Chapter 8

# Structural Fire-Fighting Operations

**8-1.** This chapter addresses many of the basic priorities and procedures that will be used throughout the rest of this manual for other fire-fighting purposes. The structural fire-fighting mission will include responding to all fire incidents that involve structures (including TO structures), tents, warehouses, and hangers. Responding to structural fires will be according to the fire-response chart. Factors such as total fire involvement, life hazards, fire-fighting resources, security, and mission-essential priorities will determine the type and degree of response.

## SECTION I. FIRE OPERATIONS

**8-2.** Fire operations include all actions from the time a call comes into an FCC to the after-action review that is conducted following an incident. Responding to an incident, fighting a fire, rescue, and salvage/overhaul are considered components of fire operations.

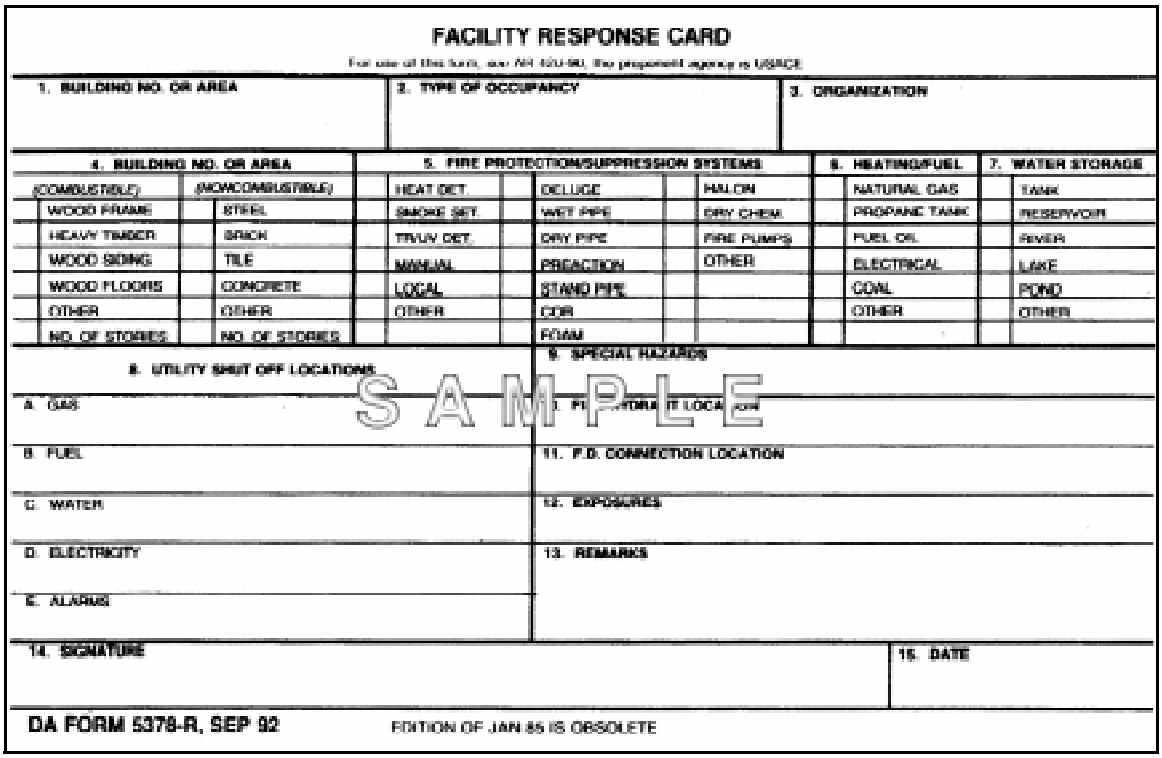
## STRUCTURAL OPERATIONS

**8-3.** When a crew chief or an SFO arrives at a fire scene, he assesses the situation and decides what actions firefighters will take. The crew chief/SFO bases his decisions on different factors. Prefire plans list constant factors such as the type of building construction, the building's dimensions, or the fire-department connection/standpipe locations. The weather; traffic; use of the building; types of materials stored; and time, size, and location of a fire are changing factors.

**8-4.** Fire crews must conduct prefire plans on all high-priority/high-target facilities. Response routes (primary and alternate), water sources, hazardous areas, and an attack strategy can all be determined before an incident occurs. If the crew is familiar with the facilities, the fire-fighting operations could occur quickly. DA Form 5378-R (see Figure 8-1, page 8-2) should be filled out for this purpose. If the form is not available, the following information should be included on the prefire plan:

- Building identification.
- Construction type.
- Occupancy.
- Response requirements.
- Special hazards, such as HAZMATs storage and presence of significant quantities of asbestos.

- Water supply.
- Building sketch.



FACILITY RESPONSE CARD

For use of this form, see AR 420-90; the proponent agency is USACE

| 1. BUILDING NO. OR AREA | 2. TYPE OF OCCUPANCY | 3. ORGANIZATION |
|---|---|---|
| | | |

| 4. BUILDING NO. OR AREA | | 5. FIRE PROTECTION/SUPPRESSION SYSTEMS | | | | 6. HEATING/FUEL | 7. WATER STORAGE |
|---|---|---|---|---|---|---|---|
| (COMBUSTIBLE) | (NONCOMBUSTIBLE) | HEAT DET. | DELUGE | HALON | | NATURAL GAS | TANK |
| WOOD FRAME | STEEL | SMOKE DET. | WET PIPE | DRY CHEM. | | PROPANE TANK | RESERVOIR |
| HEAVY TIMBER | BRICK | TR/UV DET. | DRY PIPE | FIRE PUMPS | | FUEL OIL | RIVER |
| WOOD SIDING | TILE | MANUAL | PREACTION | OTHER | | ELECTRICAL | LAKE |
| WOOD FLOORS | CONCRETE | LOCAL | STAND PIPE | | | COAL | POND |
| OTHER | OTHER | OTHER | COR | | | OTHER | OTHER |
| NO. OF STORIES | NO. OF STORIES | | FOAM | | | | |

| 8. UTILITY SHUT OFF LOCATIONS | 9. SPECIAL HAZARDS |
|---|---|
| A. GAS | SAMPLE |
| B. FUEL | 11. F.D. CONNECTION LOCATION |
| C. WATER | 12. EXPOSURES |
| D. ELECTRICITY | 13. REMARKS |
| E. ALARMS | |

| 14. SIGNATURE | 15. DATE |
|---|---|
| | |

DA FORM 5378-R, SEP 92 EDITION OF JAN 85 IS OBSOLETE

**Figure 8-1. Sample DA Form 5873**

## EMERGENCY NOTIFICATION

**8-5.** When notified of an emergency, the dispatcher should try to get as much information as possible from the caller. The FCC will dispatch the required response teams and notify the subordinate support units. The FCC will supply as much of the following information as available to the responding crews:

- Location and nature of the emergency.
- Number of personnel involved.
- Types of HAZMATs involved (explosives, radioactive, flammable, and/or toxic).

## STRATEGY AND TACTICS

**8-6.** The strategy and tactics employed at a fire scene are based on the situation. The on-scene SFO's evaluation of the situation will dictate how, when, and where firefighters will attack or control a fire. The SFO's ability to evaluate the incident correctly will determine the overall success or failure of the fire-fighting efforts. Although there are SOPs for most fire-fighting incidents, the SFO must be prepared for rapid changes and adjust the

strategy and tactics accordingly. The following factors could have a large effect on those efforts:

### ACCESSIBILITY TO A FIRE

**8-7.** Conditions such as mud, snow, evacuations, traffic jams, ditches across roads, and blocked alleys can prevent easy access to a fire. To prevent delays, the crew chief should check such conditions before fire crews depart to a fire.

### FIRE-FIGHTING EQUIPMENT

**8-8.** Some fire emergencies require additional equipment and personnel. One way to determine the need for more equipment is for the SFO to observe the nature and extent of a fire's progress. Another way is to consider the volume of water or other extinguishing agents that are available in relation to the estimated requirements, which are annotated on the facility response card (prefire plan). To determine how much water is needed at a fire, use the following formula and example:

$$GPM = N\,(LW/3)$$

*where—*

*GPM = amount of water needed for a fire*
*L = building length, in feet*
*W = building width, in feet*
*N = number of floors in the building*

*Fully involved building= 100%*
*50 percent-involved building= 50%*
*25 percent-involved building= 25%*

**8-9.** To cover the exposures, take 25 percent of the fire flow for each exposure. For example, you have a fully involved two-story house that is 30 by 72 feet with two exposures. Multiply 30 by 72, divide by three, and multiply by 2 to get the total GPM needed to extinguish a fire. Take 25 percent of the fire flow for each exposure and add to the other GPM to get the total GPM needed for a fire.

### BUILDING FEATURES

**8-10.** An SFO must consider the following factors to determine when a building could collapse:

- Type of construction (brick, wood, or aluminum siding).
- Percentage of the building involved in fire.
- Extent of the damages.
- Length of the burning time.
- Types and quantities of the materials in the building.
- Ability of the materials to absorb water and expand.

**8-11.** After assessing these factors, the SFO determines if the fire crews can use ladders or enter the building to fight a fire.

### PROTECTIVE SYSTEMS

**8-12.** The SFO should examine the building's protective equipment: sprinkler systems, fire doors, fire shutters, and wired glass windows. He should determine if these devices will be effective during a fire operation.

### EXPOSURE HAZARDS

**8-13.** The SFO examines exposures such as furnishings, adjacent rooms, or areas where fire spread is most likely, so that fire crews can effectively attack a fire. For example, if a fire is in the basement, a quick attack on the areas where the fire could spread could stop the fire.

**8-14.** Heat radiation or heated smoke and gases from the initial fire could endanger exposures such as the roofs and walls of adjacent buildings. In an advanced fire, fire crews must protect exposed buildings. They should consider the wind direction, the ground slope, the distance between buildings, and the extent of the fire's spread before taking action. However, life hazards, the content value, or the current need could determine the fire crews' actions.

### TIME OF EMERGENCY

**8-15.** The month, day, and hour are important factors in a fire emergency. For example, a fire in a school building at 0900 hours on a Tuesday in late September could present different problems than a fire in the same building at 2100 hours on a Tuesday in early July. Fire crews must know if people are in a building before beginning fire-fighting operations.

### HAZARDS FROM CONTENTS

**8-16.** The crew chief must determine if a building contains explosive stock, toxic fumes, chemicals, acids, compressed-gas cylinders, and high-voltage wires. When these items are heated or subjected to a hose stream, they could be a safety hazard.

## STRUCTURAL FEATURES

**8-17.** Most modern buildings have continuous foundations of concrete, brick, or stone. The foundation wall that supports the frame construction may extend above the ground. Figure 8-2 shows arrangements of structural components.

### EXTERIOR WALLS

**8-18.** The list below describes various types of exterior walls:

- Masonry walls. These walls are usually 8 to 12 inches thick, depending on the material used. Masonry walls provide the best fire protection.
- Masonry-veneered walls. These are frame walls that have wooden support members with one veneer of brick or stone. The upright, wooden support members in these walls are studs. Studs are usually 2- by 4-inch pieces, spaced at 16-, 18-, or 24-inch intervals. Fire stops are usually short, 2- by 4-inch wooden pieces placed in walls, ceilings,

partitions, and stairways between the studs at each floor level and at the upper end of the stud channels in the attic. Fire stops cut off the draft in the walls and help prevent fire and smoke from spreading. Figure 8-3, page 8-6, shows fire stops.

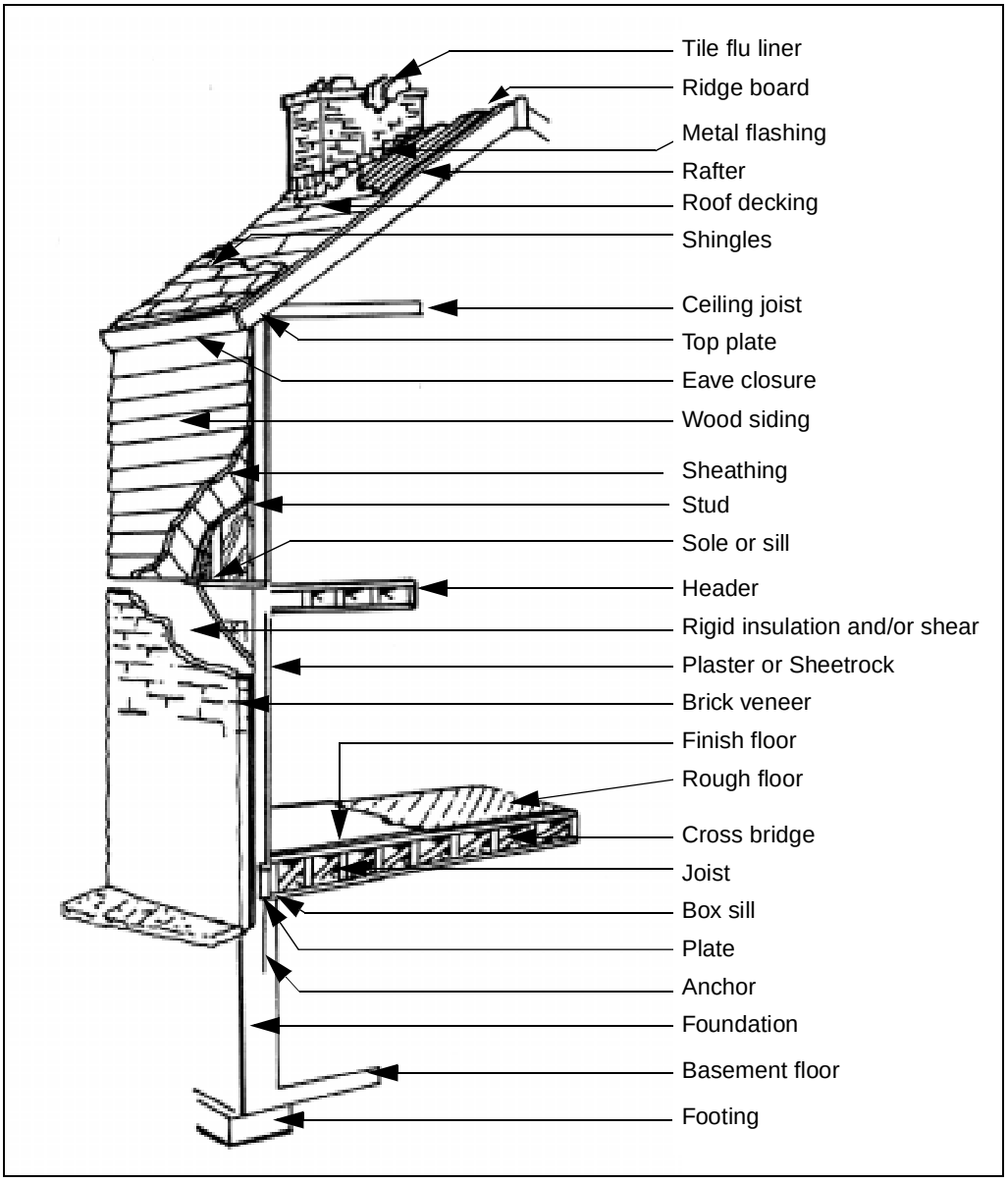



**Figure 8-2. Arrangements of structural components**

- Wooden-frame walls. These walls are constructed entirely of wood. The wood is usually treated with fire retardants to enhance the fire

resistiveness of the wood. Fire stops are of the same type and used in the same way as masonry-veneered walls.

- Metal walls. These walls are constructed of metal sections or panels and are fastened to wooden studs with bolts or screws. Metal walls may have a painted or porcelain-coated surface

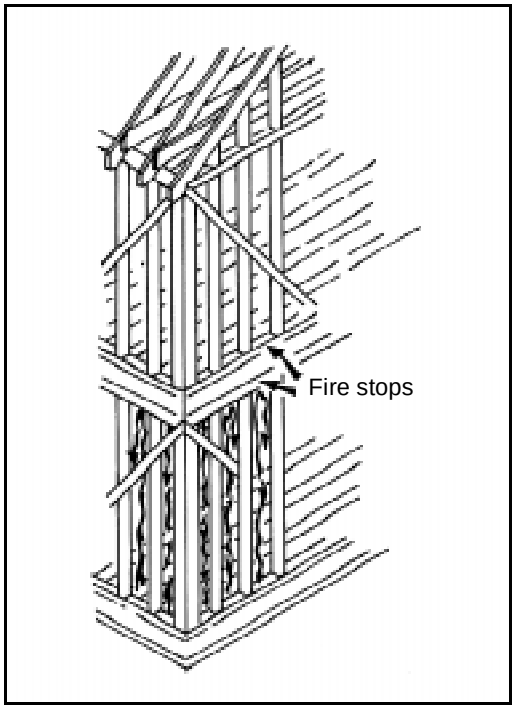



**Figure 8-3. Fire stops**

## ROOFS

**8-19.** Roofs are constructed in layers using different materials. The main support comes from the rafters, which run at right angles from the beam and ridge of the roof. Sheathing covers the rafters. Sheathing is 4- by 8-foot sheets of 1-inch plywood or 1-inch boards. Thin metal sheets or felt paper is nailed over the sheathing. The final layer can be a layer of tar or asphalt, 4- by 8-foot metal sheets, or other types of waterproof coverings. Figure 8-4 shows different types of roofs.

### Shingled Roofs

**8-20.** These roofs are made of small sections of material (wood, asphalt, fiberglass, or metal) that are fastened to sheathing. To open shingled roofs, strip off the shingles and cut away the sheathing.

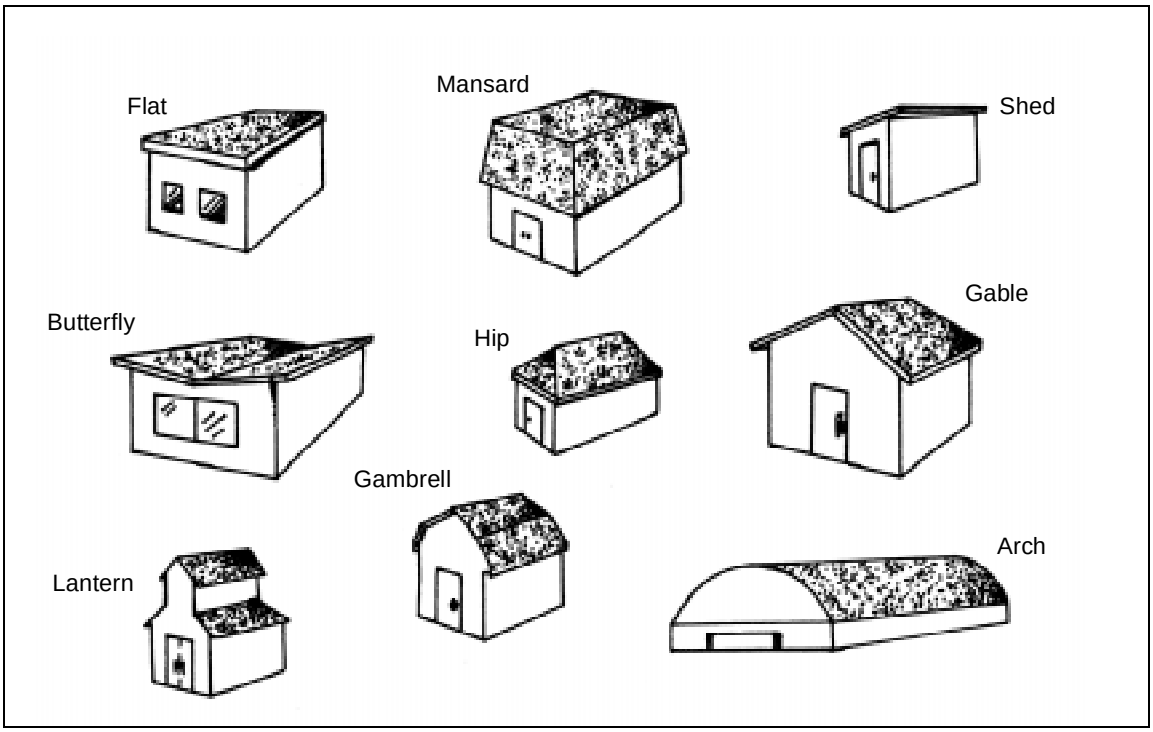



**Figure 8-4. Roof types**

### Composition Roofs

**8-21.** These roofs are made of one to six sheets of roofing material nailed to the sheathing. Hot asphalt is spread over the entire covering and allowed to cool. To open these roofs, first cut and roll back the covering and then cut the sheathing close to the joists to make an opening.

### Metal Roofs

**8-22.** These roofs are made of metal sheets that are crimped or soldered together and fastened to the sheathing. Use a pike pole or similar tool to open them. When using a fire ax to cut a roof, use short, quick, forceful strokes to prevent the ax from striking other fire personnel and from catching in overhead obstructions. Make diagonal cuts close to a joist or stud. Do not cut with the grain of the board.

**8-23.** In flooring, roofing, or sheathing, make a cut at a 60-degree angle instead of straight down. Cut diagonal sheathing the direction of the sheathing so that the chips will split outward. If you make cuts against the sheathing, the ax may bind. Make cuts through a lath-and-plaster wall in a direction diagonal to the grain. After cutting the boards, use the pick end of the ax to pry and remove the boards.

## FLOORS

**8-24.** In older buildings, wooden floors are laid double on joists, which are generally set on 16-inch centers. The subfloor is usually laid at a 45-degree

angle to the joists and the finish floor laid at right angles to the joists. To open these floors, cut through the subfloor and the finish floor. Both cuts should follow the side of the joists toward the inside of the required opening. In mobilization-type buildings, a single floor is laid directly on joists, which are set on 16-inch centers. Open single floors the same as flat roofs.

#### DOORS

**8-25.** Doors can be swinging, revolving, sliding, or overhead. Before using force, try the door. If the door is locked, examine it to determine the forcible-entry method to use. Wooden, swinging doors are panel, slab, or ledge. Doors in residential buildings usually open inward and doors in public buildings open outward. Slab doors are either hollow- or solid-core. Hollow-core doors are constructed of wooden strips formed into a grid or mesh. Solid-core doors are constructed of solid material. The core can be either tongue-and-groove blocks or boards glued in the frame or a fire-resistant, compressed mineral substance.

#### DOOR LOCK AND FASTENER

**8-26.** On a swinging door, the lock is a bolt (bar) that protrudes from the door to the fastener (metal keeper), which is part of a door jamb. The bolt may be part of the lock assembly or it may be separate. Use forcible entry to spring the jamb so that the bolt passes the keeper. Outside doors in barracks, store buildings, and recreation halls are set either against stops in the frame or against a rabbeted shoulder in the door jamb. Insert the wedge of a door opener just above or below the lock to gain entry. Use a spanner wrench with a wedge end when leverage is not a problem.

## FORCIBLE ENTRY

**8-27.** You can use forcible entry to open roofs, floors, skylights, partitions, walls, and locked doors and windows. You must know how the building is constructed to determine the best places for forcible entry. Practice handling and using forcible-entry tools to ensure safety during an operation.

#### DOORS

**8-28.** Before using forcible entry to open a door, determine how the door hangs on the frame and how the door locks. Locks are either surface or mortised and can be pried until they spring free. Usually, the best method for opening these locks is to remove the hinge pins from the hinge with an ax or a spanner wrench.

#### Overhead Doors

**8-29.** Forcible entry on steel, overhead, rolling doors is difficult. These doors can only be opened by operating the gears and chain. Prying may spring the doors so that the gears will not function. Some doors have glass windows. Break a section of the glass to reach the latch and raise the door. On overhead lift doors, pry upward from the bottom of the door using a crowbar or claw tool. After the lock bar breaks, the door opens.

### Stopped-Frame Doors

**8-30.** On these doors, raise the stop with a sharp wedge and swing the door clear of the fastener. When using a door opener, separate the lock and the jamb so that the lock passes the keeper.

### Rabbeted-Frame Doors

**8-31.** Method 1: Split the jamb or break the lock bolt with a door opener. Insert the opener and push the door inward. Method 2: Insert a wedge above or below the lock and pry the door until the bolt passes the keeper. The door and jamb will be slightly damaged, but the door will close.

### Double Doors

**8-32.** Open double doors by prying between the doors until the bolt clears the keeper. If an astragal or wooden molding covers the opening, remove it before inserting the wedge. Many double warehouse doors are secured with a bar that is dropped in the stirrups, which are located on the inside of the wall. Use forcible entry by battering down the door. On brick walls, batter a large hole through the wall and crawl through the hole and unlock the doors. This method is usually the quickest and least destructive entry method.

### Latched Doors

**8-33.** Night latches will normally yield to the same prying tactics as mortised locks. However, if night latches are fastened to the door with screws, remove the locks by hitting them with a heavy object, such as a battering ram. When a battering ram is not available, push your shoulder against the side of the door opposite the hinges to spring the lock.

### Single-Hinged Doors

**8-34.** On single-hinged doors locked with a hasp and padlock, such as those on sheds and stables, use a door opener to pry or twist off the hasp staple.

### Fire Doors

**8-35.** These doors are mainly used to protect openings in division walls of vertical shafts. On fire doors that close automatically, pry open the doors using forcible-entry tools. On fire doors with exterior openings, force the lock by prying between the jamb and lock. Block the open fire doors to prevent cutting off the water supply in a hose line or trapping yourself in the building.

## WINDOWS

**8-36.** A working knowledge of the various types of windows is necessary to effect successful forcible entry with minimal damage. This is only possible by becoming familiar with the types of windows used in your AO and learning how they operate.

### Factory-Type Windows

**8-37.** These windows consist of steel sashes that are often set in the frame so that only a portion of the window can open. The movable portion is either pivoted at the center or hinged at the top and latched on the inside. Factory-type windows have small panes. Breaking the glass near the latches is the fastest, simplest entry method.

### Check-Rail Windows

**8-38.** These windows have two frames (sashes) that are in contact at the top and bottom horizontals. If the window has no weights, the sash locks either with bolts in the window stiles or with a friction lock pressing against the window jamb. Open these windows by prying upward on the lower sash rail. If the window is locked on the check rail, the screws of the lock give way and the sashes separate. When the window is locked with spring-activated bolts, break or bend the sash before raising the sash. Pry the window where the lock is located.

### Basement Windows

**8-39.** Open these windows the same as a door in a rabbeted frame. If you pry at the center of the lower rail, you can pull or spring the lock.

### Casement Windows

**8-40.** Open these windows the same as double doors. When these windows are locked, break the glass to enter. Wooden casement sashes are generally hinged at the top and locked at the bottom or top. In some instances, breaking the glass causes less damage than other entry methods. If you follow the procedure below, the glass falls down away from your hands and to your side.

- Use an ax, crowbar, or pike pole.
- Stand to the windward side of the glass pane that you intend to break, if possible.
- Strike the top of the pane.
- Keep your hands above the point of impact.

## CEILINGS

**8-41.** Use a pike pole to open plastered ceilings. Break the plaster and pull off the laths (Figure 8-5). Pull the metal and composition ceilings from the joists. Board ceilings are difficult to remove because the lumber resists when you jam a pole between the boards.

## WALLS

**8-42.** Wooden-framed walls are constructed of wooden or fiberboard sheathing that is nailed over studs. The exterior siding, which may be wooden clapboard, board and batten siding, stucco, or other exterior finishes, is fastened over the sheathing. Open these walls as you would floors and roofs. Metal walls are metal sheets that are either fastened to wood or metal studs with bolts, screws, or rivets or are welded to metal studs. Use a breach-entry method.

## FENCE LOCKS

**8-43.** Wood, metal, masonry, or woven-wire fences usually have gates that are locked with padlocks and hasps. Either pull these locks apart, using a claw tool, or cut the locks, using a cutting tool.

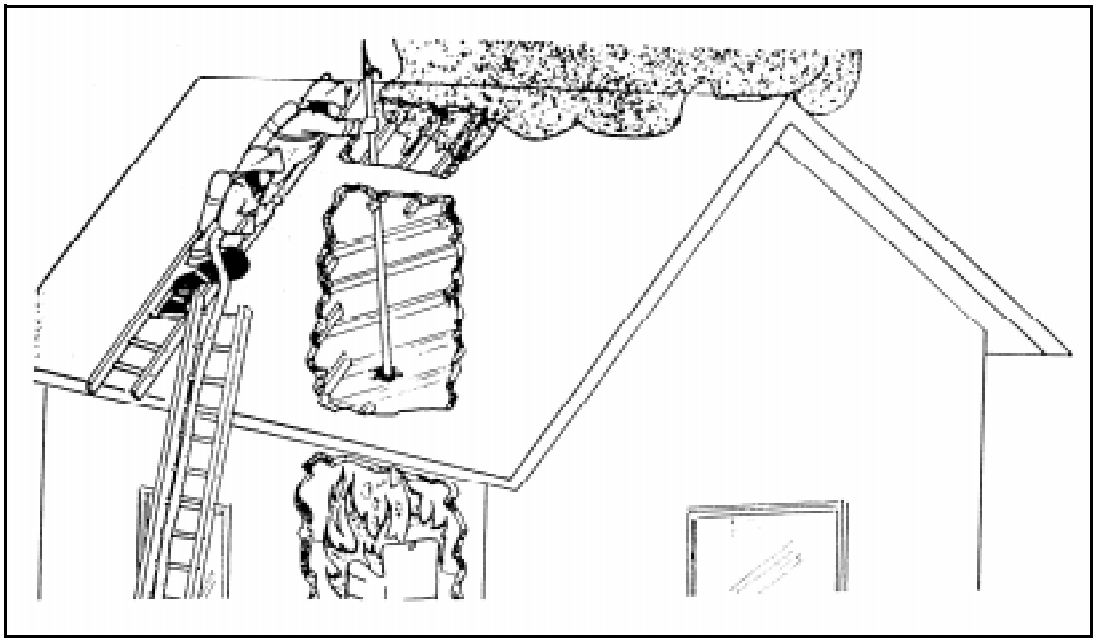


**Figure 8-5. Opening a plastered ceiling**

## SAFETY PRECAUTIONS

**8-44.** The following are some of the safety precautions and procedures you should use during forcible-entry operations:

- Try opening a door or window before prying it.
- Carry your tools safely.
- Watch for explosive materials.
- Block open a door or window after entering, if possible.
- Place your tools in a safe place to avoid tripping.
- Stand to the side when breaking the glass; remove all jagged pieces.
- Block all overhead doors (up position) after entering.
- Be aware of obstructions and bystanders when using an ax; keep the area clear whenever possible.
- Watch for electrical wires and pipes when opening walls and ceilings.
- Make one large opening rather than several small ones.

## VENTILATION

**8-45.** Ventilation is the systematic removal of smoke, heat, and toxic gases from a structure and the replacement of these gases with cooler air. Ventilating an area makes rescue and fire-fighting operations safer. In rescue operations, a ventilated area decreases the danger for trapped occupants

because the hot, toxic gases are channeled out of the structure. In fire-fighting operations, a ventilated area increases the fire crew's visibility and makes the working area more bearable. After fire crews properly ventilate an area, they can enter the area and locate and extinguish the seat of the fire. Proper ventilation usually reduces the chance of back draft.

**8-46.** An SFO decides when fire crews ventilate an area to avoid problems. If fire crews are not ready and told to ventilate, a fire could advance to a more difficult stage. If fire crews ventilate too late, a back draft could occur, causing extensive property damage, injury, or death. When a building is not immediately ventilated, the smoke and gases rise, spread, and fill the entire room or structure (mushrooming). When this occurs, fire crews must ventilate the area quickly before starting fire operations.

### TYPES

**8-47.** The three basic methods of ventilation are horizontal (cross), vertical (top), and forced. The two subtypes of forced ventilation are mechanical and hydraulic. Vertical ventilation involves opening the structure directly above (or as close to) the seat of a fire as possible. Horizontal ventilation involves opening one side of the structure and then the opposite side (probably windows) to remove heated gases and smoke. Forced (mechanical) ventilation uses blowers or ejectors at a doorway or window to help remove the smoke and heated gases.

### Horizontal

**8-48.** To cross ventilate, first open one side of the structure so that the heat and smoke can escape, and then open the other side so that the fresh air can enter the structure. Cross ventilation is more effective in certain types of structural fires than in others, such as the following:

- Residential buildings, when the attic is not on fire.
- Buildings with windows near the eaves.
- Attics of residential buildings with louver vents in the walls.
- Involved floors of multistoried structures.
- Buildings with large, unsupported open spaces under the roof. In this situation, a fire is not contained by fire curtains nor has the structure been weakened by the burning process.

**8-49.** You must consider wind conditions when cross ventilating. If there is no wind or if it is too windy, cross ventilation is not effective. Determine the wind direction and ventilate. First, open the top section of the windows on the leeward side to relieve the smoke and heat pressure. Second, open the lower section of the windows on the windward side to allow cool air to enter. Figure 8-6 shows horizontal ventilation.

**8-50.** Consider the interior and exterior building exposures when cross ventilating because you may have to route a fire. Be cautious; fire could spread from cross ventilating. Do not block the wind flow once you establish a cross-ventilation pattern. If the cool air flow is interrupted, hot air and gases could fill up the structure. If possible, avoid using an opening in the cross-ventilation pattern for applying a hose stream.

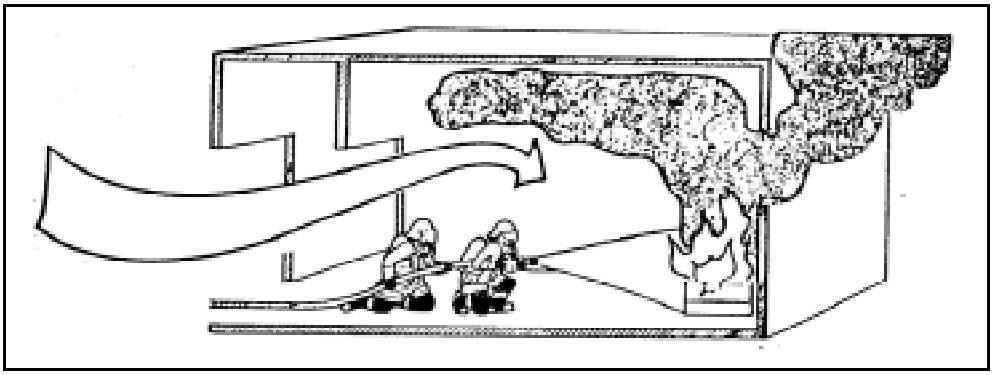


**Figure 8-6. Horizontal ventilation**

### Vertical

**8-51.** Opening roofs is the primary method of top ventilation (Figure 8-7). To top ventilate, cut a hole in the roof above the seat of a fire. Hot air currents rise and remove the heat and gases. Before ventilating, consider—

- Coordinating your efforts with the ground and attack units.
- The wind direction.
- Obstructions or weight on the roof.
- Additional escape methods, such as a lifeline to the roof.
- Installed roof openings as a ventilation source.
- The size and number of the holes to cut.
- The condition of the structural supports.
- Possible accidents from opening.

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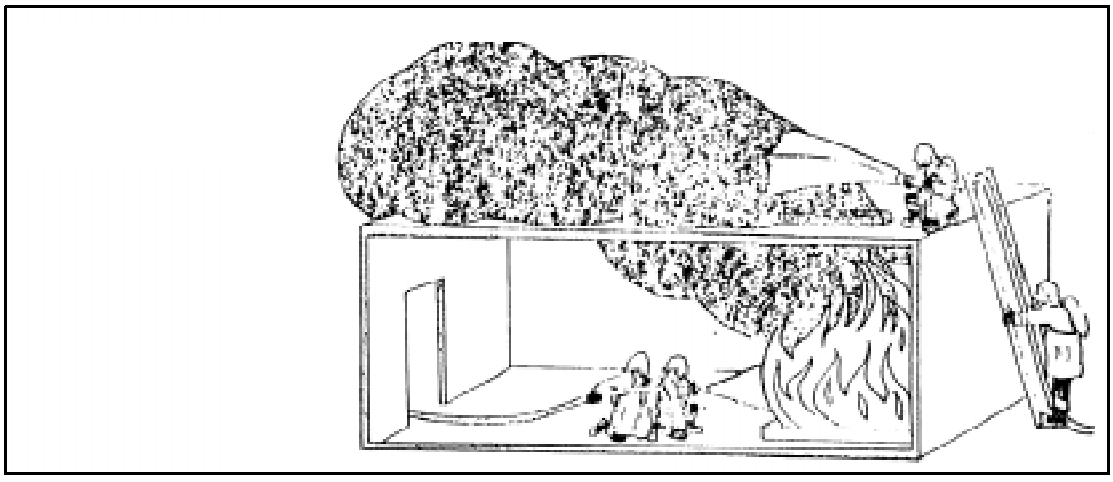

**Figure 8-7. Top ventilation**

### Forced

**8-52.** Forced ventilation uses two removal techniques. Negative-pressure ventilation uses smoke ejectors to develop artificial circulation and pull the smoke out of a structure. The ejector is placed by a window, door, or roof vent. Positive-pressure ventilation uses a blower or smoke ejector to force air (at a doorway or window) into the structure creating a pressure differential. The higher pressure that is created inside the building forces the smoke through openings to the outside (area of lower pressure). The hydraulic technique uses a hand line with a fog pattern (at a door or window) to draw heat and smoke out of the building. In forced ventilation, mechanical blowers, fans, and fog streams move the air currents out of the structure.

### Portable Machines

**8-53.** When using gasoline- or electric-powered, portable fans, locate them so that they will either pull out the smoke or force in fresh air. Place smoke ejectors at the highest level to draw out more heat. Seal a fan with curtains or drapes so the air cannot circulate around the fan and reduce its effectiveness.

### Fog Streams

**8-54.** When using fog streams, fire crews must be inside the area that they are ventilating. The nozzle man will place the hose stream in an area at the top of the windowsill with just enough fog pattern to fill the window opening about 3/4 and hold the nozzle there. The smoke and heat will be drawn into the pattern and forced out of the structure.

## COMMON ROOF TYPES AND OPENING TECHNIQUES

**8-55.** The more common roof types that a firefighter will encounter are listed below:

- Flat roof. To ventilate a flat roof—
  - — Locate the roof supports.
  - — Mark the roof area to be cut.
  - — Use an ax to remove the built-up material or metal.
  - — Cut the wood decking diagonally along the joist toward the center of the hole that you are making.
  - — Use short strokes when chopping. If you use high strokes, clear the area and check for overhead obstructions.
  - — Pry up the roof boards with the pick head of an ax. Use the blunt end of a pike pole, or similar tool, to knock through the ceiling.
  - — Use power tools when necessary, such as a rotary-disc saw (K-12 saw) or chain saw, to speed up the operation.
- Pitched roof. To ventilate a pitched roof—
  - — Determine where to make an opening, and place a roof ladder on either side of the opening. Use the ladder for support.
  - — Remove the shingles or roofing felt.

— Cut the sheathing along each side of the rafters.

— Remove the sheathing boards with the pick of an ax.

— Use the blunt end of a pike pole to knock down the ceiling.

- Metal roof. To ventilate a metal roof, either pry up the metal sheets with a prying tool or cut the metal sheets with a cutting saw.
- Arch roof. To ventilate an arch roof, use the same procedures as for flat or pitched roofs. Roof ladders will be difficult to handle; use aerial or long, straight ladders.
- Installed roof openings. Be aware that a building can contain several types of roof openings: skylights, scuttle hatches, stairways, and ventilators (Figure 8-8). You can easily force most of these open without damaging the roof. If possible, use these openings to save time.

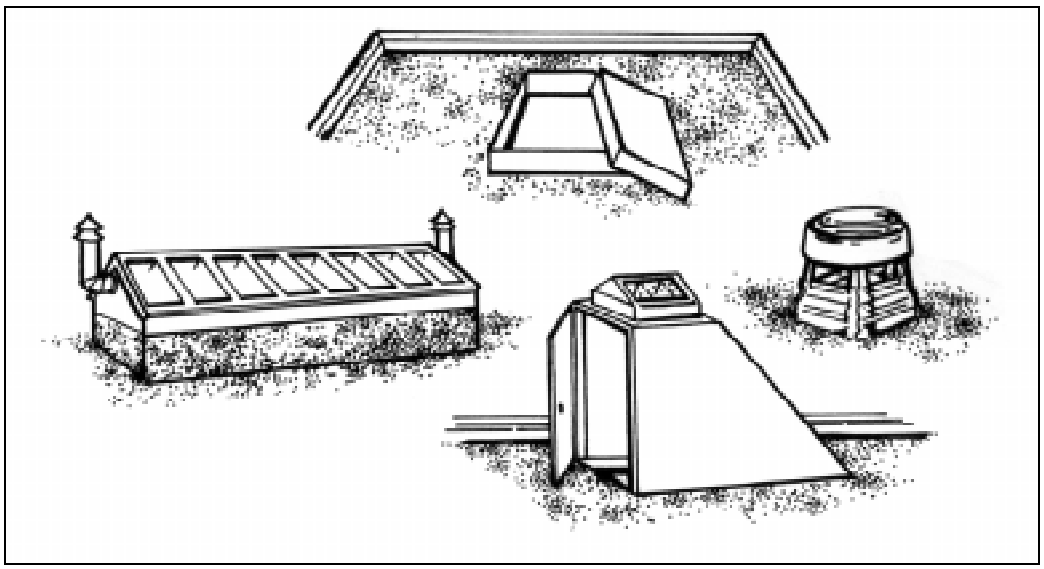

**Figure 8-8. Roof openings**

**8-56.** Do not disrupt top-ventilation patterns. With an opening in the roof of a structure, the natural convection of air currents expels the heat and gases. When this flow is interrupted, ventilation is ineffective. Do not direct a hose stream into ventilated openings. Heat and gases cannot escape. Direct hose streams above the horizontal plane of the opening to control hot embers and sparks. When deciding to ventilate, the SFO should—

- Ensure that the firefighters doing the ventilating wear full protective clothing and SCBA and that they stand on the windward side of the cut.
- Provide a secondary means of escape.
- Prevent personnel from walking on spongy roofs.
- Ensure that firefighters work from ladders to prevent slipping and sliding.

- Ensure that a hand line is positioned at the roof when the cut is made to provide protection to the firefighters on the roof.
- Ensure that the firefighters are cautious when using power tools.

**LOCATION**

**8-57.** The SFO should consider the following factors when determining a ventilation site:

- Availability of the installed roof openings.
- Location of a fire and the direction in which he wants the fire crews to draw the fire.
- Type of building construction.
- Wind direction.
- Extent of the fire and conditions of the structure and its contents.
- Bubbles or melting of roof tar.
- Indications of roof sag.

## SECTION II. RESCUE

**8-58.** The primary function of rescue operations is to remove victims from inescapable places. A firefighter's first consideration is to save lives. He does this by removing victims from hazardous situations, carrying them to a safe place, and administering first aid. Rescue personnel must act cautiously when transporting victims to ensure that further injuries do not occur.

### PROCEDURES

**8-59.** When performing rescue operations in a building, firefighters should—

- Always wear full protective clothing and SCBA.
- Not attempt rescue operations if the building is unsafe because of advanced fire conditions.
- Ventilate the building before entering it, if a back draft is possible.
- Work in pairs, when possible, and keep in contact with each other.
- Develop a plan and work from it to avoid becoming disoriented.
- Carry forcible-entry tools.
- Use a charged hose line when operating on the floor above a fire.
- Tie a rope to their body for safety when working in the dark or under extremely hazardous conditions.
- Remember the direction that they turned to enter a room. They should keep in contact with a wall while moving around and ventilate the area, if doing so will not enhance a fire.

- Exit a room by turning in the opposite direction from which they entered the room.
- Feel the doors before opening them. They should stand to one side, keep low, and open the door. If fire is behind the door, they should close the door to contain a fire temporarily so that they can continue searching. Once they complete a search, they should report their findings to the SFO.
- Stay low, move cautiously (Figure 8-9), and carry a hand light.

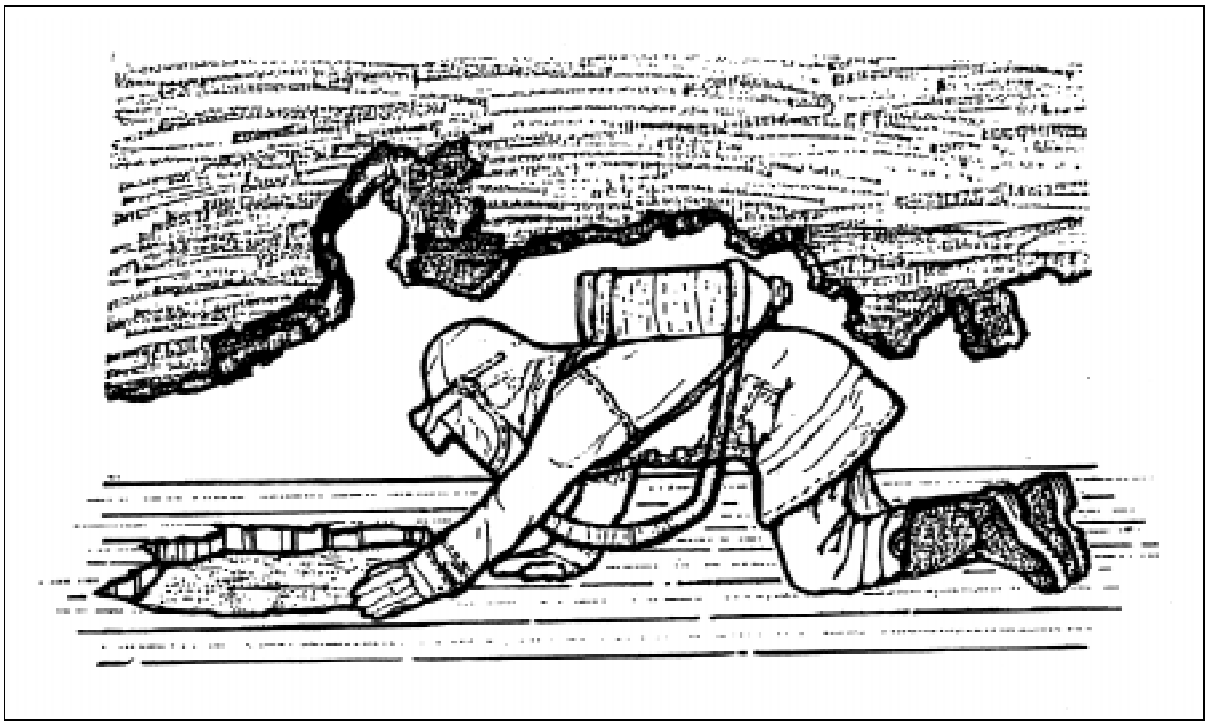

**Figure 8-9. Rescue position**

- Stay alert and use all their senses. Occasionally they should pause during the search and listen for signs or signals (moans, coughing, cries for help) from trapped victims.
- Watch for weakened structure or hot spots.
- Follow a wall if they lose their direction. If they see a hose line, they should crawl along the hose line; it will lead them to a nozzle man or outside.
- Follow a wall to the nearest window and signal for help if they become trapped. If they cannot find a window, they should stop momentarily and consider other escape actions.
- Push a door slowly, if it is initially difficult to open. A victim may be blocking the door. They should feel behind the door and check for a victim. They should not kick the door open.

## SEARCH PATTERN

**8-60.** Your main consideration in a search is locating victims in relation to a fire. A primary search is a rapid search of the building to verify removal of all victims. A secondary search is a thorough search of a fire area after initial fire control. Always work in pairs when searching for victims. First check the fire floor and then the floor directly above the fire. If personnel are available, conduct rescue operations on both floors.

**8-61.** If multiple rooms or apartments lead into a center hallway, conduct a search in a series. Enter the first room and turn right or left to establish the search pattern. When exiting the room, turn in the same direction as you entered and continue searching. Always exit a room as you entered it to ensure a complete search. After searching a room, mark it as stated in your standing operating procedure (SOP). Doing so avoids duplicating efforts. If you abort a search or are removing a victim, exit the area by turning in the opposite direction from which you entered the area.

## SEARCH AND RESCUE

**8-62.** Whether searching a room or an entire building, use a systematic approach. Do not just go into an area and start a haphazard search. Evaluate each area quickly and start a search and rescue based on your evaluation.

### ROOMS

**8-63.** After entering a room, follow the wall around the room. Keep low and feel ahead for obstacles or pitfalls. Reach out with your hand or foot to cover a greater area. Keep in constant and direct contact with the wall. This method brings you back to your entry point (Figure 8-10). Search the center of the room (Figure 8-11).

**8-64.** Search all areas: behind the furniture; inside the closets, toy chests, and bathrooms; and on top of and underneath the beds. Follow the search pattern to avoid overlooking any area. Flip a mattress into a *U*-shape, indicating that you have searched the room.

### COLLAPSED BUILDINGS

**8-65.** A building's condition determines the difficulty that you will have in rescuing victims. First, rescue the victims whom you can easily reach so that they can receive medical attention. Second, rescue victims who are in areas that are difficult and require more time to reach.

**8-66.** When the floor supports fail in any building, the floors and roofs may drop in large sections, causing the floors and roofs of the lower levels to collapse (pancake collapse, Figure 8-12, page 8-20). When heavy loads of furniture and equipment are located near the center of a floor, the excess weight may cause the floor to collapse. Figure 8-13, page 8-20, shows a *V*-type collapse.

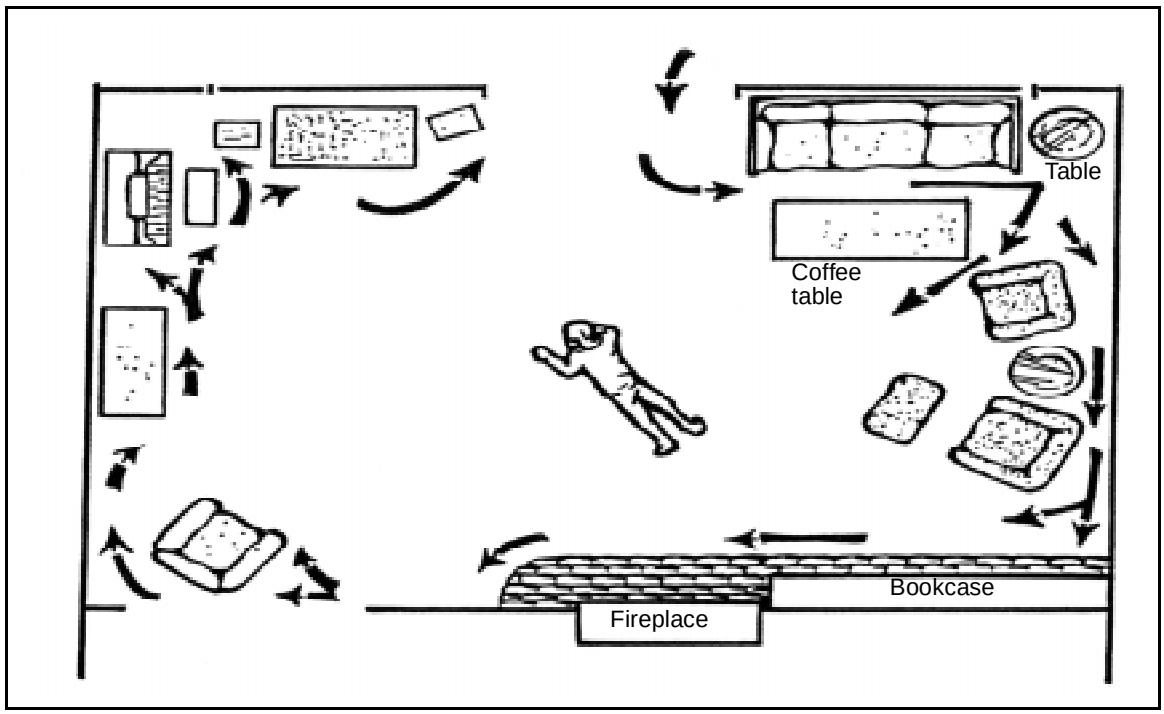


**Figure 8-10. Searching a room's perimeter**

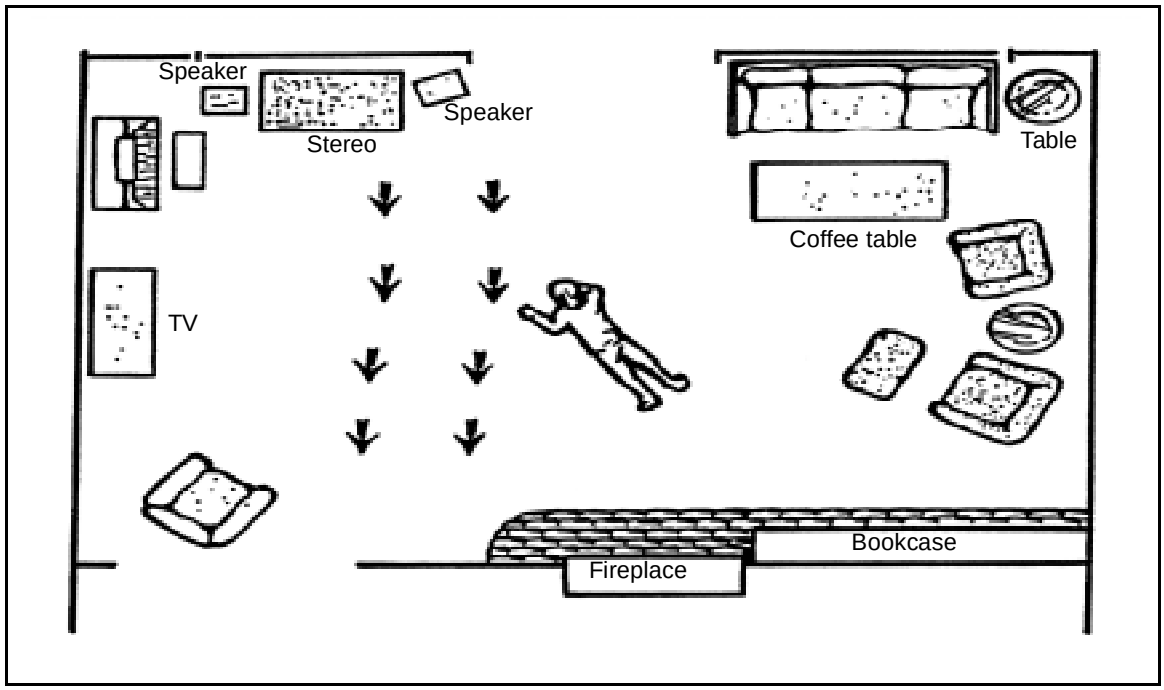


**Figure 8-11. Searching the center of a room**

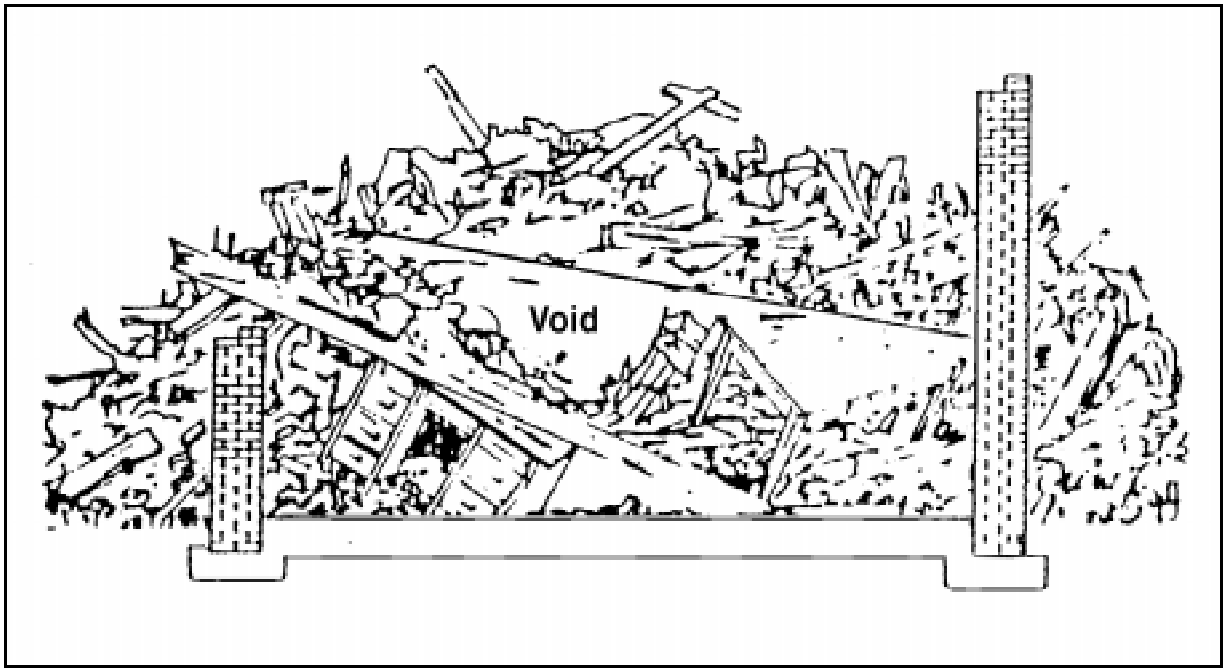


**Figure 8-12. Pancake collapse**

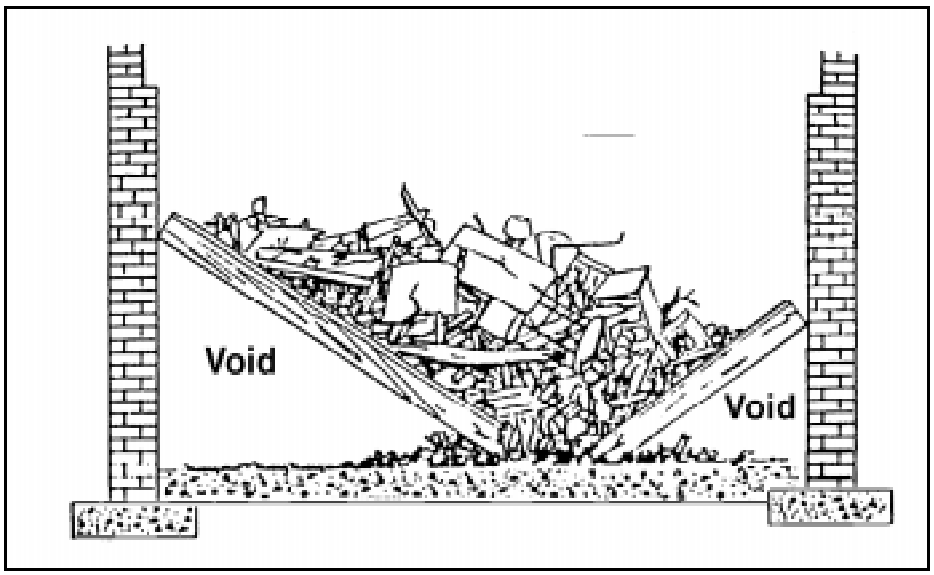


**Figure 8-13. V-type collapse**

**8-67.** To reach a buried or trapped victim, you may have to dig a tunnel. Tunneling is a slow, dangerous process. Try other rescue methods before tunneling. Do not dig tunnels to conduct a general search of an area. However, you can use tunnels to reach a void under a floor to continue a search. The following lists some tunneling procedures:

- Start a tunnel at the lowest level possible.
- Dig the tunnels large enough to accommodate the firefighters and victims.
- Do not construct the tunnels with abrupt turns.
- Drive the tunnels along a wall when possible. Doing so simplifies the framing required to prevent cave-in.

#### CAVE-INS

**8-68.** Use either shoring or cribbing to hold back weakened earth formations in a building or to secure tunnel openings and passages. Shoring is a series of timbers or jacks used to strengthen a wall or prevent collapse of a building or earth opening. Cribbing is usually adapted to roof and ceiling supports, but it can be used on walls.

**8-69.** Do not force beams, floor sections, or walls back into place. This action may cause further collapse and damage. When removing debris, watch for timbers or rocks that hold up other portions of earth or debris. Moving these pieces could cause a collapse or slide. Leave the timbers or rocks in place.

#### ELECTRICAL CONTACT

**8-70.** If a victim is in contact with electrical wires, do not touch the victim or the wire until the victim is clear of the wire. If the victim is not free from the wire or the wire will not endanger you, use a pike pole (made of a nonconductive material) to rescue the victim. Hook the victim's clothing and drag the victim clear of the wire.

#### VEHICLES

**8-71.** To rescue victims from vehicles, you must know basics about motor-vehicle design, hand and power tools, and patient care. You must also be prepared to face victims who are badly burned, mortally injured, or hysterical.

### Safety Considerations

**8-72.** Observe safety precautions during an operation. Wear complete turnout gear during the operation. The following lists hazards resulting from vehicle accidents:

- Fire and its products.
- Glass fragments.
- Sharp metal edges on vehicles.
- Flying glass and metal.
- Dangerous chemicals and radiation.

- Tool failure.
- Unstable vehicles.

**Assessment**

**8-73.** An alarm-room operator must obtain as much information about a vehicle emergency as possible. He should record the—

- Location of the accident.
- Number and types of vehicles involved.
- Number of people injured and the types of injuries.
- Information on any special hazards at the scene.
- Name of the person calling and the call-back number.

**Stabilization and Access**

**8-74.** If a vehicle is on its side or upside down in a gully or on a hillside, do not rock or push the vehicle. Stabilize any vehicles that are in such difficult positions. Use jacks, wedges or cribbing, or come-alongs. In emergencies, use the bumper jacks or ropes or open the trunk lid and hood. Do not tip a vehicle if victims are trapped inside.

**8-75.** Choose the easiest route available to gain access to a victim. Try opening the doors. If they are jammed, break a window. If any window is broken in the accident and the frame is not bent, remove a victim through that window. If not, break the rear window. This window provides a large opening, and glass should not fall on the victim as readily as from a side window. The primary objective is to gain access and stabilize and protect the victim from further injury from sparks, glass, metal, and extrication tools.

**8-76.** After accessing the vehicle, stabilize the victim. Try to identify any life-threatening injuries, and administer first aid when necessary. Vehicle parts (steering wheel, seats, pedals, dashboard) often trap a victim. Free the victim from any vehicle parts and treat his injuries. The following is a checklist covering injuries and treatment:

- Watch for breathing problems. Open an airway, when necessary.
- Perform cardiopulmonary resuscitation (CPR).
- Treat for shock.
- Control the bleeding.
- Immobilize the victims that have fractures or spinal-cord, neck, and back injuries.
- Position the victims according to sustained injury.
- Strap the victims in securely.

## VICTIM CARE AND REMOVAL

**8-77.** If the situation and time permit, carefully try to remove all the victims from an incident. However, if a fire, an explosion, or some other danger is

imminent, use whatever method you can to remove the victims and yourself from the area immediately.

**CARRIES**

**8-78.** If a victim cannot walk or has severe injuries, carry him. Use any of the following carries that is appropriate for the situation:

- One-man-supporting carry. Use this method if a victim is in the prone position. Assist him to a sitting position and then to his feet. Grab one arm, place it over your shoulder, and secure his arm by holding his wrist. Place your other arm around his waist and help him walk.
- Two-man-supporting carry. This method is similar to the one-man method except that the victim puts an arm over a shoulder of each firefighter. Each firefighter secures the victim's arm by grabbing his wrist. Firefighters place their other arm around his waist for support.
- Lone-rescue carry. If you have difficulty raising a victim to carry him—
  - — Place the victim on his back.
  - — Push his feet close to his buttocks and hold his feet in place with your foot.
  - — Grab the victim's hands and rock him up and down several times.
  - — Jerk him up, at the top of the upswing, and onto your shoulder.
- Fireman's carry. To execute this carry—
  - — Kneel on one knee near the victim's head and turn his face down. Place both hands under his armpits and gradually work your hands down the side and across his back.
  - — Raise the victim to his knees.
  - — Take a firm hold across his back.
  - — Hold the victim around his waist with your right arm, grab his right wrist with your left hand, and draw his arm over your head. (Change sides if the victim is wounded on the right side.)
  - — Bend at the waist and knees, and pull the victim's right arm down over your left shoulder so that his body comes across your shoulders. At the same time, pass your right arm between his legs and grab his right knee with your right hand.
  - — Lift the victim as you straighten up.
  - — Grab the victim's right wrist with your right hand.

- Two-firefighter carry. In this method, two firefighters form a chair with their arms to carry a victim. To execute this carry—
  - — Each firefighter kneels on one side of the victim, near his hips, and raises him to a sitting position, supporting him by placing an arm around his back.
  - — Each firefighter slips his free arm under the victim's thighs and clasps each other's wrist.
  - — The firefighters rise slowly and lift the victim from the ground. When erect, they adjust their upper arms to form a comfortable back rest to secure the victim. If he is conscious, the firefighters should tell him to place his arms around their necks.
- Chair carry. In this method, two firefighters carry a victim in a chair. To execute this carry—
  - — The firefighters should place the victim on his back.
  - — One firefighter grabs the legs of the victim and raises his legs, buttocks, and back. The other firefighter slips the chair under the victim.
  - — One firefighter is in front and one is in back of the chair. They grab the chair, tip it to a 45-degree angle, and walk forward.
- Extremities carry. This is a good carry method when a victim is conscious or unconscious and does not have leg or back injuries. Two firefighters execute this carry. To do so, the—
  - — Firefighters lay the victim on his back with his feet apart. They face each other, one standing between the victim's legs and the other at the victim's head. They kneel and raise the victim to a sitting position.
  - — Firefighter at the victim's head grabs him from behind, placing his arms around the victim's body under the armpits.
  - — Firefighter standing between the victim's legs turns around and grabs the victim's knees.
  - — Firefighters rise and carry the victim.
- Severe-injuries carry. If a victim is severely injured, at least three firefighters should carry the victim. To execute this carry, the—
  - — Firefighters must designate one person to be the leader who will give the commands.
  - — Firefighters stand on one side of the victim.
  - — Leader gives the command *prepare to lift.*
  - — Firefighters kneel on the knee nearest the victim's feet: one firefighter at the victim's shoulders, one at his hips, and one at his knees.

— Firefighters place their hands and forearms under the victim's neck and shoulders; pelvis, hips, and small of the back; and knees and ankles.

— Firefighters, at the command *lift*, raise the victim and place him on their knees.

— Firefighters, at the command *prepare to raise*, slowly turn the victim on his side toward them until he rests in the bend of their elbows.

— Firefighters, at the command *rise*, slowly rise to a standing position, holding the victim close against their chests.

— Leader gives the command *march*, if the firefighters can move forward, and all lead off on the left foot. If they must move sideways, the leader gives the command *side step left (or right)*, and all lead off with the foot the leader commands.

— Firefighters reverse the operation to lower the victim, at the command of the leader.

### OTHER REMOVAL METHODS

#### Dragging

**8-79.** Drag a victim when only one firefighter is available and speed is important. To drag a victim—

- Roll him onto a coat, blanket, or similar object.
- Grab the object on each side of his head; lift him so that his head and shoulders are off the ground.
- Drag him to safety.

#### Using a Stretcher

**8-80.** Use the same procedure for placing a victim on a stretcher as for preparing to lift in a severe-injuries carry.

#### Using a Ladder

**8-81.** Use a ladder as an escape means when a victim is trapped on a floor above ground level. If he is conscious, descend the ladder first. Keep your arms around him and one knee between his legs for support. To rescue an unconscious victim—

- Raise a ladder just above the window where you are making the rescue.
- Pass a lifeline underneath the bottom rung so that the rope feeds from the underside of the ladder.
- Thread the rope up and over three consecutive rungs when you reach the bottom of the windowsill.
- Feed about 20 feet of rope through the window. A ground crew will assist in feeding the rope.

- Step into the room, tie the rope around the victim, and assist him onto the window. The ground crew will help lower the victim to the ground.
- Use a stokes basket to lower a victim if he has severe injuries. Lace him inside the stokes and lower him to the ground.

## SECTION III. CONTROL AND EXTINGUISHMENT

**8-82.** Rescuing victims is the primary concern of any fire operation. The secondary concerns are fire control and extinguishment and related procedures essential to preserving property. Before starting extinguishing operations, fire crews must consider the type, quantity, and locations of the materials in the building.

### LOCATING A FIRE

**8-83.** Structural fires generally fall into two categories, interior and exterior. Both involve the same basic materials but in different conditions, quantities, and proportions. Fire crews can often observe an interior structural fire through open doors or windows; sometimes they must enter the structure to locate a fire. A red or orange glow usually indicates the presence or location of a fire.

#### INTERIOR FIRES

**8-84.** These fires normally involve excessive smoke and ventilation problems, back-draft possibilities, and difficulty in locating the fire. Fire crews must anticipate suffocation possibilities for themselves and building occupants. Interior fires do not threaten adjacent buildings unless the roof or walls of the burning building collapse. A delay in controlling a fire, rekindling before fire crews arrive, or widespread smoldering before ventilation could cause the building to collapse. Fire crews should not use a hose line inside the building until they see a fire or if they need a fog curtain to reach the seat of a fire.

#### EXTERIOR FIRES

**8-85.** Fires outside of a building could start from various causes (discarded cigarettes or embers falling on rooftops). Also, an exterior fire could result from an interior fire burning through the roof or outside walls. A fire crew's main objective is to prevent a fire from spreading to other buildings.

### CONFINING A FIRE

**8-86.** After locating a fire, try to confine it to its point of origin. Cover the internal exposures with hose streams, and shut the external doors and windows to localize a fire. The leeward side of a fire is the most difficult to approach. The wind carries the heat and smoke toward the fire crews. However, the leeward side is a good place to make a fire stop and prevent a fire from intensifying and spreading.

**8-87.** Attack a fire from as many sides as possible. Use proper ladder work and ventilation procedures when locating, confining, and closing in on a fire. If there is a danger of back draft, position and charge hose lines before opening them. Watch for heavy smoke escaping from cracks around doors or beneath

eaves. This is a sign of back draft. Close in on a fire as conditions permit. Do not advance hose lines too quickly; a fire could rekindle and spread. When using extinguishing agents on Class B fires, back up the agents using a water-fog line or a foam line. This precaution guards against a flashback of Class B materials.

**8-88.** Walk cautiously when working in dark areas or on weakened floor supports. Crawl on your hands and knees, if necessary. If large cracks appear in masonry walls, leave the area immediately. When advancing a hose line in radiated heat, use the helmet shield to protect the face piece of the air pack. The nozzle man receives the impact of a fire's heat, so rotate the firefighter at this position to ensure that each person rests and cools off. If you must retreat from a forward position, follow a hose line back to safety.

## SECTION IV. SALVAGE AND OVERHAUL

**8-89.** Salvage is the prevention of excessive fire, smoke, and water damage. Firefighters move material either outside the burning building or to an area not involved in a fire. The amount of salvage work firefighters must do depends on the amount of salvage equipment available, the number of personnel available, the type and amount of material involved in a fire, and the storage method of the material. Overhaul is the complete check of all structures involved in a fire. Firefighters look for hidden fires, ensure that all sparks and embers are extinguished, and look for and protect the area containing the cause of a fire.

### PROTECTION PROCEDURES

**8-90.** You can cause excessive damage to stored material if you use large amounts of water to extinguish a fire or improperly apply water, such as using a straight stream instead of a water fog. Cover the material stored on lower floors with large tarpaulins. If possible, move the material outside or to an area in the building not involved in a fire. Cover heavy crates, packing cases, machinery, and similar articles. Wipe dry and oil all metal. Protect food items from smoke and water exposure.

**8-91.** To prevent excessive water damage, apply water to the base of a fire. Watch for leaky hose connections. Do not spray water on dry material. Do not over spray absorbent-type materials. The excess weight could collapse the floors. After extinguishing a fire, use sawdust to absorb the water and to form barriers so that you can direct the water through doorways or other openings. If necessary, drill holes in the wooden floors for drainage.

**8-92.** Remove valuable items as soon as you extinguish a fire. Remove debris from the building; sweep the floors; and remove excess water with brooms, squeegees, and water vacuums. In administrative, HQ, and other office buildings, cover the records and files with canvas covers and secure the records. If a roof has been damaged, cover the hole with a tarpaulin or roofing paper. If the roof is destroyed, the post engineers should install temporary roofs of canvas truck covers.

## SALVAGE COVERS

**8-93.** Salvage covers have a number of functions. They are used to cover furniture and carpet and are used as carpet runners and catch basins to divert water outside the structure during and/or after fire-fighting operations are completed. If used in a timely manner, salvage covers can save valuable property and prevent unnecessary smoke and water damage.

### TYPES

**8-94.** Conventional salvage covers are made from closely woven, waterproof canvas materials. The covers have reinforced corners and hems with grommets for hanging or draping the covers. Newer covers are made of polyethylene plastic and are lightweight. They are not affected by alkalines, oils, acids, caustics, or solvents. These covers remain flexible in subzero temperatures; will not mold, mildew, or absorb moisture; and are not affected by abnormal temperatures.

### MAINTENANCE

**8-95.** Clean salvage covers by spraying them, scrubbing them with detergent, and rinsing them thoroughly. Examine the covers for damages after they are dry. Make sure that the covers are completely dry before folding and placing them in service. To roll a salvage cover, bring the ends together in the center of the cover. Continue this process to the desired width. Complete the operation by rolling the cover.

### THROWS AND SPREADS

**8-96.** The most common type of salvage-cover throws are the one-man throw, the two-man spread, the counter payoff, and the catch basin. What needs to be covered and how much manpower is available will determine the method used.

- One-man throw. Use the following procedures to throw and spread a 12- by 14-foot salvage cover:
  - — Place the center of the folded cover over your forearm and grab the bottom of the fold.
  - — Grab the three folds, with your other hand, between the thumb and fingers, thumb down.
  - — Swing your arm up and over your shoulder and place the three folds over the back of your hand to give weight to the throw. Bring your hand forward and throw the cover over the object with a straight-arm throw.
  - — Open the cover and tuck the edges in at the bottom.
- Two-man spread. Two firefighters should use the following procedures to carry and spread a 14- by 18-foot salvage cover:
  - — One firefighter carries the cover. He grabs the grommet ropes at the corners nearest his body. The second firefighter grabs the remaining ropes and moves away from the first fire-fighter.

— Both firefighters drop the cover and stretch it out near the material to be covered. They drop the inside edge of the cover while holding the outside edge.

— The firefighters raise the outside edge and cover the material, allowing the air to balloon the cover. This ensures correct placement. They should tuck all corners and edges in at the bottom.

- Counter payoff. Use this method to cover material to prevent damage, destruction, or disarrangement of the material. This method requires two firefighters. One firefighter holds the cover by the bottom fold. The second firefighter grabs the top fold and walks backward. Both firefighters raise the cover as it unfolds and place it over the material. They tuck in the cover's edges at the bottom.
- Catch basin. To catch large amounts of water dripping through a floor or ceiling, use a salvage cover to construct a deep catch basin. Place furniture, boxes, or other items in a circle or square beneath the leak (Figure 8-14). Spread the salvage cover over the framework, tuck in the loose edges, and tie the cover to the items. To catch small amounts of water, use a salvage cover to construct a shallow basin. Roll two sides of the cover in about 5 feet. Roll the other sides in about 1 foot. Lift the corners in and tuck under to lock the corners.

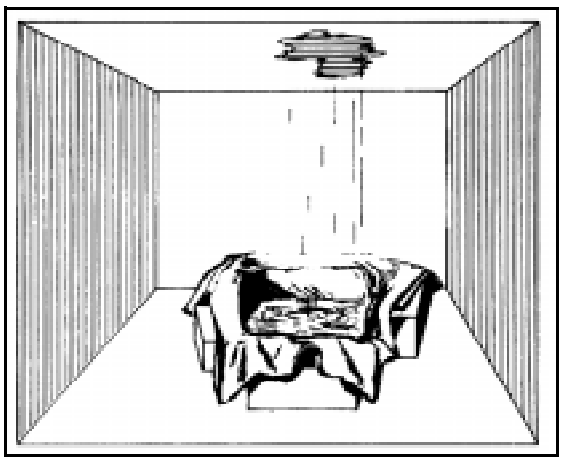

**Figure 8-14. Catch basin**

- Water chute. Use a water chute to drain water from a ceiling to the windows or doors. Spread a salvage cover over two pike poles and roll the poles toward the center to form the chute. The water's weight will tighten the rolls (Figure 8-15, page 8-30). An alternate method of constructing a water chute is by using *S*-hooks, cord, salvage covers, and pike poles. You can tie light rope or heavy cord through the grommets to support the covers. To protect interior structures and contents from water damage, use canvas covers as stairway drains to

direct the water from upper floors to a lower level and outside. Figure 8-16 shows how to form a chute on a stairway.

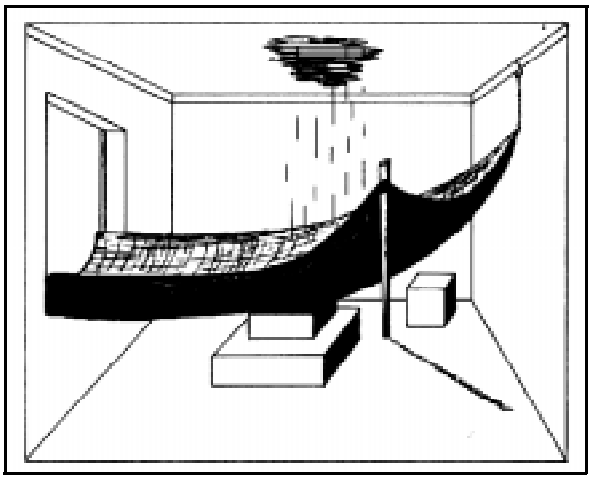

**Figure 8-15. Spreading a salvage cover**

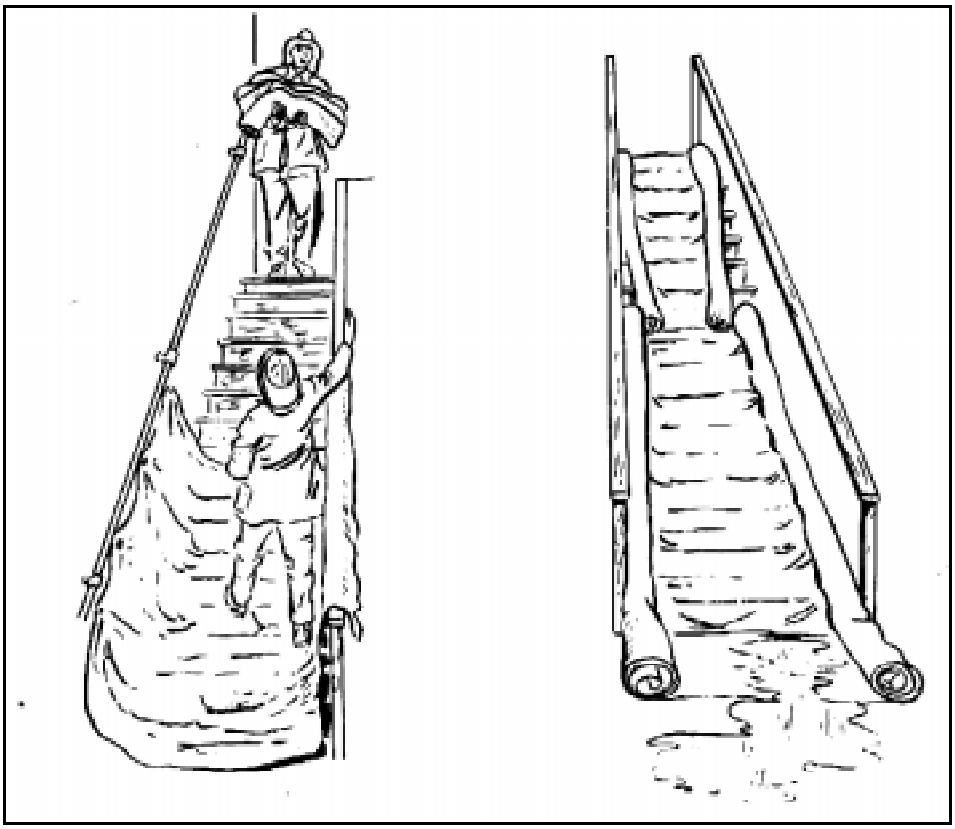

**Figure 8-16. Forming a chute on a stairway**

## OVERHAUL

**8-97.** During this operation, check the entire structure to ensure that hidden fires or embers do not cause reignition. The salvage methods you execute during an operation will affect any required overhaul work.

### STRUCTURAL CONDITIONS

**8-98.** Before searching for hidden fires, determine the building's structural condition. Check for weakened floors, spalled concrete, weakened steel roof members, offset walls, opened mortar in wall joints, and melted wall ties. Cover or block off holes that have been burned or cut in the floor. Block off approaches to damaged stairways or elevator shafts. Pull down walls or chimneys that are weak and possibly dangerous.

### HIDDEN FIRES

**8-99.** You can detect hidden fires by sight, touch, or sound. Look for discolored materials, peeling paint, or smoke emitting from cracks, cracked plaster, and dried wallpaper. Feel the walls and floors. Listen for popping, hissing, and crackling sounds. Carefully check the entire area to determine a fire's spread. If a fire spreads to other areas, determine its path. Check for hidden fires in—

- Floor beams. If the ends that enter a party wall are burned, flush water into the voids in the wall. Check the far side of the wall to see if fire or water has come through.
- Areas containing insulation. Remove insulation because it can hide fires for prolonged periods.
- Casings. If a fire has burned around windows or doors, open the casings and inspect for fire.
- Cornices. If a fire has burned around the roof, open the cornices and inspect for fire.
- Concealed spaces. Open the areas below floors, above ceilings, or within walls and partitions. Remove only enough material to check for hidden fires. Move any room item that could be damaged during overhaul operations. Do not overhaul weight-bearing members.

# SECTION V. INVESTIGATION AND RETURN TO SERVICE

**8-100.** Investigating a fire involves looking for and safeguarding evidence that could determine the cause of a fire. This procedure could occur during control, extinguishment, and overhaul operations. If fire personnel suspect arson, they should inform fire investigators (LA team).

## INITIAL INVESTIGATION

**8-101.** Take colored photographs of the entire fire scene. If arson is suspected, label items, such as gasoline cans, cotton trails, film trails, candles, oil-soaked rags, cleaning-fluid containers, matches, and cigarettes. Labels should include

the name of the person who found the item and where and when the item was found. Take notes on the following items:

- The number of people present when the fire personnel arrived.
- The number of fires burning when the fire personnel arrived.
- The color and aroma of the smoke.
- The color of the flame and from where it was coming.
- Where the doors were locked (inside or outside).
- The condition of the contents and if they were disarranged.
- The nature of the burning material.
- The wind direction, humidity, temperature, and general weather conditions.
- The direction of the fire's spread.
- The condition of the area where the fire may have started.
- The statements from observers who may have seen unusual occurrences before the fire broke out.

**8-102.** Make detailed sketches of the area. These sketches may be needed during a board of inquiry or investigation proceedings, especially if an arsonist is brought to trial.

**8-103.** If the fire building contained classified documents or equipment (reels of film, models drawings, files), the SFO should request that guards be posted over the area until the classified material is moved to a secure location. Since firefighters are not authorized to examine classified materials, they must be careful during salvage and overhaul operations. They should set aside classified items in a designated area for proper authorities to examine.

**8-104.** Before returning to the station, the SFO should gather all the facts necessary to complete the required fire-report form, Department of Defense (DD) Form 2324 or DD Form 2324-1. This report should include the—

- Type of alarm.
- Location of the fire.
- Building number.
- Description, origin, cause, and confinement of the fire.
- Property damage.
- HAZMATs (type, amount, path of released substances).
- Containment measures taken during and after fire-fighting operations.
- Agents used.
- Time required to extinguish the fire.
- Number of personnel near the burning structure.

- Mileage traveled.
- Weather.
- Remarks made by people around the burning structure.

## ORIGIN OF A FIRE

**8-105.** In a serious fire (loss of life, extensive property damage), the fire marshal or another person from higher fire-department HQ may assist in the investigation as an impartial party. The investigators may collect more detailed information than required. The information may include the—

- Reasons for delay in the alarm.
- Extensive spread of the fire.
- Heavy property loss.
- Inability of occupants to escape.
- Fire-fighting methods used.
- Adequacy of the water supply.
- Correction of previously noted deficiencies.

**8-106.** In a less serious fire, the information recorded on the fire report is sufficient. However, until all evidence is examined, you may not accurately account for a fire's origin and cause and the damage estimates.

**8-107.** To locate a fire's origin, you may have to reconstruct the walls, replace the loose boards and doors, or rearrange the furniture. Obtain as much information as possible about the types of materials that were in an area. Examine the remains because they can indicate the direction of the heat flow. However, factors such as drafts can also affect a fire's spread and heat flow. The condition of metals, grass, wood, plastics, and other materials are good indications of the temperatures at certain spots.

### WOOD

**8-108.** Char depth indicates the length of time that wood burned. Most woods will char at the rate of 1 inch per 40 to 45 minutes burn time at 1400 to 1600°F. Demarcation lines between charred and uncharred material are indicators of the type of heat involved. For example, if you chop or saw through charred boards located near a fire's origin, there should be sharp, distinct lines between charred and uncharred wood. This will occur if the fire was fast and intense and extinguished quickly. The wood will show a gradation of char and a flat, baked appearance throughout, if a fire was long and slow.

### GLASS

**8-109.** Glass is composed principally of silicon and lime. Glass will soften at 1200° to 1400°F and will become molten above 1600°F. Examining the glass

can provide information as to how a fire's heat reacted on the glass or if other forces acted on the glass.

- Heat. The following explains how heat can react on glass:
  - — Broken pieces from windows in clear, irregular, block-shaped pieces indicate a rapid, intense buildup of heat in a 1- to 5-minute time frame.
  - — Heavily glazed pieces with little or no stain indicate an intense heat with a slow buildup.
  - — Heavily stained pieces with no crazing indicate a slow buildup with considerable smoke. Half-moon checks on a stained side indicate that the glass was still in the frame during a fire and that water splashed on the glass.
  - — Unstained or heat-checked pieces found on the floor indicate that the glass was broken by intense heat early in a fire.
- Other forces. The following lists reactions glass has from other forces:
  - — Clear, long, rectangular pieces inside a building indicate that some other force (forced entry) broke the glass.
  - — Radial cracks in glass emitting from the point of impact and concentric cracks around the point of impact indicate that the glass was broken by a blow from a hard object. The glass near the break comes out in rectangular- or triangular-shaped pieces.
  - — Thermal cracks in glass have no pattern and pieces are odd-shaped.
  - — High-intensity explosives (dynamite) cause glass to sliver.
  - — Low-intensity explosives (dust or gas) cause glass to break off in chunks.

### METAL

**8-110.** Most chromium or shiny metal surfaces, such as light fixtures, toasters, and irons, turn different colors when subjected to intense heat. The color variance could indicate the progress of a fire.

## CAUSE OF A FIRE

**8-111.** When investigating the cause of a fire, first consider common causes, such as discarded cigarettes, overheated or defective stoves or flues, faulty electrical appliances, and slag or sparks from welding and cutting machines. If none are the cause of a fire, question all the people who are at the fire scene (mainly building occupants), the people who were present at the time of or immediately before the discovery of the fire, and the people who had left the building and may have returned. When investigating a fire's cause—

- Reconstruct all the areas as much as possible.
- Determine the heat path and the fire's point of origin.

- Determine the approximate burning time.
- Evaluate the combustion characteristics of the materials involved.
- Compare similar materials and situations, if possible.
- Fit the known facts to the various possibilities.
- Compare the information from the occupants and neighbors as to the activities before the fire.

**8-112.** Extensive investigations are required for high property-loss fires or those involving loss of life. Appointed officials, assisted by the fire marshal and appointed aides, usually conduct these investigations. Before moving or shoveling out any material, carefully examine the layers of material as you work to the floor. This method could show the sequence of materials burned from the point of origin. In a fire, aluminum and similar alloys will melt fairly early, splash or run on other materials, solidify at lower temperatures, and protect the material from further damage.

## LOSS ESTIMATE

**8-113.** Loss estimates are calculated after you complete salvage operations. Inventory all remains and compare that list with a prefire inventory list. Loss includes damages from smoke, heat, water, and fire. Installation engineers often assist in estimating loss value. The fire chief examines the fire scene and writes a brief description of the extent of the physical damage.

**8-114.** On an installation, the organization that is responsible for construction contracts estimates partial losses of Army structures. Total structural loss is the structural value taken from a recent prefire real-property report. Because construction costs fluctuate, evaluators should make an estimate based on current restoration costs. Vehicle and aircraft losses will be determined by replacement in kind for partial losses and recorded inventory value less salvage for total losses.

**8-115.** When preparing a preliminary report, the fire chief should not go into detail in a loss estimate. If available, the fire chief should use the estimate that the evaluators provide. If the two estimates vary greatly, a further investigation may be necessary. Either party may have overlooked important evidence during their evaluation, which would account for a discrepancy.

## FINAL ACTION

**8-116.** In large fire operations, the SFO must obtain as much information as possible, such as the names of witnesses, statements, photographs, a sketch of the building, and the location of apparatus and hose lines. Firefighters not involved in salvage and overhaul operations should return to the station. Crew chiefs should double check the area to ensure that all the equipment and tools are back on the fire apparatus. If a building occupant borrows fire equipment, the fire personnel must have a receipt for the equipment and leave instructions on returning the equipment.

**8-117.** Before leaving, reload hose lines in the bed of the fire truck in case an emergency occurs before returning to the fire station. If you used only a few sections, you may roll and stack the hose line on the tailgate.

## RETURN TO QUARTERS

**8-118.** Once back at the station, the crew chief in charge reports on the status of his truck to the alarm-room operator. He also notifies the alarm-room operator when his truck is back in service. The fire chief or crew chief completes the required fire reports and makes entries in the daily log book. Firefighters—

- Check the fire apparatus.
- Wash the tires and inspect them for cuts, nails, and other damages.
- Check and resupply the fuel, oil, and water levels in the radiator and booster tank.
- Replace the used hose lines with clean, dry hose lines.
- Wash the dirty hose lines and place them on racks to dry.
- Roll clean, dry hose lines.
- Wash wet salvage covers, inspect them for cuts and tears, and hang them to dry.
- Inspect the ladders for damages.
- Clean and dry all dirty and wet tools and appliances.
- Apply a light coat of oil on the metal surfaces that might rust.
- Wash the entire fire apparatus to remove mud, dirt, and carbon.

**8-119.** After completing all clean-up operations, the crew chief or assistant chief should conduct a general discussion with all fire personnel involved in the operation. The crew chief should review the entire operation, pointing out negative and positive aspects of the firefighter's actions. Before conducting a general discussion, the crew chief should administer private reprimands as a means of correcting individuals who committed serious mistakes. If the entire crew needs improvement, the crew chief should conduct training sessions and drills. If an individual or the entire crew does exceptionally well, the crew chief should extend praise during the general discussion.