire behavior



- b. Fire attack crews with charged hoselines, search and rescue teams, and exposure protection must be in place
- IC determines if ventilation is necessary When, where, and in what form should it be initiated
- 4. Conditions upon arrival influence ventilation decisions
 - a. Incidents may simply require locating and extinguishing fire, and ventilating afterward to clear residual smoke from structure
 - b. Other incidents require immediate ventilation to enable firefighters to enter building to conduct search and rescue, fire suppression operations
- 5. Type and means of ventilation must be appropriate for situation
- Tactical ventilation must be capable of exhausting volume of heat, smoke, and toxic gases produced by fire

F. Location for Ventilation

- 1. Before selecting place Gather as much information about fire, building, and occupancy
- 2. Factors that have a bearing on where to ventilate
 - a. Location of occupants
 - b. Availability of existing roof openings which access fire area
 - c. Location of the fire
 - d. Desired air flow path
 - e. Type of building construction
 - f. Wind direction
 - g. Extent of progress of fire
 - h. Condition of building and its contents
 - i. Indications of potential structural collapse
 - j. Effect ventilation will have on fire





- k. Effect ventilation will have on exposures
- I. State of readiness of fire attack crews
- m. Ability to protect exposures prior to ventilating structure
- n. Protecting means of egress, access

G. Weather Conditions

- 1. Building openings allow atmosphere to affect what happens inside building
- 2. Conditions that affect ventilation
 - a. Temperature
 - b. Atmospheric pressure
 - c. Precipitation
 - d. Relative humidity
 - e. Wind
- 3. Wind Most important influence
 - Conditions must always be considered to determine proper means, and location of ventilation in structures
 - b. Wind can blow the fire toward an external exposure, supply oxygen to the fire, or blow the fire into uninvolved areas of the structure
 - c. Means selected should work with prevailing wind, not against it

CAUTION: A strong wind can overpower the natural convective effect of a fire and drive the smoke and hot gases back into the building.

H. Exposures

- 1. Internal Building occupants, contents, uninvolved rooms/portions
 - a. Routing of smoke
 - i. When ventilation does not release heat and smoke directly above fire, routing of smoke is necessary



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- Routes smoke, heated fire gases travel to exit building may be same that occupants need to evacuate, firefighters need for working
- Ventilation that causes heat, smoke, and fire to be discharged through wall openings below the highest point of building creates danger
 - i. Rising gases will ignite portions of building above exhaust point
 - ii. Heat and fire gases may be drawn into open windows or attic vents
 - iii. Heat and fire gases may ignite eaves of the building or adjacent structures
- External Structures located adjacent to fire, affected by radiation and direct flame content
 - a. Window-mounted air conditioning units or HVAC intake vents
 - b. Nearby structures, vegetation can be ignited by convection
 - c. Fire drawn into exterior windows or openings

I. Staffing and Available Resources

- 1. Ventilation requires
 - a. Personnel
 - b. Resources
- 2. Staffing requirements range
 - a. Two firefighters
 - b. Multiple companies
- 3. Small structure, ventilation may only require two firefighters
 - a. Open doors and windows
 - b. Allow fresh air to enter and smoke to exit
- 4. Ventilation may require additional personnel and companies when it is necessary
- 5. Resources needed for tactical ventilation



- a. Forcible entry tools
- b. Power saws
- c. Fans or blowers
- d. Smoke ejectors
- e. Flexible ducts
- f. Stacking and hanging devices
- g. Other support systems
- h. Electrical power cords
- i. Generators
- 6. As amount and size of ventilation equipment increases, the space on apparatus to store and transport it will increase

Review Question: What considerations will affect the decision to ventilate?

See pages 734-742 of the textbook for answers.

SUMMARY

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Tactical Ventilation

Module 2

Chapter 13

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Chapter 13 Tactical Ventilation

Lesson Goal

After completing this lesson, the student shall be able to apply tactical ventilation knowledge and practices following the policies and procedures set forth by the authority having jurisdiction (AHJ).

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe reasons for tactical ventilation. [NFPA[®] 1001, 5.3.11]
- 2. Identify considerations that affect the decision to ventilate. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 3. Explain the critical fire behavior indicators present during tactical ventilation. [NFPA® 1001, 5.3.11]
- 4. Define horizontal and vertical ventilation. [NFPA® 1001, 5.3.11]
- 5. Explain the means for achieving horizontal and vertical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 6. Describe the types of horizontal ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 7. Describe the types of vertical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 8. Recognize other types of ventilation situations. [*NFPA*[®] 1001, 5.3.11]
- 9. Explain the effects of building systems on tactical ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 10. Ventilate using mechanical negative pressure in a window. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 11. Ventilate using mechanical negative pressure in a doorway. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 12. Ventilate using mechanical positive pressure. [NFPA® 1001, 5.3.11, 5.3.12]
- 13. Perform horizontal hydraulic ventilation. [NFPA[®] 1001, 5.3.11, 5.3.12]
- 14. Demonstrate the procedure for sounding a roof. [NFPA® 1001, 5.3.12]
- 15. Ventilate using a rotary saw to cut an opening. [NFPA[®] 1001, 5.3.12]
- 16. Ventilate using an axe to cut an opening. [NFPA® 1001, 5.3. 7]
- 17. Demonstrate the procedure for opening a flat roof. [NFPA® 1001, 5.3.8]
- 18. Perform the steps for opening pitched roofs. [NFPA® 1001, 5.3.12]

19. Demonstrate the procedure for making a trench cut using a rotary saw. $[NFPA^{\ensuremath{\mathbb{R}}}\ 1001, 5.3.12]$

Instructor Information

This is the lesson covering tactical ventilation. This lesson covers types of ventilation, reasons for ventilation, and considerations that should be taken into account when performing ventilation. The lesson also covers the effects of building systems on tactical ventilation.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. TYPES OF TACTICAL VENTILATION

pp. 742-744

Objective 4 — Define horizontal and vertical ventilation.



Objective 5 — Explain the means for achieving horizontal and vertical ventilation.

A. Types of Tactical Ventilation

- Horizontal Any technique by which heat, smoke, and other parts of combustion are channeled horizontally out of a structure by way of existing or created horizontal openings such as windows, doors, or other openings in walls
- 2. Vertical Ventilating at a point above the fire through existing or created openings and channeling the contaminated atmosphere vertically within the structure and out the top
 - Cutting a hole in roof above fire or opening existing roof access doors, scuttles, and skylights
 - b. Requires horizontal inlet opening at or below level of fire

B. Means to Accomplish

- 1. Natural horizontal ventilation
 - Opening doors and windows to allow natural air currents and pressure differences to move smoke, heat out
 - b. Uses buoyancy of heated smoke and gases to draw them out through roof openings while entraining (pulling or drawing) fresh air into structure
- 2. Mechanical horizontal ventilation
 - a. Uses fans, blowers, and smoke ejectors
 - Most often used for horizontal May be applied to vertical
 - c. Means involve pulling smoke and fire gases out through an opening or pushing fresh air



into structure and displacing smoke, fire gases

- 3. Hydraulic ventilation
 - a. Uses spray nozzle set on fog pattern to draw smoke out opening
 - b. Requires firefighters to operate nozzle within contaminated atmosphere
 - c. Disadvantage Increased water damage to structure if done improperly
- 4. Indicators for mechanical or hydraulic ventilation
 - a. Location and size of fire have been determined
 - b. Layout of building not conducive to natural ventilation
 - c. Natural ventilation slows, becomes ineffective and needs support
 - d. Fire burning below ground in structure
 - e. Involved area within compartment so large natural ventilation inefficient
 - f. Type of building or fire situation dictates its use

Review Question: What are the basic means used to accomplish ventilation?

See pages 742-744 of the textbook for answers.

Objective 6 — Describe the types of horizontal ventilation.



pp. 744

C. Horizontal Ventilation – Apply to

- 1. Buildings in which fire has not involved attic or cockloft area
- 2. Involved floors of multistoried structures below top floor, or top floor if the attic is uninvolved
- 3. Buildings so weakened by fire that vertical ventilation is unsafe
- 4. Buildings with daylight basements





5. Buildings in which vertical ventilation is ineffective

D. Natural Horizontal Ventilation

- 1. Should work with existing atmospheric conditions, taking advantage of natural air flow
- 2. Requires no additional personnel or equipment to set up and maintain
- 3. When directed by IC
 - a. Create exit point first by opening windows and doors on leeward side of structure
 - Next Openings on windward side of structure opened to permit fresh air to enter; forcing smoke toward exhaust openings
- 4. Only single opening Vent will serve as both inlet for air and exit for smoke

E. Mechanical Horizontal Ventilation

- 1. Necessary when natural flow of air currents and currents created by fire insufficient to remove smoke, heat, and fire gases
- 2. Negative-pressure ventilation (NPV)
 - a. Oldest type of mechanical ventilation
 - i. Smoke ejectors used to expel, pull smoke from structure by developing artificial air flow or enhancing natural ventilation
 - ii. Smoke and fire gases drawn out of structure and fresh air drawn in by fans
 - b. Fan/smoke ejector placement
 - i. Placed in windows, doors, and roof vent openings to exhaust smoke, heat, and gases to exterior
 - Position in openings on leeward side to exhaust in same direction as prevailing wind – Creates lower pressure at inlet allowing fresh air to replace expelled air





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- iii. Properly seal open areas around to prevent air recirculation back into structure
 - (a) Atmospheric pressure pushes air back through open spaces in doorway or window, and pulls smoke back into room
 - (b) Recirculation reduces efficient ventilation
 - (c) Prevent by covering open area around fan with salvage cover or other material
- iv. Flow of smoke, gases to exhaust opening
 - (a) Should be kept as straight as possible
 - (b) Every corner causes turbulence, decreasing efficient ventilation
 - (c) Smoke, gases accumulate near ceiling -Ejector should be located near top of opening
- Avoid opening windows or doors near smoke ejector — Reduces efficient ventilation
- vi. Remove obstacles that reduce airflow
- vii. Do not allow intake side of smoke ejector to become obstructed by debris, curtains, and drapes — May decrease amount of intake air
- c. Selection and use
 - i. In potentially flammable atmospheres Use those equipped with intrinsically safe motors and power cable connections
 - ii. Must be turned off when moved, carried by handles provided
 - iii. Before starting make sure
 - (a) No one near blades
 - (b) Clothing, curtains, draperies are not in a position to be drawn into fan blades
 - iv. Avoid air discharged from fan May contain debris
- Positive-pressure ventilation (PPV) Technique using high-volume fan to create



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slightly higher pressure inside structure than outside

- a. When pressure higher inside building, smoke forced through openings to lowerpressure area outside
- b. Requires good fireground discipline, coordination, and tactics

Instructor Note: Discuss with students the Information Box "Uses of Positive-Pressure Techniques" on pp. 746 of textbook. Point out the various ways to apply positive-pressure ventilation.

- c. Types of openings
 - i. Entry (inlet) opening Location where fan or blower set up
 - ii. Exhaust opening Point varies with size of entry opening, capacity of blower, and may be a window or doorway
- d. Once an exhaust opening created Blower placed outside entry opening
 - Normal single 3-foot (0.9 m) wide door, distance between door and fan should be 4 to 6 feet (1.2 to 1.8 m) – Distances may be altered for larger door openings
 - ii. Cone of air must completely cover opening
 - iii. To maintain positive pressure inside Important to control location, number, and size of exterior openings
- e. During post fire suppression
 - i. Can be used to ventilate interior compartments by systematically opening, closing interior doors, and exterior windows
 - ii. Process accelerates removal of heat and smoke from building
- f. In multistory building
 - i. Best when applied at lowest point
 - ii. Applied at ground level with one or more blowers
 - iii. Directed throughout by opening, and closing doors until smoke evacuated

- iv. More fans added on upper floors, at entry point if single fan insufficient
- v. Smoke systematically removed one floor at time by selectively opening exit points
 - (a) Cross-ventilating floors
 - (b) Directing smoke up stairwell and out rooftop opening
- vi. Larger blowers available for multi-story, large-volume buildings
- g. Main problem Coordination of opening, closing doors in stairwell used to ventilate building
- h. To control openings or pressure leaks
 - i. One person in charge of pressurizing process
 - ii. Use portable radios
 - iii. Firefighters patrol stairwell, hallways
- i. For effective PPV operation
 - i. Ensure exhaust opening sufficient to handle air flow
 - ii. Monitor operation of PPV fan
 - iii. Maintain communications between IC, interior attack crews, and PPV operator
 - iv. Take advantage of existing wind conditions
 - v. Make certain cone of air from fan covers entire entry opening
 - vi. Reduce volume of area pressurized by selectively opening, closing interior doors
 - vii. Avoid creating unintended horizontal openings



WARNING! Improperly applied, PPV can change the interior conditions and injure personnel working inside the structure.

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- 4. Advantages of PPV compared to NPV
 - a. PPV blowers can be set up without entering smoke-filled environment
 - PPV equally effective with either horizontal or vertical ventilation because it supplements natural air currents
 - c. Removal of smoke and heat is more efficient
 - Velocity of air currents is minimal, creates little to no effects that disturb contents or smoldering debris – Total exchange of air within building faster than NPV alone
 - e. Fans powered by internal combustion engines operate more efficiently in clean air
 - f. Cleaning, maintenance of fans used for PPV significantly less than those needed for NPV fans
 - g. PPV effective in all structure types, particularly in large, high-ceiling areas where NPV is ineffective
 - h. Heat, smoke may be directed away from unburned areas or egress paths
 - i. Exposed buildings or adjacent compartment can be pressurized, reducing fire spread
- 5. Disadvantages of PPV
 - a. Structure must be intact
 - Interior carbon monoxide levels may be increased if fan exhaust from fans powered by internal combustion engines is allowed to enter
 - c. Hidden fires may accelerate, and spread throughout building
- 6. Hydraulic ventilation
 - a. Used where other types of forced ventilation unavailable
 - i. Used to clear room or building of smoke, heat, steam, and gases after fire controlled



- ii. Uses spray stream from fog nozzle to entrain smoke, gases – Carry out of structure through door or window
 - (a) Fog nozzle set on wide fog pattern to cover 85 to 90 percent of opening where smoke will be drawn
 - (b) Nozzle tip at least 2 feet (0.6 m) back from opening
 - (c) Faster ventilation occurs with larger openings
- b. Disadvantages
 - i. May increase water damage within structure if done incorrectly
 - ii. Drain on available water supply Especially crucial in rural operations where water shuttles used
 - iii. In freezing temperatures Will be increase in amount of ice on ground surrounding building
 - iv. Nozzle operators must remain in heated, contaminated atmosphere throughout operation
 - v. Operation may have to be interrupted when nozzle team leaves area to replenish air supply

Review Question: What are the main types of horizontal ventilation?

See pages 744-749 of the textbook for answers.

- 7. Precautions against upsetting horizontal ventilation
 - Must take care not to upset effects Opening door on windward side before creating exhaust on leeward may
 - i. Pressurize building
 - ii. Intensify fire
 - iii. Cause fire spread
 - b. Take advantage of air currents established by horizontal ventilation – Obstruction in



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established currents may reduce or eliminate positive effects

- 8. Advantages of mechanical ventilation
 - a. Supplements, enhances natural ventilation
 - b. Ensures more control of air flow
 - c. Speeds removal of contaminants
 - d. Reduces smoke damage
 - e. Promotes good public relations
 - f. Benefits confined spaces with low oxygen levels
- 9. Disadvantages of improper mechanical ventilation
 - a. Can cause fire to intensify and spread
 - b. Depends upon power source
 - c. Requires special equipment
 - d. Requires additional resources, personnel

Review Question: How do the advantages and disadvantages of natural, mechanical, and hydraulic ventilation compare to one another?

See pages 744-751 of the textbook for answers.

pp. 751

Objective 7 — Describe the types of vertical ventilation.

F. Vertical Ventilation

- 1. Occurs after IC
 - a. Determined need for ventilation
 - b. Determined it can be done safely, effectively
 - c. Considered age and type of construction involved
 - d. Considered location, duration, extent of fire
 - e. Observed safety precautions
 - f. Identified escape routes
 - g. Selected place to ventilate
 - h. Moved personnel, tools to roof









- 2. Presents increased risks
 - a. Placing personnel above ground level
 - b. Working on both peaked and flat surfaces
 - c. Working above fire
 - d. Working on roofs that may have been weakened because of age or fire damage
- 3. IC must assess risks, implement safety precautions, and determine if vertical ventilation must be offensive or defensive
 - a. Offensive Aid in reaching, extinguishing fire
 - b. Defensive Stop spread of fire and contain it in one area of structure
- 4. Safety precautions
 - a. Check wind direction and velocity to determine effect on exposures
 - i. Work with wind at back or side when cutting roof opening
 - ii. Protects from heat, smoke, embers
 - b. Note obstructions or excessive weight that may contribute to roof collapse
 - c. Provide secondary means of escape for crews from roof
 - d. Ensure main structural supports not cut while creating opening
 - e. Guard opening to prevent personnel from falling into it
 - f. Evacuate roof promptly when work complete or ordered to leave
 - g. Use lifelines, roof ladders, and other means to prevent personnel from sliding, and falling off the roof
 - h. Make sure roof ladder firmly secured over roof peak before working

CAUTION: Roof ladders are only meant to prevent slipping and are not intended to be used on fire-weakened roofs.

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- i. Exercise caution when working around electric wires, solar panels, and guy wires
- j. Ensure all personnel on roof are wearing full PPE including SCBA and breathing SCBA air
- k. Keep firefighters out of range of those swinging axes, operating power saws
- I. Remain aware of overhead obstructions within range of swing
- Mathematical Start power tools on ground to ensure operation – Shut off before hoisting or carrying to roof
- n. When using power saw Make sure angle of cut is away from body
- Extend ground ladders at least three to five rungs above edge of roof or top of parapet wall – Secure to wall or roof
- When operating from aerial ladder platforms
 Ensure that floor of platform is even with or slightly above roof level
- q. Check roof for structural integrity before stepping onto it, continue sounding throughout operation
- Both before and after ventilating Walk on load-bearing walls and strongest points of roof structure whenever possible
- s. When roof has been opened Penetrate ceiling below to enhance ventilation

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WARNING! Never direct a fire stream into a vertical exhaust opening when interior attack crews are inside the structure because it will force smoke, heat, and steam down on them.

- 5. Sounding the roof
 - a. Should be done
 - i. Before stepping off ladder, parapet wall, other place of safety onto roof
 - ii. Especially if obscured by smoke or darkness

- b. How to perform, what to expect
 - i. Striking the roof surface with blunt end of pike pole, rubbish hook, and axe
 - ii. May feel solid over structural supports Tool bounces off surface
 - iii. May feel softer, less rigid between supports
 - iv. May sound solid over rafter or joist Producing hollow sound struck between supports
 - v. Practice on structurally sound roofs needed to recognize different feeling and sounds of areas
 - vi. Several layers of composition shingles or other coverings may not respond to sounding
 - vii. Tile or slate roofs cannot be sounded Must be removed to reveal underlying structure
- Use preincident planning information to identify buildings with roofs supported by lightweight or engineered trusses – These roofs may fail early in a fire, extremely dangerous to work on or under
- d. Warning signs of a possible unsafe roof condition
 - i. Melting asphalt
 - ii. Spongy roof Normally solid roof that springs back when walked upon
 - iii. Smoke coming from roof
 - iv. Fire coming from roof

Note: Some roofs are spongy with no fire involvement. Know the roofs in your response area.

Caution: Work in groups of at least two, but with no more personnel than absolutely necessary to perform the assigned task.

- 6. Roof-cutting operations
 - a. Rotary saws, carbide-tipped chain saws, chain saw with adapted features best for



CAUTION

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roof-cutting – Faster, less damaging than other tools

- b. Saw operator must
 - i. Have good footing and maintain control of saw at all times
 - ii. Use rubbish hook or Halligan on pitched roof to provide secure foothold
- c. Turn off saw during transportation to or from operation point – Especially when moving up or down ladder
- Roof ventilation team should be in constant communication with supervisor or IC with team leader
- 8. Responsibilities of ventilation team leader
 - a. Ensuring roof is safe Sounding, visual observation
 - b. Ensuring only required openings made
 - c. Directing efforts to minimize secondary damage (damage caused by fire fighting operations)
 - d. Coordinating team's efforts with those of firefighters inside building
 - e. Ensuring safety of all personnel assisting with ventilation operations
 - f. Ensuring there are two means of egress from roof
 - g. Ensuring adequate exhaust opening size
 - h. Ensuring the team leaves roof as soon as their assignment completed
- 9. Before cutting any type of ventilation hole, should cut inspection hole in roof
 - a. Used to help determine location of fire and direction of fire located in attic or cockloft
 - b. Used in offensive and defensive operations
- 10. Kerf cut inspection hole easiest, fastest to cut
 - a. Make single cut using rotary saw, chair saw or axe





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- b. Hole should be width of saw or axe blade
- c. Disadvantage Fire heat can melt tar or membrane, sealing cut
- 11. Triangle or "A" cut inspection hole Provides most reliable condition information
 - a. Created from single kerf cut if conditions indicate need
 - b. Use rotary or chain saw to cut three overlapping cuts that form triangle or letter "A"
 - i. First Diagonal cut from upper left to lower right
 - ii. Next Diagonal cut from top of first cut to lower left
 - iii. Last Connect two lower ends of previous cuts
 - iv. Center should fall through May be necessary to push to free, use tool; NEVER use hand
 - c. Heated smoke, gases, and sometimes fire may exit hole
- 12. Offensive ventilation methods
 - a. Involves making opening over seat of fire at or near highest point of roof
 - b. Type of exhaust opening and method used will depend on roof type
 - c. Two critical points when cutting exhaust opening
 - i. Square or rectangular opening is easier to cut and repair after fire
 - One large opening at least 4 by 8 feet (1.2 m by 2.4 m) much better than several small ones
- 13. Flat roof
 - a. Most common type of opening made in flat roof Square or rectangular
 - b. Openings made between roof trusses or with truss in middle of opening





- c. Use louver cut when truss is in middle of opening
 - i. Steps to make louver cut in flat roof
 - (a) Make initial opening no smaller than 4 by 8 feet (1.2 m by 2.4 m) - Exhaust opening may need enlargement
 - (b) Identify location of rafters
 - (c) Make short cuts across top and bottom of rafter; long cuts parallel to either side of rafter
 - (d) Strike near side to break loose from rafters and pull far side toward you with roof hook
- 14. Pitched roof, shingle-covered
 - a. Cut few inches (mm) below peak on leeward side
 - b. Always cut exhaust openings at or very near highest point on roof when possible
 - c. Work from roof ladder with hooks attached to ridge line
 - d. Work from aerial platform on extremely steep roofs
- 15. Pitched roof, slate or tile-covered
 - a. May be attached to solid sheathing or battens with spaces between
 - Open by removing individual pieces or using sledgehammer to smash slate and tile pieces
 - c. For solid sub roof Cut hole in manner for pitched roofs
 - d. Hole may not be needed in battens if enough space between for ventilation

16. Arched roofs

- a. Same procedure as flat or pitched Except no ridge to hook ladder
- b. Curvature prevents ladder from laying flat
- c. Before proceeding Make kerf cut to locate arches, observe truss space, and determine fire involvement



d. Walk on trusses, other strong points only

17. Metal roofs

- a. Thin metal can be sliced open with axe, carbide tip chain saw, rotary saw and peeled back
- b. Thick metal can be opened by metal cutting tool, power saw with metal cutting blades
- c. Industrial buildings Easier, faster to open skylights, monitors, and scuttle hatches
- d. Older buildings
 - i. May be large pieces of sheet metal laid over skip sheathing
 - ii. Open with power saw, axe, and large sheetmetal cutter

18. Defensive ventilation methods

- a. Trench cut
 - i. Strictly defensive
 - ii. NOT to be confused or used as offensive vertical ventilation
 - iii. Used to create fire break to stop fire spread in common attic or large structures
 - iv. Can be time consuming and physically taxing on personnel
 - v. Works well in large buildings with common cockloft or attic
- IC decides on defensive stance if fire too great to extinguish – Will abandon efforts to save building
- c. To make trench cut Opening must be created
 - i. At least 30 feet (9.1 m) ahead of advancing fire,
 - ii. Only after offensive vertical ventilation opening made Allows
 - (a) Heat and to smoke escape
 - (b) Trench completion before fire front reaches that point
 - iii. If offensive opening not made





- (a) Fire quickly drawn to and burns past unfinished trench
- (b) Continues to spread through building while endangering firefighters on roof
- d. Created by
 - i. Making two parallel cuts extending from one exterior wall to other
 - ii. Removing roof material between cuts
 - iii. Pushing ceiling material down
 - iv. Distance between cuts
 - (a) Large enough to prevent fire burning past opening
 - (b) Small enough to not compromise roof integrity
 - (c) Cut of 3 to 4 feet (0.9 to 1.2 m) should be sufficient
- e. Improper trench cut
 - i. Places firefighters in dangerous position Working ahead of fire
 - ii. May cause fire to spread more rapidly and potentially destroy entire structure

Review Question: What are the types of vertical ventilation? *See pages 751-759 of the textbook for answers.*

- f. All members must
 - i. Plan ahead
 - ii. Establish communications between roof ventilation team and IC
 - iii. Maintain good communications
 - iv. Be aware of the dangers
 - v. Have clear understanding of objective
 - vi. Have charged hoseline present
 - vii. Wear full PPE and SCBA
 - viii. Have two means of escape from roof that are remote from each other and do not include crossing over cut





WARNING

- ix. Assign roof safety officer to observe conditions
- x. Cut small inspection holes a few feet from trench on both fire and safe working side
- 19. Precautions against upsetting established vertical ventilation
 - a. Factors that can reduce effectiveness
 - i. Improper use of mechanical ventilation
 - ii. Indiscriminant window breaking
 - iii. Fire streams directed at ventilation openings
 - iv. Explosions
 - v. Burn-through of roof, floor, or wall
 - vi. Additional openings between attack team, upper opening
 - vii. Improper location of vertical ventilation opening
 - b. Not solution to all ventilation problems
 - i. May be impractical or impossible
 - ii. Use other strategies when necessary

Warning! Do not direct a fire stream into a ventilation opening during offensive interior operations.

Review Question: What differences are there between horizontal and vertical ventilation? *See pages 742-759 of the textbook for answers.*

pp. 760



Objective 8 — Recognize other types of ventilation situations.

- G. Other Types of Ventilation Situations
 - 1. Basement fires
 - a. Heat and smoke quickly spreads upward into building unless vents installed
 - b. Access
 - i. Difficult without effective ventilation

- ii. Must descend through rising heat and smoke to get to seat of fire
- iii. May be through interior or exterior stairs, exterior windows, and hoistways
- iv. Outside entrances may be blocked or secured
- c. Ventilation accomplished several ways
 - i. Horizontal ventilation effective if groundlevel windows or below ground-level window wells available
 - ii. Interior vertical ventilation used if no groundlevel windows available
 - Stairwells, hoistway shafts used to evacuate heat, smoke – Use only if there is means to expel into atmosphere, and not endanger other building portions
 - iv. Last resort Cut opening in floor near ground-level door or window; force heat, and smoke from opening through exterior opening using fans
- 2. Fires in windowless buildings
 - a. Complicate operations
 - b. Cause delays when creating openings
 - c. Problems vary depending on
 - i. Size
 - ii. Occupancy
 - iii. Configuration
 - iv. Construction materials
 - d. Usually requires mechanical ventilation for smoke removal
 - Can clear smoke through HVAC systems if designed to do so – If not may cause spread of heat, fire
 - ii. HVAC systems should be brought under fire department control prior to fire operations
 - Allow systems to work if designed to contain combustion products, operating properly—if not, IC notified, and steps are taken to control manually
- 3. High-rise fires





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- a. Buildings may contain
 - i. Hospitals, hotels, apartments, and offices
 - ii. More occupants Higher life safety considerations
- b. Tactical ventilation must be carefully coordinated
- c. Personnel required often four to six times greater than typical low-rise building
- d. Fire, smoke, and toxic gases can spread rapidly through pipe shafts, stairways, elevator shafts, unprotected ducts, other vertical or horizontal openings
 - i. Openings contribute to stack effect
 - ii. Creating upward draft, interfering with evacuation and ventilation
- e. Horizontal smoke spread
 - i. Heated smoke, fire gases travel upward until reaching top of building or cooling to temperature of surrounding air
 - ii. When equalization occurs gases stop rising; will spread horizontally and stratify
- f. Hot gas layer development
 - i. Layers may collect on floors below top floor
 - ii. Additional heat and smoke forces layers to expand, move upward to building top floor
 - iii. May occur when vertical exhaust opening not large enough
- g. Tactical vertical ventilation must be considered during preincident planning
 - i. Usually must be accomplished horizontally with mechanical ventilation, building's HVAC systems

Instructor Note: Discuss with students the tactical ventilation example for high-rise buildings on pp. 762 of textbook. Point out how the different tactics used help address the problems inherent in stratified smoke.

ii. Many buildings, only one stairwell penetrates roof

- (a) Stairwell can be used like a chimney to ventilate smoke, heat, and fire gases from various floors
- (b) Another stairwell used as escape route for occupants
- iii. During a fire, doors on uninvolved floors must be controlled so occupants do not accidentally enter ventilation stairwell as they are evacuating
 - (a) Before doors on fire floors opened and stairwell ventilated, door leading to roof must be blocked open or removed from its hinges
 - (b) Preventing door at top of shaft from closing ensures it cannot compromise established ventilation operations
- iv. When ventilating top of a stairwell you are drawing the smoke and heat to you or anyone else in stairwell between fire floor and roof
- v. When enclosed secondary stairwell used for evacuating occupants, PPV fans should be located at bottom of floor to pressurize stairwell, and keep smoke from entering
- Ventilation fans may be built into top of stairwell to assist
 - i. Fans draw smoke from fire floor to top when activated
 - ii. Technique may make fire suppression team entry on fire floor from this stairwell difficult
 - iii. May need to pressurize stairwells with PPV fans to confine smoke

Note: Under some conditions, elevator shafts that penetrate the roof may be used for ventilation.



WARNING! Do not use stairwells or elevator shafts simultaneously for both evacuation and ventilation.

Fire Protection Publications Oklahoma State University **Review Question:** What other types of ventilation situations might firefighters encounter? *See pages 760-763 of the textbook for answers.*

II. EFFECTS OF BUILDING SYSTEMS ON TACTICAL VENTILATION

Objective 9 — Explain the effects of building systems on tactical ventilation.

A. Effects of Building Systems on Tactical Ventilation

- Modern buildings have HVAC systems Can contribute to spread of smoke, fire, and toxic gases
- 2. Systems usually controlled from panel in maintenance, and operations center in basement or at ground level
 - a. Control panel includes
 - i. Building duct system diagram
 - ii. Information on smoke detection and fire suppression systems built into HVAC ductwork – Designed shut system down automatically when smoke or fire detected in ducts
 - Firefighters should be familiar with location, operation of controls to shut down HVAC system
- 3. Restoring HVAC system to operation responsibility of building engineer or maintenance superintendent
- 4. Ductwork may create additional fire damage
 - a. Through heat conduction through metal
 - b. Check combustibles adjacent to ductwork for possible fires created by conduction
- 5. Built-in smoke control systems



pp. 763-764



Fire Protection Publications Oklahoma State University

- a. Designed to confine fire to smallest area possible by compartmentalizing building when smoke or fire is detected
- b. Often used in high-rises, shopping malls, and buildings with open atria
- c. Methods of compartmentalizing structure Automatic closing of doors, partitions, windows, and HVAC systems
- 6. Smoke control system may include system diagram in same location as control panel
 - a. Panel should indicate where alarm originated, which automatic closers activated
 - b. Should only be operated by building engineers or maintenance superintendents
 - c. Incorrect use can cause severe damage, create more hazardous conditions



WARNING! Do not attempt to operate building systems that assist in ventilation.

Review Question: How can a built-in heating ventilation and air conditioning (HVAC) system affect tactical ventilation? *See pages 763-764 of the textbook for answers.*

III. SKILLS

pp. 765	Objective 10 — Ventilate using mechanical negative pressure in a window.
рр. 766	Objective 11 — Ventilate using mechanical negative pressure in a doorway.
рр. 767	Objective 12 — Ventilate using mechanical positive pressure.
рр. 768	Objective 13 — Perform horizontal hydraulic ventilation.
рр. 769	Objective 14 — Demonstrate the procedure for sounding a roof.

p. 770	Objective 15 — Ventilate using a rotary saw to cut an opening
p. 771	Objective 16 — Ventilate using an axe to cut an opening.
рр. 772-774	Objective 17 — Demonstrate the procedure for opening a flat roof.
рр. 775-776	Objective 18 — Perform the steps for opening pitched roofs.
рр. 777-778	Objective 19 — Demonstrate the procedure for making a trench cut using a rotary saw.

IV. SUMMARY AND REVIEW



A. Chapter Summary

- 1. Tactical ventilation of a burning building allows heat, smoke, and fire gases to escape to the atmosphere and also draws fresh air into the building.
- 2. Properly applied tactical ventilation allows firefighters to see better, locate victims more easily, and find the seat of the fire sooner.
- 3. Tactical ventilation limits fire spread and channels heat and smoke away from trapped victims; but must be correctly coordinated.
- 4. Firefighters must understand fire behavior, know various ventilation methods, and have knowledge of roof construction and know how to create exhaust openings in all types of roofs that have a variety of openings in order to perform ventilation correctly.

B. Review Questions

- 1. What are the reasons for tactical ventilation? *(pp. 732-733)*
- 2. What considerations will affect the decision to ventilate? (pp. 734-742)
- 3. What are the basic means used to accomplish ventilation? (*pp.* 742-744)
- 4. How do smoke, air flow, heat, and flame impact fire behavior in a structure? *(pp. 737-738)*
- 5. What differences are there between horizontal and vertical ventilation? (*pp. 744-760*)
- 6. How do the advantages and disadvantages of natural, mechanical, and hydraulic ventilation compare to one another? (*pp. 749-751*)
- 7. What are the main types of horizontal ventilation? (*pp.* 744-751)
- 8. What are the types of vertical ventilation? (*pp.* 751-756)
- 9. What other types of ventilation situations might firefighters encounter? (*pp. 760-763*)
- 10. How can a built-in heating ventilation and air conditioning (HVAC) system affect tactical ventilation? (*p. 761*)

Chapter 14 Water Supply

Lesson Goal

After completing this lesson, the student shall be able to discuss the various components of water supply systems, including fire hydrants. The student will also be able to describe alternative water supply sources and methods used for rural water supply operations.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain the ways water supply system components are used by firefighters. [NFPA[®] 1001, 5.3.15]
- 2. Describe types of fire hydrants and hydrant markings. [NFPA® 1001, 5.3.15]
- 3. Explain fire hydrant operation and inspection considerations. [NFPA[®] 1001, 5.3.15]
- 4. Explain alternative water supply sources and methods of access. [NFPA[®] 1001, 5.3.15]
- 5. Describe methods used for rural water supply operations. [NFPA[®] 1001, 5.3.15]
- 6. Operate a hydrant. [*NFPA*[®] 1001, 5.3.15]
- 7. Make soft-sleeve and hard-suction hydrant connections. [NFPA[®] 1001, 5.3.15]
- 8. Connect and place a hard-suction hose for drafting from a static water source. [$NFPA^{@}$ 1001, 5.3.15]
- 9. Deploy a portable water tank. [NFPA[®] 1001, 5.3.15]

Instructor Information

This is the lesson covering water supply. This lesson describes the components of a water supply system, and types, marking, operation, and inspection of fire hydrants. The lesson also covers alternative water supplies, and rural water supply operations.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

FireFighter I



Water Supply

Chanter 14
This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

WATER SUPPLY SYSTEM COMPONENTS

pp. 784-793

Objective 1 — Explain the ways water supply system components are used by firefighters.

Α. Types of Water Supply Systems

- 1. Public Function of local government
- 2. Private
 - a. May provide water under contract to municipality, region, or single property
 - b. May take variety of forms, including industrial facilities
 - c. May be public supply distribution system separated from private system
 - d. May serve particular area such as residential subdivision
- 3. Designs may vary from region to region

Water Supply Sources Β.

- 1. Natural freshwater sources
 - a. Wells
 - b. Springs
 - c. Rivers
 - d. Lakes
 - e. Ponds
- 2. Ocean
 - a. May be used, but is 220 times saltier than freshwater
 - b. Also contains other impurities
- 3. Amount of water needed for domestic use and fire protection
 - a. Calculated based on history of consumption and estimates of anticipated needs
 - b. Averages and maximum daily water consumption tracked



THE AMOUNT OF WATER NEEDED FROM A SUPPLY SOURCE CONSIDERS SEVERAL FACTORS













c. Domestic needs added to anticipated fire flow requirements needed for fire protection within jurisdiction's boundaries

d. To be considered adequate, a system must be capable of supplying the water needed for fire protection in addition to the domestic requirement

C. Water Treatment or Processing Facilities

- 1. Process water to remove impurities and minerals that can be harmful to humans, animals, and plants
- 2. Use for fire fighting operations may be limited by several situations
 - a. Mechanical breakdown
 - b. Natural disaster
 - c. Loss of power supply
 - d. Fire

D. Means of Moving Water

- Required to move water from original source to treatment facilities and then on to distribution/use point
- 2. Gravity systems
 - a. Deliver water from source or treatment plant to distribution system without pumping equipment
 - b. Create elevation pressure through difference in height of water source and point of use
 - c. Adequate only when primary water source is located more than 100 feet (30 m) higher than highest point in water distribution system
 - d. Most common examples Those supplied from alpine lake or mountain reservoir that supplies water to consumers below
- 3. Direct pumping systems
 - a. Place pump near water source or treatment plant to create required pressure

- b. Most found in agricultural and industrial settings
- c. One or more pumps draw water from primary source and transport to point of use
- d. Disadvantages
 - i. Total dependence on pumps
 - ii. Dependence on electricity to run pumps
- e. Require duplicate pumps and piping to ensure system reliability
- 4. Combination systems
 - a. Used by most communities
 - Consist of both gravity tanks and direct pumping process to provide adequate pressure
 - c. Water is pumped into distribution system and elevated storage tanks
 - d. When consumption demand is greater than rate at which water is pumped, water flows from storage tanks into distribution system
 - e. When consumption demand is less, water is pumped into storage tanks
 - f. Found at many industrial facilities; may be available to fire department in emergency

Review Question: What are the three main means of moving water used by firefighters? *See pages 786-789 of the textbook for answers.*

E. Water Distribution and Storage Systems

- 1. Piping
 - a. Determines ability of water system to deliver sufficient quantity of water at adequate pressure
 - b. Often referred to as water mains
 - c. Generally made of cast iron, ductile iron, asbestos cement, steel, polyvinyl chloride (PVC) plastic, or concrete
 - d. Water flowing through piping creates friction that may reduce water pressure





- e. Internal surface offers resistance to water flow
- f. Grid Interlocking network of water mains that compose water distribution system
- g. Primary feeders
 - i. Large pipes with relatively widespread spacing
 - ii. Convey large quantities of water to various points in distribution system and supply smaller secondary feeder mains
 - iii. Can be very large, ranging from 16 inches (400 mm) to 72 inches (1 825 mm) in diameter or greater
- h. Secondary feeders
 - i. Intermediate pipes that interconnect with primary feeder lines to create grid
 - ii. 12 to 14 inches (300 mm to 350 mm) in diameter
 - iii. May include control valves to isolate
- i. Distributors
 - i. Small water mains
 - ii. 6 to 8 inches (150 mm to 200 mm) in diameter
 - iii. Serve individual fire hydrants and commercial and residential consumers
 - iv. May form intermediate grid between secondary feeders
 - v. May be dead-end lines with hydrant or supplied property at end of line
- j. Two or more primary feeders should run from source of supply to high-risk and industrial districts of community along separate routes
- Secondary feeders should provide water from primary feeders along two directions to any end point
- I. Design
 - i. Generally using computer programs and hydraulic calculations that ensure constant pressure and quantity throughout system
 - ii. Grid or loop Provides constant pressure or flow when pipes or grid must be repaired

- iii. High demand in one area does not reduce water flow in other areas
- iv. Dead-end lines may exist but have disadvantages
- m. Adequate quantities of water
 - i. Depends on capacity of system's network of pipes
 - 8-inch (200 mm) pipe is often minimum size used; some communities allow 6-inch (150 mm) in residential subdivisions
- n. Access to water supply system
 - i. Made through connections to piping system
 - ii. May be through waterflow control valves and flow meters at point that customers gain water from system
 - iii. May be through fire hydrants used for fire protection
- 2. Storage tanks
 - a. May be located throughout system to create pressure through gravity and ensure constant pressure
 - b. Usually constructed of steel or concrete
 - c. May be located on high towers or at ground level on hilltops
 - d. Higher the tank, more elevation head pressure generated
 - e. Range from 5,000 gallons (20 000 L) to over a million gallons (greater than 4 000 000 L)
- 3. Isolation and control valves
 - a. Interrupt water flow to
 - i. Individual hydrants or properties
 - ii. Distribution lines
 - iii. Secondary feeders
 - iv. Primary feeders
 - v. Entire water systems
 - b. Most constructed of brass, steel, or cast iron
 - c. Isolation valves
 - i. May also be known as stop or shutoff valves
 - ii. Either gate valves or butterfly valves





- iii. Used to isolate sections for maintenance and repair, to replace hydrants, or to make new connections to the system
- iv. Location is intended to disrupt minimum number of customers while system is down
- v. Maximum lengths for spacing should be 500 feet (150 m) in high-value districts and 800 feet (240 m) in other areas as recommended by Commercial Risk Services, Inc.

NOTE: Commercial Risk Services, Inc. is a subsidiary of the Insurance Services Office (ISO) that conducts property rating systems to help insurance companies develop accurate premiums.

- vi. Should be tested at least once a year to ensure good working condition; usually performed by municipal water department
- vii. Generally located on municipal easement and below ground
- viii. Usually marked with word *Water* or name of municipality or jurisdiction
- ix. Directions for use
 - (a) Remove cover to access non-indicating type valve
 - (b) Insert water shutoff key into opening to turn valve stem 90° to direction of flow to shut off water
 - (c) Open valve by rotating stem or operating nut to left or counterclockwise
- x. Usually indicating-type for private systems
 - (a) Indicating valve shows whether gate valve seat is open, closed, or partially closed
 - (b) Post indicator valve (PIV) Hollow metal post that houses valve stem; plate attached to valve stem has words OPEN and SHUT
 - (c) Outside stem and yoke (OS&Y) Has yoke on outside with threaded stem that opens or closes gate inside valve; threaded portion of stem is visible when valve is open and not visible when valve is closed



- d. Control valves
 - Located between public water supply distribution systems and private water supply distribution systems
 - ii. Typical types
 - (a) Pressure-reducing
 - (b) Pressure-sustaining
 - (c) Pressure-relief valves
 - (d) Flow-control valves
 - (e) Throttling valves
 - (f) Float valves
 - (g) Check valves
 - iii. In addition to these valves, a water flowmeter and backflow preventer will be installed on the water supply line
 - (a) Water flowmeter determines quantity of water that facility is using for billing purposes
 - (b) Backflow preventer prohibits any water from flowing back into public water system
- 4. Fire hydrant locations
 - a. Found in urban, suburban, and some rural areas
 - b. Served by both public and private water supply systems
 - c. Located along all portions of water distribution system
 - i. Generally connected at specified intervals by 6-inch (150 mm) connecting pipes
 - ii. Generally determined by water department personnel
 - iii. Should not be spaced more than 300 feet (100 m) apart in high-value districts
 - iv. Should be located at every other intersection so that every building on a given street is within one block of a hydrant





- v. Additional intermediate hydrants may be required where distances between intersections exceed 350 to 400 feet (105 m to 120 m)
- d. Factors affecting location and spacing
 - i. Types of building construction
 - ii. Types of occupancies
 - iii. Building densities
 - iv. Sizes of water mains
 - v. Required fire flows for occupancies within given area
- e. Friction loss
 - i. Can reduce pressure in distribution system
 - ii. May be caused by encrustations of minerals and sediment that accumulate over period of years
 - iii. Reduces volume and pressure of water available from hydrants
- f. Locations affecting water volume and pressure
 - Dead-end hydrant Hydrant that receives water from only one direction; has limited water supply
 - ii. Circulating hydrant Receive water from more than one direction

Review Question: How do the main components of water distribution and storage systems operate? *See pages 789-793 of the textbook for answers.*

II. FIRE HYDRANTS

pp. 793

Objective 2 — Describe types of fire hydrants and hydrant markings.

A. Fire Hydrants

- 1. Most dependable water source for firefighters
- 2. Can provide consistent volume of water under constant pressure



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	Construction materials		
	Two components to be standard	- in loss are large (Lar GL Index (20 non ar 20 not) ander - Tan base anter marten in 20 herb (El not) couplings	
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- 3. Can fail; failures or reduction in water supply or pressure can result from
 - a. Damaged hydrant valves and connections
 - b. Broken water mains
 - c. Greater demand than the system can provide
 - d. Hydrants located on dead end water mains
 - e. Closed isolation valves
 - f. Restricted mains caused by sediment and mineral deposits
 - g. Pipes or hydrants that are frozen
- 4. If fail, require use of alternate water supply
- 5. Types
 - a. Construction materials
 - i. Most made of cast iron
 - ii. Internal working parts made of bronze
 - iii. Valve facings may be made of rubber, leather, or composite materials
 - b. Outlets considered standard if they contain two components
 - i. At least one large (4 or 4½ inches [100 mm or 115 mm]) outlet often referred to as the pumper outlet nozzle or steamer connection
 - ii. Two hose outlet nozzles for 2½-inch (65 mm) couplings
 - c. Specifications
 - Require a 5-inch (125 mm) valve opening for standard three-way hydrants and 6-inch (150 mm) connection to water main
 - Male threads on discharge outlets must conform to those used by local fire department
 - Regulations for number of threads per inch and outside diameter of male thread set by NFPA[®] 1963, Standard for Fire Hose Connections
 - d. Dry-barrel hydrants
 - i. Designed for use in climates that have freezing temperatures

- ii. Main control valve is located at base or foot of hydrant below frost line with isolation valve located on distribution line
- iii. Stem nut used to open and close control valve is located on top of hydrant
- iv. Water only allowed into hydrant when stem nut is operated
- v. Any water remaining drains through small valve that opens at bottom of hydrant when main valve approaches closed position
- vi. Valve is opened by turning hydrant wrench counterclockwise; valve is closed by turning wrench clockwise
- e. Wet-barrel hydrants
 - i. Designed to have water inside at all times
 - ii. Usually installed in warmer climates where prolonged periods of subfreezing weather are uncommon
 - iii. Horizontal compression valves usually at each outlet
 - iv. May have another control valve in top of hydrant to control water flow to all outlets

Review Question: What are the main types of fire hydrants? *See pages 793-795 of the textbook for answers.*

- 6. Fire hydrant markings
 - a. Can be used to designate flow capacity
 - b. Designate according to color; vary in different jurisdictions
 - c. Rate of flow from individual hydrants varies for several reasons
 - i. Size of water main to which hydrant is connected
 - ii. Sedimentation and deposits within water mains
 - d. Colors of bonnets (tops) and discharge caps on public hydrants should be painted as required in NFPA[®] 291, *Recommended Practice for Fire Flow Testing and Marking* of *Hydrants*

Instructor Note: Refer students to Table 14.1 on page 796 of the textbook for a description of markings used to designate flow

Classed	fications and N	Table 14.1 farkings of M	unicipal Fire M	dranta
Excilization	fire from	Barral Salar	fop and Barris Exp Exten	-
Case AA.	1.500 gpm (5.400 Line) or prester	Onorm Nilow	22	200
Cash	1.00-1.40 ges.0.10- 14751/46	Occase Nature		100
Case B	(1 100-100 gans (1 100-11 feet	Ocore Miles	Crange	215
Chas C	500 gan (7 800 Citat) 17 bas	Occiae Nature	-	(NEW)

rates. Also point out the information box "Hydrant Flow Rates: SLIP" for an acronym that can be used to remember factors that affect hydrant flow rate.

Objective 3 — Explain fire hydrant operation and inspection considerations.

B. Fire Hydrant Operation

- 1. Should be inspected and operated at least twice a year
- 2. Necessary knowledge in order to
 - a. Provide water through hoses for fire suppression operations
 - b. Flow water from hydrant discharge openings to flush sediment
 - c. Perform periodic inspections
 - d. Ensure proper operation of valves and caps
 - e. Assist in flow tests
- 3. Operating wet-barrel hydrants
 - Ensure that valve is shut by placing hydrant wrench on operating stem and turning clockwise
 - b. Tighten discharge caps that will not be used and then remove cap from discharge outlet onto which you are going to attach hose
 - c. Check that discharge is free of debris or obstructions and flush the hydrant by flowing a small amount of water
 - d. Attach hose to discharge outlet and tighten coupling
 - e. Stand on opposite side of hydrant from open discharge outlet
 - f. Turn operating stem slowly counterclockwise until hydrant valve is completely open
 - g. Remove any kinks or bends from hose
- 4. Operating dry-barrel hydrants
 - a. Main valve is located underground



p. 796-799

- b. Barrel from top of stem down to main valve is empty
- c. When stem nut is turned counterclockwise, main valve moves downward allowing water to flow into hydrant
- d. As main valve moves downward, drain valve plate attached to step closes drain hole located near bottom of hydrant, but allows water to flow past into hydrant barrel
- e. When hydrant is shut down by slowly turning stem nut clockwise, main valve rises and shuts off flow of water into hydrant barrel; drain valve plate rises, opening drain hole
- f. Water remaining in hydrant barrel empties through drain hole into surrounding soil
- g. Precautions
 - i. If not opened fully, drain may be left partially open
 - ii. Resulting flow can cause erosion of soil around base of hydrant
- h. When shut down, should be verified that water left in barrel is draining out; can be tested by taking the following steps
 - i. Close the main valve by turning the stem nut clockwise until resistance is felt; then turn it a quarter-turn counterclockwise
 - ii. Cap all discharges except one
 - iii. Place the palm of one hand over the open discharge
 - iv. If hydrant is draining, slight vacuum should be felt by pulling palm toward discharge; if vacuum is not felt, repeat process
- i. If hydrant is not draining, drain hole is probably plugged; notify water authority
- j. If hydrant is not draining in winter, it must be pumped until empty
- If water is seen bubbling up out of ground at base when hydrant is fully open, broken component is allowing water to get past drain opening; report to water authority
- 5. All hydrants must be opened and closed slowly to prevent damage to fire hose, hydrants, and

other equipment, or possible injury to firefighters

- a. Opening too fast may cause fire hose to flail violently
- b. Closing too fast may cause sudden increase in pressure called water hammer which can damage system piping or appliances

C. Fire Hydrant Inspection – Potential Problems

- Obstructions, such as sign posts, utility poles, weeds, bushes, or fences that might interfere with pumper-to-hydrant connections or with opening hydrant valve
- 2. Outlets that face wrong direction for pumper-tohydrant connections
- 3. Insufficient clearance between outlets and ground
- 4. Damage to hydrant
- 5. Rusting or corrosion
- 6. Outlet caps missing or stuck in place with paint
- 7. Stem or operating nut that cannot be turned or turns freely with no visible result
- 8. Obstructions inside hydrant outlets
- 9. Damp ground surrounding hydrant or erosion indicating drain valve leak
- 10. Hydrants painted by property owners

Review Question: How does the operation of a dry-barrel hydrant compare to that of a wet-barrel hydrant? *See pages 795 of the textbook for answers.*



III. ALTERNATIVE WATER SUPPLIES

pp. 799-800

Objective 4 — Explain alternative water supply sources and methods of access.

A. Alternative Water Supplies

- 1. Examples
 - a. Adjacent private water systems
 - b. Available lakes, ponds, rivers, and the ocean
 - c. Swimming pools
 - d. Farm stock tanks
 - e. Rainwater collection cisterns and detention ponds
- 2. Almost any static source of water can be used if
 - a. Sufficient in quantity
 - b. Not contaminated to point of creating a health hazard or damaging fire pump
 - c. Depth of water source is important consideration
- 3. In order to access, will be necessary to establish drafting operation
 - a. All hard-suction hoses should have strainers attached to end
 - b. Hose should be positioned and supported so strainer does not rest on or near bottom of source
 - c. Requires minimum of 24 inches (600 mm) of water above and below hard intake strainer; silt and debris can clog strainers, seize or damage pumps, and small sand and rocks can enter the attack lines and clog fog nozzles
 - Floating strainers can draft water from sources as shallow as 24 inches (600 mm) deep
- 4. May include drafting hydrants to increase water supply available for fire fighting





- a. Usually constructed of steel or PVC pipe with strainers at water source and steamer ports to connect to pumper
- b. Designed to supply at least 1,000 gpm (4 000 L/min)
- 5. Should be identified, marked, and recorded by fire department during preincident planning

Review Question: When should alternative water supplies be identified? *See page 800 of the textbook for answers.*

IV. RURAL WATER SUPPLY OPERATIONS

pp. 800-804



Objective 5 — Describe methods used for rural water supply operations.

A. Rural Water Supply Operations

- 1. Necessary in areas lacking public water distribution systems or with systems of inadequate volume and pressure
- 2. Require preincident planning and frequent practice

B. Water Shuttles

- 1. Involve hauling water from supply source (fill site) to incident scene
- 2. Water is transferred to attack pumper's tank or to portable tanks (dump sites) from which water may be drawn to fight fire
- Recommended for distances greater than ½ mile (0.8 km) from nearest fire hydrant or water source or greater than fire department's capability of laying supply hoselines
- 4. Fast-fill and fast-dump capabilities are critical
- 5. Require coordination between officers at fill and dump sites equipped with radios
- 6. Key components
 - a. Dump site at fire

- b. Fill site at water source
- c. Mobile water supply apparatus to haul water from fill site to dump site
- 7. Dump site
 - a. Generally located near actual fire or incident
 - b. Usually consists of one or more portable tanks into which mobile water supply apparatus deposit water before returning to fill site
- 8. Portable tanks
 - a. Have capacities beginning at 1,000 gallons (4 000 L)
 - b. Types
 - i. Collapsible or folding style that uses square metal frame and synthetic or canvas duck liner
 - Round, self-supporting synthetic tank with ii. floating collar that rises as tank is filled
 - c. Before opening, spread salvage cover or heavy tarp to protect liner
 - d. Should be as level as possible to ensure maximum capacity
 - e. Should be positioned in location that allows easy access from multiple directions but does not inhibit access of other apparatus
 - Will ideally be set up so that more than one f. mobile water supply apparatus can off-load at same time: ensure that drain is located on down-hill side of tank and away from drafting tank
 - g. May have several set up at once
 - i. One for attack pumper while mobile water supply apparatus dump into other tanks
 - Can be interconnected through drain fittings ii.
 - iii. Can use jet siphon devices to transfer water from one tank to another
- 9. Water supply volume
 - a. Can be calculated based upon complete round trip including fill time, travel time, and dump time



WATER SUPPLY VOLUME IS CALCULATED ON SEVERAL VARIABLES









- b. Total gallons (liters) carried in each apparatus divided by total time will provide gallons per minute (L/min) being supplied
- 10. Methods for unloading water supply apparatus
 - a. Gravity dumping through large (10- or 12inch [250 mm or 300 mm]) dump valves
 - b. Jet-assist dumps that increase flow rate
 - c. Apparatus-mounted pumps that off-load water
 - d. Combination of these methods
- 11. NFPA[®] 1901, *Standard for Automotive Fire Apparatus* requires that mobile water supply apparatus on level ground be capable of dumping or filling at rates of at least 1,000 gpm (4 000 L/min)
- 12. To fill mobile water supply apparatus quickly, use
 - a. Best fill site or hydrant available
 - b. Large hoselines
 - c. Multiple hoselines
 - d. If necessary, a pumper for adequate flow
- 13. Self-filling vacuum mobile water supply apparatus
 - a. Use has increased in recent years
 - Vacuum pump on apparatus permits rapid water filling and discharge and reduces number of personnel required for operation
 - c. Eliminates requirement to have pumper at fill site for drafting

C. Relay Pumping

- 1. Can be used in situations where the water source is close enough to the fire scene
- 2. Factors to consider regarding establishment
 - a. Water supply must be capable of maintaining desired volume of water required for duration of incident
 - b. Relay must be established quickly enough to be worthwhile

- Number of pumpers needed and distance between pumpers is determined by several factors
 - a. Required volume of water
 - b. Distance between water source and fire scene
 - c. Size of supply hose available
 - d. Amount of hose available
 - e. Pumper capacities
- 4. Apparatus with greatest pumping capacity should be located at water source
- Large-diameter supply hose or multiple hoselines increase distance and volume that relay can supply because of reduced friction loss
- 6. Best way to prepare is to plan in advance and practice often

Review Question: What are the common operations for accessing rural water supplies? *See pages 800-804 of the textbook for answers.*

V. SKILLS

p. 805	Objective 6 — Operate a hydrant.
pp. 806-808	Objective 7 — Make soft-sleeve and hard-suction hydrant connections.
p. 809	Objective 8 — Connect and place a hard-suction hose for drafting from a static water source.
p. 810	Objective 9 — Deploy a portable water tank.

VI. SUMMARY AND REVIEW

SUMMARY
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A. Chapter Summary

- Because water is the primary fire extinguishing agent used by firefighters, and because fires often occur considerable distances from major water sources, fire departments must develop ways to transport the available water from its source to the place it is needed.
- 2. Firefighters must be familiar with the water supply systems in their response areas.
- 3. They must know about water sources, pumping systems, gravity systems, and the system of underground water mains used to distribute the water.
- 4. They must also know how to inspect, maintain, and operate the fire hydrants in their jurisdictions.

B. Review Questions

- 1. What are the three main means of moving water used by firefighters? (*pp.* 786-789)
- 2. How do the main components of water distribution and storage systems operate? (pp. 789-793)
- 3. What are the main types of fire hydrants? (pp. 793-795)
- 4. How does the operation of a dry-barrel hydrant compare to that of a wet-barrel hydrant? (*p.* 795)
- 5. When should alternative water supplies be identified? (pp. 799-800)
- 6. What are the common operations for accessing rural water supplies? (*pp. 800-803*)

Chapter 15 Fire Hose

_	
	Fire Hose
	Module 1
	Chapter 15
6	

Lesson Goal

After completing this lesson, the student shall be able to describe fire hose characteristics, describe inspection and maintenance procedures, and explain various hose rolls, loads, and finishes. In addition, students will be able to perform various hose loads and advance hoselines.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain basic fire hose characteristics. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 2. Describe different causes of and prevention methods for hose damage. [NFPA[®] 1001, 5.5.2]
- 3. Identify basic inspection, care, and maintenance methods for fire hose. [NFPA[®] 1001, 5.5.2]
- 4. Compare various uses for hose appliances and tools. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 5. Describe basic hose rolls. [NFPA[®] 1001, 5.5.2]
- 6. Explain basic hose loads and finishes. [NFPA[®] 1001, 5.5.2]
- Compare various methods to make preconnected hose loads for attack lines. [NFPA[®] 1001, 5.5.2]
- 8. Explain the methods used for supply hose lays. [NFPA[®] 1001, 5.3.8, 5.3.15]
- 9. Recognize different methods for handling hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 10. Describe methods for advancing hoselines in various ways. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 11. List the considerations that can impact operating attack hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 12. Couple and uncouple a hose. [NFPA[®] 1001, 5.3.10]
- 13. Inspect and maintain a fire hose. [NFPA[®] 1001, 5.5.2]
- 14. Make a straight hose roll. [NFPA[®] 1001, 5.5.2]
- 15. Make a donut hose roll. [NFPA[®] 1001, 5.5.2]
- 16. Make the flat hose load. [NFPA[®] 1001, 5.5.2]
- 17. Make the accordion hose load. [NFPA[®] 1001, 5.5.2]
- 18. Make the horseshoe hose load. [NFPA[®] 1001, 5.5.2]
- 19. Make a finish. [NFPA[®] 1001, 5.5.2]

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- 20. Make the preconnected flat hose load. [NFPA[®] 1001, 5.5.2]
- 21. Make the triple layer hose load. [NFPA[®] 1001, 5.5.2]
- 22. Make the minuteman hose load. [NFPA[®] 1001, 5.5.2]
- 23. Make a hydrant connection from a forward lay. [NFPA[®] 1001, 5.5.2]
- 24. Make the reverse hose lay. [NFPA[®] 1001, 5.5.2]
- 25. Advance a hose load. [NFPA[®] 1001, 5.3.10]
- 26. Deploy a wye-equipped hose during a reverse hose lay. [NFPA[®] 1001, 5.3.10]
- 27. Advance a charged hoseline using the working line drag method. [NFPA[®] 1001, 5.3.10]
- 28. Advance a line into a structure. [NFPA[®] 1001, 5.3.10]
- 29. Advance a line up and down an interior stairway. [NFPA[®] 1001, 5.3.10]
- 30. Connect to a stairway standpipe connection and advance an attack hoseline onto a floor. [NFPA[®] 1001, 5.3.10]
- 31. Advance an uncharged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 32. Advance a charged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 33. Operate a charged attack line from a ladder. [NFPA[®] 1001, 5.3.10]
- 34. Operate a small hoseline One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 35. Operate a large hoseline for exposure protection One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 36. Operate a large hoseline Two-firefighter method. [NFPA[®] 1001, 5.3.15]
- 37. Extend a hoseline. [NFPA[®] 1001, 5.3.10]
- 38. Replace a burst hoseline. [NFPA[®] 1001, 5.3.10]

Instructor Information

This is the lesson covering fire hose. This lesson describes the basic characteristics of fire hose. The lesson also covers cleaning, inspection, and maintenance of fire hose. In addition, the chapter covers a large number of hose rolls, loads, and finishes.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

I. FIRE HOSE CHARACTERISTICS

Α.

pp. 816-825

Objective 1 — Explain basic fire hose characteristics.

Fire Hose Characteristics



 Supply hose — Transports water from fire hydrant or other water supply to apparatus equipped with pump located at or near fire scene

- 2. Attack hose Transports water or other agents, at increased pressure
 - a. From pump-equipped apparatus to nozzle or nozzles
 - b. From pump-equipped apparatus to fire department connection (FDC) mounted on structure
 - c. From building standpipe to point water is applied to fire

B. Hose Construction

- To be reliable Must be constructed of best materials, used in appropriate manner, and maintained appropriately
- 2. Most is flexible, watertight, and has smooth rubber or neoprene lining covered by durable jacket
- 3. Manufactured in variety of configurations Most common
 - a. Single-jacket
 - b. Double-jacket
 - c. Rubber single-jacket
 - d. Hard-rubber or plastic noncollapsible

C. Hose Sizes

- 1. Diameter
 - a. Refers to internal diameter
 - b. Should not be less than advertised or labeled
 - c. Some can expand beyond actual manufactured internal diameter because of elastic qualities





- 2. Length
 - a. Manufactured in sections 50 or 100 feet (15 m or 30 m) lengths
 - b. Traditionally determined for convenience and ease of handling
 - c. Modern hose may be carried or maneuvered in larger sections because constructed of highstrength, lightweight synthetic materials that have same relative weight of traditional sections of hose
 - d. Suction supply hose (intake hose)
 - i. Used to connect pumper to hydrant or other water source
 - ii. Manufactured in minimum lengths specified in NFPA[®] 1901
 - e. Soft sleeve hose
 - i. Minimum 15 feet (4.6 m) in length
 - ii. Has two female or nonthreaded couplings
 - iii. Used to connect main pumper intake to pumper connection on fire hydrant
 - iv. Not rigid
 - v. Cannot be used for drafting
 - vi. Available in sizes from 21/2 to 6 inches (65 mm to 150 mm) in diameter
 - f. Hard suction hose
 - i. Generally constructed in 10 foot (3 m) long sections
 - ii. Designed for drafting water from static water supplies or connecting to fire hydrant
 - iii. Some constructed of rubberized, reinforced material
 - iv. Others made of heavy-duty corrugated plastic
 - v. Available in sizes ranging from 2½ to 6 inches (65 mm to 150 mm) in diameter
 - vi. Has same couplings as soft sleeve hose



Designed to	National Standards	Made of
Form continuous hoseline	NFPA [*] 1963	Durable, rustproof materials
Connect hoses to nottles, hydrants	Can share between departments	Various alloys
Connect to pumper connections and FDCs		



- Designed to connect hose sections to form continuous hoseline and to connect fire hoses to nozzles, hydrants, pumper connections, and FDCs
- 2. National standards
 - Design and construction specified by NFPA[®] 1963
 - Threaded Must meet dimensions required of American National Fire Hose Connection Screw Threads
 - c. Using fire hose with national standard threads means that fire departments that respond together can connect hose sections and supply sections of hose from adjacent departments
- 3. Made of durable, rust-proof materials designed to couple and uncouple quickly and with little effort
- 4. Materials used are generally alloys in various percentages of brass, aluminum, or magnesium
- 5. Categorized by the way manufactured
 - a. Cast
 - i. Very weak and only found on occupant-use fire hose
 - ii. Often crack if reattachment to hose is attempted
 - b. Extruded
 - i. Usually made of aluminum or aluminum alloy
 - ii. Lightweight and of high strength
 - iii. Somewhat stronger than cast couplings
 - c. Drop forged
 - i. Made of brass or other malleable metal
 - ii. Strongest and most expensive of three coupling types
- 6. Coupling and uncoupling
 - a. Simple procedures for connecting and disconnecting sections of hose with either threaded or nonthreaded couplings
 - b. Should be learned and practiced





- 7. Threaded couplings
 - a. Male/female parts
 - i. Male cut on exterior surface
 - ii. Female cut on interior surface
 - iii. Threads cut on free-turning ring called swivel
 - iv. Swivel permits connecting two sections of hose without twisting entire hose
 - v. Each section has male at one end and female at other
 - vi. Together, referred to as set
 - vii. Male considered one piece; female two-piece assembly

CAUTION: Connect couplings hand tight to avoid damage to the coupling and gasket.

- b. Other parts
 - i. Shank Portion of coupling that serves as point of attachment to hose
 - Higbee cut Flattened angle at end of threads on male and female couplings; prevents crossthreading
 - iii. Higbee indicator Indentation on exterior of coupling marks where Higbee cut begins
- c. Coarse; allow couplings to be connected quickly
- d. Some large coupling sizes made with ball bearings or roller bearings under swivel to ensure smooth operation
- e. Removable rubber gasket located inside base of female coupling ensures tight fit and reduces chance of water leaks
- f. Manufactured with either lugs or handles to aid in tightening and loosening connection
 - i. Located on shank of male and swivel of female
 - ii. Grasping points where firefighters can easily hold coupling when making and breaking connections
 - iii. May be made manually or with assistance of spanner wrench





- iv. Pin
 - (a) Usually found on couplings of older fire hose
 - (b) Resemble small pegs
 - (C) Not commonly ordered with new fire hose
 - (d) Tendency to catch when hose dragged over objects or deployed from hose bed
- v. Recessed
 - (a) Normally found on booster hose
 - (b) Simply shallow holes drilled into couplings
 - (C) Prevent abrasion that would occur if hose had protruding lugs and was wound onto reels
 - (d) Require pin-lug spanner wrench to tighten or loosen
- vi. Rocker
 - (a) Found on modern couplings
 - (b) Round shape prevents hose from catching on objects
 - (C) One on swivel is scalloped with shallow indentation to mark where Higbee cut begins
- vii. Handles or extended lugs
 - (a) Located on swivels of large intake supply or suction hose
 - (b) Can be grasped when manually tightened
 - (C) Can be loosened or tightened by using rubber mallet



- 8. Nonthreaded couplings
 - a. Connected with locks or cams rather than screw threads
 - Most are sexless, with no distinct male or female components – both couplings are identical
 - c. Some have male and female ends
 - d. Quarter-turn
 - i. Two hook-like lugs on each coupling
 - ii. Lugs extend past raised lip or ring on open end of coupling
 - iii. When couplings are mated, lug of one coupling slips over ring of opposite coupling and then rotates 90 degrees clockwise to lock
 - iv. Gasket on face of each coupling seals connection to prevent leakage
 - e. Storz
 - i. Most commonly found on large-diameter hose
 - ii. Joined and then rotated until locked in place to form connection
 - iii. Locking components consist of grooved lugs and inset rings built into face of each coupling swivel
 - iv. When mated, lugs of each coupling fit into recesses in opposing coupling ring and then slide into locking position behind ring with onethird-turn rotation
 - v. External lugs at rear of swivel provide leverage for connecting and disconnecting couplings
 - vi. On most, lugs align to give visual indicator of connected coupling
 - f. Advantages
 - i. Fire hose can be quickly connected
 - ii. No risk of cross-threading connection and damaging coupling
 - iii. Adapters not needed; hose can be deployed from hose bed regardless of load type

g. Disadvantages

- i. Hose can become uncoupled, often suddenly and violently, if complete connection has not been made
- ii. Hydrants require adapter to make connections with nonthreaded couplings
- Dirt and other large debris can become lodged inside coupling's grooves, giving impression that tight seal has been made when hose is not connected

Note: Although not widely seen, some fire and emergency service organizations that have adopted sexless couplings for their supply hose operations use permanent adapters installed on hydrants for fire hydrant connections.

Review Question: What are the three basic fire hose characteristics a firefighter must understand? *See pp. 816 of the textbook for answers.*

II. CAUSES AND PREVENTION OF FIRE HOSE DAMAGE

Objective 2 — Describe different causes of and

pp. 825-831



A. Mechanical Damage

prevention methods for hose damage.

- Occurs when contact with an object or surface causes slices, rips, and abrasions on the exterior covering, crushed or damaged couplings, and cracked inner linings
- 2. Prevention
 - a. Avoid laying or pulling hose over rough, sharp edges or objects
 - b. Protect hoses by using hose roller or placing a folded salvage cover over sharp edges
 - c. Clear window sills of broken glass fragments
 - d. Provide traffic control to prevent vehicles from driving over hose







- e. Use hose ramps or bridges to protect hose from vehicles running over it when traffic cannot be rerouted
- f. Open and close nozzles, valves, and hydrants slowly to limit excessive stress and prevent water hammer
- g. Provide chafing blocks to prevent abrasion to hose when it vibrates near the pumper
- h. Avoid excessive pump pressure on hoselines
- i. Deploy hoselines away from debris or clear debris from the path of hose during overhaul operations
- j. Change position of folds in hose when reloading on apparatus
- k. Clean hose before reloading it to prevent abrasions from dirt or grit

B. Thermal Damage

- 1. Can result from exposure to excess heat or cold temperatures
- 2. Can be caused by excessive heat exposure or direct flame contact, which can char, melt, or weaken outer jacket and dehydrate rubber lining
- 3. When hose is hung to dry in drying tower longer than necessary or in direct sunlight, can dehydrate inner linings
- 4. Prevention
 - a. Protect hose from exposure to excessive heat or fire when possible
 - b. Remove hose from any heated area as soon as it is dry
 - c. Use moderate temperature for mechanical drying
 - d. Keep the outside of woven-jacket fire hose dry when not in use
 - e. Run water through hose that has not been used for some time to keep liner soft
 - f. Avoid laying fire hose on hot pavement to dry

- g. Roll dry hose in straight roll for storage
- h. Prevent hose from coming in contact with, or being placed close to, vehicle exhaust systems
- i. Use hose bed covers on apparatus to shield hose from sun
- 5. Cold damage
 - a. Occurs when water on inside and/or outside of fire hose freezes
 - b. Fire departments in regions suffering severely cold temperatures must use special cold-resistant hose designed for use at temperatures down to
 -65°F (-54°C)
 - c. Allow water to flow through nozzle to prevent water from freezing inside hose during intermittent use at fires
 - d. Prevention
 - i. Maintain water flow in intake hose by circulating water from hydrant through fire pump, discharging it through drain-off hose that routes water down gutter or to place away from pumping apparatus
 - ii. Immediately drain and roll hose that is no longer needed for fire fighting
 - iii. Tighten all hose connections to prevent couplings from leaking and freezing
 - iv. Apply a manufacturer approved, cold-weather lubricant that contains an antifreeze agent on swivel and gasket portions of couplings
 - e. If fire hose becomes frozen to ice-covered surface
 - i. Melt ice with steam-generating device
 - ii. Chop hose loose with axes
 - iii. Leave hose until weather warms enough to melt ice
 - f. Guidelines for removing frozen hose
 - i. Make all cuts well away from hose when chopping hose out of ice in order to minimize chance of axe blade striking and damaging hose fabric



- ii. Avoid using exhaust manifold heat from pumping apparatus
- iii. Wait until hose is thawed before folding
- iv. If fire hose sections can be uncoupled, carefully load them onto flatbed vehicle and transport to location to be thawed and protected from damage
- v. Perform service test before placing thawed hose back in service

C. Organic Damage

- 1. Caused by mildew and mold
- 2. Caused when hose with woven-jacket of cotton or other natural fiber is stored wet
- 3. Can weaken the jacket which can lead to ruptures under pressure
- 4. Prevention
 - a. Remove all wet hose from apparatus after fire and replace with dry hose, or dry wet hose thoroughly before reloading on apparatus
 - b. Inspect, wash, and dry hose that has been contaminated
 - c. Remove, inspect, sweep, and reload hose if not been unloaded in past six months
 - d. Inspect and test hose annually and after possible damage or freezing
 - e. Ensure that cotton or cotton-blend fire hose is completely dry before storing or loading
 - f. Cover hose beds with water-repellent covers to keep hose loads dry during inclement weather
 - g. Inspect fire hose in storage racks and hose beds periodically
 - h. Remove and rotate hose periodically
 - i. Ventilate all areas where fire hose is kept
 - j. Wash hose immediately whenever mildew is discovered
 - i. Scrub cover jacket with very mild soap or bleach solution

- ii. Rinse well
- iii. Dry completely or to point recommended in manufacturer's instructions
- iv. Inspect hose section within few days for reappearance of mildew

D. Chemical Damage

- 1. Common examples
 - a. Exposure to petroleum products, paints, acids, or alkalis may weaken hose to point of bursting under pressure
 - i. Motor oil, found on most streets and highways, will penetrate woven outer cover and cause reaction that separates inner lining of hose
 - ii. Gasoline contact will react to separate inner lining of hose More severe reaction
 - b. Battery acid can destroy hose jacket fibers
 - c. Runoff water from fire may carry foreign materials that can cause chemical damage to fire hose
 - d. Water not drained completely from hose can form sulfuric acid
 - 2. Recommended cleaning practices after exposure
 - a. Avoid laying fire hose directly against curbs where oil, gasoline, and battery acid may accumulate or pool
 - i. Place hose 2 to 4 feet (0.6 m to 1.2 m) away from curb or gutter but not in vehicle travel lanes
 - ii. Move hose, if possible, onto sidewalk or into median to avoid vehicle and contamination damage
 - b. Avoid exposing fire hose to hazardous material spills
 - c. Avoid exposing fire hose to spills of foam concentrate
 - d. Scrub fire hose suspected of having contacted acid or other caustic chemical thoroughly with solution of bicarbonate of soda and water; remove hose from service and contact





manufacturer for further maintenance procedures

- e. Remove hose periodically from apparatus, wash with plain water, and dry thoroughly
- f. Test hose properly if any suspicion of damage
- g. Dispose of hose according to departmental SOP if exposed to hazardous materials and cannot be decontaminated

E. Corrosion

- Chemical process in which metal is attacked by some substance in environment and converted to unwanted compound that gradually weakens or destroys metal
- 2. Brass couplings
 - a. Highly resistant to corrosion
 - b. Over time, will corrode when in contact with moist organic material or earth
 - c. Should be cleaned to remove most surface corrosion; swivels and operating mechanisms should be lubricated
- 3. Aluminum couplings
 - a. Develop layer of corrosion that "seals" metal against further oxidation
 - b. Protective layer can be scratched or abraded during normal use

F. Age Deterioration

- Leaving hose in apparatus for long period of time can cause deterioration and cracking between folds
- 2. Prevention
 - a. Hose loads should be removed and replaced at least four times a year if not used
 - b. Reload loosely and fold hose in places not previously folded
- 3. May occur if left hanging in hose tower for excessive periods of time





- a. Remove hose from tower as soon as dry
- b. Change hose/peg contact point periodically

Instructor Note: Refer students to the information box titled "Care for Fire Hose" on page 831 of the textbook.

Review Question: How are thermal damage and corrosion in a hose similar or different? *See pp. 826-830 of the textbook for answers.*

III. INSPECTION, CARE, AND MAINTENANCE OF FIRE HOSE

pp. 831

Objective 3 — Identify basic inspection, care, and maintenance methods for fire hose.

- A. Inspection
 - 1. Schedule
 - a. Within 90 days before being placed in service for first time
 - b. At least annually after first use
 - c. After each use for visible soil or damage
 - 2. Should include check of couplings
 - 3. Deficiencies should be corrected or reported before storage or future service
 - a. Evidence of dirt or debris on hose jacket or couplings
 - b. Damage to hose jacket
 - c. Coupling loosened from hose
 - d. Damage to male and female threads
 - e. Obstructed operation of swivel
 - f. Absence of well-fitting gasket in swivel
- B. Washing Hose
 - 1. Method depends on type of hose





- a. Hard-rubber booster hose, hard intake hose, and rubber-jacket collapsible hose only require rinsing with clear water
- b. Most woven-jacket hose requires more care
 - i. Dust and dirt should be thoroughly brushed or swept off hose
 - ii. Wash with clear water while scrubbing with stiff brush
- 2. If exposed to oil, should be washed with mild soap or detergent using common scrub brushes or straw brooms, then rinse with clear water
- 3. Hose-washing machine
 - a. Can make care and maintenance of fire hose much easier
 - b. Most common type washes almost any size up to 3 inches (77 mm)
 - c. Flow of water can be adjusted as desired
 - d. Movement of water assists in propelling hose through device
 - e. Hoseline can be connected to pumper or hydrant
 - f. Cabinet-type machine
 - i. Washes, rinses, and drains
 - ii. Designed to be used in station
 - iii. Can be operated by one person
 - iv. Self-propelled
 - v. Can be used with or without detergents

C. Drying Hose

- 1. Methods depend on type of hose
 - a. In accordance with departmental SOP and manufacturer's recommendations
 - b. Woven-jacket hose must be thoroughly dried before being reloaded
 - c. Hard-rubber booster hose, hard intake hose, and synthetic-jacket collapsible hose may be placed back on apparatus while wet



- 2. Hose towers and drying racks must have adequate ventilation and protection
- 3. Drying hose in hose towers or on racks
 - a. Remove hose from exterior hose towers as soon as dry
 - b. Lash or tie coupling ends of hose hung in outside drying towers together to prevent swinging
 - c. Cover male threads with precut sections of tubing
 - d. Incline drying racks enough to allow water to drain from hose during drying
 - e. Avoid placing hose sections too close together or allowing them to touch

D. Storing Hose

- 1. Mount racks permanently on wall or stand free on floor
- 2. If stored in apparatus room/bay
 - a. May be exposed to cleaning solvent, lubricants, oils, and diesel fumes
 - b. Inspect and clean more frequently

CAUTION: Never store solvents, petroleum products, or other chemicals close to fire hose and couplings.

- 3. Preventing damage to hose stored in racks
 - a. Locate hose racks in clean, well-ventilated room easily accessible to apparatus room/bay
 - b. Store hose where not exposed to direct sunlight
 - c. Pack cotton fabric hose loosely so that air circulates around it
 - d. Store hose in rack so that couplings are not in walkways and will not come into contact with equipment or passing personnel
 - e. Roll hose with male end inside roll to protect male coupling threads


WHEN CARING FOR FIRE HOSE COUPLINGS YOU SHOULD FOLLOW THESE GUIDELINES.



- f. When necessary to store with male coupling on outside, protect with cap
- g. Place sexless couplings in storage rack in way that prevents dirt or foreign objects from collecting in ramp grooves

E. Care of Fire Hose Couplings

- 1. Although designed to be durable, can be damaged
- Male Exposed when not connected; subject to denting
- 3. Female Swivel can be bent into oval shape
- 4. Guidelines for care
 - a. Avoid dropping and/or dragging
 - b. Do not permit vehicles to drive over
 - c. Inspect when hose is washed and dried
 - d. Remove gasket and twist swivel in warm, soapy water
 - e. Clean threads to remove tar, dirt, gravel, and oil
 - f. Inspect gasket and replace if cracked or creased
- 5. If coupling swivel becomes difficult to spin
 - a. Cannot be sufficiently cleaned in hose-washing machine
 - b. Submerge in warm, soapy water and move forward and backward to thoroughly clean
 - c. Clean male threads with stiff brush or wire brush
 - d. Lubricate to maintain swivel
 - e. Replace cracked, scored, or inflexible gaskets

Review Question: What are the steps taken to perform basic inspection and maintenance for fire hose? *See pp. 831 of the textbook for answers.*

IV. HOSE APPLIANCES AND TOOLS

pp. 835-844

Objective 4 — Compare various uses for hose appliances and tools.

- A. Hose Appliances Any piece of hardware used in conjunction with fire hose for controlling flow of water, creating variety of pathways for water through hose layouts
 - 1. Valves
 - a. Ball valves
 - i. Used in pumper discharges and gated wyes
 - ii. Open when handle in line with hose
 - iii. Closed when at right angle to hose
 - iv. Used in fire pump piping systems
 - b. Gate valves
 - i. Used to control flow from hydrant
 - ii. Have baffle lowered into path of water by turning screw-type handle
 - c. Butterfly valves
 - i. Used on large pump intakes
 - ii. Incorporate flat baffle that turns 90 degrees
 - iii. Most operated manually using quarter-turn handle; some operated by electric motor
 - iv. Baffle in center of waterway and aligned with flow when valve is open
 - d. Clapper valves
 - i. Used in Siamese appliances and FDC to allow water to flow in one direction only
 - ii. Prevent water from flowing out of unused ports when one intake hose is connected and charged before addition of more hose
 - iii. Flat disk hinged at top or one side which swings open and closed like a door
 - 2. Valve devices
 - a. Allow number of hoselines operating on fire ground to be increased or decreased



- b. Wye appliances
 - i. Used to divide single hoseline into two or more lines
 - ii. Have single female inlet and multiple male outlet connections
 - iii. Gated wyes Have valve-controlled outlets
 - iv. One of most common has 2½-inch (65 mm) inlet that divides into two 1½-inch (38 mm) outlets
 - v. Available with large diameter hose (LDH) inlet and 2¹/₂-inch (65 mm) outlets for high water volume operations
- c. Siamese appliances
 - i. Combine multiple lines into one line
 - ii. Permit multiple supply hoselines to be laid parallel to supply pumper or high-output device
 - Usually consist of two female inlets, with either center clapper valve or two clapper valves, and single male outlet
 - iv. Some equipped with three clappered inlets
 - (a) Called triamese appliances
 - (b) Clapper valves used to control flow of inlet streams into single outlet stream
 - v. Commonly used when LDH is not available to overcome friction loss in exceptionally long hose lays
 - vi. Used when supplying ladder pipes that are not equipped with permanent waterway
- d. Water thief appliances
 - i. Similar to wye, but have inlet and outlet of matching size combined with smaller outlets that "steal" water from main line
 - Larger volume appliances consist of LDH inlet and outlet and two or more 2¹/₂-inch (65 mm) valve-controlled male outlets
- e. Large-diameter hose appliances
 - i. Water thief Used when operations require water to be distributed at various points along main supply line

- ii. LDH manifold
 - (a) Used when large volume of water needed near end of main supply line
 - (b) Consists of one LDH inlet and three 2¹/2inch (65 mm) valve-controlled male outlets
- f. Hydrant valves
 - i. Known by variety of regional names
 - ii. Used when forward lay is made from lowpressure hydrant to fire scene
 - iii. Functions
 - (a) Allow additional hoselines to be laid to hydrant
 - (b) Connect supply pumper to hydrant
 - (C) Boost pressure in original supply line without interrupting flow of water in line
 - (d) Allow original supply line to be connected to hydrant and charged before arrival of another pumper at hydrant
- 3. Fittings
 - a. Used to connect hose of different diameters and thread types
 - b. Used to protect couplings on standpipes and on apparatus intakes and outlets
 - c. Adapters
 - i. Fittings for connecting hose couplings with similar threads and same inside diameter
 - ii. Most often used Double-male and doublefemale
 - iii. Increasingly common Connects sexless coupling to threaded outlet on hydrant
 - d. Reducers
 - i. Used to connect smaller diameter to end of larger one
 - ii. Limits larger hose to supplying one smaller line only

- e. Others include elbows, hose caps, and hose plugs
- 4. Intake strainers
 - a. Devices attached to drafting end of hard suction hose when pumping from static water source
 - b. Designed to keep debris from entering apparatus or portable pump
 - c. Must not rest on bottom of static water source except when bottom is clean and hard
 - d. Preventing strainer from resting on bottom
 - i. Tie one end of rope to eyelet on strainer
 - ii. Tie other end to apparatus or other anchor point
 - e. Floating strainers available to keep strainer off bottom

B. Hose Tools

- 1. Hose roller
 - a. Protects hose from mechanical damage of dragging over sharp corners
 - b. Consists of metal frame with two or more rollers
 - c. Notch of frame is placed over potentially damaging edge or windowsill
 - d. Frame secured with rope or clamp
 - e. Hose is then pulled across rollers
 - f. Can also be used to protect rope when hoisting tools over similar edges
- 2. Hose jacket
 - a. Can be installed when hoseline ruptures but must remain charged to continue fire attack
 - b. Consists of hinged two-piece metal cylinder
 - c. Rubber lining of each half of cylinder seals rupture to prevent leakage
 - d. Locking device clamps cylinder closed when in use



- e. Two sizes 2¹/₂ inches and 3 inches (65 mm and 77 mm)
- f. Encloses so effectively that hose can operate at full pressure
- g. Can also be used to connect hose with mismatched or damaged screw-thread couplings
- 3. Hose clamp
 - a. Can be used to stop the flow of water in a hoseline for the following reasons
 - i. To prevent charging hose bed during forward lay from hydrant
 - ii. To allow replacement of burst section of hose without stopping water supply
 - iii. To allow extension of hoseline without stopping water supply
 - iv. To allow extension of charged hoseline
 - b. Types Screw-down, press-down, and hydraulic press
 - c. Can injure firefighters or damage hose if not applied correctly
 - d. Guidelines for use
 - i. Apply hose clamp at least 20 feet (6 m) behind apparatus
 - ii. Apply hose clamp approximately 5 feet (1.5 m) from coupling on supply side
 - iii. Center hose evenly in jaws to avoid pinching hose
 - iv. Close and open hose clamp slowly to avoid water hammer
 - v. Stand to one side when applying or releasing any type of hose clamp

CAUTION: Never stand over the handle of a hose clamp when applying or releasing it. The handle or frame may pop open and swing upward violently.



- 4. Spanner, hydrant wrench, and rubber mallet
 - a. Common tools used to tighten or loosen hose couplings
 - b. Spanner wrench
 - i. Primary purpose Tighten or loosen couplings
 - ii. Other features may be built in
 - (a) Wedge for prying
 - (b) Opening that fits gas utility valves
 - (c) Slot for pulling nails
 - (d) Flat surface for hammering
 - c. Hydrant wrench
 - i. Primary use To remove discharge caps from fire hydrant outlets; to open fire hydrant valves
 - ii. Usually equipped with pentagonal opening in head that fits most standard fire hydrant operating nuts
 - iii. Lever handle may be threaded into operating head to make adjustable, or head and handle may be of ratchet type
 - iv. Head may be equipped with spanner to help make or break coupling connections
 - d. Rubber mallet
 - i. Sometimes used to strike lugs to tighten or loosen intake hose couplings
 - ii. May be used to further tighten intake connection, making it easier for firefighters to achieve completely airtight connection with good seal when setting up drafting operations
- 5. Hose bridge or ramp
 - a. Help prevent damage to fire hose when vehicles must drive over it
 - Should be used wherever a hoseline is laid across a street or other area where it may be driven over
 - c. Can be positioned over small spills to keep hoselines from being contaminated
 - d. Can be used as chafing blocks

- 6. Chafing block
 - a. Devices used to protect fire hose from vibrating and rubbing against other surfaces, which can cause abrasions
 - b. Particularly useful near pumpers where intake hose comes in contact with pavement or curbs
 - c. May be made of wood, leather, or sections of old truck tires
- 7. Hose strap, hose rope, and hose chain
 - a. Used to carry, pull, or handle charged hoselines
 - b. Provide more secure means to handle pressurized hose when applying water
 - c. May also be used to secure hose to ladders and other fixed objects
- 8. LDH roller for loading
 - a. Wider version of hose roller
 - b. Mounts temporarily on tailboard of pumper
 - c. With hoseline laid between wheels along length of apparatus, apparatus slowly driven along hoseline
 - d. As apparatus moves, hose is pulled up over the roller and into hose bed
 - e. Because hose may need to be guided over roller, one of very few times firefighters are permitted to stand tailboard or ride in hose bed while apparatus is in motion



Review Question: What are the types of hose appliances and tools a firefighter may need to use? *See pp. 835 of the textbook for answers.*

Chapter 15 Fire Hose

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Lesson Goal

After completing this lesson, the student shall be able to describe fire hose characteristics, describe inspection and maintenance procedures, and explain various hose rolls, loads, and finishes. In addition, students will be able to perform various hose loads and advance hoselines.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain basic fire hose characteristics. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 2. Describe different causes of and prevention methods for hose damage. [NFPA[®] 1001, 5.5.2]
- 3. Identify basic inspection, care, and maintenance methods for fire hose. [NFPA[®] 1001, 5.5.2]
- 4. Compare various uses for hose appliances and tools. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 5. Describe basic hose rolls. [NFPA[®] 1001, 5.5.2]
- 6. Explain basic hose loads and finishes. [NFPA[®] 1001, 5.5.2]
- Compare various methods to make preconnected hose loads for attack lines. [NFPA[®] 1001, 5.5.2]
- 8. Explain the methods used for supply hose lays. [NFPA[®] 1001, 5.3.8, 5.3.15]
- 9. Recognize different methods for handling hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 10. Describe methods for advancing hoselines in various ways. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 11. List the considerations that can impact operating attack hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 12. Couple and uncouple a hose. [NFPA[®] 1001, 5.3.10]
- 13. Inspect and maintain a fire hose. [NFPA[®] 1001, 5.5.2]
- 14. Make a straight hose roll. [NFPA[®] 1001, 5.5.2]
- 15. Make a donut hose roll. [NFPA[®] 1001, 5.5.2]
- 16. Make the flat hose load. [NFPA[®] 1001, 5.5.2]
- 17. Make the accordion hose load. [NFPA[®] 1001, 5.5.2]
- 18. Make the horseshoe hose load. [NFPA[®] 1001, 5.5.2]
- 19. Make a finish. [NFPA[®] 1001, 5.5.2]



- 20. Make the preconnected flat hose load. [NFPA[®] 1001, 5.5.2]
- 21. Make the triple layer hose load. [NFPA[®] 1001, 5.5.2]
- 22. Make the minuteman hose load. [NFPA[®] 1001, 5.5.2]
- 23. Make a hydrant connection from a forward lay. [NFPA[®] 1001, 5.5.2]
- 24. Make the reverse hose lay. [NFPA[®] 1001, 5.5.2]
- 25. Advance a hose load. [NFPA[®] 1001, 5.3.10]
- 26. Deploy a wye-equipped hose during a reverse hose lay. [NFPA[®] 1001, 5.3.10]
- 27. Advance a charged hoseline using the working line drag method. [NFPA[®] 1001, 5.3.10]
- 28. Advance a line into a structure. [NFPA[®] 1001, 5.3.10]
- 29. Advance a line up and down an interior stairway. [NFPA[®] 1001, 5.3.10]
- 30. Connect to a stairway standpipe connection and advance an attack hoseline onto a floor. [NFPA[®] 1001, 5.3.10]
- 31. Advance an uncharged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 32. Advance a charged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 33. Operate a charged attack line from a ladder. [NFPA[®] 1001, 5.3.10]
- 34. Operate a small hoseline One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 35. Operate a large hoseline for exposure protection One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 36. Operate a large hoseline Two-firefighter method. [NFPA[®] 1001, 5.3.15]
- 37. Extend a hoseline. [NFPA[®] 1001, 5.3.10]
- 38. Replace a burst hoseline. [NFPA[®] 1001, 5.3.10]

Instructor Information

This is the lesson covering fire hose. This lesson describes the basic characteristics of fire hose. The lesson also covers cleaning, inspection, and maintenance of fire hose. In addition, the chapter covers a large number of hose rolls, loads, and finishes.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

I. HOSE ROLLS

pp. 844-846

Objective 5 — Describe basic hose rolls.



A. Straight Roll

- 1. Simplest of all hose rolls
- 2. Usually made by starting at male coupling and rolling toward female coupling end of hose
- 3. When roll is completed, female end is exposed and male end is protected in center of roll
- 4. Commonly used for following situations
 - a. Transporting damaged or dirty hose to station for repair, replacement, or cleaning
 - b. Storing sections of hose in storage rack or other location
 - c. Carrying spare sections of hose in apparatus compartments
 - d. Making hose loading easier
- 5. Marking hose for repair and/or test
 - a. Start roll at female end
 - b. Tie knot in exposed end
 - c. Attach tag indicating type and location of damage

B. Donut Roll

- 1. Commonly used in situations where hose is likely to be deployed for use directly from a roll
- 2. Advantages
 - a. Firefighter has control of both couplings, which protects them from damage
 - b. Hose rolls out easier with fewer twists or kinks
 - c. Holding both couplings enables quicker connection to other couplings

C. Twin Donut Roll

1. Usually works best on 1¹/₂-inch (38 mm) and 1³/₄-inch (45 mm) hose





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- 2. Creates compact roll that can be easily transported and carried for special applications
- 3. If couplings offset by about 1 foot (0.3 m) at beginning, can be coupled together after roll is tied or strapped
- 4. Hose strap, inserted into center of roll, used to carry hose roll

D. Self-Locking Twin Donut Roll

- 1. Twin donut roll with built-in carrying loop formed from hose itself
- 2. Loop locks over couplings to keep roll intact for carrying
- 3. Length of carrying loop may be adjusted to accommodate height of person carrying hose

Review Question: When should firefighters use basic hose rolls? *See pp. 844-846 of the textbook for answers.*

II. BASIC HOSE LOADS AND FINISHES

pp. 846-852

Objective 6 — Explain basic hose loads and finishes.

A. Basics of Hose

- 1. NFPA[®] 1901 lists minimum quantity of hose to be carried on standard pumper or engine
 - a. Minimum 800 feet (240 m) of 2½-inch (65 mm) or larger fire supply hose
 - b. Minimum 400 feet (120 m) of 1¹/₂-inch (38 mm), 1³/₄-inch (45 mm), or 2-inch (52 mm) attack fire hose
- 2. Typically carried in open compartments called hose beds
 - a. Vary in location, size, shape
 - b. Front is part closest to front of apparatus; rear is part closest to rear of apparatus









- c. Most have aluminum slats in bottom that allow air to circulate throughout to prevent mildew damage
- d. May be single compartment or divided or separated by vertical panel

B. Flat Load

- 1. Easiest to load
- 2. Suitable for any size of supply hose
- 3. Best way to load large-diameter hose
- 4. Laid so that hose folds lie flat rather than on edge
- 5. Less subject to wear from apparatus vibration during travel
- 6. Disadvantage Hose folds contain sharp bends at both ends, which requires hose to be reloaded periodically to prevent damage to lining
- 7. In single hose bed, may be started on either side
- 8. In split hose bed, lay first length against partition with coupling hanging far enough below hose bed so that coupling can be connected to last coupling of load on opposite side and laid on top of load
- 9. For large-diameter hose, should be started 12 to 18 inches (300 mm to 450 mm) from front of hose bed

C. Accordion Load

- 1. Named for manner in which hose appears after loading
- 2. Hose is laid on edge in folds that lie adjacent to each other
- 3. First coupling is placed in rear of bed; in single hose bed, can be placed in either corner
- 4. Easy to load, requiring two or three people
- 5. Advantage Firefighters can easily pick up number of folds and place on one shoulder to carry hose from bed

D. Horseshoe Load

15-5



- 1. Loaded on edge in U-shaped configuration around perimeter of hose bed working toward center
- 2. Each length is progressively laid from outside of bed toward inside so that last length is at center of horseshoe
- 3. Advantage Fewer sharp bends in hose than accordion or flat loads
- 4. Disadvantages in single hose beds
 - a. Excess hose may be deployed because hose is pulled alternately from one side of bed and then other, creating wavy or snakelike lay
 - b. Folds for should carry cannot be pulled as easily as with accordion load
 - c. Two people are required to make shoulder folds for carry
 - d. Hose is loaded on edge, which can result in wear on hose edges
 - e. Does not work for large-diameter hose
- 5. In single hose bed, may be started on either side
- 6. In split hose bed, lay first length against partition with coupling hanging far enough below hose bed so that coupling can be connected to last coupling of load on opposite side and laid on top of load

E. Combination Load

- 1. Used with split hose beds loaded with threadedcoupling hose
- 2. Permits apparatus to make forward lay from water source to fire followed by reverse lay back to water source
- 3. One half of bed is loaded with female coupling exposed; other half has male coupling exposed
- 4. Where two beds are connected, double female adapter fitting used
- 5. May be used to load large-diameter supply hose on one side of bed and smaller-diameter hose for supply or attack on other side





F. Hose Load Finishes

- 1. Added to basic hose load to increase versatility of load
- 2. Normally loaded to provide enough hose to connect hoseline to hydrant and provide attack hoseline at fire scene
- 3. Categories Finishes for forward hose lays and finishes for reverse hose lays
- 4. Straight finish
 - a. Consists of last section of hose arranged loosely back and forth across top of hose load
 - b. Hydrant wrench, gate valve, and any necessary adapters strapped to hose at or near female coupling
- 5. Reverse horseshoe finish
 - a. Similar to horseshoe load except that bottom of U portion is at rear of hose bed
 - b. Made of one or two 100-foot (30 m) sections of hose, each connected to one side of gated wye
 - c. Can be used on any size attack hose
 - d. Can also be used for preconnected line
 - e. Can be loaded in two or three layers
 - f. With nozzle extending to rear, firefighters can place finish over one shoulder and extend opposite arm through loops of layers to pull hose from bed for arm carry
- 6. Skid load finish
 - a. Consists of folding last three sections [150 feet (45 m)] of 2¹/₂-inch (65 mm) hose into compact bundle on top of rest of hose load
 - b. Begins by forming three or more pull loops that extend beyond end of hose load
 - c. Rest of hose, with nozzle attached, accordionfolded across hose used to form pull loops in hose bed





G. High-Rise Pack

- Assembled to provide enough attack hose for firefighters to operate from standpipe connection and still be light enough for one person to carry
- 2. May be located in compartment or secured to apparatus exterior
- 3. May be carried in roll or strapped together in accordion-like fashion
- 4. May have nozzle attached to male coupling
- 5. May include adapters and tools carried in separate bag

H. Hose Loading Guidelines

- 1. Check gaskets and swivel before connecting any coupling
- 2. Keep flat sides of hose in same plane when two sections of hose are connected
- 3. Tighten couplings hand-tight
- 4. Remove kinks and twists from hose when bent to form loop in hose bed
- 5. Make short fold or reverse bend (called a Dutchman) in hose during loading process so that couplings are not too close to front or rear of hose bed and will not flip over when pulled out of bed
- 6. Load large-diameter hose [3¹/₂ inch (90 mm) or larger] with all couplings near front of bed
- 7. Do not pack hose too tightly

Review Question: What hose loads can a firefighter choose from when storing hose? *See pp. 847-852 of the textbook for answers.*

III. PRECONNECTED HOSE LOADS FOR ATTACK LINES

pp. 852-855

Objective 7 — Compare various methods to make preconnected hose loads for attack lines.

A. Preconnected Hose Loads for Attack Lines

- 1. Primary lines most fire departments use for fire attack
- 2. Connected to discharge valve and placed in area other than main hose bed
- 3. Generally range from 50 to 250 feet (15 m to 75 m) in length
- 4. May be carried in following places
 - a. Longitudinal beds
 - b. Raised trays
 - c. Transverse beds
 - d. Tailboard compartments
 - e. Side compartments or bins
 - f. Front bumper wells
 - g. Reels
- 5. Must be fully deployed from hose bed before line is charged

B. Preconnected Flat Load

- 1. Adaptable for varying sizes of hose beds
- 2. Often used in transverse beds
- 3. Similar to flat load for larger supply hose except that exposed loops provided for pulling load from bed
- 4. Should have loops placed at regular intervals within load so that equal portions of load are pulled from bed
- C. Triple Layer Load
 - 1. Begins with hose folded in three layers
 - 2. Folds then laid into bed in S-shaped fashion







- 4. Layers may be as long as 50 feet (15 m) each
- 5. Must be completely removed from bed before deploying nozzle end of hose
- Can be used for all sizes of attack lines; preferred for larger (2- and 2¹/₂-inch [50 mm and 65 mm]) attack lines

D. Minuteman Load

- 1. Designed to be pulled and advanced by one person
- 2. Can be carried on shoulder, completely clear of ground
- 3. Deploys from shoulder as firefighter advances toward fire
- 4. Particularly well-suited for narrow hose bed
- 5. Can be awkward to carry when wearing SCBA
- 6. If in single stack, may collapse on shoulder if not held tightly in place

E. Booster Hose Reels

- 1. Booster hoselines Rubber-covered hose usually carried preconnected and coiled on reels
- 2. May be mounted in any of several places on apparatus
 - a. Above pump panel and behind apparatus cab
 - b. On front bumper of apparatus
 - c. In rear compartments
- 3. Available as manual- or power-operated

WARNING: Booster lines are not appropriate for interior fire fighting operations or for vehicle fires because they do not deliver a sufficient volume of water to protect firefighters if conditions suddenly deteriorate.

Review Question: How do the various methods to make preconnected hose loads for attack lines compare with one







another? See pp. 852-855 of the textbook for answers.

IV. SUPPLY HOSE LAYS

pp. 855-861

Objective 8 — Explain the methods used for supply hose lays.

A. Hose Lay Procedures

- 1. Vary from department to department
- 2. Either laid forward from water source to incident scene, reverse from incident scene to water source, or in combination
- 3. Guidelines
 - a. Do not ride in standing position when apparatus is moving
 - Drive no faster than 10 mph (16 km/h) slower speed allows couplings to clear tailboard as hose leaves bed
 - c. Deploy hose to one side of roadway so that other apparatus are not forced to drive over it

B. Forward Lay

- 1. Hose is deployed from water source to incident
- 2. First coupling to come off hose bed in forward lay should be female
- Consists of stopping apparatus at hydrant and allowing firefighter to safely leave apparatus and secure hose
- 4. Apparatus then proceeds to fire deploying either single hoseline or parallel hoselines
- 5. Advantage Pumper can remain at incident scene so hose, equipment, and tools are readily available
- 6. May require second pumper at hydrant to increase pressure in line
 - a. First pumper must have used four-way hydrant valve



HOSE LAY PROCEDURES WILL VARY FROM

DEPARTMENT TO DEPARTMENT

- One member of crew must stay at hydrant long enough to make hose connection and open hydrant
- 7. Making the hydrant connection
 - a. Methods depend on local SOPs and resources
 - b. Firefighter takes hydrant wrench, finish section of hose, and portable radio when connecting to hydrant
 - c. Communication between driver/operator and firefighter at hydrant essential
 - d. First task is for hydrant catcher to remove enough hose to reach hydrant and wrap around it
 - i. Finish section is usually long enough
 - ii. If not, place finish section on ground near tailboard and pull second section from hose bed
 - e. Next, take end of finish section and wrap around hydrant base
 - f. Then signal driver/operator it is safe to proceed to fire
- 8. Using four-way hydrant valves
 - a. Allows a forward-laid supply line to be immediately charged
 - b. Allows later-arriving pumper to connect to hydrant; can supply additional supply lines and/or increase pressure to original line
 - c. Typically preconnected to end of supply line, allowing firefighters making connection to secure valve and hose to hydrant in one action

C. Reverse Lay

- 1. Used when pumper must first go to fire location before laying supply line
- 2. Most expedient way to lay hose if apparatus must stay at water source
- 3. Hose beds should be loaded so that first coupling to come off is male



- Standard method for establishing relay pumping operation when using 2¹/₂- or 3-inch (65 mm or 77 mm) hose as supply line
- 5. Deploying can cause delay in initial fire attack because tools and equipment must be removed and placed at fire scene before pumper proceeds to water source
- 6. Causes pump operator to stay with pumper at water source, preventing operator from performing other essential fireground activities
- 7. Common operation involving two pumpers
 - a. First-arriving pumper goes directly to scene to start initial attack on fire using water from tank
 - b. Second-arriving pumper lays supply line from pumper back to water source
 - c. Second pumper only needs to connect hose to discharge outlet, connect intake hose, and begin pumping
- 8. Connecting four-way hydrant valve is optional
- 9. Used when first pumper arrives at fire and must work alone for extended period of time
- 10. Soft intake connections
 - a. Not all hydrants have large steamer outlets capable of accepting direct connections
 - Dperations on hydrants equipped with two 2¹/₂inch (65 mm) outlets require use of two 2¹/₂- or 3-inch (65 mm or 77 mm) hoselines
 - c. Smaller intake hose can be connected to Siamese at pump
 - d. More efficient to connect 4¹/₂-inch (115 mm) or larger intake hose to hydrant with only 2¹/₂-inch (65 mm) outlets
- 11. Hard intake connections
 - a. Require coordination and teamwork
 - b. Require more people and are more difficult than connecting soft intake hose
 - c. Positioning of pumper is important

- i. No definite rule for distance from hydrant
- ii. Position of pump intakes should be considered

NOTE: If the hard intake is marked FOR VACUUM USE ONLY, do not use it for hydrant connections. This type of hard intake is for drafting operations only.

D. Combination Lay

- 1. Refers to any of a number of ways to lay multiple supply hose with single engine
- 2. Hose must be loaded into hose bed in two separate hose bed compartments
- 3. Depending on whether beds are set up for forward or reverse lays, hoselines of same diameter can be laid in following ways
 - a. Two lines laid forward
 - b. Two lines laid reverse
 - c. Forward lay followed by reverse lay
 - d. Reverse lay followed by forward lay
 - e. Two lines laid forward followed by one or two lines laid reverse
 - f. Two lines laid reverse followed by one or two lines laid forward
- 4. Basic tasks are same in each version
 - a. When two lines laid at same time, hydrant catcher disconnects hose at crossover between beds and pulls hose from both sides of bed
 - b. Hose adapter fittings will be needed when threaded hose couplings are used in any reverse lay
 - c. When using hose equipped with sexless couplings, hose may be laid in either direction

Review Question: What methods can be used for supply hose lays?

See pp.855-861 of the textbook for answers.



V. HANDLING HOSELINES

pp. 861-862

THERE ARE SEVERAL METHODS THAT CAN BE

USED TO DEPLOY PRECONNECTED HOSELINES

Objective 9 — Recognize different methods for handling hoselines.

A. Deploying Preconnected Hoselines

- 1. Flat load
 - a. May deploy to either side or from rear of apparatus
 - b. Grasp hose loop in one hand and nozzle in other
 - c. Pull hose from compartment and walk toward fire
 - d. Spread hose and straighten to remove any kinks before line is charged with water
- 2. Minuteman load
 - a. Intended to be deployed without dragging hose on ground
 - b. Deploys by unfolding from top of stack carried on shoulder as firefighter advances toward fire
 - c. Should result in hoseline deploying with fewer kinks and bends
- Triple layer load Involves placing nozzle and fold of first tier on firefighter's shoulder and walking away from apparatus toward fire

B. Deploying Other Hoselines

- 1. Using supply hose as attack line
 - a. Hose may be deployed from either side of hose bed
 - b. May require addition of adapter to mate coupling with nozzle or connect hose to FDC
- 2. Equipped with wye appliances
 - a. Normally used in connection with reverse layout
 - b. Remove attack lines inhose bundles or disconnect preconnected hoselines and place



them on ground behind apparatus with any necessary nozzles and adapters

- c. Remove the wye and enough hose to supply smaller attack lines connected or to be connected to wye
- d. Kneel on supply hose to anchor as driver/operator drives slowly toward water source
- 3. Individual sections from flat, accordion, or horseshoe loads
 - a. Load one section of hose on another firefighter's shoulder one at a time
 - b. Multiple firefighters carry hose to desired location once disconnected from remainder of hose in bed



Review Question: How do firefighters decide what technique to use when handling hoselines? *See pp. 861-862 of the textbook for answers.*

Chapter 15 Fire Hose

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	Module 3		
	Chapter 15		
¢	ALABAMA FIRE COLLEGE	A Station	1

Lesson Goal

After completing this lesson, the student shall be able to describe fire hose characteristics, describe inspection and maintenance procedures, and explain various hose rolls, loads, and finishes. In addition, students will be able to perform various hose loads and advance hoselines.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain basic fire hose characteristics. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 2. Describe different causes of and prevention methods for hose damage. [NFPA[®] 1001, 5.5.2]
- 3. Identify basic inspection, care, and maintenance methods for fire hose. [NFPA[®] 1001, 5.5.2]
- 4. Compare various uses for hose appliances and tools. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 5. Describe basic hose rolls. [NFPA[®] 1001, 5.5.2]
- 6. Explain basic hose loads and finishes. [NFPA[®] 1001, 5.5.2]
- Compare various methods to make preconnected hose loads for attack lines. [NFPA[®] 1001, 5.5.2]
- 8. Explain the methods used for supply hose lays. [NFPA[®] 1001, 5.3.8, 5.3.15]
- 9. Recognize different methods for handling hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 10. Describe methods for advancing hoselines in various ways. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 11. List the considerations that can impact operating attack hoselines. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 12. Couple and uncouple a hose. [NFPA[®] 1001, 5.3.10]
- 13. Inspect and maintain a fire hose. [NFPA[®] 1001, 5.5.2]
- 14. Make a straight hose roll. [NFPA[®] 1001, 5.5.2]
- 15. Make a donut hose roll. [NFPA[®] 1001, 5.5.2]
- 16. Make the flat hose load. [NFPA[®] 1001, 5.5.2]
- 17. Make the accordion hose load. [NFPA[®] 1001, 5.5.2]
- 18. Make the horseshoe hose load. [NFPA[®] 1001, 5.5.2]
- 19. Make a finish. [NFPA[®] 1001, 5.5.2]

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- 20. Make the preconnected flat hose load. [NFPA[®] 1001, 5.5.2]
- 21. Make the triple layer hose load. [NFPA[®] 1001, 5.5.2]
- 22. Make the minuteman hose load. [NFPA[®] 1001, 5.5.2]
- 23. Make a hydrant connection from a forward lay. [NFPA[®] 1001, 5.5.2]
- 24. Make the reverse hose lay. [NFPA[®] 1001, 5.5.2]
- 25. Advance a hose load. [NFPA[®] 1001, 5.3.10]
- 26. Deploy a wye-equipped hose during a reverse hose lay. [NFPA[®] 1001, 5.3.10]
- 27. Advance a charged hoseline using the working line drag method. [NFPA[®] 1001, 5.3.10]
- 28. Advance a line into a structure. [NFPA[®] 1001, 5.3.10]
- 29. Advance a line up and down an interior stairway. [NFPA[®] 1001, 5.3.10]
- 30. Connect to a stairway standpipe connection and advance an attack hoseline onto a floor. [NFPA[®] 1001, 5.3.10]
- 31. Advance an uncharged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 32. Advance a charged line up a ladder into a window. [NFPA[®] 1001, 5.3.10]
- 33. Operate a charged attack line from a ladder. [NFPA[®] 1001, 5.3.10]
- 34. Operate a small hoseline One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 35. Operate a large hoseline for exposure protection One-firefighter method. [NFPA[®] 1001, 5.3.10]
- 36. Operate a large hoseline Two-firefighter method. [NFPA[®] 1001, 5.3.15]
- 37. Extend a hoseline. [NFPA[®] 1001, 5.3.10]
- 38. Replace a burst hoseline. [NFPA[®] 1001, 5.3.10]

Instructor Information

This is the lesson covering fire hose. This lesson describes the basic characteristics of fire hose. The lesson also covers cleaning, inspection, and maintenance of fire hose. In addition, the chapter covers a large number of hose rolls, loads, and finishes.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

I. ADVANCING HOSELINES

pp. 862-868

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Objective 10 — Describe methods for advancing hoselines in various ways.

A. Advancing a Charged Hoseline

- 1. Working line drag
 - a. One of the quickest and easiest ways
 - b. Limited by available personnel
 - c. Can be adapted to certain situations

B. Advancing Hose into a Structure

- 1. Be alert for potential dangers such as backdraft, flashover, and structural collapse
- 2. Safety guidelines
 - a. Check for and remove kinks and bends from hoselines as advanced
 - b. Bleed air from hoseline as it is being charged and before entering building or fire area
 - c. Position nozzle operator and all members of hose team on same side of hoseline
 - d. Check for heat using back of gloved hand before opening door
 - e. Stay low and avoid blocking ventilation openings
 - f. Chock self-closing doors to prevent door from closing and pinching hoseline

C. Advancing Hoseline Up and Down a Stairway

- 1. Can be very difficult
- 2. Should be advanced uncharged when conditions allow
- 3. Shoulder carry works well
- 4. Minuteman load and carry is excellent
- 5. Lay uncharged hose against outside wall to keep stairs as clear as possible and avoid sharp bends and kinks



- 7. When advancing charged hoseline up stairway, excess hose should be deployed on stairs toward floor above fire flow
- When advancing charged hoseline down stairway, excess hose should be stretched outside stairway and firefighters positioned at corners and pinch points

D. Advancing Hose from a Standpipe

- Preassembled hose rolls, bundles, or packs on apparatus are easiest ways get hose to upper floor standpipes
- 2. Hose must be carried to fire floor over aerial ladder or up interior stairway
- 3. Stop one floor below fire floor and connect attack hoselines to standpipe
- 4. If standpipe is in enclosed stairway, acceptable to connect on fire floor
- 5. Be alert for pressure-relief devices and follow SOPs for removal or connection
- 6. While standpipe connection is being completed, extra hose should be deployed up stairs toward floor above fire
- When two lines advanced from same standpipe connection, deploy one hoseline down lower set of stairs and other up stairway to lessen the chances of two hoselines becoming entangled
- 8. When fire extinguishment is complete, carefully drain water contained in hoselines down floor drain, out window, or down stairway

E. Improvising a Standpipe

1. May be necessary in older buildings or those less than three stories





CAUTION: When firefighters must improvise a standpipe system, there will be a delay in applying water to the fire. This delay must be considered in planning the overall fire fighting strategy.

- 2. Interior stairway stretch
 - a. Labor-intensive task used in stairways that have open shaft or stairwell in center
 - b. Uncharged hoseline is suspended in middle of stairs rather than laying on stairs and around each corner
 - c. Hose rolls or bundles can be carried up stairs, secured to hand rail and end lowered to point where another section is attached
 - d. Secure hose to hand rails for support at appropriate intervals to reduce tendency of water weight to pull hose back down once hose is charged
 - e. Advancing dry hoseline should take into consideration the diameter of pressurized hose relative to space between handrail openings
- 3. Outside stretch
 - a. Can be used for lower floors of high-rise buildings
 - b. Supply hose can be hoisted up exterior of building to desired floor using rope
 - c. Because weight of water in charged line can cause hose to fall back down building, some can be extended into windows and secured to available anchor points inside building at interval of about every three stories

F. Advancing Hose Up a Ladder

- 1. Used when standpipes are not available and stairways are not accessible
- 2. Easier and safer with uncharged line
- 3. In most cases, firefighter heeling ladder can help feed hose to those on ladder
- 4. If hose is already charged, drain hose before advancing



WARNING

IT MAY BE NECESSARY TO OPERATE A HOSELINE FROM A LADDER.

- 5. Only one person is allowed on each section of the ladder
- 6. May require use of rope hose tools or utility straps

WARNING: Do not exceed the rated weight capacity of the ladder. If the hose cannot be passed up the ladder without exceeding the load limit, it should be hoisted up.

- 7. Sometimes necessary for firefighters to operate hoseline from ground ladder or supported aerial ladder
- 8. Aerial platforms can be used as portable standpipes for advancing hoseline onto floor

Review Question: What are the safety guidelines for advancing a hose into a structure? *See pp. 862-868 of the textbook for answers.*

II. OPERATING ATTACK HOSELINES

pp. 868-871



Objective 11 — List the considerations that can impact operating attack hoselines.

A. Operating Small Hoselines

- Small hoselines: One-firefighter method Only occurs when combating a small ground cover fire, rubbish or trash fire, vehicle fire, small structure fire, or during overhaul operations
- 2. Small hoselines: Two-firefighter method
 - a. Minimum number required for handling any attack line during interior structural operations
 - b. Nozzle operator
 - i. Holds nozzle with one hand and holds hose just behind nozzle with other hand
 - ii. Rests hoseline against waist and across hip
 - c. Backup firefighter
 - i. Takes position on same side of hose about 3 feet (1 m) behind nozzle operator



- ii. Holds hose with both hands and rests it against waist and across hip or braces it with leg
- iii. Responsible for keeping hose straight behind nozzle operator

B. Operating Large Hoselines

- 1. Large hoselines: One-firefighter method
 - a. May occur during exposure protection or overhaul operations
 - b. May occur if master stream device is not available
 - c. To reduce fatigue, nozzle operator can
 - i. Use a hose strap or rope hose tool looped over shoulder
 - ii. Reduce nozzle flow if conditions allow
- 2. Large hoselines: Two-firefighter method
 - a. May require means of anchoring hoseline to offset nozzle reaction
 - b. May require hose straps or rope hose tools to assist in anchoring hose
 - i. Nozzle operator loops hose strap or rope hose tool around hose a short distance from nozzle, placing large loop across back and over outside shoulder
 - Operator then holds nozzle with one hand and hose just behind nozzle with other hand; hoselines rests against body
 - iii. Backup firefighter serves as anchor about 3 feet (1 m) back
 - iv. Backup firefighter has hose strap or rope hose tool around hose and leans shoulder forward to absorb nozzle reaction
- 3. Large hoselines: Three-firefighter method
 - a. Nozzle operator is same as described for twofirefighter method
 - b. First backup firefighter may stand directly behind nozzle operator, with third firefighter kneeling on hose behind second firefighter
 - c. All firefighters may use hose straps or rope hose tools and remain in standing position



d. Requires situational awareness and focus

C. Extending a Section of Hose

- 1. May be necessary during interior or exterior operations
- 2. Requires hose clamp, spanner wrench, and necessary number of hose rolls or bundles for distance required

D. Controlling a Loose Hoseline

- One in which water under pressure is flowing through nozzle, open butt, or rupture, and is out of control
- 2. Water pressure will cause loose hoseline to flail about or whip back and forth
- 3. Safest method Close valve at pump or hydrant to stop flow of water
- 4. Other methods
 - a. Apply hose clamp at stationary point in hoseline
 - b. May be possible to put kink in hose at point away from break until appropriate valve is closed
 - i. Form loop in line
 - ii. Press down on top of loop
 - iii. Apply body weight to bends in hose
 - iv. Will not completely stop flow of water, but will reduce flow sufficiently for firefighters to safely gain control of end of hose

Note: The procedure for placing a kink in hose does not apply to LDH due to its size and weight when charged.

E. Replacing Burst Sections

- 1. Nozzle operator should request that pump operator close the discharge controlling hoseline
- 2. Water flow may be stopped at any gated wye in line, by applying hose clamp, or by creating kink in hose



3. Two sections should be used to replace any one bad section

Review Question: What considerations can impact operating attack hoselines? *See pp. 868-871 of the textbook for answers.*

III. SKILLS

рр. 875-879	Objective 12 — Couple and uncouple a hose.
pp. 880-882	Objective 13 — Inspect and maintain a fire hose.
рр. 883	Objective 14 — Make a straight hose roll.
рр. 884-887	Objective 15 — Make a donut hose roll.
рр. 888-889	Objective 16 — Make the flat hose load.
p. 890	Objective 17 — Make the accordion hose load.
рр. 891-893	Objective 18 — Make the horseshoe hose load.
рр. 894-896	Objective 19 — Make a finish.
рр. 897-899	Objective 20 — Make the preconnected flat hose load.
рр. 900-902	Objective 21 — Make the triple layer hose load.
рр. 903-905	Objective 22 — Make the minuteman hose load.
рр. 906-907	Objective 23 — Make a hydrant connection from a forward lay.
p. 908	Objective 24 — Make the reverse hose lay.
рр. 909-914	Objective 25 — Advance a hose load.
рр. 915-916	Objective 26 — Deploy a wye-equipped hose during a reverse hose lay.
р. 917	Objective 27 — Advance a charged hoseline using the working line drag method.
рр. 918-919	Objective 28 — Advance a line into a structure.

рр. 920-923	Objective 29 — Advance a line up and down an interior stairway.
рр. 924-925	Objective 30 — Connect to a stairway standpipe connection and advance an attack hoseline onto a floor.
рр. 926-927	Objective 31 — Advance an uncharged line up a ladder into a window.
рр. 928-929	Objective 32 — Advance a charged line up a ladder into a window.
рр. 930-931	Objective 33 — Operate a charged attack line from a ladder.
рр. 932-933	Objective 34 — Operate a small hoseline – One- firefighter method.
p. 934	Objective 35 — Operate a large hoseline for exposure protection – One-firefighter method.
p. 935	Objective 36 — Operate a large hoseline – Two- firefighter method.
р. 936	Objective 37 — Extend a hoseline.
p. 937	Objective 38 — Replace a burst hoseline.

IV. SUMMARY AND REVIEW



A. Chapter Summary

- 1. Fire hose is a basic tool used to carry water from its source to the point it is needed to extinguish a fire.
- 2. Firefighters must know the types of hose their department uses, how it is constructed, the way hose can be damaged, and how to care for it.
- 3. Firefighters must know the differences between supply and attack hose, and how to deploy, advance and operate both kinds of hose.
- 4. It is critical that firefighters know the types of fire hose loads and finishes and how they relate to various hose deployments.

B. Review Questions

- 1. What are the three basic fire hose characteristics a firefighter must understand? (*pp. 816-820*)
- 2. How are thermal damage and corrosion in hose similar or different? (*pp. 826-829*)
- 3. What are the steps taken to perform basic inspection and maintenance for fire hose? (*pp. 831-834*)
- 4. What are the types of hose appliances and tools a firefighter may need to use? (*pp. 835-843*)
- 5. When should firefighters use basic hose rolls? (pp. 844-846)
- 6. What hose loads can a firefighter choose from when storing hose? (*pp. 846-852*)
- 7. How do the various methods to make preconnected hose loads for attack lines compare with one another? (*pp. 852-855*)
- 8. What methods can be used for supply hose lays? (*pp.* 855-861)
- 9. How do firefighters decide what technique to use when handling hoselines? (*pp. 861-862*)
- 10. What are the safety guidelines for advancing a hose into a structure? (*pp. 862-867*)

Chapter 15 Fire Hose

Lesson Goal

After completing this lesson, the student shall be able to explain safety rules for service testing a fire hose.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- Describe the safety considerations taken when service testing a fire hose. [NFPA[®] 1001, 6.5.5]
- 2. Service test a fire hose. [NFPA[®] 1001, 6.5.5]

Instructor Information

This is the lesson covering service testing fire hose. This lesson describes safety considerations when service testing a fire hose.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and a skills evaluation checklist. The level of learning is application.
pp. 872-873







I. SERVICE TESTING FIRE HOSE

Objective 1 — Describe the safety considerations taken when service testing a fire hose.

A. Service Testing Fire Hose

- Guidelines provided in NFPA[®] 1962, Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose
- 2. Should be performed annually, after repairs have been made, and after a vehicle has run over the hose
- 3. Before being service tested, hose should be examined for excessive wear or damage to jacket, coupling damage, and defective or missing gaskets
- 4. If defects found, hose should be tagged for repair
- 5. If damage is not repairable, hose should be removed from service

B. Test Site Preparation

- 1. Test area should be
 - a. Paved area with enough room to lay out hose in straight lines, free of kinks, bends, or twists
 - b. Protected from vehicular traffic
 - c. Well lighted
 - d. Smooth and free from rocks and debris
 - e. On a slight grade to aid water drainage
 - f. Complete with water source sufficient for charging hose
- 2. Necessary equipment
 - a. Hose testing machine, portable pump, or fire department pumper equipped with gauges certified as accurate within one year before testing



- b. Hose test gate valve
- c. Means of recording hose numbers and test results
- d. Tags or other means to identify sections that fail
- e. Nozzles with shutoff valves
- f. Means of marking each length with year of test

C. Service Test Procedure

1. Exercise care, especially when hose is under pressure

CAUTION: All personnel operating in the area of the pressurized hose should wear at least a helmet as a safety precaution.

- 2. Connect hose to discharges on side of apparatus opposite pump panel
- 3. Close all valves slowly to prevent water hammer
- 4. Test lengths of hose 300 feet (100 m) in length or shorter
- 5. Lay large-diameter hose flat on ground before charging it
- 6. Stand away from discharge valve connection when charging hose
- 7. Keep hose testing area as dry as possible when filling and discharging air from hose

Review Question: What are the safety considerations that should be taken when service testing a fire hose? *See pp. 872-873 of the textbook for answers.*

II. SKILLS

p. 939

Objective 2 — Service test a fire hose.

III. SUMMARY AND REVIEW



A. Chapter Summary

 Beyond the understanding of fire hose necessary of a Firefighter I, advancing to Firefighter II includes knowledge of the procedures for testing hose.

B. Review Questions

1. What are the safety considerations that should be taken when service testing a fire hose? (*pp. 872-873*)

2.

Chapter 16 Fire Streams

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	Fire Streams	
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Lesson Goal

After completing this lesson, the student shall be able to describe characteristics of fire streams and their uses. The student shall also be able to operate smooth bore nozzles, fog nozzles, and broken stream delivery devices.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain the way vaporization and steam relate to the extinguishing properties of water. [NFPA[®] 1001, 5.3.10]
- 2. Identify the factors that create pressure loss or gain. [NFPA® 1001, 5.3.10]
- 3. Describe the impact water hammer has on fire streams. [NFPA® 1001, 5.3.10]
- 4. Explain fire stream patterns and their possible limiting factors. [NFPA[®] 1001, 5.3.10]
- 5. Describe the three types of fire stream nozzles. [NFPA® 1001, 5.3.10]
- 6. Compare the different types of nozzle control valves. [NFPA[®] 1001, 5.3.10]
- 7. Describe the factors in operating and maintaining handline nozzles. [NFPA[®] 1001, 5.3.10]
- 8. Operate a fog-stream nozzle. [NFPA[®] 1001, 5.3.10]
- 9. Operate a broken stream nozzle. [NFPA[®] 1001, 5.3.10]
- 10. Operate a solid stream nozzle. [NFPA[®] 1001, 5.3.10]

Instructor Information

This is the lesson covering fire streams. This lesson describes factors influencing fire streams, fire stream patterns, and nozzles and control valves. The lesson also covers nozzle operation and maintenance.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning application.



I. EXTINGUISHING PROPERTIES OF WATER

pp. 944-947

Objective 1 — Explain the way vaporization and steam relate to the extinguishing properties of water.

Ask Students: Why is water an extinguishing agent that is commonly used by the fire service?

Discuss the answers with students. Possible answers include its availability and cost.

A. Extinguishing Properties of Water – Value for fire extinguishment

- 1. Readily available
- 2. Relatively inexpensive
- 3. High specific heat Greater heat-absorbing capacity than most other agents
- 4. High latent heat of vaporization Changing to steam requires relatively large amount of heat
- 5. Can be applied in variety of ways
- B. Vaporization When heated to boiling point, water converts to vapor or steam
 - Energy required both to raise temperature of water and to change state from liquid to gas (steam)
 - Specific heat Amount of energy required to increase the temperature of a substance by one degree
 - Customary system used in U.S., number of British thermal units (Btu) to raise temperature of one pound (lb) of water by 1°F
 - Standard International System of Units (SI) expressed in joules (J) per kilogram (kg) per Kelvin
 - iii. In SI system, water has specific heat of 4,200 J/kg K
 - b. Latent heat of vaporization
 - i. Amount of heat required to convert unit mass of a liquid into a vapor without temperature change



WATER HAS SEVERAL CHARACTERISTICS THAT MAKE IT VALUABLE FOR EXTINGUISHMENT.





ii. Water has latent heat of vaporization of 970 Btu/lb (2 257 kJ/kg) at boiling point

C. Properties of Steam

- 1. Water vaporized into steam expands
 - a. At 212°F (100°C) expands approximately 1,700 times original volume
 - b. As temperature increases, steam continues to expand
 - c. Volume of steam depends on amount of water applied
 - d. Effects of steam on conditions inside compartment depend on where steam is produced
- 2. For complete vaporization, boiling temperatures must be maintained long enough for entire volume of water to be vaporized
 - a. Solid stream of water has smaller surface area, absorbs heat less efficiently
 - Water broken into small particles or droplets absorbs heat, converts to steam more rapidly – more surface exposed to heat
- 3. Steam produced necessary for effective and efficient use of water as extinguishing agent
- 4. Care must be taken to apply appropriate amount of water in right place to achieve desired effect
 - When steam is produced on contact with surfaces hotter than 212°F (100°C), water is vaporized into steam
 - i. Steam adds to total volume of upper layer of hot smoke and fire gases
 - ii. As total volume increases, room fills with hot smoke and steam
 - Upper layer of smoke expands downward, potentially making conditions uncomfortable or dangerous for firefighters inside the room
 - b. When water turns to steam in upper layer of hot smoke and fire gases, upper layer tends to shrink
 - i. Cooling upper layer requires vaporizing water while it passes through hot gases



- ii. As water vaporizes, hot gases are cooled, and upper layer contracts
- iii. Temperature of hot gases drops faster and farther than temperature of steam rises
- iv. Water turned to steam in hot gases causes volume of upper layer to decrease, contract toward ceiling

Instructor Note: Refer students to Information Box "Effects of Stream Patterns on Vaporization at Ceiling Level" on page 947 of the textbook. Discuss how nozzle control affects fire stream operation and fire control. Answer any student questions.

Review Question: What are the extinguishing properties of water?

Objective 2 — Identify the factors that create pressure

See page 944 of the textbook for answers.

II. PRESSURE LOSS OR GAIN

pp. 947-948



loss or gain.

A. Principles of Friction Loss

- Friction loss Part of total water pressure lost while forcing water through pipes, fittings, fire hose, and adapters
 - a. When water flows through, water molecules rub against inside, producing friction
 - b. Friction slows water flow, and reduces pressure at nozzle
 - c. Loss of pressure in hoseline between pumper and nozzle, most common example of friction loss
 - i. Can be measured by inserting in-line gauges at different points in hose layout
 - ii. Difference in pressure between gauges is friction loss for length of hose between gauges
- Practical limit to velocity or speed water can travel through hoseline; beyond this limit, friction becomes so great water is agitated by resistance

- 3. Characteristics of hose layout affect friction loss
 - a. Hose size
 - b. Length of hose lay
 - c. Smaller the hose diameter and longer the hose lay Higher friction loss
- 4. Friction loss in fire hose increased by
 - a. Rough linings in fire hose
 - b. Damaged hose couplings
 - c. Sharp bends in hose
 - d. Number of adapters
 - e. Length of hose lay
 - f. Hose diameter
- 5. Friction loss overcome by
 - a. Increasing hose size
 - b. Adding additional parallel hoselines
 - c. Increasing pump pressure
- 6. Friction loss reduced by taking kinks and sharp bends out of hoseline

B. Elevation Loss or Gain

- 1. Difference in elevation between nozzle, and pumping apparatus causes elevation pressure
 - a. Nozzle above fire pump Pressure loss
 - b. Nozzle below pump Pressure gain
- 2. Changes in pressure are caused by gravity
- Compensated for by adjusting pressure at pump

Review Question: How can friction loss and elevation loss/gain impact fire stream pressure? *See pages 947-948 of the textbook for answers.*

III. WATER HAMMER

pp. 949

Objective 3 — Describe the impact water hammer has on fire streams.





SOME ACTIONS CAN OVERCOME OR REDUCE FRICTION LOSS.

Adding parallel



A. Water Hammer

- 1. When nozzle closed quickly and suddenly
 - a. Shock wave produced when moving water reaches closed nozzle and bounces back
 - b. Resulting pressure surge referred to as water hammer
- 2. Creates excessive pressures, can cause damage to
 - a. Water mains
 - b. Plumbing
 - c. Fire hose
 - d. Hydrants
 - e. Fire pumps
- 3. Minimal at low flow rates, at higher rates effects increase significantly
- 4. To prevent, close slowly
 - a. Nozzles
 - b. Hydrants
 - c. Control valves
 - d. Hose clamps

Review Question: What impact does water hammer have on fire streams?

See pages 949 of the textbook for answers.

IV. FIRE STREAM PATTERNS, NOZZLES, AND CONTROL VALVES

pp. 949-956



Objective 4 — Explain fire stream patterns and their possible limiting factors.

- A. Fire Stream Patterns, Nozzles, and Control Valves
 - Fire stream Stream of water or extinguishing agent, after it leaves fire hose until it reaches desired target
 - 2. Factors affecting fire stream

- a. Velocity of water
 - b. Gravity
 - c. Wind direction, velocity
 - d. Air friction
- e. Operating pressure
- f. Nozzle design and adjustment
- g. Condition of nozzle opening
- 3. Fire streams are used to
 - a. Apply water or foam directly to burning material to reduce temperature
 - b. Apply water or foam into open flames to reduce temperature so firefighters can advance handlines
 - c. Reduce temperature of upper gas layers
 - d. Disperse hot smoke, and fire gases from heated area
 - e. Create water curtain to protect firefighters, property from heat
 - f. Create barrier between fuel and fire by covering fuel with foam blanket
- 4. Fire streams described in terms of
 - a. Patterns they form
 - b. Nozzles that create patterns
 - c. Types of control valves that permit flow of water through nozzle
 - d. Factors that limit fire stream
- 5. Nozzle effect on fire streams
 - a. Size of nozzle opening or orifice and nozzle pressure determines quantity of water flowing from nozzle
 - b. Size of opening also influences reach or distance of fire stream
 - c. Type of nozzle determines shape of fire stream
 - i. Smooth bore nozzle produces solid stream
 - ii. Fog nozzle produces fog or straight stream



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Patterns formed	Types of control valves	
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	Nozzles that create patterns	Factors that limit stream
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THE TYPE HAVE	OF NOZZLE USED (DN A HOSE WILL FIRE STREAM.
	Size of opening and nozzle pressure	Determines quantity of flow
	Size of opening	Influences reach or distance
	Type of nozzie	Determines shape
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B. Fire Stream Patterns

- 1. Patterns defined by
 - a. Size Volume of water flowing from nozzle per minute
 - b. Type Specific pattern or shape of water after leaves nozzle
- Size Rate of discharge of a fire stream is measured in gallons per minute (gpm) or liters per minute (L/m)
 - a. Low-volume stream
 - i. Discharges less than 40 gpm (160 L/m)
 - ii. Supplied by ¾-inch (20 mm), 1-inch (25 mm), or 1½-inch (38 mm) hoselines
 - b. Handline stream
 - i. Flows from 40 to 350 gpm (160 L/min to 1 400 L/min)
 - ii. Supplied by 1½- to 3-inch (38 mm to 77 mm) hose
 - iii. Nozzles with flows in excess of 350 gpm (1 400 L/min) not recommended for handlines.
 - c. Master stream
 - i. Discharges more than 350 gpm (1 400 L/min)
 - Fed by one or more 2½- or 3-inch (65 mm or 77 mm) hoselines, or large-diameter hoselines connected to master stream nozzle
 - iii. Nozzle pressures of 80 to 100 psi (550 to 700 kPa) are common
 - iv. Large-volume fire streams created by master stream appliances such as apparatus-mounted deck pipes, ladder pipes
- 3. Volume of water discharged determined by
 - a. Design of nozzle
 - b. Water pressure at nozzle
- 4. Fire stream must deliver volume of water sufficient to absorb heat faster than fire generates heat



5. If heat-absorbing capability of fire stream does not exceed heat output of fire, extinguishing by cooling impossible

Instructor Note: Point out to students that this is Figure 16.8 on page 951 of the textbook. Discuss the influence of flow rate on time of extinguishment.







- 6. Type Specific pattern or shape of stream as leaves nozzle
 - a. Pattern must be compact enough for majority of water to reach burning material
 - b. Must meet or exceed critical flow rate
 - c. Must have sufficient reach to put water where needed
 - d. Pattern types may be any size classification
- 7. Effective fire streams must have
 - a. Agent (water)
 - b. Pressuring device (pump)
 - c. Means for agent to reach discharge device (hoseline)
 - d. Discharge device (nozzle)
- 8. Solid stream Produced from fixed orifice, smooth bore nozzle
 - a. Designed to produce stream as compact as possible with little shower or spray
 - b. Has ability to reach areas other streams might not reach
 - c. Can penetrate and saturate burning materials and debris
 - d. Reach can be affected by
 - i. Gravity
 - ii. Friction of air
 - iii. Wind
- 9. Characteristics of solid steams
 - a. Good reach and stream penetration
 - b. Stream produced at low nozzle pressure
 - c. Produces less steam conversion



- d. Provides less heat absorption per gallon (liter)
- e. More likely to conduct electricity

Caution: Do not use solid streams on energized electrical equipment.

- 10. Operation and testing classify effective streams as stream
 - a. That does not lose continuity until point where it
 - i. Loses forward velocity (breakover)
 - ii. Falls into showers of spray, easily blown away
 - b. Cohesive enough to (even in light gentle breeze)
 - i. Maintain original shape
 - ii. Attain required height
- 11. Performance of a solid stream depends on velocity resulting from pump pressure, size of nozzle orifice
 - Nozzle pressure of 50 psi (350 kPa) Will produce fire streams from smooth bore nozzles with good reach and volume
 - b. If greater reach and volume needed, nozzle pressure may be increased to 65 psi (448 kPa) above this pressure, nozzle, hoseline require more personnel to handle safely
- 12. Fog stream Fine spray composed of tiny water droplets
 - a. Fog nozzles permit adjustment of tip to produce different patterns
 - Water droplets In shower or spray, formed to expose maximum water surface for heat absorption
- 13. Desired performance of fog stream characterized by
 - a. Amount of heat absorbed
 - b. Rate by which water converted to steam
- 14. Characteristics of fog streams



- a. Patterns can be adjusted to suit situation
- b. Can be used for
 - i. Hydraulic ventilation
 - ii. Vapor dispersion
 - iii. Crew protection
- c. Reduce heat by exposing maximum water surface for heat absorption
- d. May be used to cool hot fire gas layer, hot surfaces
- e. Compared to solid or straight streams
 - i. Have shorter reach or penetration
 - ii. More affected by wind
- f. If applied incorrectly May
 - i. Disturb thermal layering in room or compartment
 - ii. Intensify fire by pushing fresh air into fire area
- 15. Angle of fog streams range from narrow to wide
 - a. Narrow-angle fog pattern
 - i. Highest forward velocity
 - ii. Reach varies in proportion to pressure applied
 - b. Wide-angle fog pattern
 - i. Less forward velocity
 - ii. Shorter reach
- 16. Any fog pattern will have a maximum reach
 - a. Nozzle pressure of 100 psi (700 kPa) is standard
 - Once nozzle pressure has produced stream with maximum reach, increasing pressure will have little effect except to increase volume
- 17. Straight stream Pattern is a semi-solid stream produced by a fog nozzle
 - a. Done by rotating stream shaper until straight stream produced
 - b. Characteristics similar to solid stream







Broken stream – Fire stream broken into coarsely divided droplets

- a. Created by specialized nozzles
 - i. Cellar nozzles
 - ii. Piercing (penetrating) nozzles
 - iii. Chimney nozzles
- b. Solid stream may become broken stream past break-over point – True broken stream takes on form leaving discharge device
- c. Effects can be produced by deflecting solid or straight streams off walls, ceiling
- d. Used to extinguish fires in
 - i. Attics
 - ii. Cocklofts
 - iii. Basements
 - iv. Other confined spaces
- 19. Characteristics of broken streams
 - a. Coarse droplets absorb more heat per gallon (liter) than solid stream
 - b. Greater reach and penetration than fog stream
 - c. Can be effective on fires in confined spaces
 - d. May have sufficient continuity to conduct electricity
 - e. Stream may not reach some fires





C. Fire Stream Limiting Factors – Affect Reach

- 1. Gravity
 - a. Limits horizontal distance
 - b. Causes solid steams to separate and lose compact shape
- 2. Water velocity
 - a. Effective forward velocity 60 to 120 feet per second (18.3 to 36.6 meters per second)
 - b. Generated by nozzle pressures of 25 to 100 psi (105 kPa to 700 kPa)
- Fire stream pattern Solid steam patterns have greater reach than straight, fog, and broken patterns
- Water droplet friction with air Greater effect on fine droplets of fog stream than on outer surfaces of compact solid stream
- 5. Wind
 - a. Wind direction and speed can shorten reach and deteriorate shape of fire stream
 - b. Effect increased on fog streams
- 6. Greatest horizontal reach
 - a. Under ideal circumstances Attained at 45 degrees from horizontal plane
 - In actual operation Are angles between 30 and 34 degrees

Instructor Note: Refer students to Figure 16.15 "Effective Horizontal Reach" on page 957 of the textbook. Discuss how changing the angle of the fire stream changes the effective reach of the stream.

Review Question: How do the four types of fire stream patterns compare with one another? *See pages 951-956 of the textbook for answers.*



pp. 957-962

Objective 5 — Describe the three types of fire stream nozzles.

Instructor Note: Show students examples of the different types of fire stream nozzles. Discuss the similarities and the differences.

D. Fire Stream Nozzles

- NFPA[®] 1963 Established two general categories
 - a. Straight tip Smooth bore
 - b. Spray Fog
 - c. Used on
 - i. Handlines
 - ii. Master stream appliances
 - (a) Fixed apparatus-mounted monitors
 - (b) Portable monitors
 - (c) Elevated monitors mounted on aerial devices
- 2. Not covered by standard
 - a. Delivery devices for broken fire streams
 - b. Can be used to apply water in confined spaces attack hoselines cannot reach
- 3. Functions of nozzles and broken steam delivery devices
 - a. Controlling water flow
 - b. Creating reach
 - c. Shaping fire stream

Ask Students: What terms have you heard that refer to various types of nozzles?

Discuss the fact that terminology is often regional and may change. Refer students to the Information Box "Nozzle Terminology" on page 957 of the textbook.





- 4. Smooth bore nozzles
 - a. Designed so shape of water in nozzle gradually reduced until reaches a point a short distance from orifice
 - At this point, nozzle becomes smooth cylinder Length 1 to 1 ½ times its inside diameter
 - c. Short, cylindrical section gives water round shape before discharge

NOTE: The smooth bore nozzle tip size should not be larger than one-half the diameter of the hose.

Instructor Note: Show students examples of smooth bore nozzles; point out cylindrical section that shapes water stream.

- 5. Characteristics of smooth bore nozzles
 - a. Operate at low nozzle pressures
 - b. Are less prone to clogging with debris
 - c. Can be used to apply compressed-air foam
 - d. May allow hoselines to kink due to less pressure used
 - e. Do not allow for selection of different stream patterns
- Flow rate Depends on velocity of stream, size of nozzle
 - a. Velocity of stream is result of nozzle pressure
 - i. On handlines Usually operated at 50 psi (350 kPa)
 - ii. Most master stream appliances Operated at 80 psi (560 kPa)
 - b. Tips equipped for flow rate
 - i. Single-size tip Single flow rate
 - ii. Stacked tip Varied flows
 - (a) Remove low-flow tips before placing into operation if higher flows required
 - (b) Changing flow rate requires nozzle be shut off, tip changed



THE FLOW R/ DEPEN	ATE OF SMOOTH BORE NOZZLES NDS ON TWO CONCEPTS.	
	Velocity of stream	
	Size of nozzle	
		27

Instructor Note: Show students examples of stacked tip nozzles.

- FOG NOZZLE OPERATION CAN CREATE SEVERAL PATTERNS USING SPECIFIC PRESSURE. Patterns * Straft Storm * Historia fra * Historia
- Fog nozzles May be manually or automatically adjusted
 - a. Resulting in different patterns
 - i. Straight stream
 - ii. Narrow-angle fog
 - iii. Wide-angle fog

Instructor Note: Show students examples of fog nozzles, show cylindrical section that shapes water stream.

- b. Should be operated at designed operating pressures
- 8. Characteristics of fog nozzles
 - a. Discharge pattern can be adjusted
 - b. Can provide protection to firefighters with wide fog pattern
 - c. Can be used for variety of applications
 - d. Offer variety of nozzle choices
 - e. Can be used to apply certain types of foam
- 9. Types of fog nozzles
 - a. Basic Adjustable pattern, rated discharge delivered at designated nozzle pressure, and nozzle setting
 - b. Constant gallonage Adjustable pattern, constant discharge rate throughout range of patterns at desired nozzle pressure
 - c. Constant pressure (automatic) Adjustable pattern, pressure remains constant through range of discharge rates
 - Constant/select gallonage Constant discharge rate, allows manual adjustment of orifice to affect predetermined discharge rate while nozzle is flowing
- 10. Change rate of discharge from manually adjustable fog nozzle by rotating selector ring to specific setting
 - a. Usually located behind nozzle tip





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- b. Each constant rate of flow as long adequate nozzle pressure present
- c. Operator has choice of making flow rate adjustments
 - i. Before opening nozzle
 - ii. While water is flowing
 - iii. Flow rates depend on nozzle size
 - (a) Handlines 10 gpm to 250 gpm (40 L/min to 1 000 L/min)
 - (b) Master streams 350 gpm to 2,500 gpm (1 200 L/min to 10 000 L/min)
 - iv. Most nozzles have "flush" setting to rinse debris from nozzle
 - v. Make adjustments to flow in small increments
 - (a) Major adjustments can cause abrupt change in reaction force of hoseline
 - (b) May throw firefighters off balance

Caution: Abrupt changes in the reaction force of the hoseline may throw firefighters off balance.

- 11. Constant-pressure fog nozzles automatically vary rate of flow to maintain constant pressure through specific flow range
 - a. Minimum nozzle pressure needed to maintain good fog pattern
 - b. Operator can
 - i. Change rate of flow by opening, closing shutoff valve
 - ii. Vary flow rate while maintaining constant nozzle pressure
 - c. Automatic nozzles for handlines designed for
 - i. Low flow 10 gpm (40 L/min) to 125 gpm (500 L/min)
 - ii. Mid-range flow 70 gpm (280 L/min) to 200 gpm (800 L/min)
 - iii. High flow 70 gpm (280 L/min) to 350 gpm (1 400 L/min)



- d. Automatic master stream nozzles
 - i. Designed for flows between 350 gpm (1 400 L/min) and 1,250 gpm (5 000 L/min)
 - ii. Supplied by large diameter or multiple hoselines, directly connected to fire pump by piping

NOTE: Water flow adjustments in textbook and automatic fog nozzles require close coordination between the nozzle operator, the company officer, and the pump operator.

- e. Fog nozzles designed to operate at variety of nozzle pressures
 - i. For most fog nozzles is 100 psi (700 kPa)
 - Operating pressure of 75, 50, or even 45 psi (525, 350, or 315 kPa) are also available – Differences
 - (a) Have less nozzle reaction
 - (b) Droplet size is much greater
 - (c) Fog pattern density is lower
 - (d) Fire stream has less velocity
- 12. Broken stream delivery device
 - a. Can be used effectively to extinguish concealed space fires
 - i. Basement
 - ii. Chimney
 - iii. Attic
 - iv. Other types of concealed spaces
 - b. Created by special nozzles

Instructor Note: Show students examples of broken stream delivery devices.

- 13. Piercing nozzles Used to access fire in concealed spaces
 - a. Used to pierce material
 - i. Stucco
 - ii. Block
 - iii. Wood





- iv. Lightweight steel
- b. Nozzle consists of
 - i. Piercing tip
 - Shaft ii.
 - iii. Hose connection
 - iv. Supply hose
- c. Nozzle driven into place
 - Mallet i.
 - Sledgehammer ii.
 - iii. Flathead axe

Instructor Note: Point out parts of piercing nozzle.

14. Cellar nozzles

- a. Consist of rotating head and multiple outlets
- b. Distribute water in circular pattern
- c. Supplied by
 - i. 1½-inch (38 mm) or 2½-inch (65 mm) supply hose
 - ii. Control valve located one section of hose from nozzle
- d. Nozzle and hose lowered into confined space through hole cut in overhead surface
- e. Common types
 - Bresnan distributor i.
 - Rockwood cellar pipe ii.

Instructor Note: Point out parts of cellar nozzle.

Review Question: What are the benefits of each of the types of fire stream nozzles?

Objective 6 — Compare the different types of nozzle

See pages 958-962 of the textbook for answers.

Nozzle Control Valves

pp. 962-964



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control valves.

Ε.

- 1. Nozzle control, shutoff valves enable operator to influence flow of water
 - a. Start, stop
 - b. Increase, decrease
- 2. Valves allow operator to
 - a. Open nozzle slowly
 - b. Control nozzle reaction increases
 - c. Close nozzle slowly to prevent water hammer
- 3. Ball valve Most common nozzle control valve
 - a. Provide effective control with minimum effort
 - b. Operation
 - i. Ball perforated by smooth waterway, suspended from both sides of nozzle body, sealed against seat
 - ii. Can be rotated up to 90 degrees
 - iii. Move valve handle (bale) backward to open, forward to close
 - (a) When closed, waterway perpendicular to nozzle body, blocks flow of water
 - (b) When open, waterway in line with axis of nozzle, allows water flow
 - c. Nozzle will operate in any position between fully closed and fully open
 - i. Fully open gives maximum flow, performance
 - ii. With smooth bore nozzle, partially open valve causes turbulence, may affect quality of stream
- Slide valve Seats a moveable cylinder against shaped cone to turn off flow of water
 - a. Shutoff handle in forward position, cylinder closed, preventing water flow
 - b. As handle pulled back, cylinder slides open permitting water to flow without creating turbulence
- 5. Rotary control valve Found only on rotary control fog nozzles





- a. Exterior barrel guided by screw
 - i. Screw moves exterior barrel forward or backward
 - ii. Rotating around interior barrel
- b. Control discharge pattern of stream
- c. Commonly found in standpipe cabinets attached to occupant-use hoselines

Review Question: How do the different types of nozzle control valves compare with one another? *See pages 963-964 of the textbook for answers.*

V. OPERATING AND MAINTAINING HANDLINE NOZZLES

pp. 964-967



Objective 7 — Describe the factors in operating and maintaining handline nozzles.

- A. Operating Smooth Bore Nozzles
 - When water flows from smooth bore nozzle, it creates force in direction of stream and equal force in opposite direction
 - a. Force in opposite direction, pushes back on the nozzle operator Nozzle reaction
 - b. Nozzle reaction caused by stream
 - i. Velocity
 - ii. Flow
 - iii. Discharge pattern
 - c. Reaction acts against both nozzle and curves in hoseline, making nozzle difficult to handle
 - d. Increasing discharge pressure and flow rate increases nozzle reaction
 - 2. Control nozzle as follows
 - a. Cradle hoseline in one arm, hold nozzle, pistol grip in one hand
 - b. Pull slowly back on bale with other hand, open nozzle







- c. As action increases, lean forward with both legs apart, one foot forward, weight distributed evenly on both feet
- d. Interior operation, operate in similar fashion, kneeling on one knee
- 3. Personnel required
 - One person can operate smooth bore nozzle on 1½-inch (38 mm) or smaller hoseline
 - b. 1 ³/₄-inch (44 mm) and larger hoselines require additional personnel to overcome reaction, maneuver hoseline

B. Operating Fog Nozzles

- 1. Nozzle reaction will vary depending on setting
 - a. Straight-stream, narrow-stream pattern Reaction similar to smooth bore
 - b. As pattern widens, reaction decreases Nozzle easier to handle
- 2. Handle fog nozzle same as smooth bore nozzle

C. Maintaining Nozzles

- 1. Inspect after each use, at least annually
 - Maintenance, care, cleaning Performed according to manufacturer's recommendations
 - b. Technical maintenance Performed by qualified technicians
- 2. Inspection actions
 - Inspect swivel gasket for damage, wear Replace worn, missing gaskets
 - b. Look for external damage to body, coupling, tip
 - c. Look for internal damage and debris
 - d. Check for ease of operation of parts
 - e. Ensure pistol grip (if applicable) secured to nozzle
 - f. Ensure all parts in place and in good condition



- 3. General nozzle care
 - a. Thoroughly clean after each use with soap, water, and soft bristle brush
 - b. Follow manufacturer's recommendations to clean, lubricate moving parts that are sticking
 - c. Store with valve control bale in closed position
 - d. Never drop or drag nozzle
 - e. Use flush setting on fog nozzle, remove internal debris – If debris remains, shut off water, remove nozzle, and remove debris

Review Question: What are the main factors to consider when operating and maintaining a handline nozzle? *See pages 964-967 of the textbook for answers.*

VI. SKILLS

рр. 988-990	Objective 8 — Operate a fog stream nozzle.
p. 991	Objective 9 — Operate a broken stream.
p. 992	Objective 10 — Operate a solid stream nozzle.

VII. SUMMARY AND REVIEW

	SUMMARY	
Prefighters must know the estiguiding prosente of water and the prosente of the hotels available hotels available	They must indextand the factoristication frei streams	They must know how to select, operate, and most and the selection of notifier and the selection of their department.
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A. Chapter Summary

- 1. Firefighters must know the extinguishing properties of water, and the properties of the nozzles available in their departments.
- 2. They must understand the factors affecting fire streams.

3. They must know how to select, operate, and maintain the nozzles available in their department.

B. Review Questions

- 1. What are the extinguishing properties of water? (*p. 944*)
- 2. How can friction loss and elevation loss/gain impact fire stream pressure? (*pp. 947-948*)
- 3. What impact does water hammer have on fire streams? (*p. 949*)
- 4. How do the four types of fire stream patterns compare with one another? (*pp. 951-956*)
- 5. What are the benefits of each of the types of fire stream nozzles? (*pp. 958-962*)
- 6. How do the different types of nozzle control valves compare with one another? (pp. 963-964)
- 7. What are the factors for operating and maintaining handline nozzles? (*pp. 964-967*)

Chapter 16 Fire Streams

Fire Streame	
Fire Streams	
Module 2	
Chapter 16	
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Lesson Goal

After completing this lesson, the student shall be able to explain how foam is generated and used as a fire fighting tool. The student shall also be able to place a foam line in service using an in-line eductor and to extinguish an ignitable liquid fire.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe the methods by which fire fighting foam prevents or controls a hazard. [NFPA[®] 1001, 6.3.1]
- 2. Identify foam concentrates. [NFPA[®] 1001, 6.3.1]
- 3. Explain the factors that impact foam expansion and selection. [NFPA[®] 1001, 6.3.1]
- 4. Describe methods by which foam may be proportioned. [NFPA[®] 1001, 6.3.1]
- 5. Explain the advantages and disadvantages of various foam proportioners, delivery devices, and generating systems. [*NFPA*[®] 1001, 6.3.1, 6.3.2]
- 6. Identify causes of poor foam production. [NFPA® 1001, 6.3.1, 6.3.2]
- 7. Distinguish among various foam application techniques. [NFPA[®] 1001, 6.3.1, 6.3.2]
- 8. Identify foam hazards and ways to control them. [NFPA® 1001, 6.3.1, 6.3.2]
- 9. Place a foam line in service using an in-line eductor. [NFPA[®] 1001, 6.3.1, 6.3.2]
- 10. Extinguish an ignitable liquid fire. [*NFPA*[®] 1001, 6.3.1]

Instructor Information

This is the lesson covering fire fighting foam. This lesson describes types of foam and equipment used to proportion, generate, and deliver foam. The lesson also covers foam application methods.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

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This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. FIRE FIGHTING FOAM

pp. 967-978

Objective 1 — Describe the methods by which fire fighting foam prevents or controls a hazard.

Objective 2 — Identify foam concentrates.

Objective 3 – Explain the factors that impact foam expansion and selection.

Objective 4 — Describe methods by which foam may be proportioned.

Ask Students: Why is foam used in conjunction with water as an extinguishing agent?

Discuss the answers with students. Possible answers include the ability of foam to create a barrier between fuel and fire, prevent release of flammable vapors, prevent air from reaching fuel, and lowering surface tension of water for better penetration.



- A. Fire Fighting Foam
 - Foam works by forming a blanket of foam on the surface of burning fuels – Both liquid and solid
 - 2. Extinguishes or prevents ignition in several ways
 - a. Separating Creates barrier between fuel and fire
 - b. Cooling Lowers temperature of fuel and adjacent surfaces
 - c. Smothering Prevents air from reaching fuel and mixing with vapors and prevents release of flammable vapors, reducing possibility of ignition, reignition
 - Penetrating Lowers surface tension of water, allows it to penetrate fires in Class A materials
 - 3. Majority of fire fighting foams are

- a. Class A Intended for ordinary combustibles (Class A fuels)
- b. Class B Intended for use on flammable liquids
- 4. On solid fuels, Class A foam blankets and cools fuels, stops burning process
 - a. After controlling flames, water in foam is slowly released into the fuel as foam breaks down
 - b. This action provides cooling effect on fuel
- On liquid fuels, Class B foam also prevents or reduces release of flammable vapors from surface of fuel
- Class B especially effective on two basic categories of flammable liquids – Hydrocarbon fuels and polar solvents

B. How Foam is Generated

- 1. Foam concentrate and water are
 - a. Mixed in correct proportion or ratio with a foam proportioner
 - b. Air added to solution through mechanical agitation or aeration
- Foam concentrate, water, and air must be present and blended in correct ratios – Removing any element results in
 - a. No foam production
 - b. Poor-quality foam
- 3. Aeration needed to produce adequate amount of foam bubbles to form effective foam blanket
 - a. Proper aeration produces uniform-sized bubbles that provide longer-lasting blanket
 - Bood foam blanket required to maintain effective cover for period of time required for extinguishment
 - c. Even though foam bubbles dissipate Residual foam layer still present

C. Foam Expansion





	ion Rate
w Expansion	Less then 20:1
(id-Expansion	Between 20:1 and 200:1
igh Expansion	Greater than 200:1

- Key characteristic that must be considered when concentrate for specific application is chosen – Refers to increase in volume of foam solution when aerated
- 2. Degrees of expansion depend on
 - a. Type of foam concentrate used
 - b. Accurate proportioning (mixing) of the foam concentrate in the solution
 - c. Quality of the foam concentrate
 - d. Method of aeration
- 3. Three classifications of foam based on expansion rates
 - a. Low-expansion foam
 - i. Air/solution ratio up to 20 parts finished foam for every part of foam solution (20-to-1 ratio)
 - ii. Effective for controlling and extinguishing most Class B fires
 - iii. Effective for cooling and penetrating Class A fires
 - b. Medium-expansion foam
 - i. Used at ratio of 20-to-1 to 200-to-1 through hydraulically operated nozzle-style delivery devices
 - ii. Used to suppress vapors from hazardous materials spills when applied at expansion ratios of 30-to-1 and 55-to-1
 - c. High-expansion foam Synthetic foaming agents created by high-expansion foam generators
 - i. Expansion ratios from 200-to-1 to 1,000-to-1
 - ii. Typically used in confined spaces such as
 - (a) Shipboard compartments
 - (b) Basements
 - (c) Mines
 - (d) Enclosed aircraft hangers

D. Foam Concentrates



- 1. To be effective, foam concentrates must match the fuel to which they are applied
 - a. Class A foams are not designed to extinguish Class B fires
 - Class B foams designed solely for hydrocarbon fires will not extinguish polar solvent fires, regardless of concentration used
 - Many types of foam intended for polar solvents may be used on hydrocarbon fires

 This should not be attempted unless manufacturer of concentrate specifically says this can be done
 - d. Incompatibility factor is reason it is important to identify type of fuel involved before applying foam

Instructor Note: Refer students to Appendix D on pp. 1295 of textbook. Discuss types of foam used on various fuels.



CAUTION: Failing to match the proper foam concentrate to the burning fuel will result in an unsuccessful extinguishing attempt and could endanger firefighters. Likewise, mixing different types of foam together can result in substandard quality foam.

Instructor Note: Show students sample foam concentrate containers. Point out label information to help students identify the type of foam concentrate each contains.



- Class A foam Specifically designed for use on Class A fuels
 - a. Used in both wildland and structural fire fighting
 - b. Special formulation of hydrocarbon-based surfactants
 - i. These surfactants reduce surface tension of water in the foam solution
 - ii. Allow better water penetration into the fuel, increasing its effectiveness

- c. Aerated Class A foam coats and insulates fuels, preventing pyrolysis and ignition from adjacent fire
- d. Used with
 - i. Fog nozzles
 - ii. Air-aspirating fog nozzles
 - iii. Medium- and high-expansion devices
 - iv. Compressed air foam systems (CAFS)
- e. Class A foam concentrate has solvent characteristics, mildly corrosive – Important to flush equipment after use
- 3. Class B foam
 - a. Used to prevent ignition of or to extinguish fires involving flammable and combustible liquids
 - b. Used to suppress vapors from unignited spills of these liquids
 - c. Types of liquid fuels Class B foam is effective on
 - i. Hydrocarbon fuels Petroleum-based combustible or flammable liquids that float on water including
 - (a) Crude oil
 - (b) Fuel oil
 - (c) Gasoline
 - (d) Benzene
 - (e) Naphtha
 - (f) Jet fuel
 - (g) Kerosene
 - ii. Polar solvents Flammable liquids that mix readily with water including
 - (a) Alcohols
 - (b) Acetone
 - (c) Lacquer thinner
 - (d) Ketones







- (e) Esters
- (f) Acids
- d. Several types of Class B foam concentrates – Each has advantages and disadvantages
- e. Class B foam concentrates are manufactured from either a synthetic or protein base
 - i. Protein-based foams derived from animal protein
 - ii. Synthetic foam is made from mixture of fluorosurfactants
 - iii. Some foam made from combination
 - iv. Protein and fluoroprotein foams are effective extinguishing agents, vapor suppressants on hydrocarbon fuels because they float on surface of these fuels
 - v. Alcohol-resistant foams specially developed for polar solvents
 - vi. Ethanol or ethanol-based fuels (E-10, E-85, or E-95) also require alcohol-resistant foams for extinguishment
- f. Class B foam may be proportioned into fire stream through
 - i. Fixed system
 - ii. Apparatus-mounted system
 - iii. Portable foam proportioning equipment
- g. Aqueous film forming foam (AFFF) and film forming fluoroprotein foam (FFFP) may be applied with
 - i. Fog nozzles
 - ii. Air-aspirating foam nozzles
- Minimum amount of foam solution that must be applied (rate of application) varies, depending on
 - i. Type of foam concentrate used
 - ii. Whether or not fuel is on fire
 - iii. Type of fuel involved
 - iv. Whether fuel is spilled or contained in tank
 - v. Whether foam is applied via fixed system or portable equipment

NOTE: If the fuel is in a tank, the type of tank will have a bearing on the application rate.

- i. Unignited spills create vapor hazards that may ignite
 - i. Foam blanket can be applied to suppress vapors, and separate fuel from oxygen
 - ii. Depth of foam blanket and application techniques depend on
 - (a) Type of foam
 - (b) Manufacturer's recommendations
- j. Foam concentrate supplies should be on fireground at point of proportioning before application is started
 - i. Once application has started, it should continue uninterrupted until extinguishment is complete
 - ii. Stopping and restarting may allow fire to consume whatever foam blanket has been established
- k. Because polar solvent fuels have differing affinities for water, important to know application rates for each type of solvent
 - i. Rates also vary with
 - (a) Type of foam concentrate
 - (b) Manufacturer of foam concentrate
 - ii. Foam concentrate manufacturers provide information on proper application rates as listed by Underwriters' Laboratories (UL)

Instructor Note: For more complete information on application rates, consult NFPA[®] 11, the foam manufacturer's recommendations, and the IFSTA textbook *Principles of Foam Fire Fighting*.

- 4. Specific application foams
 - Numerous types of foams available for specific applications according to properties and performance
 - i. Thick and viscous foams form tough, heatresistant blanket over burning liquid surfaces





- ii. Thinner foams spread more rapidly
- iii. Some foams produce vapor-sealing film of surface-active water solution on a liquid surface
- iv. Medium- and high-expansion foam are used in large volumes to flood surfaces, fill cavities
- b. Specialized foams also used for
 - i. Acid spills
 - ii. Pesticide fires
 - iii. Confined- or enclosed-space fires
 - iv. Deep-seated Class A fires
- c. There are also foams designed solely for use on unignited spills of hazardous liquids
 - i. Unignited chemicals tend to change pH of water or remove water from fire fighting foams
 - ii. Regular fire fighting foams then rendered ineffective

Review Questions: How does fire fighting foam prevent or control a hazard?

See pages 967 of the textbook for answers.

What are the types of foam concentrates used in the fire service? *See pages 969-973 of the textbook for answers.*

E. Foam Proportioning

- FOAM PROPORTIONING IS THE MIXING OF WATER WITH FOAM CONCENTRATE.
- 1. Mixing of water with foam concentrate to form foam solution
 - a. For maximum effectiveness, foam concentrates must be proportioned at the specific percentage for which they were designed
 - i. Percentage rate varies with intended fuel
 - ii. Percentage rate written on outside of foam container
 - Failure to follow procedure will result in poor-quality foam – Will not perform as desired

Instructor Note: Show students sample concentrate containers. Point out the labeled percentage rates on each container.
2. Most foam concentrates intended to be mixed with 94 to 99.9 percent water

Instructor Note: Discuss example mixing ratios, The textbook uses the following, you may wish to add your own:

Using 3 percent foam concentrate: 97 parts water mixed with 3 parts foam concentrate equals 100 parts foam solution

Using 6 percent foam concentrate: 94 parts water mixed with 6 parts foam concentrate equals 100 parts foam solution

- Proportioning percentage for Class A foams can be adjusted to achieve specific objectives

 Within limits recommended by the manufacturer
 - To produce a dry (thick) foam, suitable for exposure protection, creating fire breaks in wildland fires – Adjusted to higher percentage
 - b. To produce wet (thin) foam, rapidly penetrates fuel's surface – Adjusted to lower percentage
 - c. Most Class A foams are mixed in proportions of 1 percent or less
- 4. Class B foams are mixed in proportions from 1 percent to 6 percent
 - Some multipurpose Class B foams designed for use on both hydrocarbon and polar solvent fuels
 - i. Can be used at different concentrations depending on fuel burning
 - ii. Hydrocarbons Normally used at 3 percent rate
 - iii. Polar solvents Normally used at 6 percent rate
 - Newer multipurpose foams may be used at 3 percent concentrations regardless of fuel type
 - b. Always follow manufacturer's recommendations for proportioning
- 5. Proportioning equipment may be designed for
 - a. Mobile apparatus
 - b. Fixed fire protection systems



	Class B
Mixed in proportio	ns from 1 to 6 percent
May be multipurpo	se
 Hydrocarbons – 3 	percent rate
Polar solvents – b	percent rate
Always tollow manu	stacturers recommendations



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- c. Selection depends on
 - i. Foam solution flow requirements
 - ii. Available water pressure
 - iii. Cost of foam
 - iv. Intended use for foam (truck, fixed, or portable)
 - v. Foam agent to be used
- Proportioners and delivery devices (foam nozzle, foam maker) designed to work together

 Using foam proportioner not compatible with delivery device can result in unsatisfactory foam or no foam at all
- 7. Basic methods by which foam may be proportioned
 - a. Eduction
 - b. Injection
 - c. Batch-mixing
 - d. Premixing
- 8. Eduction (Induction)
 - Uses pressure energy in stream of water to induct (draft) foam concentrate into fire stream
 - i. Achieved by passing stream of water through an eductor
 - ii. Eductor depends on Venturi Principle to draw foam through hose connected to foam concentrate container and into water stream
 - b. In-line eductors, foam nozzle eductors use eduction method
- 9. Injection
 - a. Uses external pump or head pressure to force foam concentrate into fire stream at correct ratio for water flow
 - Injection systems are commonly employed in apparatus-mounted or fixed fire protection system applications
- 10. Batch-mixing
 - a. Simplest method of mixing foam concentrate and water





- i. Commonly used to mix foam within fire apparatus water tank or portable water tank
- ii. Common with Class A foams, less common with Class B foams
- 11. Batch-mixing Disadvantages and special considerations
 - May not be effective on large incidents When tank is empty, foam attack lines must be shut down until tank filled with water, concentrate added
 - b. Class B concentrates and water must be circulated for a period of time to ensure thorough mixing before solution is discharged – time required depends on viscosity, and solubility of foam concentrate
 - c. Can be difficult to refill an apparatus water tank due to excessive bubbling from residual solution
 - d. After the incident, all components in which foam was batch-mixed must be thoroughly flushed with plain water
 - e. Because foam solution goes through pump during batch-mixing, pump may require additional maintenance due to foam's degreasing capabilities
- 12. Premixing
 - a. Premeasured portions of water and foam concentrate are mixed in a container
 - b. Commonly used method
 - c. Typically used with
 - i. Portable extinguishers
 - ii. Wheeled extinguishers
 - iii. Skid-mounted twin-agent units
 - iv. Vehicle-mounted tank systems
 - d. In most cases, premixed solutions are discharged from pressure-rated tank using compressed inert gas or air
 - e. Pump and non-pressure-rated atmospheric storage tank – pump discharges foam solution through piping or hose to delivery devices

- f. Premix systems are limited to one-time application – when used, tank must be completely emptied and then refilled before it can be used again
- g. Since most Class A foams are biodegradable, premixing solution and storing it for long periods can result in decreased foaming ability

Review Question: Which methods can be used to proportion foam?

See pages 975-977 of the textbook for answers.

II. PROPORTIONERS, DELIVERY DEVICES, AND GENERATING SYSTEMS

Objective 5 — Explain the advantages and disadvantages of various foam proportioners, delivery devices, and generating systems.

A. Proportioners, Delivery Devices, and Generating Systems

- In addition to a pump to supply water and fire hose to transport it, two other pieces of equipment needed to produce foam fire stream
 - a. Foam proportioner
 - b. Foam delivery device Nozzle or generating system
 - c. Proportioner and delivery device/system must be compatible to produce usable foam
- 2. Results of process
 - Foam proportioning Introduces appropriate amount of foam concentrate into water to form foam solution
 - Foam-generating system/nozzle Adds air into foam solution to produce finished foam

B. Foam Proportioners

pp. 978-983





Instructor Note: Provide students an opportunity to look at the different types of proportioners. Discuss the differences in proportioners used in your organization.



- Portable foam proportioners Simplest and most common in use today
 - a. In-line foam eductors
 - i. Most common type of foam proportioner used in fire service
 - ii. Designed to be directly attached to pump panel discharge outlet or connected at some point in hose lay
 - iii. When using, important to follow manufacturer's instructions about
 - (a) Inlet pressure
 - (b) Maximum hose lay between eductor and appropriate discharge nozzle
 - iv. In-line eductors use the Venturi Principle to draft foam concentrate into the water stream
 - (a) Eductor pickup tube is connected to eductor at this low-pressure point
 - (b) Pickup tube submerged in foam concentrate draws concentrate into water stream, creating foam/water solution
 - (c) Foam concentrate inlet to eductor should not be more than 6 feet (2 m) above liquid surface of foam concentrate – if inlet is too high, foam concentration will be very lean or foam may not be inducted at all
 - b. Foam nozzle eductors
 - i. Operates on same principle as in-line eductor; eductor built into nozzle rather than into hoseline
 - (a) Requires foam concentrate to be available where nozzle is operated
 - (b) If foam nozzle is moved, foam concentrate container must also be moved

- (c) Size and number of concentrate containers required magnify logistical problem of relocation
- (d) Use of foam nozzle eductor can compromise firefighter safety – firefighters cannot always move quickly, may have to leave concentrate supplies behind if required to retreat
- 2. Apparatus-mounted proportioners
 - a. Foam proportioning systems are commonly mounted on
 - i. Structural apparatus
 - ii. Industrial apparatus
 - iii. Wildland apparatus
 - iv. Aircraft rescue and fire fighting apparatus (ARFF)
 - v. Fire boats
 - b. Types of apparatus-mounted foam proportioning systems
 - i. Installed in-line eductors
 - ii. Around-the-pump proportioners
 - iii. Balanced pressure proportioners

Ask Students: Which types of apparatus-mounted foam proportioning systems are used in your jurisdiction(s)?

Answers will vary according to systems in the students' jurisdictions.

- 3. Compressed-air foam systems (CAFS)
 - a. Mounted on many types of fire fighting apparatus
 - b. A CAFS system functions as follows
 - i. A standard centrifugal pump supplies the water
 - ii. A direct-injection foam-proportioning system mixes foam solution with the water on the discharge side of the pump
 - iii. An onboard air compressor adds air to the mix before it is discharged from the apparatus
 - c. With CAFS, the hoseline contains the finished foam





- d. Advantages of using compressed-air foam
 - i. Stream reach is considerably longer than with other foam systems
 - ii. Hoselines are lighter than those full of water or foam solution
 - iii. Foam produced is very durable
 - iv. Foam produced adheres well to vertical surfaces
- e. Some disadvantages of using compressedair foam
 - i. CAFS adds expense to purchase and maintenance of apparatus
 - Stored energy created by compressed air pressure in the hose can create a high nozzle reaction when the nozzle is opened – may throw nozzle operator off balance
 - iii. Additional training required for firefighters, driver/operators

Instructor Note: Show students examples of the different types of foam delivery devices as you explain each type. Discuss the similarities and the differences.

C. Foam Delivery Devices (Nozzles/Generating Systems)

- 1. Designed to discharge foam, sometimes called foam makers
- 2. Many types, including standard fire stream nozzles

NOTE: Foam nozzle eductors are considered portable foam nozzles but they have been omitted from this section because they were covered earlier in the Portable Foam Proportioners section.

- 3. Handline nozzles
 - a. Smooth bore and fog handline nozzles
 - i. Generally flow less than 350 gpm (1 400 L/min)
 - ii. Most flow considerably less



- b. Smooth bore nozzles Use limited to certain types of Class A foam applications
 - i. Provides effective fire stream with maximum reach capabilities
 - ii. Most often used with compressed air foam systems (CAFS)
- c. Fog nozzles
 - i. Can be used with foam solutions to produce low-expansion, short-lasting foam
 - ii. Break foam solution into tiny droplets, use agitation of water droplets moving through air to achieve foaming action
 - iii. Best application with regular AFFF and Class A foams
 - iv. Cannot be used with protein and fluoroprotein foams
 - v. May be used with alcohol-resistant AFFF foams on hydrocarbon fires
 - (a) Should not be used on polar solvent fires
 - (b) Insufficient aeration occurs to handle polar solvent fires
 - vi. Some nozzle manufacturers have foam aeration attachments – Can be added to end of nozzle to increase aeration of foam solution
- d. Air-aspirating foam nozzles
 - i. Most effective appliance for generation of low-expansion foam
 - ii. Inducts air into foam solution using Venturi Principle
 - iii. Nozzle especially designed to provide aeration required to make highest quality foam possible
 - iv. Must be used with protein and fluoroprotein concentrates; may also be used with Class A foams
 - v. Provide maximum expansion of the agent
 - vi. Reach of stream is less than that of standard fog nozzle

- e. Advances in foam technology have created specialized application systems
 - i. Uses solid foam/wetting agent
 - ii. Solid agent container is inserted into specially perforated foam sleeve between hoseline and adjustable fog nozzle
 - iii. Concentrate is designed for use on Class A and Class B fires
 - (a) Each 1½-pound (0.68 kg) cartridge of solid agent equal to 5 gallons (18.93 L) liquid agent
 - (b) Each cartridge will treat approximately 660 gallons (2 498.37 L) of water
- 4. Medium- and high-expansion foam generating devices
 - a. Produce a foam that is semi-stable with high air content
 - b. Two basic types
 - i. Water-aspirating type nozzle
 - ii. Mechanical blower generator
 - c. Water-aspirating type nozzle
 - i. Similar to other foam producing nozzles
 - (a) Larger and longer
 - (b) Back of nozzle open to allow air flow
 - ii. Foam solution pumped through nozzle in fine spray that mixes with air to form moderate-expansion foam
 - End of nozzle has screen or series of screens that break up foam even more while mixing with air
 - iv. Typically produce foam with lower air volume than do mechanical blower generators
 - d. Mechanical blower generator
 - i. Similar in appearance to smoke ejector
 - Operates on same principle as wateraspirating nozzle, except powered fan used to force air through foam spray instead of water movement
 - iii. Produces foam with high air content



- iv. Typically associated with total-flooding applications
- v. Use limited to high-expansion foam

Review Question: What are the advantages of each type of foam delivery device? See pages 981-983 of the textbook for answers.

III. ASSEMBLING A FOAM FIRE STREAM SYSTEM

pp. 983-984

Objective 6 — Identify causes of poor foam production.



A. Assembling a Foam Fire Stream System

- To provide foam fire stream Firefighter or apparatus driver/operator must be able to
 - a. Correctly assemble components of the system
 - b. Locate problem areas
 - c. Make adjustments
- 2. Most common reasons for failure to generate foam, for generating poor-quality foam
 - Eductor and nozzle flow ratings do not match – Prevent foam concentrate from inducting into fire stream
 - b. Air leaks at fittings Cause loss of suction
 - Improper cleaning of proportioning equipment – Causes clogged foam passages
 - d. Nozzle not fully open Restricting water flow
 - e. Hose lay on discharge side of the eductor is too long
 - i. Creating excess back pressure
 - ii. Causing reduced foam pickup at eductor
 - f. Hose kinked Restricts or stops flow
 - g. Nozzle too far above eductor Causes excessive elevation pressure
 - Mixing different types of foam concentrate in same tank – Results in mixture too viscous to pass through eductor

Review Question: What are some possible causes of poor foam production? *See pages 983-984 of the textbook for answers.*

IV. FOAM APPLICATION TECHNIQUES

pp. 984-985





Objective 7 — Distinguish among various foam application techniques.

A. Foam Application Techniques

- Important to use correct techniques when applying foam from handline or master stream nozzles
- 2. If incorrect techniques used, effectiveness of foam is reduced

B. Roll-On Method

- Directs foam stream on ground near front edge of burning liquid spill – foam rolls across surface of fuel
- 2. Firefighters continue to apply foam until it spreads across entire surface of fuel and fire is extinguished
- It may be necessary to move stream to different positions along edge of liquid spill to cover entire pool
- 4. Method used only on pool of ignited or unignited liquid fuel on open ground

C. Bank-Down Method

- May be employed when elevated object is near or within the area of burning pool of liquid or unignited liquid spill – may be wall, tank shell, similar vertical structure
- 2. Foam stream directed onto object, allowing foam to run down and onto surface of fuel
- 3. It may be necessary to direct the stream onto various points around fuel area to achieve total coverage and extinguishment of fuel



 Method used primarily on fires contained in diked pools around storage tanks and fires involving spills around damaged or overturned transport vehicles

D. Rain-Down Method

- Used when other two methods are not feasible because of size of ignited or unignited spill area or lack of object from which to bank foam
- 2. Primary manual application technique used on aboveground storage tank fires
- Directs stream into air above fire or spill and allows foam to float gently down onto surface of fuel
 - On small fires, operator sweeps stream back and forth over entire surface of fuel until fuel completely covered and fire extinguished
 - b. On large fires, may be more effective for firefighter to direct stream at one location and to allow the foam to collect there and float out from that point

Review Question: What are the three main types of foam application techniques and how do they work? *See pages 984-985 of the textbook for answers.*

V. FOAM HAZARDS

pp. 985-986



Objective 8 — Identify foam hazards and ways to control them.

A. Foam Hazards

- 1. Foam concentrates
 - a. Either full strengths or in diluted forms Pose minimal health risks to firefighters
 - b. Concentrates may be mildly irritating to skin and eyes – Affected areas should be flushed with water

- c. Some concentrates and their vapors may be harmful if ingested or inhaled
- d. Consult manufacturer's safety data sheets (SDS) for information on any specific foam concentrate
- 2. Most Class A and Class B foams
 - a. Are mildly corrosive
 - Although foam concentrate is used in small percentages and in diluted solutions, follow proper flushing procedures to prevent damage to equipment
 - c. Pumps, eductors, hoselines and nozzles must be thoroughly flushed and washed to remove concentrate residue
- 3. Effect of finished foam after it has been applied to liquid fuel fire or spill
 - a. Primarily environmental concern
 - b. Biodegradability of foam is determined by rate at which environmental bacteria cause it to decompose
 - i. Decomposition process results in consumption of oxygen
 - ii. In river, stream, pond, or lake, the subsequent reduction in oxygen can kill fish and other aquatic creatures
 - c. Take care to prevent foam from directly entering bodies of water
 - Less oxygen required to degrade a particular foam, better or more environmentally friendly when it enters body of water
- 4. Environmental effect of foam concentrate varies
 - a. Each foam concentrate manufacturer can provide information on its specific products
 - In United States, Class A foams should be approved by the U.S. Department of Agriculture Forest Service for environmental suitability
 - c. The chemical properties of Class B foams and their environmental effects vary



depending on type of concentrate and manufacturer

- d. Generally, protein-based foams are safer for the environment
- e. Consult the various manufacturers' data sheets for environmental impact information

Review Question: How can firefighters work to mitigate foam hazards?

See pages 985-986 of the textbook for answers.

VI. SKILLS

pp. 993-994 Objective 9 — Place a foam line in service using an inline eductor.

pp. 995-998 Objective 10 — Extinguish an ignitable liquid fire.

VII. SUMMARY AND REVIEW



A. Chapter Summary

- 1. Firefighters must know the differences between the types of foam used by their departments.
- 2. They must know how to generate foam.
- 3. They must know how to apply foam most effectively.

B. Review Questions

- 1. How does fire fighting foam prevent or control a hazard? (p. 967)
- 2. What are the types of foam concentrates used in the fire service? (*pp. 969-973*)
- 3. Which methods can be used to proportion foam? (*pp. 975-977*)
- 4. What are the advantages of each type of foam delivery device? (pp. 981-983)
- 5. What are some possible causes of poor foam production? (*pp. 983-984*)
- 6. What are the three main types of foam application techniques and how do they work? *(pp. 984-985)*

7. How can firefighters work to mitigate foam hazards? (*pp. 985-986*)

Chapter 17 Fire Control

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Fire Control	,	
Module 1		
Chapter 17		
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Lesson Goal

After completing this lesson, the student shall be able to discuss fire control of fires in structures, in Class C fires, in Class D fires, vehicle fires, and ground cover fires and be able to perform various skills related to fire attack.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe initial factors to consider when suppressing structure fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 2. Summarize considerations taken when making entry. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 3. Describe direct attack, indirect attack, combination attack, and gas cooling techniques. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 4. Describe safety considerations that must be identified for upper level structure fires. [*NFPA*[®] 1001, 5.3.8, 5.3.10]
- 5. Explain actions taken when attacking belowground structure fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 6. Discuss methods of fire control through exposure protection and controlling building utilities. [*NFPA*[®] 1001, 5.3.18]
- 7. Describe steps taken when supporting fire protection systems at protected structures. [*NFPA*[®] 1001, 5.3.8, 5.3.10, 5.3.14]
- 8. Explain considerations taken when deploying, supplying, and staffing master stream devices. [NFPA[®] 1001, 5.3.8]
- 9. Describe situations that may require suppression of Class C fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 10. Identify hazards associated with suppressing Class C fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 11. Describe actions associated with suppressing Class D fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 12. Explain actions taken when suppressing a vehicle fire. [NFPA[®] 1001, 5.3.7]
- 13. Compare methods used to suppress fires in stacked and piled materials, small unattached structures, and trash containers. [NFPA[®] 1001, 5.3.8]
- 14. Summarize the main influences on ground cover fire behavior. [NFPA[®] 1001, 5.3.19]



- 15. Compare types of ground cover fires. [NFPA® 1001, 5.3.19]
- 16. Describe elements that influence ground cover fire behavior. [NFPA[®] 1001, 5.3.19]
- 17. Identify the parts of a ground cover fire. [NFPA[®] 1001, 5.3.19]
- 18. Describe protective clothing and equipment used in fighting ground cover fires. [*NFPA*[®] 1001, 5.3.19]
- 19. Describe methods used to attack ground cover fires. [NFPA® 1001, 5.3.19]
- 20. Summarize safety principles and practices when fighting ground cover fires. [NFPA[®] 1001, 5.3.19]
- 21. Attack a structure fire using a direct, indirect, or combination attack. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.13]
- 22. Attack a structure fire above, below, and at ground level Interior attack. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.13]
- 23. Turn off building utilities. [NFPA[®] 1001, 5.3.18]
- 24. Connect supply fire hose to a fire department connection. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.14]
- 25. Operate a sprinkler system control valve. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.14, 5.3.15]
- 26. Stop the flow of water of an activated sprinkler. [NFPA® 1001, 5.3.8, 5.3.10, 5.3.14]
- 27. Deploy and operate a portable master stream device. [NFPA[®] 1001, 5.3.8]
- 28. Attack a passenger vehicle fire. [NFPA[®] 1001, 5.3.7]
- 29. Attack a fire in stacked or piled materials. [NFPA® 1001, 5.3.8]
- 30. Attack a fire in a small unattached structure. [NFPA® 1001, 5.3.8]
- 31. Extinguish a fire in a trash container. [NFPA[®] 1001, 5.3.8]
- 32. Attack a ground cover fire. [NFPA[®] 1001, 5.3.19]

Instructor Information

This is the lesson covering fire control. This lesson describes fire control in structures, stored Class A materials, ground cover, vehicles, Class C materials, and Class D materials.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

I. SUPPRESSING STRUCTURE FIRES

pp. 1004-1008



Objective 1 — Describe initial factors to consider when suppressing structure fires.

A. Strategy and Coordination of Resources

- 1. Determined by Incident Commander (IC)
- 2. Based in order of importance on three priorities
 - a. Incident stabilization
 - b. Property conservation
- 3. Offensive
 - Usually entails deploying resources for interior tactical operations to accomplish incident priorities
 - b. Factors that help tactics used
 - i. Value
 - (a) Life and safety hazards at scene
 - (b) Savable lives and/or salvageable property
 - ii. Time
 - (a) Time to accomplish selected tactics
 - (b) Potential for collapse and deterioration of structural stability
 - (c) Potential changes in fire conditions
 - iii. Size
 - (a) Tactical flow rates needed to control fire
 - (b) Available resources
 - (c) Fire conditions
 - c. Objective Rescue and/or fire extinguishment; may occur simultaneously





- 4. Defensive
 - a. Typically selected given one or more of the following factors
 - i. No threat to occupant life exists
 - ii. Occupants are not savable
 - iii. Property is not salvageable
 - iv. Sufficient resources are not available for offensive strategy
 - v. Danger of structural collapse
 - vi. Offensive strategy would endanger lives of firefighters because of hazardous conditions at scene
 - b. Intended to isolate or stabilize incident and keep it from expanding
 - c. Generally exterior operation chosen because interior attack is unsafe or resources are insufficient
 - d. Employed when following conditions are present at structure fire
 - i. Excessive volume of fire Amount of fire exceeds ability of available resources to confine or extinguish it; lack of resources includes
 - (a) Lack of personnel or lack of trained personnel
 - (b) Inability to provide adequate fire flow in gpm (L/min) because of insufficient pumping capacity or availability of water supply
 - (c) Lack of appropriate apparatus or equipment to implement required tactics
 - ii. Structural deterioration Structure is unsafe for interior entry
 - iii. Risk outweighs benefit If amount of risk to emergency responders is greater than benefit
 - iv. Unfavorable wind conditions Situations where wind conditions prohibit safe entry due to potential development of high temperature flow paths within structure

5	STRATEGIC TRANSITIONS DURING SUPPRESSION MAY OCCUR AT ANY TIME.
	Defensive to offensive
	Offensive to defensive
	Follow guidelinesduring
(Ö) A	

- 5. Strategic transitions
 - a. May occur at any time
 - b. Defensive to offensive
 - i. First-arriving unit may need to deploy hoselines and begin with defensive strategy until additional resources arrive or amount of fire has been reduced or extinguished to safe levels
 - ii. May be necessary when not enough firefighters to meet Occupational Safety and Health Administration (OSHA) two-in, twoout regulation
 - c. Offensive to defensive
 - Necessary when situation rapidly changes Occurrence depends on speed at which situation changes
 - ii. Incident Commander
 - (a) Communicates change to all personnel and units operating at incident
 - (b) Orders personnel accountability report (PAR) from all personnel
 - iii. All personnel must be made aware of transition
 - iv. Supervisors/company officers must always know location of personnel and must conduct personnel accountability checks when withdrawal is complete
 - v. Hoselines should not be abandoned unless absolutely necessary
 - vi. Rapid intervention team or crew (RIT/RIC) must be ready to assist any units during transition
 - vii. Guidelines
 - (a) Use or maintain situational awareness to recognize changes in fire behavior and structural stability
 - (b) Know department's evacuation signal
 - (c) Continue to monitor radio for further orders
 - (d) Remain calm and follow orders

- (e) Stay with team
- (f) Use hoseline to guide to exit
- (g) Use hoseline and have nozzle set on appropriate pattern to protect self during tactical withdrawal
- (h) Evacuate as quickly and as safely as possible
- (i) Respond to requests for PARs
- (j) Know department's SOP on offensive and defensive strategies
- 6. Resource coordination
 - a. Fire attack must be coordinated with
 - i. Forcible entry
 - ii. Search and rescue operations
 - iii. Ventilation
 - iv. Control of utilities
 - b. As operation progresses Must also be coordinated with
 - i. Loss control
 - ii. Cause determination
 - iii. Victim recovery efforts

Instructor Note: Discuss the Safety Box "Situational Awareness Increases Your Safety" on p. 1008 of the textbook. Discuss the definition of situational awareness, as well as acts that can help maintain situational awareness.

B. Hoseline Selection

- 1. Should be dependent upon fire conditions and other factors
 - a. Fire load and material involved
 - b. Flow rate needed for extinguishment
 - c. Stream reach needed
 - d. Number of firefighters available to advance hoselines
 - e. Need for speed and mobility
 - f. Tactical requirements





- g. Ease of hoseline deployment
- h. Potential fire spread
- i. Size of building
- j. Size of fire area
- k. Location of fire
- 2. Selection is critical for efficiency and safety
- 3. For interior fire fighting, area involved and fire load should dictate size of hoseline
- 4. Backup hoseline
 - a. Must be placed in service at same time as primary attack line
 - b. Critical functions
 - i. Protecting attack hoseline team from extreme fire behavior
 - ii. Protecting means of egress for attack hoseline team
 - iii. Providing additional fire suppression capability in event that fire increases in volume
 - c. Should be at least same size and provide same fire flow as attack hoseline
 - d. Should use fog nozzle because it provides greatest protection for both teams
 - e.

Instructor Note: Refer students to Table 17.1 on page xx for a sample analysis of hose stream characteristics. This table is intended to help firefighters make decisions about which hose streams to select.



CAUTION: A hoseline no smaller than $1\frac{1}{2}$ -inch (38 mm) should be used on an interior fire.

- C. Nozzle Selection
 - 1. Based upon
 - a. Fire conditions
 - b. Available water supply

Fire Protection Publications Oklahoma State University

- c. Number of firefighters available to safely operate hoseline
- d. Capabilities of nozzle being used
- 2. Interior fire attack
 - a. Fog nozzle generally most useful
 - b. Wide fog pattern can be used to protect firefighters from radiant heat as well as cool hot fire gases
 - c. Straight stream can be used to penetrate hot gas layer and cool compartment linings or reach burning fuel
- 3. Exterior attack Solid stream
 - a. Best choice
 - b. Will deliver greatest amount of water over farthest distance
 - c. Can be directed through opening at compartment lining, causing stream to disperse into small drops and absorb more heat
- 4. Water pressure and water quantity available
 - a. Determines nozzle type selected
 - b. Nozzle tip that is too large will produce a stream that lacks the necessary pressure to reach the target
 - c. Nozzle tip that is too small will not deliver volume of water required to extinguish fire
- 5. Nozzle reaction will dictate number of personnel required to advance hoseline and operate nozzle within confines of structure
 - a. Greater the reaction, the more firefighters needed
 - b. If number of personnel is limited, may be necessary to reduce size of nozzle or use master stream device from exterior

Review Question: What initial factors must be considered when suppressing structure fires? *See pp. 1004-1011 of the textbook for answers.*

pp. 1011-1013

HOSE	ELINE USE AN	D PLACEMENT W ENTRY .	HEN MAKING
- 11 - 5	icklon made by C upervisor	Place to protect • Firefighters • Occupants • Property	Factors used to place • Whit direction and velocity • adulting conditions • Initial films location • Location • Supporter • Supporter
a .			

Objective 2 — Summarize considerations taken w	/hen
making entry.	

- D. Making Entry
 - 1. Decision made by IC or supervisor
 - 2. Attack hoselines placed to protect
 - a. Firefighters
 - b. Occupants
 - c. Property
 - 3. Factors used to place attack hoselines
 - a. Wind direction and velocity
 - b. Building conditions
 - c. Initial fire location
 - d. Location of occupants
 - e. Exposures
 - 4. Before entering burning building, every member should
 - a. Conduct quick size-up
 - b. Maintain high level of situational awareness
 - 5. Pre-entry considerations critical to firefighter safety and effectiveness
 - a. Reading fire behavior indicators
 - b. Understanding crew's tactical assignment
 - c. Identifying potential emergency escape routes
 - d. Evaluating forcible entry requirements
 - e. Identifying hazards
 - f. Verifying radios are receiving and transmitting on correct channel
 - g. Ensuring self-contained breathing apparatus (SCBA) is on, cylinder is full, and operating properly
 - Ensuring all Personal Alert Safety System (PASS) devices are on and operating properly





- i. Ensuring other team members are prepared to enter structure by doing buddy check
- 6. Interior fire attack crews must carry tools and equipment needed to
 - a. Open interior doors
 - b. Check concealed spaces for fire extension
 - c. Make an emergency exit
- 7. Firefighter assigned to nozzle should
 - a. Open nozzle fully to ensure adequate flow
 - b. Check pattern setting
 - c. Bleed air from hoseline

CAUTION: DO NOT open the door until you have a charged hoseline and are ready to control the conditions encountered.

- 8. When making interior attack on structure fire
 - a. Wait in safe area near building entrance
 - Extinguish visible fires in fascia or soffit, boxed cornices, other exterior overhangs, open windows and doors, or around entry or exit points
 - c. Stay low and out of doorway while door is forced open
 - d. Check door for heat before opening by using back of gloved hand, TI, or applying small amount of water spray to surface of door
 - e. Keep door closed until hoseline is charged and crew is ready to enter
- 9. If fire is ventilation controlled and door is opened
 - a. Significant increase in heat release rate can quickly occur
 - Unburned fuel in form of smoke will escape at top of doorway while fresh air will enter at bottom providing oxygen for fire development
 - c. Cooling overhead hot gases can reduce risk of ignition potentially leading to flashover
- 10. When opening door

- a. Observe smoke movement and airflow
- b. Open slightly, apply water to hot gas layers
- c. Wait 5-10 seconds to observe any reactions before entering structure
- d. Maintain control of door Place rope hose tool or utility strap over doorknob
- e. Chock door to prevent it from closing on hoseline
- 11. Traditional guideline Attack fire from unburned side
 - Disproved by major fire departments and National Institute of Science and Technology (NIST)
 - Factors changing fire service's understanding of fire behavior in structure fires
 - i. Greater heat release rates of modern building construction materials and modern furnishings
 - ii. Increased effect of wind on fire expansion and development
- 12. Wind creates airflow patterns within structure
 - a. Directly increase fire expansion and cause firefighter casualties
 - b. Attack with wind to back
 - c. To determine best entry point based upon wind direction, IC should complete thorough size-up and do 360-degree survey, whenever possible, before deploying attack hoselines

Review Question: What are the factors that must be considered when making entry? *See pp. 1011-1013 of the textbook for answers.*

Objective 3 — Describe direct attack, indirect attack, combination attack, and gas cooling techniques.

E. Fire Attack



рр. 1013





- 1. Direct attack
 - a. Uses water most efficiently on free-burning fires (when using solid or straight stream)
 - b. Water is applied directly onto burning fuels until fire is extinguished
 - c. Direct stream onto ceiling and walls to slow or stop pyrolysis process on hot surfaces
 - d. Do not apply water long enough to upset thermal layering in compartment
- 2. Indirect attack
 - a. Used when firefighters are unable to enter burning building or compartment because of intense heat inside
 - b. Can be made from outside structure or involved area
 - c. Made through window or other opening, directing stream toward ceiling to cool room
 - d. Produces large quantities of steam and must be coordinated with ventilation
 - e. Cools fire environment and results in fairly uniform temperature from floor to ceiling and fills compartment with combined mixture of smoke and steam
 - f. Steps
 - i. Fog stream is introduced through opening and directed at ceiling where temperature is highest
 - Heat converts water spray to steam, which fills compartment and absorbs majority of heat
 - One majority of fire has been reduced in quantity and space has been ventilated, hoselines can be advanced inside and firefighters can make direct attack on body of fire
- 3. Combination attack
 - a. Combines cooling hot gas layer at ceiling level using indirect attack with direct attack on fuels burning near floor level
 - b. Move nozzle from area overhead to floor in a Z, inverted T, or rotational manner



- c. Excessive application of water to smoke does not extinguish fire and may cause unnecessary water damage and disturbance of thermal layering
- d. Applying water to smoke that is not heated may disrupt the thermal layering and decrease visibility

Review Question: How do direct attack and combination attack techniques compare with one another? *See pp. 1013-1014 of the textbook for answers.*

F. Gas Cooling

- 1. Way of reducing heat release from hot gas layer
- 2. Effective when faced with shielded fire (a fire you cannot see from the doorway because it is located in remote part of structure or objects are hiding the fire)

Instructor Note: Remind students that smoke is fuel, and it may transition to rollover, flashover, or a smoke explosion at any time.

- 3. Slows transfer of heat to other combustibles and reduces the chances of overhead gases igniting
- 4. Steps
 - a. Direct short bursts or pulses of water fog onto gas layer
 - Set nozzle on fog pattern, direct it upward toward gas layer and quickly and smoothly open and close it
 - c. Vary length of pulse depending on size of space
 - d. Adjust nozzle pattern based on fire conditions in compartment and configuration and size
 - e. Restrict fog pattern in narrow hallways
 - f. Increase pulses in large-volume compartments or when upper layer temperature is extremely high



- g. Ensure that stream reach is cooling gas layer, NOT the ceiling
- h. Repeat as necessary while hose team advances under gas layer toward fire

Review Question: What are the main differences between indirect attack and gas cooling techniques? *See pp. 1014-1015 of the textbook for answers.*

Objective 4 — Describe safety considerations that must be identified for upper level structure fires.

G. Fires in Upper Levels of Structures

- 1. In structures that lack standpipes
 - a. Fire attack proceeds through main entrance and up closest stairway to fire location
 - b. Check for fire extension below fire floor before advancing up stairs
- 2. In structures equipped with standpipe systems
 - a. Location of standpipe will determine method of fire attack
 - b. If located in unprotected location, attack hoseline is connected on floor below fire floor and advanced up nearest stairwell
 - c. If located in protected stairway
 - i. Hoselines may be connected on fire floor
 - Extra sections of attack hoseline may be flaked up stairway to first landing above fire floor
- 3. Can require large numbers of personnel
 - a. Conduct large-scale evacuations
 - b. Carry tools and equipment to upper levels
 - c. Maintain sustained fire attack
- 4. Use of elevators
 - a. Must not be used to transport fire crews to fire floor
 - b. May be used to transport personnel, fire fighting tools, and equipment to staging area (normally located two floors below the fire floor)



pp. 1016-1017



Instructor Note: Remind students to exercise caution in the streets around the perimeter of the high-rise building. Glass and other debris falling from many stories above the street can be dangerous and even deadly.

Review Question: How does the presence or absence of a standpipe system impact upper level structure fires? *See pp. 1016-1017 of the textbook for answers.*

Objective 5 — Explain actions taken when attacking belowground structure fires.

H. Belowground Structure Fires

- 1. Residential basements
 - a. May be used as
 - i. Self-contained living quarters
 - ii. Entertainment rooms
 - iii. Utility spaces for
 - (a) Storage
 - (b) Heating, ventilation, and air conditioning equipment
 - (c) Water heaters
 - (d) Coal or fuel oil storage
 - iv. Garages
 - v. Storm shelters
 - b. May be totally unfinished, partially finished, or completely finished
 - i. In unfinished basement First floor joists are exposed to fire and will fail sooner than ceiling protected with drywall
 - ii. Because unfinished basements are generally unoccupied – Fire may have chance to spread before found
 - iii. In partially or completely finished basements

 Ceiling may be composed of metal grid system to support drop-in tiles that offer minimal fire resistance and may add to fuel load

рр. 1017-1020





- c. Other factors contributing to basement fires
 - i. Fuel loading
 - ii. Age of exposed joists
 - iii. Hidden path for fire in walls and ducts that could be exposed in basements
 - iv. Use of lightweight construction materials that are susceptible to rapid collapse
- d. If converted to living spaces, create life safety hazards
- e. Initial size-up extremely important

WARNING: Basement fires weaken the main floor of a structure creating a constant danger of structural collapse.

- f. Floor assemblies over basements can reach point of collapse *before* firefighters arrive on scene
 - i. Underwriters Laboratories tests
 - ii. Sounding floor and using thermal imager NOT sufficient to determine if floor is safe to walk on
 - iii. After fire is extinguished, visual inspection of floor joists should be made before personnel are permitted to work

CAUTION: Thermal imagers (TI) will not always provide an accurate assessment of structural integrity of the floor system.

- g. Access may be made through
 - i. An interior or exterior enclosed stairwell
 - (a) Act as flow path for smoke, flames, and heated gases
 - (b) Attempting to advance attack hoseline may be only available avenue
 - (c) Exposes firefighters to tremendous hazards
 - ii. An exterior open stairwell
 - iii. Window wells
 - iv. A grade-level walk-in door or window
- h. Water from 1½- to 1 ¾-inch (38 mm to 45 mm) hoseline may not provide enough



cooling to overcome gases venting up stairway

i. If fire is ventilation limited, added ventilation may result in flashover of basement and be fatal to firefighters on stairs or in basement

Review Question: What are the main actions that should be taken when attacking a below ground structure fire? *See pp. 1017-1020 of the textbook for answers.*

- 2. Commercial basements and subfloors
 - a. May have similar construction to those residential structures
 - May be more robust than residential basements if fuel load on main floor is significant
 - c. Older Floor joists may be exposed wood joists or heavy timbers
 - Modern Floor joists may be exposed or unexposed concrete panels or metal Cjoists
 - e. May include multiple subfloors used for mechanical spaces or parking garages
 - f. Exposure may weaken metal floor supports
 - i. Heavy objects on floor above fire can increase chances of floor collapse because added weight accelerates failure of supporting members
 - ii. Unprotected steel girders and other supports elongate when exposed to temperatures of 1,000°F (538°C)
 - iii. Supports have been known to topple walls during fire
 - g. Standpipe connections may exist in stairwells leading to subfloors
 - h. Risk/benefit analysis Performed same way as residential basement fire
 - i. Preincident surveys and inspections
 - i. Help determine type of basement ceiling construction
 - ii. Help determine amount of fire can withstand before collapse



Should include location of standpipe connections and potential ventilation airflow paths

Review Question: How quickly can floor assemblies over basements reach a point of collapse? *See pp. 1020 of the textbook for answers.*

Objective 6 — Discuss methods of fire control through exposure protection and controlling building utilities.

I. Exposure Protection

- 1. Protection of areas unaffected by fire
- 2. Can take a number of forms depending on location and type and resources available
- 3. Interior exposure protection
 - a. Closing doors or other openings between fire area and unaffected area
 - b. Proper use of tactical ventilation to ensure that smoke movement is limited
 - c. Passive forms Fire-rated walls and doors
- 4. Exterior exposure protection
 - a. Remove endangered persons, property, or items
 - i. Especially useful at fast-moving fires, ground cover fires, and flammable liquid fires
 - ii. May include
 - (a) Evacuating persons who are in path of fire
 - (b) Relocating parked vehicles or railroad cars
 - (c) Using forklifts or other heavy equipment to move piled storage
 - (d) Relocating fire apparatus when fastmoving fires have put them in danger
 - Apply protective spray of water or foam extinguishing agent between fire and exposure

pp. 1020-1026



- i. Most likely approach, especially if exposure is adjacent structure
- ii. Keeps exposed surface cool, limiting effect of radiated heat on exposure
- iii. Direct application more effective than traditionally used water curtain

J. Controlling Building Utilities

1. Helps control fire and limits damage

Instructor Note: Remind students that fire department personnel are not responsible for turning utilities back on and should NOT attempt to do so.

- 2. Electricity
 - a. Sources Commercial power company or alternative power source
 - b. Must be disconnected when fire in structure
 - c. Commercial power supply
 - i. Provided to urban, suburban, and rural areas by commercial company
 - ii. Lines may be above or belowground; connect structures to main power grid
 - iii. Primarily location for shutting off power Electric meter
 - (a) Locations vary
 - (b) Pull handle on side of meter box down
 - (c) In residential structure, can shut off main circuit breakers; individual circuit breakers will NOT cut all power off
 - iv. Should not be shut off until ordered because electrical power is necessary to operate elevators, air-handling equipment, and other essential systems
 - v. If shut off, main power switch should be locked out and tagged out or firefighter must be assigned to stand by
 - vi. May need to remain on to provide power for lighting, ventilation equipment fire pumps, and other essential systems



Ask Students: Can fire department personnel remove the meter box, if necessary?

Briefly discuss answers with students. Explain that ONLY the power company should ever attempt to remove a meter. Also remind them that in some residential and commercial occupancy, removing the electric meter does NOT completely stop the flow of electricity to the structure.

Instructor Note: Discuss the Safety Box "Avoid Service Masts" on p. 1023 of the textbook. Discuss the potentially dangerous situation of coming in contact with an electrified mast pipe.

- d. Alternative sources
 - i. Solar panels
 - (a) Can generate enough power to kill a person
 - (b) Marked with red warning labels
 - (c) Most have two shutoff switches
 - (d) Will include shutoff switch on electric meter
 - (e) If found on roof while performing tactical vertical ventilation avoid completely

WARNING: Solar panels generate current whenever there is a light source (sunlight, moonlight, artificial lighting) and are always energized.

- ii. Wind turbines
 - (a) Provide alternative power in addition to or in place of Power Company
 - (b) Power can be turned off at meter box with main power shutoff
- iii. Fuel-powered generators
 - (a) Primarily used to replace Power Company's service when service is interrupted
 - (b) May be sole source of power





(c) Can be controlled by simply shutting off

NOTE: When shutting off building utilities do not assume there is no back-up generator or alternative source of energy present. Always use CAUTION when performing this skill and refer to local policy for further guidance.

- 3. Gas utilities
 - a. Natural gas
 - i. In pure form is methane, which has flammability range of 5 to 15 per cent
 - ii. Lighter than air, so rises and diffuses in open
 - iii. Nontoxic, but classified as asphyxiant
 - iv. Has no odor, but has smell added
 - v. Can be shut off at meter
 - (a) Usually located outside, but may be found inside
 - (b) Close valve using spanner wrench, pipe wrench, or similar tool to turn rectangular bar (tang) 90 degrees to pipe
 - vi. Contact utility company when gas has been shut off or when any emergency involving natural gas occurs
 - (a) Will provide crew equipped with special tools, maps of distribution system, and training and experience needed
 - (b) Their responsibility to turn utilities back on after they have been shut off

CAUTION Hubble Jass that the subsidie rais to the subsidie rais

CAUTION: Natural gas that leaks underground in wet soil can lose its odorant and become difficult to detect without instruments.

- b. Liquefied petroleum gas (LPG)
 - i. Fuel gases stored in liquid state under pressure
 - ii. Includes two main gases Butane and propane; propane most widely used
 - iii. Used primarily as fuel gas in campers, manufactured homes, agricultural applications, rural homes, and businesses


- iv. Used as fuel for motor vehicles
- v. Has no odor, but smell is added
- vi. Nontoxic, but classified as asphyxiant
- vii. One and one-half times as heavy as air; will sink to lowest point possible
- viii. Explosive in concentrations between 1.5 and 10 percent
- ix. Shipped from distribution point to point of usage in cylinders and tanks on cargo trucks
- x. Stored in cylinders and tanks near point of use; tank or cylinder is connected by steel piping and copper tubing to appliances
- xi. Supply may be stopped by shutting valve at tank valve
- xii. Leak will produce visible cloud of vapor that hugs ground; fog stream of at least 100 gpm (400 L/min) can be used to dissipate
- xiii. Shutoff valve should be located at point where supply line from tank enters structure
- xiv. Do not open valve after fire or emergency is terminated; responsibility of owner and LPG supplier
- 4. Water
 - a. Should be shut off to prevent water damage from broken pipes
 - b. Shutoff valves located underground with water meter
 - c. Location will depend on the location of the water distribution lines in jurisdiction
 - d. Water shutoff keys or pipe wrenches should be used to turn tang 90 degrees to pipe
 - e. Commercial structures and large institutional and industrial facilities have larger supply lines and larger tangs; will require special water shutoff key
 - f. Restoration responsibility of water department or owner

Review Question: How can using exposure protection or controlling building utilities help in fire control? *See pp. 1020-1026 of the textbook for answers.*

II. SUPPORTING FIRE PROTECTION SYSTEMS AT PROTECTED STRUCTURES

pp. 1027-1028

Objective 7 — Describe steps taken when supporting fire protection systems at protected structures.



A. Connecting to a FDC

- 1. One of first priorities at fire in protected structure
- 2. Allows pumper to supplement water supply and pressure in structure's sprinkler or standpipe system
- 3. Each is labeled for system and/or building zone it serves

B. Shutting a Control Valve

- 1. Stops water flow from activated sprinkler heads
- 2. Located between sprinkler system and main water supply
- 3. Used to shut down water supply to entire system
- 4. Located immediately under alarm valve, drypipe or deluge valve, or outside building near sprinkler system
- 5. Either secured in open position with chain and padlock or electronically supervised to make sure not inadvertently closed
- 6. Should only be done once fire is under control and IC has given order
- 7. If closed, requires firefighter with portable radio so that valve can be reopened if necessary

NOTE: Some departments prefer to plug active sprinklers individually rather than close the fire suppression system's control valve.

- 8. Types of control valves
 - a. Outside stem and yoke (OS&Y) valve
 - i. Has yoke on outside with threaded stem that opens and closes gate inside valve housing

- ii. Threaded portion of stem is visible beyond yoke when valve is open and not visible when valve is closed
- b. Post indicator valve (PIV)
 - i. Hollow metal post that houses valve stem
 - ii. Attached to valve stem is movable plate with words OPEN or SHUT visible through small glass window on side of housing
 - iii. When not in use, operating handle is locked to valve housing
- c. Wall post indicator valve (WPIV) Similar to PIV except that it extends horizontally through wall with target and valve operating nut on outside of building
- d. Post indicator valve assembly (PIVA)
 - i. Does not use plate with words OPEN and SHUT
 - ii. Uses a circular disk inside flat plate on top of valve housing
 - iii. When valve is open, disk is perpendicular to surrounding plate
 - iv. When valve is closed, disk is in line with plate that surrounds it
 - v. Operated with built-in crank

C. Stopping the Flow from a Sprinkler

- 1. Once fire has been brought under control in protected structure
- 2. May include use of wooden wedges, sprinkler tongs, and other devices

Review Question: What are the steps that must be taken when supporting a fire protection system at a protected structure? *See pp. 1027-1028 of the textbook for answers.*

III. DEPLOYING MASTER STREAM DEVICES

pp. 1028-1031

Objective 8 — Explain considerations taken when deploying, supplying, and staffing master stream devices.

A. Deploying Master Stream Devices

- 1. Usually deployed in situations where
 - a. Fire is beyond effectiveness of handlines
 - b. There is need for fire streams in areas that are unsafe for firefighters
- 2. Four main uses
 - a. Direct fire attack
 - b. Indirect fire attack
 - c. Supplement handlines that are already attacking fire from exterior
 - d. Provide exposure protection
- 3. Proper placement
 - a. Must be properly positioned to apply effective stream on fire
 - b. If necessary to move, must be shut down
 - c. Angle at which stream enters structure Aim stream so it enters structure at upward angle causing it to deflect off ceiling or other overhead objects
 - d. Place master stream device in location that allows stream to cover most surface area of building
- 4. Can be effective for providing exposure protection to other structures
 - a. Direct stream at surface of structure that faces fire
 - b. Create water curtain between fire and exposure





CAUTION

STAFFING MASTER STREAM DEVICES USUALLY REQUIRES TWO FIREFIGHTERS.

ELEVATED MASTER STREAMS ARE USED FOR

UPPER STORIES IN MULTISTORY BUILDINGS

B. Supplying Master Streams

- Not practical to supply with anything less than two 2 ¹/₂-inch (65 mm) hoselines
- May be temporarily supplied by one 2 ½-inch (65 mm) line while adding additional hoselines
- When greater quantities of water are required, third 2 ½-inch (65 mm) or large-diameter supply line will be required
- 4. Operation consumes large volumes of water that accumulate inside structures
 - a. Adds weight
 - b. Increases potential for structural collapse during overhaul and fire investigation activities

CAUTION: Added water weight from master stream operations increases the potential for structural collapse.

C. Staffing Master Stream Devices

- 1. Deployment usually requires a minimum of two firefighters
- 2. Once in place, can be operated by one firefighter
- 3. When water is flowing, at least one firefighter should be stationed at all times
- 4. If situation is too dangerous to have firefighters stationed, can be securely anchored in position

D. Elevated Master Streams

- 1. Used to apply water to upper stories of multistory buildings
- 2. Can provide exposure protection to endangered structures
- 3. Can be delivered by a number of different types of aerial apparatus



Review Question: How should a master stream device be properly deployed? *See pp. 1028-1030 of the textbook for answers.*



Chapter 17 Fire Control

Eiro Control	
Module 2	
Chapter 17	
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Lesson Goal

After completing this lesson, the student shall be able to discuss fire control of fires in structures, in Class C fires, in Class D fires, vehicle fires, and ground cover fires and be able to perform various skills related to fire attack.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe initial factors to consider when suppressing structure fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 2. Summarize considerations taken when making entry. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 3. Describe direct attack, indirect attack, combination attack, and gas cooling techniques. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 4. Describe safety considerations that must be identified for upper level structure fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 5. Explain actions taken when attacking belowground structure fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 6. Discuss methods of fire control through exposure protection and controlling building utilities. [*NFPA*[®] 1001, 5.3.18]
- 7. Describe steps taken when supporting fire protection systems at protected structures. [*NFPA*[®] 1001, 5.3.8, 5.3.10, 5.3.14]
- 8. Explain considerations taken when deploying, supplying, and staffing master stream devices. [NFPA[®] 1001, 5.3.8]
- 9. Describe situations that may require suppression of Class C fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 10. Identify hazards associated with suppressing Class C fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 11. Describe actions associated with suppressing Class D fires. [NFPA[®] 1001, 5.3.8, 5.3.10]
- 12. Explain actions taken when suppressing a vehicle fire. [NFPA[®] 1001, 5.3.7]
- 13. Compare methods used to suppress fires in stacked and piled materials, small unattached structures, and trash containers. [NFPA[®] 1001, 5.3.8]
- 14. Summarize the main influences on ground cover fire behavior. [NFPA[®] 1001, 5.3.19]



- 15. Compare types of ground cover fires. [NFPA® 1001, 5.3.19]
- 16. Describe elements that influence ground cover fire behavior. [NFPA[®] 1001, 5.3.19]
- 17. Identify the parts of a ground cover fire. [NFPA[®] 1001, 5.3.19]
- 18. Describe protective clothing and equipment used in fighting ground cover fires. [*NFPA*[®] 1001, 5.3.19]
- 19. Describe methods used to attack ground cover fires. [NFPA® 1001, 5.3.19]
- 20. Summarize safety principles and practices when fighting ground cover fires. [NFPA[®] 1001, 5.3.19]
- 21. Attack a structure fire using a direct, indirect, or combination attack. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.13]
- 22. Attack a structure fire above, below, and at ground level Interior attack. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.13]
- 23. Turn off building utilities. [NFPA[®] 1001, 5.3.18]
- 24. Connect supply fire hose to a fire department connection. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.14]
- 25. Operate a sprinkler system control valve. [NFPA[®] 1001, 5.3.8, 5.3.10, 5.3.14, 5.3.15]
- 26. Stop the flow of water of an activated sprinkler. [NFPA® 1001, 5.3.8, 5.3.10, 5.3.14]
- 27. Deploy and operate a portable master stream device. [NFPA[®] 1001, 5.3.8]
- 28. Attack a passenger vehicle fire. [NFPA[®] 1001, 5.3.7]
- 29. Attack a fire in stacked or piled materials. [NFPA® 1001, 5.3.8]
- 30. Attack a fire in a small unattached structure. [NFPA® 1001, 5.3.8]
- 31. Extinguish a fire in a trash container. [NFPA[®] 1001, 5.3.8]
- 32. Attack a ground cover fire. [NFPA[®] 1001, 5.3.19]

Instructor Information

This is the lesson covering fire control. This lesson describes fire control in structures, stored Class A materials, ground cover, vehicles, Class C materials, and Class D materials.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills evaluation checklists. The level of learning is application.

I. SUPPRESSING CLASS C FIRES

pp. 1031-1037



Objective 9 — Describe situations that may require suppression of Class C fires.

A. Suppressing Class C Fires

- 1. Fires involving energized electrical equipment
- 2. Can be handled with relative ease once equipment has been de-energized
 - a. May self-extinguish
 - b. Will become either Class A or Class B fires
- 3. May occur in following locations
 - a. Electric power stations or substations
 - b. Commercial high-voltage installations
 - c. Telephone relay switch stations
 - d. Photovoltaic arrays
 - e. Electrical substations
 - f. Railroad lines and yards with electric engines
 - g. Streetcar and subway tracks or stations
 - h. Vehicle incidents that involve hybrid or electric vehicles
 - i. Computer server rooms or data centers

WARNING: Before initiating fire suppression activities, stop the flow of electricity to the device involved.

- 4. Delicate electronic or computer equipment
 - a. Require use of clean extinguishing agents such as Halotron[®]
 - b. Multipurpose dry-chemical agents are effective, but may be chemically reactive
 - c. Require considerable cleanup



MARNING

d. Must not include water due to inherent shock hazard and resulting damage to electrical equipment

Review Question: What situations may require suppression of a Class C fire? *See pp. 1031-1032 of the textbook for answers.*

e pp. 1031-1032 of the textbook for answers.

B. Transmission Lines and Equipment

- Can be damaged during earthquakes, snow and ice storms, high winds, tornados, hurricanes, or traffic accidents
- 2. Can start fires in grass and other vegetation, on exterior of structures, or vehicles
- 3. To reduce risk of shock from electric current in ground
 - a. Cordon off circle with radius equal to distance between power poles around point where power line contacts earth
 - b. If ground cover fire starts Wait for fire to burn away from point of contact before attempting to extinguish
 - c. For maximum safety Only utility personnel should cut electrical power lines

WARNING: Assume that all power lines are energized until the power company informs you otherwise.

- 4. Fires in electrical transformers
 - a. Relatively common
 - Older transformers may present serious health and environmental hazards because of coolant liquids that contain polychlorinated biphenyls (PCBs)

Instructor Note: Remind students that they should always assume that any transformer contains PCBs until proven otherwise. Most have been replaced, but even those marked as containing no PCBs can legally contain up to 49 parts per million.

c. Use a dry chemical or carbon dioxide extinguisher for fires at ground level





d. Allow pole-top fires to burn until utility personnel can extinguish fire with drychemical extinguisher from aerial device

C. Underground Transmission Lines

- 1. Consist of conduits and vaults below grade
- 2. Can create explosions when fuse opens or short-circuit ignites accumulated gases
 - a. Can throw utility access covers considerable distance, endangering both public and firefighters
 - b. Firefighters and public should stay at least 300 feet (91 m) away from site and make sure that apparatus is not positioned over utility access cover
- 3. Firefighters should not enter electrical utility vault until qualified person has shut off power

WARNING: Only personnel who are properly trained and equipped for confined space entry should enter a utility vault.

D. Commercial High-Voltage Installations

- 1. Found in many commercial and industrial complexes
- 2. May house current in excess of 600 volts
- 3. Usually housed in vaults or fire-resistive rooms with *High-Voltage* warning signs on entry doors
- 4. Water should not be used because of damage to electrical equipment not involved in fire
- 5. Smoke from fires may contain toxic chemicals emitted from plastic installations and coolants used
- 6. Firefighters properly trained in confined space rescues should enter these only when rescue operations require it and rescue is possible without jeopardizing life of firefighter
 - a. Entry team must wear full PPE including SCBA
 - b. Entry personnel must wear tag line monitored by attendant outside enclosure



- c. Rapid intervention crew or team (RIC/RIT) is required
- d. Entrants should search with clenched fist or back of hand to prevent grabbing energized equipment

CAUTION: Before cutting into walls and ceilings that may contain electrical wiring or gas piping, verify with the Incident Commander that electrical and gas utilities have been shut off.

Objective 10 — Identify hazards associated with suppressing Class C fires.

E. Electrical Hazards

- 1. Consequences of electrical shock
 - a. Cardiac arrest
 - b. Ventricular fibrillation
 - c. Respiratory arrest
 - d. Involuntary muscle contractions
 - e. Paralysis
 - f. Surface or internal burns
 - g. Damage to joints
 - h. Ultraviolet arc burns to eyes
- 2. Factors most affecting seriousness of electrical shock
 - a. Path of electricity through body
 - b. Degree of skin resistance Wet (low) or dry (high)
 - c. Length of exposure
 - d. Available current Amperage flow
 - e. Available voltage Electromotive force
 - f. Frequency Alternating current (AC) or direct current (DC)
- F. Guidelines for Electrical Emergencies
 - Establish exclusion zone equal to distance between power poles in all directions from downed power lines





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- 2. Be aware that short circuit may have weakened other wires, and they could fall at any time
- 3. Wear full protective clothing and use only tested and approved tools with insulated handles
- 4. Guard against electrical shocks, burns, and eye injuries from electrical arcs
- 5. Wait for utility company workers to cut any power lines
- 6. Use lockout/tagout devices when working on electrical equipment
- Stay at least 10 feet (3 m) away from power lines when raising or lowering ground ladders or aerial devices
- 8. Do not touch any vehicle or apparatus that is in contact with electrical wires
- 9. Do not use solid and straight streams on fires in energized electrical equipment
- 10. Use fog streams with at least 100 psi (700 kPa) nozzle pressure on energized electrical equipment
- 11. Be aware that live wires outside your field of view may be in contact with wire mesh or steel rail fences, energizing them and posing an electrocution hazard
- 12. Where wires are down, heed any tingling sensation felt in the feet and back away
- Maintain a large safety zone around downed electrical wires to avoid ground gradient hazards
- 14. Remain inside a vehicle or apparatus that is in contact with power lines; if you must leave the vehicle or apparatus, jump clear of the apparatus, landing with both feet together
- 15. Ground gradient
 - a. Electrical behavior that produces electrical pulses in ground starting at point where power line contacts earth and expanding out in concentric circles



- b. Invisible; imagine ripples that result from throwing stone into pond
- c. Stepping from one ripple to another creates electrical differential that will result in shock and physical injury
- d. If inside gradient field or feel tingling in legs, put or place feet close together and hop or shuffle until out of danger area
- e. Do not attempt to walk or crawl as both may place astraddle of ripples
- f. Fire fighting boots are designed to meet NFPA[®] 1971, which requires footwear to provide certain level of protection from electrical shock

CAUTION: To exit a ground gradient area, keep both feet in contact with each other and hop or shuffle out of the affect area.

Review Question: What are some safety guidelines that can be used when suppressing Class C fires? See pp. 1035-1037 of the textbook for answers.

II. SUPPRESSING CLASS D FIRES

pp. 1037-1038



Objective 11 — Describe actions associated with suppressing Class D fires.

- A. Suppressing Class D Fires
 - 1. Combustible metal fires
 - 2. Present dual problem of burning at extremely high temperatures and being reactive to water
 - Directing hose streams can result in violent decomposition of water and subsequent release of flammable hydrogen gas
 - Water is only effective for keeping nearby exposures below ignition temperatures
 - 5. Class D extinguishing agents
 - a. Can be manually shoveled or scooped onto burning metal

- b. Can be applied using Class D fire extinguishers in sufficient quantity to completely cover burning metal
- 6. Emit characteristic brilliant white light that only diminishes when ash layer covers burning material
- 7. Do not assume that fires are extinguished just because flames are not visible
- 8. May be extended period of time before area or substance cools to safe levels

Review Question: How can a Class D fire be suppressed? *See pp. 1037-1038 of the textbook for answers.*

III. SUPPRESSING VEHICLE FIRES

pp. 1038-1046

Objective 12 — Explain actions taken when suppressing a vehicle fire.

A. Suppressing Vehicle Fires

- 1. Among most common types of fires to which firefighters will be called
- 2. May be result of collision, malfunction of vehicle propulsion system, or intentional act
- 3. Require full PPE including SCBA
- 4. Generate a wide variety of toxic and nontoxic smoke and vapors
- 5. Fuel sources
 - a. Gasoline
 - b. Diesel
 - c. Electricity
 - d. Hybrids
 - e. Compressed or liquefied natural gas
 - f. Biofuels
 - g. Hydrogen

VEHICLE FIRES ARE AMONG THE MOST COMMON TYPES OF FIRES. May be result of collision, intertional set Require full BPE, including SCBA Generate Konco, montoxic smote/yapors





B. Vehicle Incident Size-Up

- Decide if incident scene requires diversion of traffic
- Follow U.S. Department of Transportation (DOT) guidelines for protecting scene from vehicular traffic
- Determine if there are victims in vehicle and if they require extrication
- 4. Determine if vehicle is on fire or leaking fuel
- Confirm type of fuel and select appropriate extinguishing agent
- Avoid components in modern vehicles under constant pressure
- Follow department's SOP for establishing scene protection
- Isolate vehicle from ignition sources or eliminate ignition source
- 9. Stabilize vehicle
- 10. Control any downed power lines
- 11. Address any additional hazards
- 12. May necessitate use of defensive fire fighting techniques

C. Vehicle Fire Attack

- 1. Basic procedures
 - a. Position hoseline between burning vehicle and any exposures
 - b. Attack fire from 45-degree angle to avoid potential for injuries from exploding hydraulic or pneumatic struts
 - c. Extinguish any fire near vehicle occupants first
 - d. Issue "all clear" when all occupants are out of vehicle
 - e. Extinguish any ground fire around or under vehicle
 - f. Extinguish any fire remaining in or around vehicle

- 2. Deploy attack hoseline that will provide minimum 95 gpm (380 L/m) flow rate
- 3. Approach fire at 45-degree angle to vehicle's side and from upwind and uphill when possible
- 4. Deploy backup hoseline as soon as possible
- 5. Extinguishment will be complete when flaming and smoldering combustion has ceased
- 6. Apply water to cool combustible metal components that are not burning but exposed to fire
- 7. Extraordinary hazards
 - a. Large-capacity saddle fuel tanks
 - b. Pressurized natural gas tanks
 - c. Alternative fuel tanks
 - d. Hazardous contents
 - e. Radioactive materials
 - f. Munitions
 - g. Vehicles disguised to hide mobile, illegal drug labs
- 8. Once fire has been controlled, conduct overhaul to check for extension and hidden fires
 - a. Disconnect battery
 - b. Secure air bags
 - c. Cool fuel tanks and any intact, sealed components
- 9. Engine or trunk compartment fires
 - a. Must gain access to extinguish fire
 - b. First use normal methods, then use forcible entry
 - c. Cool front and rear bumper struts to prevent accidental activation
 - d. Force entry with manual forcible entry tools or power tools
 - e. Once truck is open, direct hose stream into space until fire is extinguished

- f. In engine compartment fires, fire must be controlled before hood can be opened
 - i. Direct hose stream through grill or air scoop
 - ii. Drive piercing nozzle through hood, fenders, or wheel wells
 - iii. Make or cut an opening large enough for hose stream to be introduced
 - iv. Use pry tool to create opening between hood and fender, then direct straight stream or narrow fog nozzle in opening
- 10. Passenger compartment fires
 - a. Use most appropriate nozzle and pattern for situation
 - b. Attempt to open door; if locked, ask driver for key
 - c. If normal entry not possible, break window and attack fire with medium fog pattern
- 11. Undercarriage fires
 - a. If there is hazard in getting close to vehicle, use straight stream from distance to reach under vehicle
 - b. If vehicle is on hard surface, direct stream downward and allow water to deflect up toward underside of vehicle
 - c. Open hood and direct stream through engine compartment

D. Alternative Fuel Vehicles

- 1. Visual indicators
 - a. Vehicle logos
 - b. Fuel-specific logos
 - c. Special fuel ports
 - d. Distinctive vehicle profiles

CAUTION: There may be no visual indicators that a vehicle uses an alternative fuel source.









2. Tactics to be considered

- Park apparatus minimum 100 feet (30 m) from incident
- b. Approach from uphill and upwind, if possible
- c. Approach from 45-degree angle to vehicle
- d. Wear full PPE including SCBA
- e. Use non-sparking extrication tools
- f. Do not use flares
- g. Deploy backup hoseline
- Select extinguishing agent specific to type of fuel or battery pack
- 3. Natural gas
 - a. Used in form of compressed natural gas (CNG) and liquefied natural gas (LNG)
 - b. Properties
 - i. Clean burning
 - ii. High ignition temperature
 - iii. Narrow explosive range
 - iv. Nontoxic
 - v. Noncorrosive
 - vi. Naturally colorless and odorless
 - vii. Lighter than air
 - viii. Stored under pressure
 - ix. Visible flame
 - c. Most likely vehicles Government agencies, and taxi, utility, refuse, and mass transit bus companies
 - d. Fuel tanks located in trunk area, under side panels, or in open bed of pickup trucks
 - e. Tanks can rupture if exposed to fire, resulting in explosion
 - f. Pressure-relief device, vent, and fuel shutoff valve may be located in wheel well
 - g. CNG Stored under high pressure in gaseous state

- h. Tactics for fires or leaks involving CNG vehicles
 - i. If no fire is visible
 - (a) Use gas detector to locate leaks, shut off valves, and eliminate any ignition sources
 - (b) Stay clear of any vapor clouds detected
 - ii. If fire is visible
 - (a) Allow fuel to burn itself out
 - (b) Use water or foam to extinguish if necessary
 - (c) Use fog stream to disperse vapor clouds
 - (d) Avoid contact with high velocity jet of escaping gas
- i. LNG
 - i. Stored in liquid state by cooling to -260°F (-162°C) in double-walled, vacuum-insulated pressure tanks
 - ii. Lighter than water and has vapor cloud that is heavier than air
 - iii. Frost on fuel tank exterior indicates tank failure
 - iv. If no fire or leak
 - (a) Stabilize vehicle
 - (b) Set emergency brake or chock tires
 - (c) Turn off ignition
 - (d) Shut off gas cylinder valve handle
- j. Tactics for fires or leaks involving LNG
 - i. Avoid any contact with LNG
 - ii. Stay clear of vapor clouds identified
 - iii. Shut off ignition to stop fuel flow to leak or fire
 - iv. Use Purple K dry chemical agent or highexpansion form on surface of LNG fire
 - v. Use sand or dirt to prevent LNG from entering storm drains





- a. Third most common vehicle fuel type
- b. Characteristics
 - i. Clean burning
 - ii. Safer than gasoline
 - iii. Colorless and odorless in natural state
 - iv. Stored under pressure
- c. Expands rapidly when heated, 1.5 times for every 10 degrees of increase in temperature
- d. May be marked with logo
- e. Tactics for incidents involving LPG vehicles
 - i. Approach only from sides at 45-degree angle, never from ends
 - ii. Use gas detectors to determine leaks and isolate leaks from ignition sources
 - iii. Allow fire (if present) to self-extinguish
 - iv. Use foam or water when necessary for extinguishment
 - v. Direct fire streams at top of LPG tank to provide adequate cooling
 - vi. Stay clear of any identified vapor clouds
- 5. Electric
 - a. Should have visible indicators such as vehicle name, logo, charging port on side or front, and distinctive profile
 - b. Batteries may be located in engine compartment, trunk area, or under vehicle
 - c. When engine is running, may not be any noise
 - d. Most also contain 12-volt battery system with separate battery and wiring harness
 - e. If no fire is visible
 - i. Secure vehicle
 - ii. Chock wheels
 - iii. Turn off ignition
 - iv. Remove key
 - f. If smoke is visible
 - i. Wear full PPE and SCBA



- ii. Do not approach
- iii. Establish scene security and protect exposures
- iv. Avoid contact with fluids
- g. Batteries
 - i. Sole source of power
 - ii. Many types, designs, and locations
 - iii. Use inertia switches and pilot circuits to shut off high-voltage system
 - iv. It will take approximately 5 minutes for energy in system to dissipate
 - v. Do not cut orange high-voltage cables
 - vi. Blue and yellow color-coded cables also present electrocution hazard, but do not carry high voltage
 - vii. Require full PPE, insulated tools, and specific extinguishing agent
- h. Hybrids
 - i. Combine battery electrical systems with gasoline, diesel, biodiesel, and natural gas
 - ii. Some use photovoltaic solar panel mounted in roof as power source
 - iii. Shut off power with ignition or power switch and remove ignition key
 - iv. Water is recommended for extinguishment, although specific agents or tactics may be required

WARNING: Do not cut or contact any orange, blue, or yellow color-coded electrical cables or components in electric or hybrid electric vehicles.

- 6. Ethanol/methanol
 - a. Gasoline blends
 - b. Water soluble, electrically conductive, clear liquids that have slight gasoline odor
 - c. Fires burn bright blue and may be hard to see during day
 - d. Require TI to see flames and locate fire
 - e. Currently found in over 50 percent of gasoline sold in U.S.



- f. If no fire or leak is visible
 - i. Secure vehicle
 - ii. Chock tires
 - iii. Turn off ignition
- g. If fuel leak is suspected Use caution and approach in full PPE and SCBA with hoselines deployed and charged
- h. If vehicle is on fire
 - i. Establish control zone
 - ii. Use only Alcohol Resistant (AR) Class B foam to extinguish

7. Biodiesel

- a. Blend of liquids made from natural plants and diesel
- b. Yellow liquid with odor of cooking oil
- c. Nontoxic, biodegradable, and sulfur free
- d. Slightly lighter than water
- e. Has flash point of 266°F (130°C)
- f. Used in any vehicle designed for diesel fuel
- g. Does not require a logo
- h. If leaking Control leak per SOP and request hazardous materials team
- i. If vehicle is on fire Use dry chemical, CO₂, water fog spray, or foam to extinguish
- 8. Hydrogen
 - a. Used in some areas of North America, although most are in concept stage
 - b. Colorless, odorless, nontoxic, and energy efficient
 - c. Self-ignition temperature of 550°F (287.7°C) with flammability range between 4 to 75 percent
 - d. Flame is invisible during day; use TI to see flame
 - e. Marked with manufacturer's logo
 - f. Vented fuel cell in truck
 - g. Tactics for leak or fire

- i. Shut off ignition
- ii. Isolate fuel from ignition sources
- iii. Chocking wheels
- iv. Do NOT extinguish fire
- v. Protect exposures and allow fuel to burn off
- vi. If extrication required, do not cut C posts

Review Question: What steps should be taken when suppressing a vehicle fire? *See pp. 1039-1040 of the textbook for answers.*

IV. SUPPRESSING FIRES IN OTHER CLASS A MATERIALS

pp. 1046-1049



Objective 13 — Compare methods used to suppress fires in stacked and piled materials, small unattached structures, and trash containers.

A. Stacked and Piled Materials

- 1. Can be found around all types of occupancies and in all types of jurisdictions
 - Raw materials such as those found at sawmills, lumberyards, and manufacturing facilities
 - b. Bales of used cardboard or pallets near large retail outlets
 - c. Miscellaneous and varied materials stored outdoors at residences
 - d. Bales or large rolls of hay on farms
 - e. Loose flammable materials such as mulch or fertilizer at nurseries or garden centers
- 2. Value of materials vary widely
- 3. Greatest danger to exposures
- 4. Goal Confine fire to pile or building of origin
- 5. Fire streams should be directed at extreme edge of fire, controlling spread
- 6. Use straight stream from distance and then shift to fog pattern
- 7. Class A foam very effective



B. Small Unattached Structures

- 1. Found in all jurisdictions in varying shapes and sizes
- 2. Not defined by NFPA[®]
- 3. Unless overwhelming reason, primary mission to prevent fire spread
- 4. Class A foam and fog streams very effective
- 5. May be used for storage of miscellaneous chemicals, flammable/combustible liquids, explosives, or illegal materials
- 6. If question of hazard, apply water through straight stream, protect exposures, allow structure to self-extinguish

Instructor Note: Discuss the Information Box "Clandestine Drug Labs" on p. 1048 of the textbook. Discuss with students the hazards and dangers associated with these drug labs.



CAUTION: Chemicals used in the production of some illegal drugs are extremely toxic and volatile. Incidents involving them may require the assistance of trained hazardous materials personnel.

C. Trash Container Fires

- 1. Vary greatly in size
- 2. Create toxic products of combustion
- 3. Require full PPE and SCBA
- 4. May include
 - a. Hazardous materials or plastics that emit highly toxic smoke and gases
 - b. Aerosol cans and batteries which may explode when exposed to heat
 - c. Biological waste in marked or unmarked containers
- 5. Once fire is controlled, may be possible to use standard overhaul techniques

- 6. May require Class A foam
- Some departments use master stream to flood container with water to drown hidden fires; can present containment problems if water becomes contaminated with hazardous substance

Review Question: What are the factors that influence suppression methods in stacked and piled materials, small unattached structures, and trash containers? *See pp. 1046-1049 of the textbook for answers.*

V. COMBATING GROUND COVER FIRES

pp. 1049-1057

GROUND COVER FIRES V AND CA	ARY IN SIZE, LOCATION, JUSES.
Sta May occur Very publy Fundar all plan	Causes
Daracteristics Influences Director Time Evidence Net	lume.

Objective 14 — Summarize the main influences on ground cover fire behavior.

A. Combating Ground Cover Fires

- 1. Vary greatly in size
- 2. May occur in a number of different places
- 3. Causes Natural or human
 - a. Lightning strikes
 - b. Auto ignition
 - c. Volcanic activity
 - d. Sparks from rockslides
 - e. Arson
 - f. Discarded smoking materials
 - g. Campfires
 - h. Sparks or other ignition sources from machinery
 - i. Electrical shorts in power lines and fences
- 4. Characteristics very different from fires in burning buildings
- 5. Influences Fuel, weather, topography
- 6. Can burn rapidly and continuously



WARNING: Ground cover fires can be deadly to firefighters even if they are working in very light fuels or working during the overhaul phase of an operation.

Review Question: What are a few of the main causes of ground cover fires? *See pp. 1049 of the textbook for answers.*

pp. 1050



Objective 15 — Compare types of ground cover fires.

B. Types of Ground Cover Fires

- 1. Ground fire
 - a. Burns in layer of dead organic matter that generally covers soil in forested area
 - b. Slow-moving, smoldering
 - c. Can go undetected for months before entering flaming stage
 - d. Generally limited to forest
 - e. Very difficult to extinguish
- 2. Surface fire
 - a. Most common type
 - b. Burns on soil surface, consuming low-lying grass, shrubs, and other vegetation
 - c. Can occur anywhere
 - d. Can be natural or human caused
- 3. Crown fire
 - a. Wind-driven, high-intensity
 - b. Moves through tree tops of heavily forested areas
 - c. Typical causes Lightning strikes or extensions from ground or surface fires
 - d. Called ladder fires because fire spreads upward through small tress, fallen timber, and vines to reach forest canopy

NOTE: Some documents include the ladder fire as a fourth type of ground cover fire.

Review Question: How do surface fires and crown fires compare with ground fires? *See pp. 1050 of the textbook for answers.*

pp. 1051



Objective 16 — Describe elements that influence ground cover fire behavior.

C. Ground Cover Fire Behavior

- Two elements of fire triangle always present Oxygen and fuel
- 2. Addition of ignition source results in ground cover fire
- 3. Fuel Categorized based on location
 - Subsurface fuels Roots, peat, and other partially decomposed organic matter that lie under surface of ground
 - b. Surface fuels
 - i. Needles
 - ii. Duff
 - iii. Twigs
 - iv. Grass
 - v. Field crops
 - vi. Brush up to 6 feet (2 m) in height
 - vii. Downed limbs
 - viii. Logging slash
 - ix. Small trees on or immediately adjacent to surface of ground
 - c. Aerial fuels Suspended and upright fuels physically separated from ground's surface to extent that air can circulate freely between them and ground
 - d. Factors affecting burning characteristics
 - i. Fuel size Small or light fuels burn faster than heavier ones
 - ii. Compactness Tightly compacted fuels burn slower than those that are loosely piled
 - iii. Continuity Fire spreads faster when fuels are close together



GROUND COVER FIRE BEHAVIOR IS INFLUENCED BY TOPOGRAPHY.	
Steepness of slope	
Aspect	
Local terrain features	
Drainages	
	16

- iv. Volume Amount of fuel present in given area influence's intensity and amount of water needed
- v. Fuel moisture content Fuels that contain less moisture ignite more easily and burn with greater intensity
- 4. Weather
 - a. Wind
 - i. Fans flames into greater intensity
 - ii. Supplies fresh air that speeds combustion
 - b. Temperature
 - i. Has effects on wind and is closely related to relative humidity
 - ii. Primarily affects fuels as result of long-term drying
 - c. Relative humidity Has significant effect on dead fuels that only gain moisture from surrounding air rather than their root system
 - d. Precipitation Largely determines moisture content of live fuels
- 5. Topography Features of earths' surface
 - a. Steepness of slope affects fire spread Fires spread faster uphill than downhill; the steeper the slope, the faster the fire spreads
 - b. Other factors
 - i. Aspect
 - (a) Compass direction a slope faces
 - (b) Determines effects of solar heating
 - (c) In North America, full southern exposures receive more of sun's direct rays and therefore receive more heat
 - ii. Local terrain features May alter airflow and cause turbulence or eddies, resulting in erratic fire behavior
 - iii. Drainages
 - (a) Create turbulent updrafts, causing chimney effect
 - (b) Critical in chutes and saddles

(c) Fires can spread extremely fast

Review Question: What three elements influence ground cover fire behavior? *See pp. 1051-1052 of the textbook for answers.*

pp. 1052-1053



D. Parts of a Ground Cover Fire

- 1. Origin
 - a. Area from where fire started
 - b. Point from which fire spreads
- 2. Head
 - a. Part of ground cover fire that spreads most rapidly
 - Usually found on opposite side of fire from area of origin and in direction toward which wind is blowing
 - c. Burns intensely
 - d. Usually does most damage
 - e. Key to controlling fire controlling head and preventing formation of new head
- 3. Finger
 - a. Long narrow strip of fire extending from main fire
 - Usually occurs when fire burns into area that has both light fuel and patches of heavy fuel
 - c. Can form new heads
- 4. Perimeter
 - a. Outer boundary, or distance around outside edge, of burning or burned area
 - b. Will continue to grow until fire is suppressed
- 5. Heel
 - a. Side opposite head
 - b. Usually burns downhill or against wind
 - c. Burns slowly and quietly
 - d. Easier to control than head



- 6. Flanks
 - a. Sides, roughly parallel to main direction of fire spread
 - b. Form fingers
 - c. Can change into head with shift in wind direction
- 7. Spot fire
 - a. Caused by flying sparks or embers landing outside main fire
 - b. Present hazard to personnel and equipment
 - c. Must be extinguished quickly or will form new head and continue to grow in size
- 8. Islands
 - a. Patches of unburned fuel inside fire perimeter
 - b. Potential fuels for more fire
 - c. Must be patrolled frequently and checked for spot fires
- 9. Green
 - a. Area of unburned fuels next to involved area
 - b. Simply opposite of burned area and does NOT indicate that area is safe
- 10. Black
 - a. Opposite of green
 - b. Area in which fire has consumed or "blackened" fuels
 - c. Can sometimes be relatively safe during fire, but can be very hot and smoky

Review Question: What are the parts of a typical ground cover fire?

See pp. 1052-1053 of the textbook for answers.

pp. 1054

Objective 18 — Describe protective clothing and equipment used in fighting ground cover fires.

E. Protective Clothing and Equipment



- Standard structural turnout clothing is inappropriate – Need wildland fire protective clothing
- 2. Should meet requirements of NFPA[®] 1977
- 3. NFPA[®] 1500 specifies minimum PPE for firefighters to participate in ground cover fire fighting
 - a. Helmet with eye protection and neck shroud
 - b. Flame retardant shirt and pants
 - c. Protective footwear
 - d. Gloves
 - e. Fire shelter
- 4. Most wildland fire agencies also provide
 - a. Canteen or bottled water
 - b. Backpack or web belt for carrying extra gear

Review Question: What types of protective clothing and equipment can be used when fighting ground cover fires? *See pp. 1054 of the textbook for answers.*

pp. 1054



Objective 19 — Describe methods used to attack ground cover fires.

F. Attacking the Fire

- 1. Direct Action taken directly against flames at its edge or closely parallel to it
- 2. Indirect
 - a. Used at varying distances from advancing fire
 - Starting from anchor point, line is constructed some distance from fire's edge and unburned intervening fuel is allowed to self-extinguish
 - c. Generally used against fires that are too hot, too fast, or too big for direct attack
- 3. May begin with one attack method and switch to another

Review Question: How do direct attack and indirect attack methods for ground fires compare with one another? *See pp. 1054 of the textbook for answers.*

pp. 1055-1057

SIZE-UP I FIRES I	NFORMATI NCLUDES S	ON AT GROU EVERAL CAT	JND COVER EGORIES.
Fire location	Fire type	Incident access	Exposures
Weather conditions	Wind direction	Wind velocity	Topography
	Visibility	Resources	

тн	E LECS CONCEPT CAN HELP SITUATIONAL AWARENESS BE MORE EFFECTIVE.
	Lookouts Received on the first a set where it is pring.
	Communications
	Escape Routes
	Safe Zones Mare for the price or over of relays
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Objective 20 — Summarize safety principles and practices when fighting ground cover fires.

G. Safety Principles and Practices

- 1. Size-up information
 - a. Fire location
 - b. Fire type
 - c. Incident access
 - d. Exposures
 - e. Weather conditions
 - f. Wind direction
 - g. Wind velocity
 - h. Topography
 - i. Visibility
 - j. Resources
 - i. Water supply
 - ii. Personnel
 - iii. Apparatus/equipment
- 2. Lookouts, communications, escape routes, and safety zones (LCES)
 - a. LCES Situational awareness technique that stands for
 - i. Lookout
 - ii. Communications
 - iii. Escape routes
 - iv. Safety zones
 - b. Can be used for any size ground cover fire
 - c. Lookouts
 - i. Used to monitor fire development and spread
 - ii. Used to watch for rekindles within burned are and keep IC informed





- iii. Placed in locations that can observe fire without being in front of fire
- iv. May include helicopters or airplanes
- d. Communications
 - i. Essential part of any ground cover operation
 - ii. IC must be kept informed, and must be in communication with every unit or person operating in incident
- e. Escape route Marked path that leads to safety zone and is short enough to allow personnel to safety travel to it
- f. Safety zone Should be available in burned area if it is sufficiently cooled and accessible
- 3. Ten standard fire fighting orders
 - a. Developed by the U.S. Department of Agriculture's Forest Service due to wildland firefighter deaths
 - b. Violating any of these orders can result in fatality or serious injury
 - c. Since inception, have been applied to all fire fighting situations
 - d. Orders
 - i. Keep informed on fire weather conditions and forecasts
 - ii. Know what the fire is doing at all times
 - iii. Base all actions on current and expected behavior of the fire
 - iv. Identify escape routes and safety zones, and make them known
 - v. Post lookouts when there is possible danger
 - vi. Be alert, keep calm, think clearly, and act decisively
 - vii. Maintain prompt communications with your forces, your supervisor, and adjoining forces
 - viii. Give clear instructions and ensure that they are understood
 - ix. Maintain control of your forces at all times
 - x. Fight fire aggressively, providing for safety first

Instructor Note: In addition to these orders, there are 18 Watch Out Situations that should be reviewed and practiced during ground cover fires. This list is provided in Appendix E of the textbook.

- 4. Non-fire hazards
 - a. Unstable hazard trees Trees that have been weakened by age or fire may collapse
 - Animals Animals that have escaped fire as well as reptiles may be found in caves and confined spaces
 - Insects Usually more of nuisance than hazard; some can be fatal to persons with allergies
 - Electrified fences All wire strand fences should be considered electrified until proven otherwise
 - e. Electrical power lines Ground cover fires can cause power poles to fall and power lines to break
 - f. Explosives May be found around military training areas, near construction sites, and in areas open to hunting
 - g. Hazardous materials Treat like hazardous materials incident; establish a perimeter and withdraw designated distance
 - h. Rolling or falling debris Can fall and strike or create slipping or tripping hazard
 - i. Pits or shafts May be covered by loose debris
 - Animal traps Those used for hunting may be hidden under brush much like booby traps
 - k. Lightning Requires special precautions
 - i. Be aware of weather
 - ii. Do not stand under tall, isolated trees
 - iii. Stay away from open water, metal objects, equipment, or wire fences
 - iv. In forested area, seek shelter in low ravine
 - v. If in flat field, drop to knees and bend forward putting hands on knees



THERE ARE C	DTHER NON-FIRE	HAZARDS YOU
SHOUL	D BE AWARE OF	AS WELL.
Hazardous	Rolling or	Pits or
materials	falling debris	shafts
Animal traps	Lightning	Heart failure
() ALABAMA PIRE	COLLECK	

I. Heart failure

Review Question: What safety principles and practices should firefighters use when fighting ground cover fires? *See pp. 1055-1057 of the textbook for answers.*

VI. SKILLS

рр. 1078-1082	Objective 21 — Attack a structure fire using a direct, indirect, or combination attack.
рр. 1083-1085	Objective 22 — Attack a structure fire above, below, and at ground level – Interior attack.
рр. 1086	Objective 23 — Turn off building utilities.
рр. 1087	Objective 24 — Connect supply fire hose to a fire department connection.
рр. 1088	Objective 25 — Operate a sprinkler system control valve.
рр. 1089-1090	Objective 26 — Stop the flow of water of an activated sprinkler.
рр. 1091	Objective 27 — Deploy and operate a portable master stream device.
рр. 1092-1093	Objective 28 — Attack a passenger vehicle fire.
рр. 1094	Objective 29 — Attack a fire in stacked or piled materials.
рр. 1095	Objective 30 — Attack a fire in a small unattached structure.
рр. 1096	Objective 31 — Extinguish a fire in a trash container.
рр. 1097	Objective 32 — Attack a ground cover fire.

VII. SUMMARY AND REVIEW



A. Chapter Summary

- Attacking fires early in development is an important aspect of a successful fire fighting operation. In addition, selecting and applying the most effective fire attack strategy and tactics are also important.
- 2. Failing to do any of these things can result in a fire growing out of control, an increase in fire damage and loss, and possibly in firefighter injuries.
- Firefighters need to know how to safely and effectively attack and extinguish fires involving structures, vehicles, stacked and piled materials, and ground cover.

B. Review Questions

- 1. What initial factors must be considered when suppressing structure fires? (*p. 1004*)
- 2. What are the factors that must be considered when making entry? (*pp. 1011-1012*)
- 3. How do direct attack and combination attack techniques compare with one another? (*p.* 1014)
- 4. What are the main differences between indirect attack and gas cooling techniques? (*pp. 1014-1015*)
- 5. How does the presence or absence of a standpipe system impact upper level structure fires? (*pp. 1016-1017*)
- 6. What are the main actions that should be taken when attacking a belowground structure fire? *(pp. 1017-1018)*
- 7. How quickly can floor assemblies over basements reach a point of collapse? (*p. 1020*)
- 8. How can using exposure protection or controlling building utilities help in fire control? *(pp. 1020-1024)*
- 9. What are the steps that must be taken when supporting a fire protection system at a protected structure? (*p. 1027*)
- 10. How should a master stream device be properly deployed? (pp. 1028-1029)
- 11. What situations may require suppression of a Class C fire? (pp. 1031-1032)
- 12. What are some safety guidelines that can be used when suppressing Class C fires? (*p.* 1035)
- 13. How can a Class D fire be suppressed? *(pp. 1037-1038)*
- 14. What steps should be taken when suppressing a vehicle fire? (*p. 1038*)
- 15. What are the factors that influence suppression methods in stacked and piled materials, small unattached structures, and trash containers? *(p. 1046)*
- 16. What are a few of the main causes of ground cover fires? (p. 1049)
- 17. How do surface fires and crown fires compare with ground fires? (p. 1050)
- 18. What three elements influence ground cover fire behavior? (pp. 1051-1052)
- 19. What are the parts of a typical ground cover fire? (pp. 1052-1053)
- 20. What types of protective clothing and equipment can be used when fighting ground cover fires? (pp. 1054)
- 21. How do direct attack and indirect attack methods for ground fires compare with one another? (p. 1054)
- 22. What safety principles and practices should firefighters use when fighting ground cover fires? (p. 1054)

Chapter 17 Fire Control

Lesson Goal

After completing this lesson, the student shall be able to describe tasks related to coordinating fireground operations, establishing command, and controlling Class B fires.

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Describe considerations taken when coordinating fireground operations. [NFPA[®] 1001, 6.1.1, 6.1.2, 6.3.2]
- 2. Explain fireground roles and responsibilities a firefighter II may need to coordinate. [NFPA[®] 1001, 6.1.1, 6.1.2, 6.3.2]
- 3. Discuss the process of establishing and transferring Command. [NFPA[®] 1001, 6.1.1, 6.1.2, 6.3.2]
- 4. Describe hazards that may be present at fires in underground spaces. [NFPA[®] 1001, 6.3.2]
- 5. List safety precautions that should be taken at flammable/combustible liquid fire incidents. [NFPA[®] 1001, 6.3.1, 6.3.3]
- 6. Recognize methods used when coordinating operations at a property protected by a fire suppression system. [NFPA[®] 1001, 6.3.2]
- 7. Explain ways to use water to control Class B fires. [NFPA[®] 1001, 6.3.1]
- 8. Compare methods used to suppress bulk transport vehicle fires and flammable gas incidents. [NFPA[®] 1001, 6.3.3]
- 9. Establish Incident Command and coordinate interior attack of a structure fire. [NFPA[®] 1001, 6.1.1, 6.1.2, 6.3.2]
- 10. Control a pressurized flammable gas container fire. [NFPA[®] 1001, 6.3.3]

Instructor Information

This is the lesson covering coordinating fireground operations and the process of establishing and transferring Command. This lesson describes methods used when operating with fixed suppression systems. The lesson also covers attack considerations for flammable/combustible liquid and Class B fires.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skills practice. The level of learning is application.

I. COORDINATING FIREGROUND OPERATIONS

pp. 1057-1058

Fireground knowledge	Fireground operations require specific knowledge of priorities and tactics.		
	Emergency incident priorities	Life safety incident stabilization Property conservation	
	Tactics	Rescue Exposures Confinement Extinguishment Overhaul Ventilation Salvage	
	17-2		

Firefighter II the principles	duties inclue of situation	de knowing al awareness.
 Apply to reco effects 	gnize changes	, predict
 Listen to fire 	fighters around	d you
 Depends on crew – Not a 	open communi vote	ication of
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Objective 1 — Describe considerations taken when coordinating fireground operations.

A. Coordinating Fireground Operations

- 1. Emergency incident priorities
 - a. Life safety
 - b. Incident stabilization
 - c. Property conservation
- 2. Apply following tactics to achieve
 - a. Rescue
 - b. Exposures
 - c. Confinement
 - d. Extinguishment
 - e. Overhaul
 - f. Ventilation
 - g. Salvage

B. Situational Awareness

- 1. Firefighter II duties
 - a. Apply situational awareness
 - i. Responsible for safety of firefighters assigned to you
 - ii. Use additional training to recognize changes, predict effects on surroundings
 - b. Listen to concerns, observations of firefighters with you They may
 - i. See something you overlooked or have additional information
 - ii. Have different physical point of view, be able to see something you cannot

- 2. Depends on open communication of all members of crew; allows leader to make informed decisions
 - a. Is not meant as opportunity for debate, vote
 - b. Crew leader has final authority Gather information, make a decision based on input

Review Question: What are the priorities that must be considered when beginning fireground operations? *See pages 1057-1058 of the textbook for answers.*

Objective 2 — Explain fireground roles and responsibilities a firefighter II may need to coordinate.

First-arriving engine company actions can vary depending on the department.

pp. 1058-1060

- A. First-Arriving Engine Company
 - 1. Department SOPs define actions Typically include
 - a. Establish Command
 - b. Make the initial size-up
 - c. Deploy available resources
 - d. Communicate situation to communication center, other responding units

NOTE: Establishing Command is described in more detail later in this chapter.

- 2. Other possible SOP defined duties
 - a. If smoke, fire visible
 - i. May lay supply line from closest hydrant to fire
 - ii. Hydrant can be opened, supply line charged as soon as hose clamp applied at scene
 - b. May have option to deploy supply line or proceed directly to scene, initiating quick attack with apparatus water supply
- 3. Perform quick evaluation based on certain questions
 - a. Are there occupants in need of immediate rescue?
 - b. Does fire threaten other exposures?



- c. What does visible fire, and smoke indicate?
- d. Are only contents involved or is structure burning?
- e. Are there sufficient resources on scene or en route to handle situation?
- 4. Request additional resources to meet incident objectives established during size-up if needed
 - a. Must be able to adhere to two-in, two-out rule
 - b. No one enters until enough personnel present to conform to rule
 - C. Rule may be amended
 - i. Two-person attack team, one person outside
 - ii. Only if known life safety hazard to victim that can be saved without undue risk to firefighters
- 5. If not obvious, immediate life safety concerns and fire is threatening nearby exposure
 - a. May order hoselines deployed to apply water
 - b. Master stream or handline may cool exposure while hoselines deployed for direct attack
- 6. After size-up, 360-degree survey complete; location of fire known – Accomplish priorities
 - a. Intervene between trapped occupants and fire
 - b. Protect rescuers
 - c. Protect primary means of egress
 - d. Protect interior exposures (other rooms)
 - e. Protect exterior exposures (other buildings)
 - f. Initiate extinguishment
 - g. Operate master streams

B. Second-Arriving Engine Company

- 1. First Make sure adequate water supply established to fireground
- 2. May complete tasks begun by first engine company
 - a. Finishing hose lay





- b. Deploying additional hoseline
- c. Connecting to hydrant to support hoselines already deployed
- 3. Local factors that determine need to pump hoselines from hydrant
 - a. Size and quantity of hoselines
 - b. Distance from fire hydrant to scene
 - c. Available water pressure in distribution system
- 4. Once water supply established Perform tasks as assigned by IC
 - a. Assist advancing first attack hoseline
 - b. Back up initial attack line
 - c. Protect secondary means of egress
 - d. Prevent fire extension (confinement)
 - e. Protect most threatened exposure
 - f. Assist in extinguishment
 - g. Assist with fireground support company operations
 - h. Form rapid intervention crew/team (RIC/RIT)

C. Fireground Support Company

- 1. If dispatched May arrive before, with, after first engine
- 2. Situation will dictate tasks performed

Instructor Note: Discuss the possible support company tasks listed on p. 1061 of the textbook. Ask students what types of support companies exist in their jurisdictions. *Answers will vary, be sure to emphasize that the tasks performed by these companies will be determined by local SOPs.*

- a. May be performed by engine company if support company not available
- b. Initially may be assigned to
 - i. Check outside of building for victims needing immediate rescue

Initially	
Check outside for victims	
Raise ladders	100000000
 Force entry for simultaneous interior attack, rescue 	search and
Search	
· Not put firefighters at risk of severe injury, de	eath
May begin in areas likely inhabited	
 Conduct systematically 	100
 Priority areas 	

- ii. Raise ladders needed for rescuers, roof access for ventilation
- iii. Force entry into building for simultaneous interior fire attack, search and rescue operations
- 3. Search
 - a. Area closest to fire if it will not put firefighters at risk of severe injury, death
 - b. Patterns may begin in areas most likely inhabited, where known victims are trapped
 - c. Must be conducted systematically, in accordance with SOPs
 - d. Priority areas
 - i. Most severely threatened If searchable without undue risk to firefighter safety
 - ii. Where largest number are threatened If area is searchable without undue risk to firefighter safety
 - iii. Remainder of fire area
 - iv. Exposures
- 4. May assist engine company in fire attack Depends on SOPs
 - a. Accompany hose team advancing toward seat of fire when equipped with forcible entry tools
 - b. May place ground ladders, set up scene lighting, or similar exterior functions
- 5. Blitz attack May be performed with master stream device, aerial ladders, platforms, ladder towers
 - a. Must be coordinated with other operations to avoid fire spread
 - b. Steam can injure interior teams Poorly directed streams can force retreat
- D. Rapid Intervention Crew/Team (RIC/RIT)
 - 1. Basic description, requirements
 - a. Locate, assist firefighters trapped, lost, or incapacitated during operations





- May be any engine, ladder, rescue company equipped and assigned when arriving on scene – May be permanently designated
- c. Number needed established by SOPs or IC Crews added as necessary
- 2. Team operations
 - a. Defined as Two or more members wearing complete PPE, respiratory protection
 - b. Be equipped with
 - i. Radio
 - ii. Special rescue tools needed
 - iii. Spare SCBA or air cylinder
 - iv. Equipment needed to perform rescue
 - c. May be assigned other minor scene duties Must stop immediately, deploy if needed
- 3. Report to IC and perform several tasks
 - a. Staging equipment
 - b. Sizing up building for possible paths of egress
 - c. Completing 360-degree survey if possible
 - d. Removing barriers to egress
 - e. Monitoring radio traffic for distress calls
 - f. Clearing windows
 - g. Placing ladders
 - h. Opening exits
 - i. Illuminating building

Caution: Do not allow additional assigned duties to prevent you from deploying in your primary rescue capacity when working as a RIT/RIC member.

E. Chief Officer/Incident Commander

- Chief officer may assume command from original IC – Take responsibility for all onscene operations
- 2. May choose to assume other role if original IC has

Staging	Sizing up possible paths	Completing 360-degree
Removing	Montorpa	survey
egress	radio traffic for distress cals	Clearing windows
acing ladders	Onening exts	Dumnating



Do not allow additional assigned duties to prevent you from deploying in your primary rescue capacity when working as a RIT/RIC member.



- a. Incident well organized
- b. Made reasonable progress toward incident stabilization

Review Question: What are the fire ground roles a firefighter II may need to coordinate at an incident? *See pages 1058-1063 of the textbook for answers.*

Objective 3 — Discuss the process of establishing and transferring Command.

Objective 4 — Describe hazards that may be present at fires in underground spaces.



pp. 1064-1068

- A. Establishing Command Follow local SOPs to relay initial Command options
 - 1. Nothing showing Problem is not obvious to first-arriving unit
 - a. Assume Command Broadcast "nothing is showing"
 - b. Direct other responding units to
 - i. Assume predetermined positions at scene or stage at last intersection in route of travel
 - ii. Allows for maximum deployment flexibility Applies to all types of emergencies
 - c. Accompany unit personnel on investigation of situation
 - i. Maintain command using portable radio
 - ii. Known as investigation mode
 - 2. Fast-attack Necessary to take immediate action to save life, or stabilize situation
 - a. Take Command Announce unit is initiating fast attack
 - b. Personnel continue fast attack until
 - i. Incident is stabilized
 - Incident is not stabilized Must withdraw outside hazardous area to establish formal Incident Command Post (ICP)
 - iii. Command is transferred



- c. Balance of unit may be left inside hazardous area
 - i. If they can function safely and have radio communications
 - ii. No fewer than two may be left If officer/firefighter must leave, both must leave
- 3. Name the incident and establish the ICP Based on nature, scope of incident
 - a. Assume Command by
 - i. Naming incident
 - ii. Designating ICP
 - iii. Giving initial report on conditions
 - iv. Requesting additional resources
 - b. Types of incidents that may require
 - i. Combat command Officer/firefighter performs
 - (a) Multiple tasks Serves as Incident Commander (IC), develops incident action plan (IAP)
 - (b) Active tasks Advancing hoseline
 - ii. Formal command Company officer remains at mobile radio in the apparatus
 - (a) Assigns tasks to unit personnel
 - (b) Communicates with other responding units
 - (c) Expands NIMS-ICS as needed
 - (d) Must decide how to deploy remainder of the unit
 - (e) Three options

Instructor Note: Discuss the possible deployment options listed on p. 1064-1065 of the textbook. Ask students how to best determine when each option might be the best choice. *Answers will vary, be sure to emphasize that these choices will be influenced by local SOPs and conditions at each situation.*



- 4. Transferring Command Must be done correctly to avoid confusion
 - a. Communicate either face-to-face or over radio with officer/firefighter being relieved
 - i. Face-to-face preferred
 - ii. Command should never be transferred to anyone not on scene
 - b. Brief relieving officer on
 - i. Name of incident
 - ii. Incident status
 - iii. Safety considerations
 - iv. Goals and objectives listed in IAP
 - v. Progress toward completion of tactical objectives
 - vi. Deployment of assigned resources
 - vii. Assessment of need for additional resources

Review Question: How should Command be established at an incident?

See pages 1064-1066 of the textbook for answers.

B. Fires in Underground Spaces

Instructor Note: Discuss the types of underground spaces listed on p. 1066 of the textbook. Ask students which of these exist in their local jurisdictions. *Answers will vary, be sure to ask students to include mutual aid locations when considering possible spaces.*

- 1. Most important safety factor Recognition of inherent hazards
 - a. Electrical equipment should be intrinsically safe for use in flammable atmospheres
 - b. Expect atmospheric, physical hazards
 - i. Oxygen deficiencies
 - ii. Flammable gases and vapors
 - iii. Toxic gases
 - iv. Extreme temperatures
 - v. Explosive dusts
 - vi. Limited means of entry and egress



Location of command for a fire in an underground space must be outside the hot zone.
 Near, not obstructing entrance No entry until IAP developed, communicated Accountability officer, incident safety officer tracks entering, leaving
Asses Triday 17-19

Tire more o	uiddy, consume air fas	ter
Releve bef	ore out of air	
Effective-air	management part of)	IAP

- vii. Cave-ins or unstable support members
- viii. Standing water or other liquids
- ix. Utility hazards Electricity, gas, sewage
- c. Plant, building supervisors or other knowledgeable people can provide information on
 - i. Fire
 - ii. Probable location
 - iii. Hazards present
- d. Preincident plans reduce guesswork Refer to during operations
- e. Be ready to implement prearranged hazard mitigation plans, rescues, extinguishment efforts without delay
- 2. Command Post, staging area must be established outside hot zone
 - a. Staging near, not obstructing, entrance
 - b. Do not allow entry until IAP developed, communicated to on-scene personnel
 - c. Accountability officer or incident safety officer at entrance to track personnel, equipment entering and leaving
- 3. May attack indirectly using penetrating, cellar, or distributor nozzles
 - a. May tire more quickly, consume air faster due to difficulty venting heat from space
 - b. Relieve before out of air
 - c. Effective air-management should be part of IAP to prevent advancing farther than air supplies safely allow

Review Question: What hazards may be present at fires in underground spaces? *See pages 1066-1068 of the textbook for answers.*

II. SUPPRESSING CLASS B FIRES

pp. 1068 Objective 5 — List safety precautions that should be taken at flammable/combustible liquid fire incidents.

Objective 6 — Recognize methods used when coordinating operations at a property protected by a fire suppression system.

	- Flammable liquids	
Involve	Combustible liquids	
	Further broken into	Hydrocarbona
	Spill or leak resulting	Polar solvents
Causedby	Notur al closatter	
Causedby	Notur al disester	
	Copened valve	CIES

A. Suppressing Class B Fires

- 1. Involve flammable, combustible liquids and gases
 - a. Flammable liquids
 - i. Flash point of less than 100°F (38°C)
 - ii. Can be ignited without being preheated
 - iii. Examples Gasoline, acetone
 - b. Combustible liquids
 - i. Flash point higher than 100°F (38°C)
 - ii. Must be heated above flash point before igniting
 - iii. Examples Kerosene, vegetable oil
 - c. Both further divided into
 - i. Hydrocarbons Do not mix with water
 - ii. Polar solvents Do mix with water
- 2. Class B fires may be caused by
 - a. Spill or leak resulting from vehicle accident
 - b. Natural disaster
 - c. Opened valve
- 3. Actions to take
 - a. First action Determine wind direction; current can spread vapors or gases
 - b. Locate apparatus upwind and uphill of incident
 - c. Establish perimeter
 - d. Report current conditions to all responding units, communications center
 - e. Evacuate any civilians in affected area





- f. Request hazardous materials response company; remain outside hot zone
- g. Establish water supply; deploy attack hoselines as required
- B. Safety Precautions at Flammable/Combustible Liquid Fire Incidents
 - 1. Avoid standing in pools of fuel or runoff water contaminated with fuel floating on top
 - a. Protective clothing can absorb fuel in wicking action
 - i. Can lead to skin irritation
 - ii. Clothing may catch on fire if ignition source present
 - b. Extreme danger exists if pool ignites
 - c. Benzene in petroleum product fumes is known carcinogen
 - d. Remove PPE soaked with flammable, combustible liquids from service until cleaned according to manufacturer's recommendations

WARNING!: PPE soiled with flammable and combustible liquids may ignite when exposed to heat.

- 2. Do not extinguish liquids burning around relief valves or piping until leak is controlled
 - a. Unburned vapors heavier than air
 - i. Form pools or pockets of gas in low areas
 - ii. May ignite
 - b. Attempt to control all ignition sources in leak area
 - i. Vehicles
 - ii. Smoking materials
 - iii. Electrical fixtures
 - iv. Sparks from tools
- 3. Be aware of increase in intensity of sound or fire from relief valve

There are several safety precautions to follow at flammable, combustible liquid fire incidents.

Do not extinguish burning liquids • Around relief valves or piping until leak

. In intensity of sound or fire from relief

12-33

(Cost)

IFSTA

WARNING!

controlled



- a. May indicate vessel is overheating, rupture imminent
- b. Do not assume valve sufficient to safely relieve excess pressures under severe conditions
- C. Rupture can cause fatalities
- 4. Recognize conditions created when liquid is heated in closed container
 - a. Liquid expands Change from liquid to gas increases internal pressure of vessel
 - b. When too much pressure builds Vessel loses structural integrity, ruptures
 - c. Rupture releases massive amounts of pressure, flammable contents of vessel Can result in BLEVE
 - i. Liquid or liquefied gas must be above its boiling point (at standard temperature, pressure) when container fails
 - ii. BLEVE produces
 - (a) Violent explosion that sends large pieces of tank flying in all directions
 - (b) Huge fireball with radiant heat sufficient to incinerate anything near site
 - iii. Tank failure may be result of
 - (a) Mechanical damage to tank
 - (b) Direct flame impingement on vapor space in tank
 - iv. Most common cause when
 - (a) Flames contact shell above liquid level
 - (b) Insufficient water applied to keep tank shell cool
 - v. To attack fire
 - (a) Apply water to upper portions of tank
 - (b) Preferably applied from unattended master stream devices

5. Method most often used to control flammable liquid fires – Apply foam

Review Question: What safety precautions should be taken at flammable/combustible liquid fire incidents? *See pages 1069-1070 of the textbook for answers.*

C.	Fires in	Properties	Protected	by Fix	ed Systems
----	----------	------------	-----------	--------	------------

- 1. Work to support system Not work against it
- 2. Recognize hazards particular to system
 - a. Oxygen depletion following activation of carbon dioxide flooding systems
 - b. Poor visibility
 - c. Energized electrical equipment
 - d. Toxic environments
- 3. Preincident plans contain
 - a. SOPs used at occupancies
 - b. Procedures for each response unit to follow according to conditions found
 - c. Building site plan
 - i. Shows water supplies, protection system connections, unit placement
 - ii. Must be updated regularly
- 4. Water-based systems
 - a. Operation
 - i. Depend on water from underground pipes or water storage tanks
 - ii. Supplement water or maintain operating pressure by deploying supply hoses from hydrant to fire department connection (FDC)
 - b. Automatic sprinkler system Personnel manage system following local SOPs to take action
 - i. Connect pumper to FDC to supplement water supply; maintain constant pressure on system

Recognize hazards particular to system	
Oxygen depletion	
Poor visibility	
Toxic environments	
Prencident plans contain	
SOPS	
Procedures for response units	



- ii. Assign radio-equipped firefighter to sprinkler control valve to close or reopen as ordered, prevent it from being closed prematurely
- iii. Install wooden wedges or sprinkler stops to halt flow of water from open sprinklers
- iv. Replace open sprinklers to allow system to be restored to normal
- v. Restore sprinkler system to normal
- vi. Monitor building after fire has been extinguished while waiting for owner or designee to restore sprinkler system
- c. Standpipe systems Allow deployment of attack hoselines on upper stories of structures, in large area structures or industrial sites
 - i. Pumpers connect supply hoses to standpipe connection, increase system pressure based on amount of friction loss
 - ii. High-rise structures may have pumps installed on upper stories to help maintain pressure
 - iii. Tasks to perform when coordinating fire attack
 - (a) Connect pumper to FDC to supplement water supply, maintain constant pressure on system
 - (b) Determine location of fire
 - (c) Don full PPE, respiratory protection
 - (d) Take necessary tools, hose, nozzle, equipment to standpipe outlet located in stairwell below fire floor
 - (e) Connect attack hoseline to outlet, advance line up stairs to door into fire floor
 - (f) Charge hoseline, bleed air off line, adjust nozzle for desired pattern
 - (g) Advance hoseline onto fire floor, use appropriate attack method to extinguish fire



- d. Foam systems Installed where large quantities of Class B flammable/combustible liquids stored, used
 - i. May include connections to FDCs or may be self-contained
 - ii. Critical that foam blanket not be disturbed when activated
 - iii. More of same type of foam can be added to layer
 - iv. Locations may have total flooding system installed – Entire compartment, structure filled with foam
 - v. Do not disturb foam, allow to remain in place until complete extinguishment determined
- 5. Non-water-based systems
 - a. Found in
 - i. Industrial occupancies
 - ii. Aircraft hangers, maintenance facilities
 - iii. Large cargo vessels
 - b. Include
 - i. Carbon dioxide
 - ii. Clean agent
 - iii. Dry-, wet- chemical systems
 - c. When active will either
 - i. Fill compartment with extinguishing agent (carbon dioxide, clean agent)
 - ii. Blanket fire (dry-, wet-chemical)
 - d. Do not disturb or remove agent until complete extinguishment determined
 - e. Deploy, position attack hoselines to prevent fires in adjacent Class A materials
 - f. Wear SCBA when entering, working in areas where agents have been used

Review Question: How do suppression methods for waterbased, and non-water-based suppression systems differ? *See pages 1071-1072 of the textbook for answers.*

pp. 1073

Objective 7 — Explain ways to use water to control Class B fires.

Objective 8 — Compare methods used to suppress bulk transport vehicle fires and flammable gas incidents.



- A. Using Water to Control Class B Fires
 - 1. Ineffective agent when used alone
 - 2. Must remember
 - a. Hydrocarbons do not mix with water
 - b. Polar solvents do mix with water
 - 3. Cooling agent
 - a. Without foam additives not effective on lighter petroleum distillates or alcohols
 - b. Can absorb heat in heavier oils, extinguish fire when applied as droplets in sufficient quantities
 - c. Most useful for protecting exposures
 - i. Streams must be applied to form protective water film on materials that may weaken or collapse
 - ii. Should be applied above level of contained liquid on burning storage tanks
 - 4. Mechanical tool
 - a. Can be used to move Class B fuels to areas where they can safely burn or be more easily controlled
 - b. NEVER flush down storm drains, into sewers
 - c. Use appropriate fog patterns
 - i. For protection from radiant heat
 - ii. To prevent plunging stream into liquid
 - (a) Causes increased production of flammable vapors
 - (b) Greatly increases fire intensity
 - iii. Slowly move stream from side to side, sweep fuel or fire to desired location

- iv. Keep leading edge of fog pattern in contact with fuel surface – Fire may flash under stream back toward crew
- d. Fog stream may be used to dissipate flammable vapors
- 5. Crew protection
 - a. Fog stream patterns used when advancing to shut off liquid or gas control valves
 - b. One hoseline can be used for crew protection, two lines with back up line preferred

WARNING: Only firefighters who have practiced using hoselines for crew protection should do so during an emergency.

- c. When pressure vessels exposed to flame impingement
 - i. Apply solid streams from maximum effective reach until relief valves close
 - ii. Minimum of 500 gpm (1 900 L/min) must be applied at each point of flame impingement
 - (a) Arch stream along top of vessel until water runs down on both sides
 - (b) Cools vapor space inside tank, tank shell, and steel supports under tank
 - (c) Supports cooled to prevent collapse
 - No safe angle to approach fire-involved pressurized storage tank – Rupture causes metal fragments in all directions
 - iv. If necessary to make temporary repairs, shut off fuel source
 - (a) Use hoseline advance to tank on fire using wide protective fog pattern
 - (b) Use separate pump, water source to supply backup hoseline

Review Question: What are the ways water can be used to control Class B fires? *See pages 1073-1074 of the textbook for answers.*

WARNING

Only firefighters who have practiced using hoselines for crew protection should do so during an emergency.



B. Bulk Transport Vehicle Fires

- 1. Always follow preincident plans
- 2. Techniques for extinguishment are similar to fires in flammable fuel storage facilities
 - a. Similarities
 - i. Amount of fuel available to burn
 - ii. Possibility of vessel failure
 - iii. Danger to exposures
 - b. Differences
 - i. Increased life safety risks to firefighters from traffic
 - ii. Increased life safety risks to passing motorists
 - iii. Reduced water supply
 - iv. Difficulty in identifying products involved
 - v. Difficulty in containing spills and runoff
 - vi. Force of collisions can weaken or damage tanks and piping
 - vii. Instability of vehicles
 - viii. Location of incident raises additional concerns for civilians, civilian structures
 - c. Incidents often handled while traffic passes scene at near-normal speeds
 - i. Close at least one lane of traffic in addition to incident lane
 - ii. Avoid using road flares
 - iii. Direct traffic, control access to scene using trained firefighters if law enforcement not available
 - d. Techniques for approaching, controlling leaks or fires
 - i. Involving vehicles and rail tank cars Same as for storage vessels
 - ii. Additional considerations for vehicle fires
 - (a) Tires could fail Causing flammable load to shift



- (b) Status, limitations of water supply vary more
- (c) May be necessary to protect trapped victims with hose streams until rescued
- e. Determine exact nature of cargo as soon as possible
 - i. Use bills of lading, manifests, placards, or drivers
 - ii. May not be found, be wrong, or drivers unable to identify cargo
 - iii. Contact shippers, manufacturers responsible for vehicles
- f. Protect environment Prevent runoff by blocking water drains

C. Flammable Gas Incidents

- 1. Distribution systems Pressure
 - a. Ranges from 1,000 psi (7 000 kPa) in the distribution network to 0.25 psi (2 kPa) at point of use
 - b. Usually below 50 psi (350 kPa) in local distribution piping
- 2. May be
 - a. In cylinders marked compressed natural gas (CNG)
 - b. Shipped and stored as liquid (LNG) Subject to BLEVE in this form
- 3. Most incidents generally caused by excavation equipment breaking through underground pipes
 - a. Contact utility company immediately
 - b. Approach from, stage on upwind side Even if not ignited
 - c. Wear full PPE, be prepared in event of explosion, accompanying fire
 - d. First concerns
 - i. Evacuation of area immediately around break





- ii. Evacuation of area downwind
- iii. Elimination of ignition sources
- e. Service connections may have been damaged – Check surrounding buildings for odor of gas inside
- f. Follow local SOPs when crimping gas line to stop leak
- g. If gas is burning
 - i. Do not extinguish flame
 - ii. Use hose streams to protect exposures if needed
 - iii. Contact utility company, attempt to shut off pressurized gas supply
 - iv. Request hazardous materials team if available

WARNING If gas is burning from a broken gas pipe, do not extinguish the fire. Provide protection for exposures.

WARNING!: If gas is burning from a broken gas pipe, do not extinguish the fire. Provide protection for exposures.

Review Question: How do suppression methods for bulk transport vehicle fires and flammable gas incidents compare with one another? See pages 1075-1076 of the textbook for answers.

III. SKILLS

pp. 1098 Objective 9 — Establish Incident Command and coordinate interior attack of a structure fire.

Objective 10 — Control a pressurized flammable gas container fire.

IV. SUMMARY AND REVIEW



pp. 1099

A. Chapter Summary

 Coordinating fireground operations requires knowledge of the roles and responsibilities of each team present on-scene as well as

•	When supervising teams it is importan to understand the unique considerations required for attacking not only structure fires, but also Class B liquids and gas fires.
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effective establishment and transfer of command.

2. When supervising teams it is important to understand the unique considerations required for attacking not only structure fires, but also Class B liquids and gas fires.

B. Review Questions

- 1. What are the priorities that must be considered when beginning fireground operations? (pp. 1057-1058)
- 2. What are the fireground roles a firefighter II may need to coordinate at an incident? (*pp.* 1058-1063)
- 3. How should Command be established at an incident? (*pp. 1064-1066*)
- 4. What hazards may be present at fires in underground spaces? (*pp. 1066-1068*)
- 5. What safety precautions should be taken at flammable/combustible liquid fire incidents? (*pp. 1069-1070*)
- 6. How do suppression methods for waterbased, and non-water-based suppression systems differ? (*pp. 1071-1072*)
- 7. What are the ways water can be used to control Class B fires? (*pp. 1073-1074*)
- 8. How do suppression methods for bulk transport vehicle fires and flammable gas incidents compare with one another? (pp. 1075-1076)

Chapter 18 Loss Control

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1	Loss Control	
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Lesson Goal

After completing this lesson, the student shall be able to apply loss control knowledge and practices following the policies and procedures set forth by the authority having jurisdiction (AHJ).

Objectives

Upon successful completion of this lesson, the student shall be able to:

- 1. Explain the philosophy of loss control. [NFPA® 1001, 5.3.14]
- 2. Describe the ways preincident planning impacts loss control. [NFPA[®] 1001, 5.3.14]
- 3. Determine appropriate salvage procedures. [NFPA® 1001, 5.3.14]
- 4. Compare and contrast different types of salvage covers. [NFPA[®] 1001, 5.3.14]
- 5. Explain ways to fold, roll, spread, and improvise with salvage covers. [NFPA[®] 1001, 5.3.14]
- 6. Describe ways to cover openings during salvage operations. [NFPA[®] 1001, 5.3.14]
- 7. Explain methods used to maintain fire safety during overhaul. [NFPA[®] 1001, 5.3.13]
- 8. Describe factors that influence locating hidden fires. [NFPA[®] 1001, 5.3.10, 5.3.13]
- 9. Identify different overhaul procedures. [NFPA® 1001, 5.3.13]
- 10. Indicate the ways a thermal imager can be used during overhaul. [NFPA[®] 1001, 5.3.13]
- 11. Clean, inspect, and repair a salvage cover. [NFPA® 1001, 5.3.14]
- 12. Roll a salvage cover for a one-firefighter spread. [NFPA® 1001, 5.3.14]
- 13. Spread a rolled salvage cover One-firefighter method. [NFPA[®] 1001, 5.3.14]
- 14. Fold a salvage cover for a one-firefighter spread. [NFPA® 1001, 5.3.14]
- 15. Spread a folded salvage cover One-firefighter method. [NFPA[®] 1001, 5.3.14]
- 16. Fold a salvage cover for a two-firefighter spread. [NFPA® 1001, 5.3.14]
- 17. Spread a folded salvage cover Two-firefighter balloon throw. [NFPA[®] 1001, 5.3.1]

- 18. Construct a water chute without pike poles. [NFPA[®] 1001, 5.3.14]
- 19. Construct a water chute with pike poles. [NFPA® 1001, 5.3.14]
- 20. Construct a catchall. [NFPA[®] 1001, 5.3.14]
- 21. Make a chute and attach it to a catchall. [NFPA[®] 1001, 5.3.]
- 22. Locate and extinguish hidden fires. [NFPA® 1001, 5.3.10, 5.3.]

Instructor Information

This is the lesson covering loss control. This lesson describes the philosophy of loss control, salvage methods and equipment, and overall procedures. The lesson also covers factors that influence locating hidden fires.

Important instructor information is provided in shaded boxes throughout the lesson plan. Carefully review the instructor information before presenting the lesson.

Methodology

This lesson uses lecture, discussion, and skill evaluation checklists. The level of learning is application.

I. PHILOSOPHY OF LOSS CONTROL

pp. 1104







Objective 1 — Explain the philosophy of loss control.

A. Philosophy of Loss Control

- Describes activities performed to minimize losses to property – Done before, during and after fire
- 2. Is sign of professionalism; exhibits good customer service
- 3. Properly applied activities include
 - a. Minimizing damage to structure, exposures, contents
 - b. Eliminating chance fire will reignite in structure
 - c. Reducing time needed to repair, reopen the business
 - d. Reducing stress on owner/occupants of structure
 - e. Creating goodwill for fire department within community
 - f. Minimizing financial loss for owner, occupant, insurance company, and community
- 4. Types of damage
 - a. Primary damage Caused by fire and smoke
 - b. Secondary damage Results from fire suppression activities
 - i. Forcible entry, ventilation, and fire extinguishment operations
 - ii. Vulnerability to weather and vandalism following fire suppression
- 5. Tactics intended to reduce property damage
 - a. Salvage Operations associated with firefighting that aid in reducing primary and secondary damage

b. Overhaul – Operations in searching for and extinguishing hidden or remaining fires after main body of fire extinguished

Review Question: How does the philosophy of loss control impact fire suppression? *See page 1104 of the textbook for answers.*

II. PREINCIDENT PLANNING FOR LOSS CONTROL

pp. 1104-1106 Objective 2 — Describe the ways preincident planning impacts loss control.

A. Preincident Planning for Loss Control

- 1. Special loss control-related concerns identified and addressed
- May not be your responsibility to develop May be required to implement as directed by Incident Commander (IC)
- 3. Concerns to be identified in preincident plan
 - a. Most effective, least destructive means of gaining structure access
 - b. Most effective means of evacuating or protecting building occupants during fire
 - c. Location of vital business records in structure, and how to best protect them
 - d. When and how built-in fire suppression systems are to be supported and used
 - e. How building contents are to be protected from smoke, water damage
- Develop special preincident plans for buildings with high-value contents – Especially susceptible to water and smoke damage
 - a. Electronic equipment
 - b. Computer systems
 - c. Artwork
 - d. Documents
 - e. Other





- 5. Preincident plans for residential occupancies include
 - a. Covering upholstered furniture, bedding, and other water-absorbent objects
 - b. Protecting items of monetary and sentimental value
 - i. Photographs
 - ii. Important documents
 - iii. Computer equipment
 - iv. Artwork
 - c. Protect items by
 - i. Covering
 - ii. Moving to unaffected area
 - iii. Removing from structure
- 6. Preincident plans for commercial properties
 - a. Should reflect awareness of value to contents vital to business survival – Business owner or representative resource when determining vital items
 - b. Interacting with business owner or representative is good opportunity to recommend continual loss control practices

Review Question: In what ways can preincident planning influence loss control? *See pages 1104-1106 of the textbook for answers.*

III. SALVAGE

pp. 1106-1112 Objective 3 — Determine appropriate salvage procedures.

Objective 4 — Compare and contrast different types of salvage covers.



A. Salvage Procedures

- 1. Begin upon arrival, continues until last unit leaves scene
- 2. IC may order salvage operations conducted while suppression activities underway if

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- On-scene resources are sufficient a.
- b. Situation permits
- 3. Various ways to perform
 - Contents of room(s) immediately below fire a. floor protected with salvage covers while fire suppression operations conducted
 - Delay suppression activities for short time to b. remove vital contents - IC should make decisions about delay
- 4. Choice of salvage procedures depends on
 - Number of personnel available a.
 - b. Extent and location of fire
 - Type, size, and quantity of contents C.
 - d. Current weather conditions
- 5. Salvage procedures include
 - Moving contents to a safe location in a. structure
 - i. Should be to areas
 - (a) Not in danger of fire extension
 - (b) Away from concentrations of smoke
 - (c) Where water will not spread
 - ii. Best used when
 - (a) Fire is limited
 - (b) Fire not likely to spread
 - (c) Weather conditions would damage contents if moved outside
 - iii. May be necessary to cover contents with salvage covers or raise off floor
 - b. Removing contents from structure
 - Help protect them from further primary, i. potential secondary damage
 - May interfere with suppression and ii. ventilation crews using same doors to enter structure
 - iii. Contents should





- (a) Be stacked on dry surfaces not near where firefighters may be collecting debris for disposal
- (b) Be protected from theft, vandalism once fire is extinguished
- iv. Owner/occupant must be made aware contents have been stored outside or contents should be secured
- c. Protecting contents in place Method most often used
 - i. Contents gathered into compact piles that can be covered with minimal salvage covers
 - (a) Allows more items to be protected than if covered in original position
 - (b) If possible, group household furnishings in center of room
 - ii. In many cases one salvage cover can protect contents of one residential room
 - iii. If floor covering is removable rug, slip out from under furniture as each piece moved, roll up to move
- 6. Creating one high point in furniture group
 - a. Place dresser, chest or high object at end of bed; grouping other furniture close by
 - b. Allows water to run off without collecting in depressions
 - c. Pictures, curtains, lamps, clothing, and other fragile items can be placed on bed
 - d. May need to place salvage cover over bed before putting articles on bed
- 7. Preventing furniture damage Sitting on wet carpet can cause to absorb water
 - a. Raise furniture off wet floor with waterresistant materials
 - b. Use precut plastic, foam blocks May improvise with canned goods from kitchen
- 8. Commercial occupancies present challenges
 - May be difficult to cover contents when large stocks, and display features are involved



- i. Display shelves frequently built to ceiling, directly against walls
 - (a) Makes contents difficult to cover
 - (b) Water flows down wall, comes into contact with shelving, and wetting contents
- ii. Contents stacked too close to ceiling
- b. Stock susceptible to water damage
 - i. Should be placed off floor to prevent saturation Use of skids or pallets common, if available
 - ii. Even off floor, still must be covered
- 9. Use available covers for water chutes, catchalls
 - a. Number of salvage covers may be limited
 - b. Water must be routed to floor to be removed later
- 10. Extreme caution must be used with high-piled stock
 - a. Wetness often causes material to expand, pushing out interior or exterior walls
 - b. Wetness reduces strength of material; may cause pile to collapse
- 11. Removing large quantities of water
 - a. Locating and cleaning clogged drains
 - b. Removing toilet fixtures
 - c. Creating scuppers
 - d. Using existing sanitary piping systems
 - e. Creating chutes made of salvage covers, plastic, other available materials to route water to other areas
- Water left on cabinets, other horizontal surfaces may ruin finishes – Wipe with disposable paper towels to guard against potential loss

Review Question: What is the best way to determine appropriate salvage procedures? *See pages 1106-1109 of the textbook for answers.*







B. Salvage Covers and Equipment

- 1. Depending on size, organization of fire department, and salvage operations
 - a. Generally assigned to ladder companies and specially designated salvage, overhaul companies
 - b. All firefighters trained in salvage cover and equipment use; should be familiar with all used by their department
 - c. Engine companies carry salvage covers, hand tools, and buckets for salvage operations
- 2. Salvage covers Waterproof canvas or vinyl
 - a. Various sizes
 - b. Reinforced corners with edge hems, grommets for hanging or draping
 - c. Vinyl synthetic
 - i. Lightweight
 - ii. Easy to handle
 - iii. Economical
 - iv. Indoor or outdoor use
 - d. Disposable heavy-duty plastic covers
 - i. Available on rolls
 - ii. Extended as needed to cover large areas
 - iii. Cut into different shapes or sizes as needed
- 3. Salvage cover maintenance
 - a. Properly cleaning, drying, and repairing salvage covers increases service life
 - b. Typical cleaning required for canvas
 - i. Wetting or rinsing with hose stream, scrubbing with broom
 - ii. Extremely dirty, stained covers scrubbed with detergent solution, and rinsed
 - c. Some foreign materials difficult to remove when allowed to dry on cover, even with detergent
 - d. Canvas should be clean, completely dry before folded, and stored on apparatus – Essential to prevent mildew/rot

e. Permitting canvas salvage covers to dry when dirty not good as carbon and ash stains can rot canvas – Acceptable to dry outdoors but avoid when windy

NOTE: Long-term exposure of canvas to sunlight will result in damage from ultraviolet rays. Drying in direct sunlight may degrade the material over time.

- f. Synthetic covers do not require as much maintenance as canvas covers – May be folded when wet but let dry so will not mildew
 - i. After covers are dry, should be examined for damage
 - ii. To inspect for holes, three or four firefighters stand side-by-side along one end of cover
 - iii. Firefighters pick up end, pass it back over heads while walking toward other end, looking at underside for light showing through even smallest holes
 - iv. Mark any holes using
 - (a) Chalk for canvas covers
 - (b) Marking pen for vinyl covers
 - v. Firefighters place duct tape or mastic tape over holes or patch with iron-on or sew-on patches
- 4. Salvage equipment
 - a. Requires specific collection of tools, equipment stored in specially designated toolbox or containers for ease of carrying
 - i. May be kept in plastic tub, brought into structure
 - ii. Provides a useful water-resistant container to protect items
 - b. Typical tools, equipment used include
 - i. Electrical
 - ii. Mechanical
 - iii. Plumbing
 - iv. General carpentry tools
 - v. Mops, squeegees, buckets Useful for removing water





- c. Automatic sprinkler kit Tools used to stop flow of water from an open sprinkler
 - i. Flow of water from open sprinkler can do considerable damage to merchandise on lower floors after fire controlled in commercial building
 - ii. Suggested tools for kit: sprinkler tongs or stoppers, and wooden sprinkler wedges

Instructor Note: Discuss "Routing Water Out of a Sprinklered Building" on page 1111 of textbook.

Discuss how and why it is important to route water out of a sprinklered building.

NOTE: Responsibility for restoring automatic sprinkler systems to service is determined by the authority having jurisdiction. You may only restore systems if you are authorized and trained to do so.



- d. Carryalls
 - i. Used to carry debris
 - ii. Catch falling debris
 - iii. Provide water basin for immersing small burning objects
 - iv. Constructed of nonflammable material
- e. Floor runners Firefighters often unintentionally damage flooring with their boots and equipment during fire suppression operations
 - i. Floor coverings protected by floor runners
 - ii. Can be unrolled from entrance to almost any part of building
 - iii. Commercially prepared vinyl-laminated nylon floor runners – Lightweight, flexible, tough, heat and water resistant, easy to maintain
- f. Dewatering devices Pumps to remove water from basements, elevator shafts, and sumps
 - i. Portable pumps capable of passing grey water with debris, jet-siphons, and submersible pumps best suited



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- ii. Can be moved to any point where line of hose placed and outlet for water provided
- g. Water vacuum One of easiest, fastest ways to remove water
 - i. Used to dewater floors, carpets, other areas where water is not deep enough to be picked up by submersible pump or siphon ejector
 - ii. Consists of tank (worn on the back or placed on wheels) and nozzle
 - Backpack-type tanks normally have capacity of 4 to 5 gallons (15 L to 20 L); can be emptied by pulling lanyard to empty water through nozzle or separate drain hose
 - iv. Floor models on rollers may have capacities up to 20 gallons (80 L)
- J-hooks Designed to be driven into walls or wooden framing to provide strong point to hang objects; most often used to hang salvage covers on walls to protect wallmounted book cases, and shelving units
- i. S-hooks Used for same purpose as Jhooks but cannot be driven into walls or framing – Must have horizontal ledge from which to hang

Review Question: What are the different types of salvage covers commonly used in the fire service? *See page 1109 of the textbook for answers.*

pp. 1112-1116 Objective 5 – Explain ways to fold, roll, spread, and improvise with salvage covers.

Objective 6 – Describe ways to cover openings during salvage operations.

C. Folding/Rolling and Spreading Salvage Covers



 One-firefighter spread with a rolled salvage cover – Main advantage is one person can quickly unroll salvage cover across top of an object; may be carried on shoulder or under the arm

- One-firefighter spread with a folded salvage cover – Some departments prefer to carry folded versus rolled salvage covers
 - a. Two firefighters are needed to make this fold, performing same functions simultaneously
 - b. Carrying folded cover on shoulder typically most convenient but any safe carrying method is acceptable
- Two-firefighter spread with a folded salvage cover – Single firefighter cannot easily handle large salvage cover; should be folded for twofirefighter deployment
 - a. Most convenient way to carry fold is on shoulder with open edges next to the neck
 - b. Makes little difference which end of folded cover is placed in front of carrier as two open-end folds will be exposed
 - c. Position cover so firefighter carrying it holds lower pair of corners, and second firefighter holds uppermost pair
 - d. Balloon throw most common method used for two firefighter deployment of large cover
 - i. Works best when sufficient air is pocketed under cover
 - ii. Pocketed air gives a parachute effect to float cover into place over article to be covered

D. Improvising With Salvage Covers

- 1. Typically used to cover building contents
- 2. Used to catch, route water from fire fighting operations or other structural flooding situations
- 3. Removing water with chutes
 - a. Water chute one of most practical methods of removing water coming through ceiling from upper floors
 - b. May be constructed on floor below fire fighting operations to drain runoff out of structure through windows or doors



- c. Some fire departments carry prepared chutes, approximately 10 feet (3 m) long, as regular equipment; others construct chutes when, where needed using floor runners or one or more covers
- d. Plastic sheeting, heavy-duty stapler, and duct tape can be used to construct water diversion chutes
- 4. Constructing a catchall
 - a. Constructed from salvage cover
 - b. Placed on floor to hold small amounts of water
 - c. May be temporary to control large amounts of water until chutes constructed to route water outside
 - d. Can hold several hundred gallons (liters) water, saving time
 - e. To catch as much water as possible, place cover into position as soon as possible, even if sides not uniformly rolled
 - f. Two firefighters usually needed to construct
- 5. Splicing covers
 - a. Necessary to splice covers with watertight joints when
 - i. Objects or groupings too large to be covered with single cover
 - ii. Long chutes or catchalls need to be made
 - b. Many methods for splicing covers Your department will train on specific procedure
 - c. Many departments use disposable rolled plastic sheeting, cut to size as needed
 - i. Saves time and property
 - ii. Eliminates need for splicing, reducing leakage risk
- 6. Splicing chute to catchall
 - a. Plan should be developed to remove water from catchall as soon as constructed, especially if volume of water greater than catchall's capacity

- b. Submersible pumps used if available, if significant and constant flow of water into catchall
- c. Common water removal method is splice water chute to catchall – Advantage: as soon as water accumulates in catchall, drained to outside

Review Question: Why is it necessary to know several ways to fold, roll, spread, and improvise with salvage covers? *See pages 1112-1116 of the textbook for answers.*

E. Covering Openings – Critical to prevent further damage by weather, trespassers

- 1. Doors or windows broken or removed should be covered
 - a. Plywood
 - b. Heavy plastic
 - c. Similar materials to keep out rain
 - d. Plywood, hinges, hasp, padlock can be used to make temporary door
- Openings in roofs should be covered with plywood, roofing paper, heavy plastic sheeting, and tar paper
 - a. Use appropriate roofing nails if roofing, tar paper, or plastic used
 - b. Place lath strips along edges of material, and nail in place
- Very important to cover openings cut in upper story floors or over basements, crawl spaces – Must be covered with lumber or thick plywood to support a person's weight

Review Question: What ways can firefighters cover openings during salvage operations? *See page 1116 of the textbook for answers.*



IV. OVERHAUL

pp. 1118-1123 Objective 7 — Explain methods used to maintain fire safety during overhaul.

Objective 8 — Describe factors that influence locating hidden fires.

Objective 9 — Identify different overhaul procedures.

Objective 10 — Indicate the ways a thermal imager can be used during overhaul.

- A. Overhaul
 - 1. Activities conducted once main body of fire extinguished
 - a. Searching for and extinguishing hidden or remaining fire
 - b. Placing building and its contents in a safe condition
 - c. Determining cause of fire
 - d. Recognizing and preserving evidence of arson
 - 2. Should begin when
 - a. Incident Commander (IC), individual responsible for fire investigation authorize
 - b. Once order given Firefighters attempt to put building, contents, and fire area in as safe, habitable condition as possible
 - Salvage operations performed during firefighting affects any overhaul work that may be needed later
 - 4. Many tools, equipment used for overhaul are same used for forcible entry, ventilation, salvage operations; may include
 - a. Pike poles, plaster hooks Open ceilings to inspect for fire extension
 - b. Axes Open walls, floors
 - c. Prying tools Remove door or window frames, baseboards









SAP	BE ADDRESSED BEFORE OVERHAUL.
0	Inspect premises
	Develop operational plan
	Provide needed tools
	Eliminate, mitigate hazarda
0	Monitor atmosphere before removing SCBA
0.	LARAMA FIRE COLLEGE



- d. Power saws, drills, screwdrivers Install temporary doors, window coverings
- e. Carryalls, buckets, tubs Carry debris, provide basin for immersing smoldering material
- f. Shovels, bale hooks, pitchforks Move baled or loose materials
- g. Thermal imager (TI) Check void spaces, look for hot spots
- Supervisor or officer not directly engaged in overhaul should visually direct overhaul operations
- 6. If fire investigator is on scene
 - a. Should be involved in planning, supervising overhaul activities
 - b. Plans should avoid disturbing potential evidence needed to determine fire cause

B. Fire Safety During Overhaul

- 1. Before beginning
 - a. First consideration is safety
 - b. Plan, organize after fire brought under control
 - c. Should provide highest degree of safety to firefighters, others on scene
- 2. Steps to establish safe conditions include
 - a. Inspecting the premises
 - b. Developing an operational plan
 - c. Providing needed tools and equipment
 - d. Eliminating or mitigating hazards (including securing any remaining utilities)
 - e. Monitoring the atmosphere for carbon monoxide (CO) and hydrogen cyanide (HCN) levels before removing SCBA
- 3. Significant threat to firefighters are toxic gases produced from smoldering fire
 - a. Even if air in structure appears to be without smoke, toxic combustion products can exist in dangerous concentrations

Fire Protection Publications Oklahoma State University b. Carbon monoxide (CO) and hydrogen cyanide (HCN) commonly encountered toxic gases; countless others can be present depending on building contents involved in fire

- c. Air monitoring devices should be deployed based on department's SOPs
- d. All personnel should continue to use SCBA until atmosphere in structure determined acceptable
- e. Once air monitoring confirms SCBAs can be safely removed
- f. Firefighters should wear particulate masks for protection from nontoxic, airborne particles
- g. Property owners/occupants should not be allowed to enter structure until atmosphere deemed acceptable

CAUTION: Wear proper protective clothing including selfcontained breathing apparatus (SCBA) until the atmosphere has been proven safe.

- 4. Many other hazards exist for firefighters performing overhaul
 - a. Personnel may fall, become injured when fire-weakened floors collapse or fail
 - b. Any potentially hazardous areas identified should be marked or barricaded immediately
 - c. Can also be injured by stepping on broken glass, nails, and other sharp objects
 - d. Handling fire debris during overhaul Firefighters susceptible to cuts, punctures, thermal burns if not wearing gloves
 - e. Eye protection is critical to avoid injuries to eyes
 - f. Strains, sprains prevented through physical conditioning, practicing safe lifting techniques
 - g. Preventable cause of injury is fatigue Exhausted firefighters more susceptible to injury than those rested





fork in teams of 2 or mo	xe
laintain awareness of e	eit routes
laintain RIC/RIT	
Ionitor personnel for re	hab needs
eware of hidden gas or	electrical utilities
ontinue using accounts	bility system until incident terminated

- Firefighters not directly involved in rescue and fire control should conduct overhaul operations if resources allow
- 6. Due to threat of reignition, charged hoselines should be present during overhaul operations
 - a. 1½-inch (38 mm) or 1¾-inch (45 mm) attack lines can be used
 - b. At least one attack line should be available in the event of rekindle
 - c. Regardless of type of hose used, place nozzle so it will not cause additional water damage
 - d. Hoselines should be constantly monitored for leakage, especially at couplings
 - e. Using 100-foot (30 m) section of hose as first section on attack lines reduces chances any couplings other than at the nozzle would even be inside a building
- 7. To protect yourself during overhaul operations
 - a. Continue to maintain situational awareness
 - b. Focus on safety
- 8. Additional safety considerations during overhaul operations
 - a. Continue to work in teams of two or more
 - b. Maintain awareness of available exit routes
 - c. Maintain rapid intervention crew or team (RIC/RIT) throughout operation
 - d. Monitor personnel for need of rehabilitation
 - e. Beware of hidden gas or electrical utilities
 - f. Continue using accountability system until incident terminated

Review Question: What methods can be used to maintain fire safety during overhaul operations? *See pages 1119-1120 of the textbook for answers.*

C. Locating Hidden Fires

 Before starting – Evaluate structural condition of area to be searched



- 2. Intensity of fire and amount of water used for control affect building condition
 - a. Intensity of fire determines extent structural members weakened
 - b. Amount of water used determines additional weight placed on floors, walls due to absorbent properties of building contents
- 3. Indicators of possible loss of structural integrity
 - a. Weakened floors due to floor joists being burned away
 - b. Concrete that has spalled due to heat
 - c. Weakened steel roof members
 - d. Walls offset because of elongation of steel roof supports
 - e. Weakened roof trusses due to burn-through of key members
 - f. Mortar in wall joints opened due to excessive heat
 - g. Wall ties holding veneer/curtain walls melted from heat
 - h. Heavy storage on mezzanines or upper floors
 - i. Water pooled on upper floors
 - j. Large quantities of wet insulation
- 4. Firefighters can detect hidden fires by sight, touch, sound, and electronic sensors including
 - a. Sight
 - i. Discoloration of materials
 - ii. Peeling paint
 - iii. Smoke emissions from cracks
 - iv. Cracked plaster
 - v. Rippled wallpaper
 - vi. Burned areas
 - b. Touch Heat felt through walls and floors
 - c. Sound
 - i. Popping, cracking of fire burning
 - ii. Hissing of steam





- d. Electronic sensors
 - i. Thermal (heat) signature detection with thermal imager
 - ii. Infrared heat detection

Review Question: How can a firefighter describe the factors that influence locating hidden fires? *See pages 1120-1121 of the textbook for answers.*

D. Overhaul Procedures

- 1. Overhaul typically begins in area of most severe fire involvement
- 2. Process of looking for fire extension should begin as soon as possible after the IC gives the order
- If fire has extended to other areas of structure, firefighters must determine path through which it traveled
 - a. Concealed wall spaces
 - b. Unsealed pipe chases
- If floor beams burned at their ends where enter a party wall, overhaul ends by flushing voids in wall with water — Also inspect other side of wall to determine whether fire or water has come through
- 5. Thoroughly check insulation materials
 - a. Can retain hidden fires for prolonged period
 - b. Usually necessary to remove insulation material to extinguish fire in it
- Do not start making random openings in walls or ceilings without cause – Actions must be justifiable
- Understanding basic building construction concepts will help you in searching for hidden fires
 - a. If fire burned around windows or doors, pull open areas to expose inner parts of frame or casing, visually verify full extinguishment



- b. If fire burned around combustible roof or cornice, advisable to open cornice to inspect for hidden fires
- c. In structures using balloon construction, check attic and basement for fire extension

Instructor Note: Remind students about the information in Chapter 4 concerning building construction. Note that understanding basic building construction will help in searching for hidden fires.

- 8. Often necessary to search for hidden fires in concealed spaces below floors, above ceilings, within walls and partitions
 - a. First move furnishings of room to locations where will not be damaged – If not possible, protect with salvage covers
 - b. Remove only enough wall, ceiling, floor covering to verify complete extinguishment
 - c. Weight-bearing members should not be disturbed
 - d. Inspect wall openings for possible fire extension into wall cavity
 - i. Electrical receptacles and switches
 - ii. Return air ducts
 - iii. Heating vents
 - iv. Telephone and cable connections
 - e. Walls, ceilings in kitchens, bathrooms, utility rooms contain ventilation fans, pipes, ducts, other passages that will permit fire to extend

 If these rooms show evidence of fire spread, walls and ceiling should be inspected
- When opening concealed spaces, consider if space contains indicators of presence of utilities
 - a. Electrical wiring
 - b. Gas piping
 - c. Plumbing
 - d. Electrical outlets
 - e. Gas connections



- f. Water
- Consideration should be given to future repair of structure – Openings should be made in a neat and planned manner
 - a. Reduces the amount of work for future restoration
 - b. Sign of professionalism on part of firefighter
- 11. Ceilings may be opened from below with pike pole or appropriate overhaul tool
 - To open lath and plaster ceilings, break plaster first, then pull off lath – some plaster ceilings have wire mesh embedded in plaster so when start to come down, may be in one very large piece
 - b. Some newer plaster ceilings backed with gypsum wallboard instead of wooden lath
 - c. Metal or composition ceilings may be pulled from joists in similar manner
- 12. When pulling any ceiling
 - a. Do not stand directly under area to be opened – Always position yourself between area being pulled down and doorway to keep exit route from being blocked with falling debris
 - b. Always wear full PPE including respiratory protection

CAUTION: When pulling any ceiling, stand clear of any falling debris.

- 13. Small burning objects frequently uncovered during overhaul
 - a. Because of their size, condition, often more effective to submerge entire object in containers of water than drench with hose streams
 - i. Bathtubs
 - ii. Sinks
 - iii. Lavatories
 - iv. Wash tubs



- 14. Large smoldering items should be taken outside structure for thorough extinguishment
 - a. Mattresses
 - b. Stuffed furniture
 - c. Bed linens
- 15. Scorched or partially burned articles can be helpful to investigator in preparing inventory or determining fire cause – firefighters need to work closely with fire investigator to ensure evidence not disturbed
- 16. Use of wetting agents such as Class A foam is valuable when extinguishing hidden fires
 - a. Penetrating qualities of wetting agents facilitate complete extinguishment in cotton, upholstery, baled goods
 - b. Only way to ensure fires in bales of items such as rags, cotton, and hay extinguished is to break apart

Review Question: What are some of the overhaul procedures used in the fire service? *See pages 1121-1122 of the textbook for answers.*

E. Overhaul with Thermal Imagers (TIs)

- Thermal imagers (TIs) identify heat signature of items, project resulting image onto screen for firefighter to see
 - a. Use to find hidden fires in concealed spaces such as floors, ceilings, walls without having to open up areas to visually inspect
 - b. Reduces time needed to perform search and limits secondary structure damage
- Because of the way TIs operate, they sometimes do not provide quality images of items behind reflective materials such as metal, mirrors, and glass – In these instances, traditional methods to reveal hidden fire should be used
- 3. While extremely useful, TIs are only tools If there are discrepancies between TI image and



signs of fire in a concealed space, space should be opened up, inspected visually

Instructor Note: Discuss Safety Alert "Thermal Imagers Must not Replace Your Senses" on page 1124 of the textbook. Emphasize with students that the TI is a tool that has limitations and it should not replace their own senses and judgement.

Review Question: How can using a thermal imager be useful during overhaul? *See pages 1123 of the textbook for answers.*

١	V. S	SKILLS
рр. 1125		Objective 11 — Clean, inspect, and repair a salvage cover.
pp. 1126-112	27	Objective 12 – Roll a salvage cover for a one-firefighter spread.
рр. 1128		Objective 13 – Spread a rolled salvage cover – One- firefighter method
pp. 1129-113	30	Objective 14 – Fold a salvage cover for a one-firefighter spread.
рр. 1131		Objective 15 – Spread a folded salvage cover – One- firefighter method.
pp. 1132-113	33	Objective 16 – Fold a salvage cover for a two-firefighter spread.
рр. 1134		Objective 17 – Spread a folded salvage cover – Two- firefighter balloon throw.
рр. 1135		Objective 18 – Construct a water chute without pike poles.
рр. 1136		Objective 19 – Construct a water chute with pike poles.
рр. 1137		Objective 20 – Construct a catchall.
рр. 1138		Objective 21 – Make a chute and attach it to a catchall.

pp. 1139-1140

Objective 22 – Locate and extinguish hidden fires.

VI. SUMMARY AND REVIEW



A. Chapter Summary

- 1. Loss control is an important component of fire department service delivery with the philosophy of minimizing secondary damage to structures and their contents during and after fire control operations.
- 2. Salvage and overhaul operations are two of the most effective means of loss control.
- 3. It is very important for fire personnel to identify and protect valuable contents in structures affected by fire as well as searching for hidden fires so rekindling does not occur.
- 4. Taking a customer-service oriented approach to loss control ensures that citizens' property is adequately protected and that the reputation of the fire service is held in the highest regard.

B. Review Questions

- 1. How does the philosophy of loss control impact fire suppression? (*p. 1104*)
- 2. In what ways can preincident planning influence loss control? (pp. 1104-1106)
- 3. What is the best way to determine appropriate salvage procedures? (*pp. 1106-1109*)
- 4. What are the different types of salvage covers commonly used in the fire service? (*p. 1109*)
- 5. Why is it necessary to know several ways to fold, roll, spread, and improvise with salvage covers? (*pp. 1112-1116*)
- 6. What ways can firefighters cover openings during salvage operations? (*p. 1116*)
- 7. What methods can be used to maintain fire safety during overhaul operations? (*pp. 1119-1120*)

- 8. How can a firefighter describe the factors that influence locating hidden fires? (*pp. 1120-1121*)
- 9. What are some of the overhaul procedures used in the fire service? (*pp. 1121-1122*)
- 10. How can using a thermal imager be useful during overhaul? (*p. 1123*)