

**Firefighter II, Mod B
Ventilation**

FIREFIGHTER II MOD B Ventilation

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2-11 VENTILATION

- 2-11.1** Identify the definition and principles of ventilation and the considerations of proper ventilation. (3-3.10)
- 2-11.2** Identify the safety considerations and precautions to be taken while ventilating a structure. (3-3.10, 3-3.11)
- 2-11.3** Identify the advantages and disadvantages of the following types of ventilation:
 - 2-11.3.1** Vertical (3-3.11)
 - 2-11.3.2** Horizontal (3-3.10)
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 - 2-11.3.4** Mechanical (3-3.10)
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- 2-11.4** Identify the signs, causes and effects of backdraft explosions. (3-3.10)
- 2-11.5** Identify methods of preventing a backdraft explosion. (3-3.10)
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 - 2-11.6.2** Shed
 - 2-11.6.3** Pitched
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 - 2-11.8.2** Shed
 - 2-11.8.3** Pitched
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- 2-11.9** Identify the procedures for the types of ventilation referred to in 2-11.3. (3-3.10, 3-3.11)
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- 2-11.12 Identify the procedures for opening various types of windows from inside and outside without the use of tools. (3-3.10)
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- 2-11.24 **Demonstrate the use of positive pressure ventilation. (3-3.11(b))**

REFERENCES:

IFSTA, Essentials, 4th ed., Chapter 10.

Delmar, Firefighter's Handbook, copyright 2000, Chapter 18

Jones & Bartlett, Fundamentals of Fire Fighting Skills, 1st ed., Chapters 5, 6, 11, & 14

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2-11 VENTILATION

- I. Identify the definition and principles of ventilation and the considerations of proper ventilation. **2-11.1 (3-3.10(a))**
 - A. Principles
 1. The systematic removal and replacement of heated air, smoke and gases from a structure with cooler air
 - a. Facilitates entry by firefighter
 - b. Improves life safety for rescue
 - c. Improves visibility
 2. Considerations
 - a. Roof type
 - 1) Flat
 - 2) Arched
 - 3) Pitched
 - b. Type of building involved
 - b. Location of the fire
 - c. Duration of the fire
 - d. Extent of the fire
 - e. Existing roof openings
 - f. Safety of personnel
 - 1) Wear full protective clothing with SCBA
 - 2) Charged hoseline in place
 - h. Possibility of fire spread
- II. Identify the safety considerations and precautions to be taken while ventilating a structure. **(3-3.10, 3-3.11)**
 - A. Vertical ventilation
 1. Observe the wind direction in relation to exposures.
 2. Work with the wind to your back or side
 3. Note the existence of obstructions or excessive weight on the roof.
 4. Provide a secondary means of escape
 5. Exercise care in making the opening so the main structural supports are not cut.

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6. Guard the opening to prevent personnel from falling into the building.
 7. Evacuate the roof when ventilation work is complete.
 8. Use lifelines, roof ladders, or other means to protect personnel from sliding and falling off the roof.
 9. Exercise caution in working around electric wires or guy wires.
 10. Ensure that all personnel working on the roof are wearing complete protective clothing, including SCBA.
 11. Keep other firefighters out of the range of the axe.
 12. Caution axe users to beware of overhead obstructions.
 13. Start power tools on the ground to ensure operation.
 14. Shut power tools off before carrying them up a ladder.
 15. Make sure the angle of the cut is not toward you.
 16. Extend ladders at least five (5) rungs above the roof line.
 17. “Sound” the roof for structural integrity before stepping on it.
 18. Use supporting members of the structure for travel.
 19. When using a roof ladder, make sure it is firmly secured to the peak of the roof before using it.
 20. Work in groups of two, with no more people than absolutely necessary.
 21. Be aware of the following warning signs of an unsafe roof condition:
 - a. Melting asphalt
 - b. “Spongy” roof
 - c. Smoke coming from the roof
 - d. Fire coming from the roof
- B. Horizontal ventilation
1. Open the door or window on the leeward side of the building first.
 2. Do not obstruct the ventilation openings.
 3. Watch for fire extension.
- C. Mechanical
1. Forced
 - a. Prevent smoke from churning in the opening
 - b. Avoid blockage of the intake side of the ejector.

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2. Mechanical pressurization/positive pressure

CAUTION: Improper application of positive pressure ventilation may increase fire spread and the safety hazards

- a. Do not block openings
- b. For greatest efficiency, exhaust opening should be 75% to 150% intake opening.

3. Negative

- a. Place to exhaust is in same direction as the natural wind
- b. Watch for churning action at the exhaust opening
- c. Remove all obstacles to the airflow; i.e. screens
- d. Keep airflow in as straight a line as possible

- III. Identify the advantages and disadvantages of the following types of ventilation: **2-11.3 (3-3.10, 3-3.11)**

- A. Vertical: **2-11.3.1**

1. Advantages

- a. Prevents backdraft
- b. Usually assists in confining the fire

2. Disadvantages

- a. Requires firefighters to work above the ground
- b. Possibility of roof failure
- c. Requires close communication

- B. Horizontal **2-11.3.2**

1. Advantages

- a. Uses openings
- b. Uses natural air currents

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2. Disadvantages
 - a. Depends on natural air currents
 - b. Routing may expose other parts of the building
 - c. Same routes used by ventilation may be used by occupants escaping
 - d. Danger of released gases igniting higher portions of the building.

C. Trench or strip 2-11.3.3

1. Advantages
 - a. Aids in stopping the horizontal spread of fire
2. Disadvantages
 - a. Must be cut well ahead of the advancing fire
 - b. Must be a minimum of four (4) foot wide and is time-manpower consuming

D. Mechanical (forced) 2-11.3.4

1. Advantages
 - a. Ensures positive control
 - b. Supplements natural ventilation
 - c. Speeds the removal of contaminants
 - d. Facilitates a more rapid rescue under safer conditions
 - e. Reduces smoke damage
 - f. Promotes good public relations
2. Disadvantages
 - a. Introduction of air can cause the fire to intensify and spread
 - b. Dependent upon a power source
 - c. Requires special equipment

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E. Mechanical pressurization (positive pressure) **2-11.3.5**

1. Advantages

- a. Can be set up without firefighters entering the smoke filled environment
- b. Equally effective with vertical or horizontal ventilation
- c. Allows more efficient removal of smoke and heat
- d. Air exchange is faster than negative pressure ventilation
- e. Placement of blower does not interfere with ingress or egress
- f. Cleaning and maintenance of blowers usually reduced.
- g. System applicable to all types of structures
- h. Heat and smoke may be directed away from unburned areas or paths of exit

2. Disadvantages

- a. May intensify and spread hidden fire
- b. Gas power may increase CO₂ levels in building
- c. Noise affects communications
- d. Control of openings and pressure leaks.

Caution: Prior to using PPV, firefighters must be properly trained and aware that if used improperly, it can intensify and spread fire conditions. Refer to the PPV fan manufacturer's training program.

F. Hydraulic **2-11.3.6**

1. Advantages

- a. May be used in situations other types are not
- b. Takes advantage of the air drawn into the fog stream

2. Disadvantages

- a. May increase the amount of water damage inside the structure
- b. Drain on the available water supply
- c. Increase in the ice problem during freezing weather
- d. Firefighters operating the nozzle must remain in the heated, contaminated area

- 1) Remain aware of conditions around you; can intensify fire in surrounding area

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- e. Operation may be interrupted when crew goes for fresh SCBA bottles
- IV. Identify the signs, causes and effects of backdraft explosions. **2-11.4**
- A. Definition: The explosive change of superheated gases in an oxygen deficient atmosphere to an inferno with the addition of oxygen.
 - B. Signs
 - 1. Smoke stained windows
 - 2. Smoke puffing (breathing) at intervals from building
 - 3. Pressurized smoke coming from small cracks
 - 4. Little or no visible flame from the exterior
 - 5. Color of smoke changes
 - 6. Inward movement of smoke
- V. Identify methods of preventing a backdraft explosion. **2-11.5**
- A. Provide vertical ventilation at highest point to permit the release of superheated gases.
- VI. Identify the characteristics of the following roof types: **2-11.6 (3-3.10, 3-3.11)**
- A. Flat **2-11.6.1**
 - 1. Commonly found on commercial, industrial and apartment buildings
 - 2. May have a slight slope to it
 - 3. Roof may be surrounded or divided by parapets
 - 4. May support
 - a. Water tanks
 - b. Air conditioning units
 - c. Equipment
 - d. Antennas
 - e. Other obstructions
 - 5. Structural part similar to floor construction
 - B. Shed **2-11.6.2**
 - 1. Similar to flat except slopes from front to back
 - 2. Slope may be gradual or steep

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C. Pitched **2-11.6.3**

1. Elevated in the center
2. Construction
 - a. Rafters
 - 1) Run from ridge to top plate
 - 2) Made of wood, metal or combination
 - b. Sheathing
 - c. Roofing materials
 - d. Shingles
 - 1) Wood
 - 2) Metal
 - 3) Asbestos
 - 4) Composition
 - 5) Tile
 - 6) Slate
3. Pitch of roof may be gradual or steep

D. Arched **2-11.6.4**

1. Concealed spaces between the roof and ceiling present ventilation problems and aid fire spread
2. Usually use bow string trusses for support
3. Exerts horizontal and vertical reaction
4. Trussless arch allows for considerable size hole to be cut or burned through network sheathing anyplace without causing collapse of the roof structure. Loads are redistributed to less damaged timbers.

VII: Identify the types of tools used for ventilation. **2-11.7 (3-3.10(a))**

- A. Axe
- B. Sledgehammer
- C. Pike pole
- D. Power saws
 1. Chain
 2. Circular
 3. Reciprocating
- E. Metal Cutter

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VIII. Identify the necessary precautions when ventilating the following roof types: **2-11.8 (3-3.11)**

A. Flat **2-11.8.1**

1. Use roof ladder
2. Look for hot spots or sagging of the roof area PRIOR to walking on surface and continually during ventilation.
3. Always sound roof PRIOR to walking on surface and continually during ventilation.
4. Look for roof additions or changes, such as overhangs, inverted flat roofs, security measures, parapet walls.
5. Look for obstacles and excess weights on roof, such as HVAC systems, skylights, vent pipes, other openings.
6. Provide two means of escape from the roof remote from each other.

B. Shed **2-11.8.2**

1. Use roof ladder
2. Look for hot spots or sagging of the roof area PRIOR to walking on surface and continually during ventilation.
3. Always sound roof PRIOR to walking on surface and continually during ventilation.
4. Look for roof additions or changes such as overhangs, inverted flat roofs, security measures, parapet walls.
5. Look for obstacles and excess weights on roof, other openings.
6. Provide two means of escape from the roof remote from each other.

C. Pitched **2-11.8.3**

1. Use roof ladders
2. More profound incline; take extra precautions against slipping
3. Look for hot spots or sagging of the roof area PRIOR to walking on surface and continually during ventilation.
4. Always sound roof PRIOR to walking on surface and continually during ventilation.
5. Look for roof additions or changes such as overhangs, inverted flat roofs, security measures, parapet walls.
6. Look for obstacles and excess weights on roof, such as HVAC systems, skylights, vent pipes, other openings.
7. Provide two means of escape from the roof remote from each other.

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- D. Arched **2-11.8.4**
1. Be conscious of danger of sudden and total collapse.
 2. Roof ladders useless, recommend aerial devices
 3. Be aware of concealed voids, such as cocklofts and attic spaces covered by ceilings.
- IX. Identify the procedures for the types of ventilation referred to in **2-11.9** (3-3.10, 3-3.11)
- A. Vertical **2-11.9.1**
1. Flat roof
 - a. Determine location of opening
 - 1) Location of seat of fire
 - 2) Direction of wind
 - 3) Existing exposures
 - 4) Extent of fire
 - 5) Obstructions
 - b. Locate supports by sounding with an axe.
 - c. Mark the location for opening by scratching a line on the roof with the pick head.
 - d. Remove the built up material or metal by cutting the materials and using the pick head to pull the materials out of the way.
 - e. Cut the wood decking diagonally alongside the joist towards the hole.
 - f. Pry up the roof boards with the pick end of the axe.
 - g. After opening the roof, push the blunt end of a pike pole or plaster hook through the opening to penetrate the ceiling below.
 2. Pitched roof
 - a. Determine location of opening, usually the highest point
 - b. Place a roof ladder on the roof so that personnel working off it will be upwind from the hole.
 - c. Locate supports by sounding with an axe.
 - d. Mark the location for the opening by scratching a line on the roof with the pick head
 - e. Remove the shingles or roofing sufficiently to permit the initial cut

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- f. Cut the sheathing, along side a rafter, the distance required for the opening.
- g. Opposite side is then cut in a like manner
- h. Remove sheathing boards with the pick of the axe.
- i. After opening the roof, push the blunt end of a pike pole or plaster hood through the opening to penetrate the ceiling below.

B. Horizontal 2-11.9.2

- 1. Open building on leeward side
- 2. Remove any obstructions
- 3. Open building on windward side
- 4. Remove any obstructions

C. Mechanical/mechanical pressurization (forced ventilation) 2-11.9.4, 2-11.9.5

- 1. Negative pressure
 - a. Place ejector in opening to exhaust in the same way as the wind direction
 - b. Cover the area around the ejector to prevent churning
 - c. Establish and maintain desired draft path
 - d. Remove all obstacles
 - e. Avoid blockage of the intake side of the ejector.
- 2. Positive pressure **2-11.9.5**
 - a. Place blower several feet outside the point of entry
 - b. Check to make sure air cone completely covers the opening
 - c. Open the exit opening (75% to 150% of the entrance opening)
 - d. Systematically open and close doors within the structure to exhaust the products of combustion.
- 3. Hydraulic **2-11.9.6**
 - a. Adjust fog pattern to cover 85% to 90% of the opening
 - b. Place nozzle approximately two feet from the window opening

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- X. Identify how the following factors are used to determine the integrity of a roof system. **2-14.10** (3-3.11)
- A. Construction **2-14.10.1**
 - 1. Materials
 - a. Wood
 - b. Steel
 - 2. Type of roof support
 - a. Rafters
 - b. Truss
 - B. Visual observation/warning signs
 - 1. “Spongy” roof
 - 2. Melting asphalt
 - 3. Smoke coming from roof
 - 4. Fire coming from roof
 - 5. Excess weight (ex. HVAC)
 - C. Elapsed time of fire
 - 1. The longer the fire, the less integrity
- XI. Identify the procedures for opening various types of windows from inside and outside with the use of tools. **2-11.11** (3-3.10)
- A. Forcing the window
 - 1. Checkrail windows with lock in the center
 - a. Place a prying tool in the center of the window
 - b. Apply downward pressure until the lock is pulled from the checkrail.
 - B. Casement windows
 - 1. Break window and clean out .
 - 2. Force or cut the screen in the same area
 - 3. Reach in and upward to unlock the latch
 - 4. Operate the cranks or levers at the bottom
 - 5. Completely remove the screen and enter

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- C. Projected windows
 - 1. Break the pane of glass nearest the locking mechanism and clean out the sharp edges.
 - 2. Reach in and unlock the latch
 - 3. Pivot the window outward

- D. Awning and jalousie windows
 - 1. Stand to the windward side of the glass pane to be broken
 - 2. Strike the tool at the top of the panel, keeping hands above the point of impact.
 - 3. Repeat above step until large enough opening has been made for entry.
 - 4. Remove jagged pieces from the frames with an axe or other appropriate tool

- E. Lexan
 - 1. Cut with a saw blade with medium teeth

- F. Barred or screened windows
 - 1. Barred
 - a. Strike the bars with a sledgehammer about ten (100 inches) above the sill
 - b. Strike the sill with a sledgehammer opposite the end of the bar.
 - c. Use a hammer-head pick to crack the masonry.

 - 2. Gratings or wire mesh
 - a. Force with the pick head of an axe
 - b. Cut with a torch or saw

- G. Horizontal sliding with lock in center
 - 1. Insert blade of axe or prying tool at the side center of the moving sash
 - 2. Pry towards sash forcing screws from lock

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XII. Identify the procedures for opening various types of windows from inside and outside without the use of tools. **2-11.12 (3-3.10)**

A. Checkrail

1. Rotate locking mechanism to the opposite position
2. Raise window
3. Remove the screen

B. Casement

1. Unlock the latch by pulling it out and up
2. Crank window open
3. Remove the screen

C. Projected windows

1. Unlock the locking device
2. Pivot the window outward

D. Awning and jalousie windows

1. Crank window open
2. Remove the screen

E. Horizontal Sliding

1. Unlock the locking device
2. Slide window open
3. Remove screen

XIII. Identify the procedures for breaking window or door glass and removing obstructions. **2-11.13 (3-3.10)**

A. Window glass

1. Stand to the windward side of the glass pane to be broken
2. Strike the tool at the top of the pane, keeping hands above the point of impact.
3. Remove jagged pieces from the sash with an axe or other appropriate tool.

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- B. Door glass
 - 1. Check for eye protection or cover the opening with a salvage cover or some other type of shield.
 - 2. Strike window, in bottom corner, with pick end of pick head axe or other pointed tool.
 - 3. Remove any remaining glass from frame.

- XIV. Identify ventilation using water fog. **2-11.14 (3-3.10, 3-3.11)**
 - A. Completely open window
 - B. Place nozzle approximately two (2) feet from the window opening.
 - C. Open nozzle.
 - D. Adjust fog pattern to cover 85% to 90% of the opening.

- XV. **Demonstrate opening various types of windows from inside and outside with the use of tools. 2-11.15 (3-3.10(b))**
 - A. Forcing the window
 - 1. Checkrail windows with lock in the center
 - a. Places a prying tool in the center of the window
 - b. Applies downward pressure until the lock is pulled from the checkrail.

 - B. Casement windows
 - 1. Breaks window and cleans out .
 - 2. Forces or cuts the screen in the same area
 - 3. Reaches in and upward to unlock the latch
 - 4. Operates the cranks or levers at the bottom
 - 5. Completely removes the screen and enters

 - C. Projected windows
 - 1. Breaks the pane of glass nearest the locking mechanism and cleans out the sharp edges.
 - 2. Reaches in and unlocks the latch
 - 3. Pivots the window outward

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- D. Awning and jalousie windows
 - 1. Stands to the windward side of the glass pane to be broken
 - 2. Strikes the tool at the top of the panel, keeping hands above the point of impact.
 - 3. Repeats above step until large enough opening has been made for entry.
 - 4. Removes jagged pieces from the frames with an axe or other appropriate tool

 - E. Lexan
 - 1. Cuts with a saw blade with medium teeth

 - F. Barred or screened windows
 - 1. Barred
 - a. Strikes the bars with a sledgehammer about ten (100 inches above the sill
 - b. Strikes the sill with a sledgehammer opposite the end of the bar.
 - c. Uses a hammer-head pick to crack the masonry.
 - 2. Gratings or wire mesh
 - a. Forces with the pick head of an axe
 - b. Cuts with a torch or saw

 - G. Horizontal sliding with lock in center
 - 1. Insert blade of axe or prying tool at the side center of the moving sash.
 - 2. Pry towards sash forcing screws from lock
- XVI. Demonstrate opening various types of windows from inside and outside without the use of tools. 2-11.16 (3-3.10(b))**
- A. Checkrail
 - 1. Rotates locking mechanism to the opposite position
 - 2. Raises window
 - 3. Removes the screen

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- B. Casement
 - 1. Unlocks the latch by pulling it out and up
 - 2. Cranks window open
 - 3. Removes the screen

- C. Projected windows
 - 1. Unlocks the locking device
 - 2. Pivots the window outward

- D. Awning and jalousie windows
 - 1. Cranks window open
 - 2. Removes the screen

- E. Horizontal sliding
 - 1. Unlock the locking device
 - 2. Slide window open
 - 3. Remove screen

XVII. Demonstrate breaking window or door glass and removing obstructions. 2-11.17 (3-3.10(b))

- A. Window glass
 - 1. Stands to the windward side of the glass pane to be broken
 - 2. Strikes the tool at the top of the pane, keeping hands above the point of impact.
 - 3. Removes jagged pieces from the sash with an axe or other appropriate tool.
- B. Door glass
 - 1. Checks for eye protection or covers the opening with a salvage cover or some other type of shield.
 - 2. Strikes window, in bottom corner, with pick end of pick head axe or other pointed tool.
 - 3. Removes any remaining glass from frame.

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XVIII. Demonstrate the removal of skylights, scuttle covers, and other roof openings. 2-11.18 (3-3.10(b))

- A. Scuttle hatch
 - 1. Using a saw or axe, cuts an opening as close to the edge as possible.
- B. Skylights
 - 1. Strikes glass with a pointed object.
 - 2. Removes remaining glass.
 - 3. If glass does not shatter, removes the frame.
- C. Monitor
 - 1. Glass
 - a. Strikes in corner with pointed tool
 - b. Removes any remaining glass
 - 2. Metal or wood
 - a. Forces at the top
 - b. Cuts or breaks out the panels

XIX. Demonstrate ventilation using water fog. 2-11.19 (3-3.10(b), 3-3.11(b))

- A. Completely opens window
- B. Places nozzle approximately two (2) feet from the window opening.
- C. Opens nozzle.
- D. Adjusts fog pattern to cover 85% to 90% of the opening.

XX. Demonstrate determining the integrity of a roof system by sounding. 2-11.20 (3-3.11(b))

- A. Uses head of axe held in a vertical position and bounces (strikes) the axe on the roof.
- B. A "hollow" sound will be heard between supports.
- C. A "solid" sound will be heard near the supports.
- D. A "punky" sound (like striking rotten wood) will be heard if the integrity of the roof is weakening.

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XXI. Demonstrate the ventilation of a flat roof using both hand tools and power tools. 2-11.21 (3-3.11(b))

- A. Determines location of opening.
- B. Locates supports by sounding with an axe.
- C. Marks the location for the opening by scratching a line on the roof with the head.
- D. Remove the built-up material or metal by cutting the material and using the pick head to pull the material out of the way.
- E. Cuts the wood decking diagonally alongside the joist towards the hole.
- F. Pries up the roof boards with the pick end of the axe.
- G. After opening the roof, pushes the blunt end of a pike pole or plaster hook through the opening to penetrate the ceiling below.

XXII. Demonstrate the ventilation of a pitched roof using both hand tools and power tools. 2-11.21 (3-3.11(b))

- A. Determines location of opening, usually the highest point.
- B. Places a roof ladder on the roof so that personnel working off it will be upwind from the hole.
- C. Locates supports by sounding the surface with an axe.
- D. Marks the location for the opening by scratching a line on the roof with the pick head.
- E. Rips off the shingles or roof felting sufficiently to permit the initial cut.
- F. Cut the sheathing alongside a rafter the distance required for the opening.
- G. Opposite side is then cut in a like manner.
- H. Removes sheathing boards with the pick of the axe.
- I. After opening the roof, pushes the blunt end of a pike pole or plaster hook through the opening to penetrate the ceiling below.

XXIII. Demonstrate floor ventilation procedures. 2-11.23 (3-3.11(b))

- A. Determines the approximate location for the hole based on need.
- B. Sounds for floor joists to decide the exact location.
- C. Cuts one side of the finished floor by using angle cuts.
- D. Cuts the other side of the finished floor in a like manner.
- E. Removes the flooring or floor covering with the pick of the axe.
- F. Cuts all sides of the sub-floor using the same technique and angle cuts.
- G. Removes the boards from the sub-floor.

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Ventilation**

XXIV. Demonstrate the use of positive pressure ventilation. 2-11.20 (3-3.10(b))

- A. Places blower several feet outside the point of entry.
- B. Checks to make sure air cone completely covers the opening
- C. Opens the exit opening (75% to 150% of the entrance opening)
- D. Systematically opens and closes doors within the structure to exhaust the products of combustion