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Fire Safety

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Residential Fire Detection



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Residential fires have become a significant problem throughout the U.S. The National Fire Protection Association (NFPA) estimates that in 1982 residential fires in the U.S. killed 4,940 persons and resulted in injury to 21,100 more. In addition, these residential fires accounted for an estimated \$3,253,000,000 in property damage.

Figure 1 shows the causes of residential fires as reported by the Federal Emergency Management Agency in its National Fire Incident Reporting System. The leading causes of fires in one-and-two family dwellings were heating (31 percent), cooking (15 percent), and incendiary or suspicious (10 percent).

In residential properties, cigarettes are still the leading cause of accidental multiple death fires (those fires that are fatal to three or more persons) by a factor of two to one. Fires resulting from fixed or portable heating equipment—woodstoves, kerosene heaters, gas or electric cooking stoves, etc.—are the second most common cause of accidental multiple-death fires in residential properties.

When and where fires start

An NFPA study of 1982 multiple-death fires shows that residential fires accounted for nearly 90 percent of the fires and 85 percent of the deaths. This study also showed that 83 percent of the fires originated in the living room, bedroom and kitchen (Figure 2). About 81 percent of the multiple-death fires occurred between 8:00 p.m. and 8:00 a.m. when people are asleep and unaware of the development of a fire until it is too late (Figure 3).

Fire officials estimate that at least 50 percent of lives lost due to residential fires could be saved by

installing early warning fire detection devices and developing and practicing an evacuation plan.

Choosing an early warning system

To protect the purchaser and establish criteria for the manufacture and installation of residential fire detection systems, the National Fire Protection Association has developed NFPA NO. 74, Standard for Household Fire Warning Equipment.

There are two types of residential fire detection systems: heat and smoke detectors. The *basic* residential detection system according to NFPA 74 relies primarily on the use of smoke detectors.

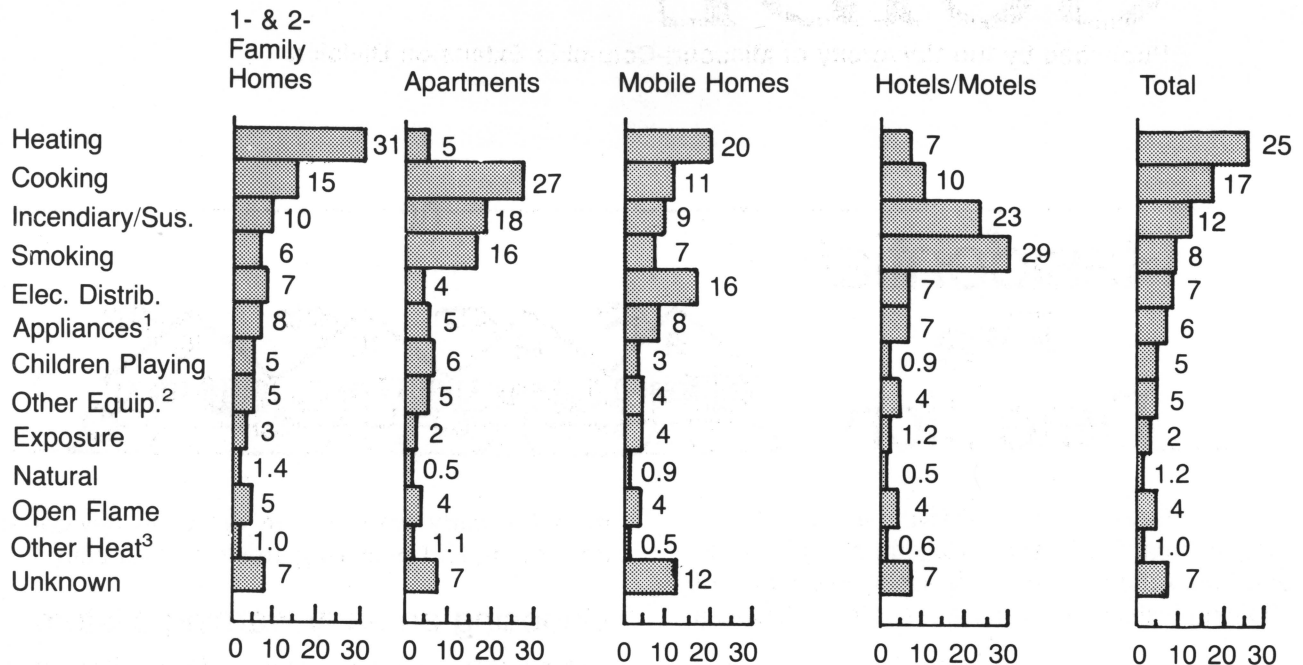
The standard **does not** require the use of heat detectors as part of the basic protection scheme, but it recommends that heat detectors be used to supplement the basic smoke detector system.

Smoke detectors consist of a sensing chamber, alarm sounding device and a means of electrical power transmission. There are two kinds of residential smoke detectors: ionization and photoelectric.

Ionization. The ionization smoke detector uses a radioactive source (typically Americium-241, an alpha emitting radionuclide) to ionize the air within the sensing chamber. The ionization of air by the radioactive particle causes a very small flow of electrical current. When smoke from a fire enters the chamber, its presence causes a reduction in the current's flow. The reduced flow is sensed. The electronic circuitry senses the reduced flow and triggers the alarm horn (Figure 4).

Photoelectric. Photoelectric smoke detectors use the principle of scattered or reflected light to indicate the presence of **visual** smoke. It works much like an automatic eye does that's used to open doors. When there's no smoke, the chamber is dark. The light shines across the chamber and is received in a light trap on the far side. When smoke is present in the chamber, a photocell located at right angles to the

Figure 1. Causes of 1981 fires in residential occupancies.



Percent of Problem 74% 18% 4% 2% 100%

Source: National Fire Incident Reporting System.

light source senses the light scattered off the smoke particles and, at a certain level of illumination, triggers the alarm horn (Figure 5).

Both detectors sense the presence of smoke. The photoelectric detector senses the large, visible smoke particles. The ion chamber detector senses the small, invisible particles.

If a fire starts and slowly smolders in upholstery without visible flame, a good photoelectric unit would be superior to a good ion chamber detector in terms of detection time. But, if the fire has flames, a good ion chamber will detect it faster than a good photoelectric detector. For this reason, it's a good idea to use both types in your detection system.

Combination. Recently, manufacturers have begun to introduce and market smoke detectors that combine ionization and photoelectric sensors in the same unit. These units should combine the superiorities of both sensors into an advanced unit that will detect smoke from a broader spectrum of fires (smoldering or flaming). As the demand for these units increases, the cost should decrease to a competitive level.

A residential fire detection system may also include a heat detector. There are two types of heat detectors: fixed temperature and rate-of-rise.

Fixed temperature detectors. These detectors are preset to sound an alarm when the air temperature

exceeds the *fixed* temperature. The most popular fixed temperature detectors used in homes are preset to sound an alarm when the temperature exceeds 135 degrees F. Other units are available to be preset up to temperatures of approximately 200 to 225 degrees F. These detectors may be used in an attic where summer temperatures normally may reach 135 degrees F.

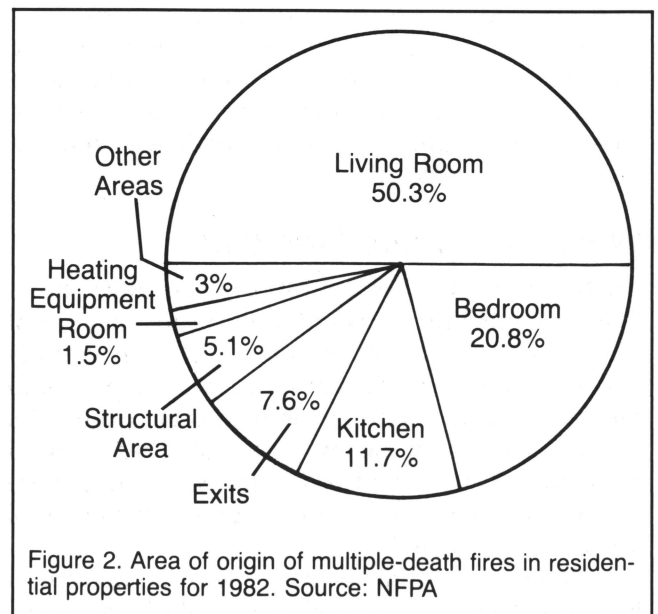
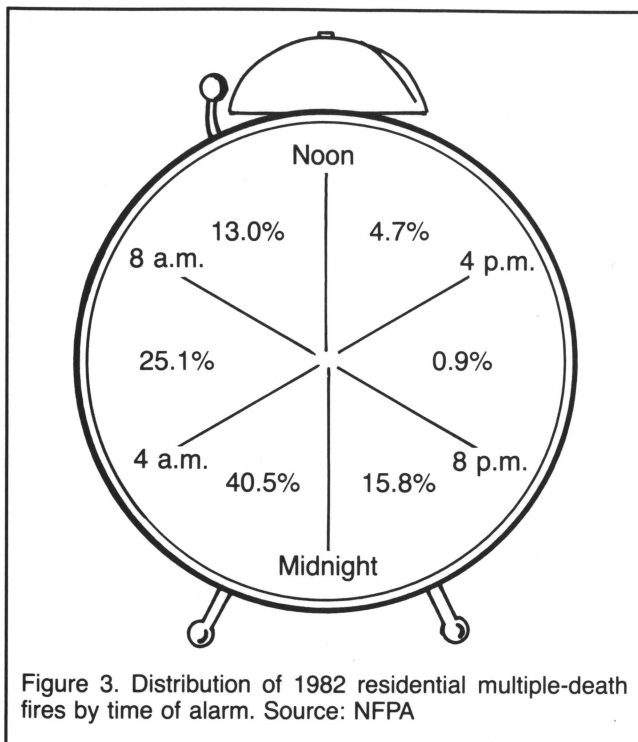


Figure 2. Area of origin of multiple-death fires in residential properties for 1982. Source: NFPA



Rate-of-rise heat detectors. These sound an alarm when the temperature in the immediate vicinity rises higher than the preset rate per time factor (minutes, etc.).

Power sources

NFPA Code No. 74 requires that AC (home current) powered units meet the following conditions:

- Power supply must be sufficient to operate the alarm signal(s) for at least four consecutive minutes at least 85 decibels.
- A visible *Power On* indicator must be provided.
- All electrical systems designed to be installed by someone other than a qualified electrician shall be powered from a source not in excess of 30 volts. these systems should meet the requirements for power-limited fire-protective signaling circuits as defined in Article 760 of the National Electric Code No. 70.
- The power source for the unit must not be subject to loss of power by a wall switch.
- Neither loss nor restoration of the primary power shall cause an alarm signal.
- A restraining means should be used at the plug-in of any cord-connected installation.
- Single-station and multiple-station smoke detectors, powered from 120 VAC sources, should not be installed on circuits protected by a ground fault circuit interrupter.

NFPA Code No. 74 requires that battery-operated units meet the following requirements:

- The alarm must be capable of producing an alarm signal of 85 decibels for four consecutive minutes.
- The batteries must meet all power requirements for

at least one year, including routine testing.

- A distinctive, audible trouble signal must be given at least once per minute for seven consecutive days before the batteries are incapable of operating (from aging, terminal corrosion, etc.)
- The unit must also be capable of producing the alarm signal for four consecutive minutes during the seven days of trouble signal.

Battery-operated smoke detectors have two advantages and one disadvantage in comparison to detectors operated from the dwelling's electrical power. One advantage of battery-powered units is that if the electrical power in the dwelling should be off due to an interruption from the utility company or from a fire within the dwelling, the detector will still function. Some manufacturers are now manufacturing units with a battery backup in case power is lost to the home-current detector.

The other advantage is that you can install a smoke detector in an existing dwelling where an appropriately placed electrical outlet is not available.

The major disadvantage is that the batteries need to be replaced once a year.

Location

The *basic* (minimal) detection system should consist of one smoke detector outside of each sleeping area and one additional smoke detector unit on each additional living level, including the basement and excluding unfinished attics, crawl spaces, etc. If hallways are longer than 40 feet between the sleeping area and living area, use two smoke detectors.

A good system should include both types of smoke detectors—one plug-in smoke detector and one battery-operated smoke detector. You might consider installing a photoelectric unit in the bedrooms of any family members who smoke.

Heat detectors or additional smoke detectors can supplement the basic system. Consider these areas for heat detectors: kitchen, dining room, furnace room, attic, garage, or utility room.

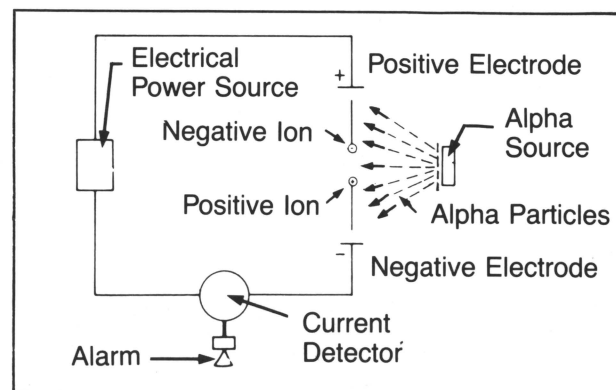


Figure 4. Circuit of an ion chamber detector. Combustion particles reduce electrical flow and trigger the alarm.

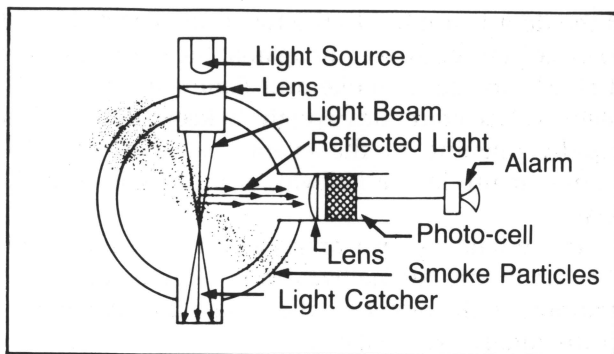


Figure 5. Sensing chamber in a photoelectric smoke detector. Smoke particles deflect the light beam and trigger the alarm.

Mounting

Follow the manufacturer's recommendations for mounting and servicing the detectors. Place the first unit in the center of the hallway ceiling between the bedrooms and the living area, not closer than 12 inches from the wall (Figure 6a).

Determine additional locations according to your lifestyle. If you must wall-mount the detector, it should be mounted no closer than 6 inches and no more than 12 inches from the ceiling (Figure 6b). This is to avoid the dead air space.

If you own a mobile home, you may want to consider wall-mounting your units on an *inside* wall to avoid some of the problems of ceiling drafts.

Smoke detectors should not be located in the following areas:

- **Kitchen** because of false alarms (burned food, etc.)
- **Garage** because of temperature extremes and false alarms.
- **In front of air registers** (also open windows or open doors) because of false alarms caused by high air velocities.
- **Attics, bathrooms, inside air ducts, unheated buildings, unheated motor homes** because temperatures may exceed typical limits of 32 to 100 degrees F.

Buying tips

With the advent of modern electronic circuitry, the single-station smoke detector has become the subject of strong sales rivalry by several companies vying for the household market. The result is that some sales personnel are using high-pressure tactics. Therefore, it is wise for the potential purchaser of a residential fire alarm system to be cautious. Here are some buying tips:

- Don't be frightened into a quick purchase. Some door-to-door sales personnel use films, pictures and tape recordings that play on your emotions. Get at least two or three price estimates from different manufacturers before purchasing.

- Test the units as you install them or if you elect to have someone else install the units, request that the installer test the units in your presence.
- Request an instruction booklet that gives you information on operation, testing and maintenance of the alarms.
- Buy only fire alarms with labels showing they have passed the tests of the Underwriters' Laboratories (UL) or Factory Mutual (FM).
- Understand the guarantee or warranty with the unit you select, and be sure you understand who will repair or replace the unit if it is defective.

An escape plan

Your job is not done, however, after you buy and install smoke detectors. There remains the task of training your family to respond properly when a fire alarm is sounded.

The first thing to do is to develop a family plan for escape. It is a good idea to make a floor plan with two escape routes.

STEP A (basic floor layout):

1. Make an outline of the entire floor area. Dimensions and details need not be exact.
2. Now add each bedroom and label it.
3. Locate windows, doors and stairway. On upper floors, shade in any rooftops that could be used as a fire escape.

STEP B (room inspection):

1. Go to each bedroom. Select the best window for an emergency escape.
2. Test the window to see that it works easily and is large and low enough.

STEP C (complete Escape Plan):

1. Black arrows show normal exits through hall or stairway.
2. Colored arrows show emergency exits in case fire blocks hallway or stairs.

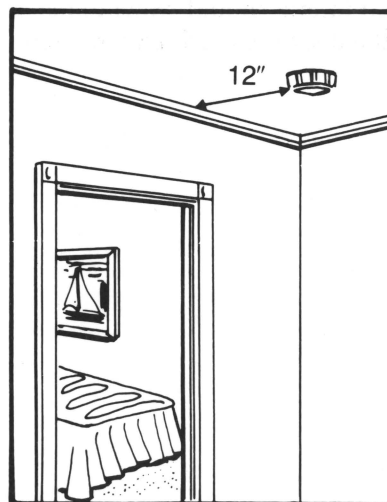
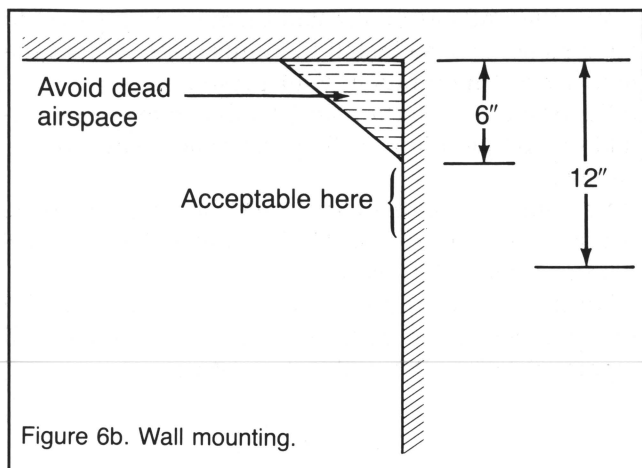


Figure 6a. Ceiling mounting.



Every member of your family should have at least two escape routes from his or her bedroom. One usually will be by the door into the hallway, and the other route usually will be by the window.

For two-story residences, it probably will be necessary to provide a chain ladder (the first choice) or a rope ladder to escape. Again, this requires training because the person using the ladder must make certain he or she is not going to be crawling past a life threatening fire on a lower floor and must know how to use the ladder.

Every member of your family should know exactly what he or she is expected to do in the event of a fire. This can be accomplished by holding family fire drills.

The first thing to learn is that no one should jump up out of bed and stand up when the alarm sounds. Instead, all family members should learn to crawl out of bed onto the floor. In the early stages of a fire, the toxic and super-heated fire gases lie in layers near the ceiling, and it is very important to stay below these gases. There have been many cases in which it appears that victims slept through the build-up of gases, only to die when they stood up and inhaled the deadly gases.

All members of your family should crawl to his or her bedroom door. If the door is closed, feel the door.

If the door is **not** hot to the touch, it is probably safe to place your body weight against the door, and open it slowly to see if smoke and flames have filled the hallway. Use your body weight to keep the door from rapidly opening in the event that there is heavy smoke or fire in the hallway or an explosion of fire gases.

If the hallway appears clear, the first member of the family into the hallway then can crawl from one bedroom to the next to make certain that all members of the family are awake.

Use the hallway and nearest outside door for escape **ONLY** if you are very certain that no flames are visible, and there is little or no smoke along the path you must travel.

Select a meeting place for all family members outside the home near the tree, mailbox, etc. Everyone should go immediately to this meeting place. When everyone is accounted for, someone can be selected to go to a neighbor's home to call the fire department.

When calling the fire department, speak slowly and distinctly so that you are sure the fire department understands whose house is on fire and where it is located. In fact, you should practice giving directions to your home, the same directions you would give to a visitor who had never been there before.

Once everyone is out of the house, no one should return. More than one person has been killed by going back into the fire to save a few dollars worth of keepsakes.

STAY OUTSIDE!

Obviously, learning the fire escape plan is like learning anything else—you get better at doing it if you practice. Periodically, preferably once a month, someone in the family should sound the alarm in the middle of the night and then monitor the actions of other family members to see that they comply with the fire drill plans.

And remember—installation of an early warning fire alarm system combined with a well-rehearsed plan for escape may save the lives of you and your family.

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