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What You should Know about Smoke Detectors

Purdue University Cooperative Extension Service
What You Should Know About

Smoke Detectors

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The U.S. Consumer Product Safety Commission

Each year in the United States, approximately 21 million people are injured and around 25,000 killed in home accidents. The majority of these injuries and deaths are product related. The current estimate of the annual cost of consumer product injuries is approximately 9.5 billion dollars.

Congress recognized the urgent need for Federal regulations to ensure safe consumer products when it passed the Consumer Product Safety Act in 1972. The Act called for the creation of a new, independent Federal regulatory agency. The U.S. Consumer Product Safety Commission was activated on May 14, 1973 and directed by Congress to:

- protect the public against unreasonable risks of injury associated with consumer products;

- assist consumers in evaluating the comparative safety of consumer products;

- develop uniform safety standards for consumer products and to minimize conflicting State and local regulations; and

- promote research and investigation into causes and prevention of product-related deaths, illnesses, and injuries.

The Commission has jurisdiction over more than 10,000 products used in the home, school, and public places. In its efforts to protect the public from serious product-associated injuries, the Commission needs the help of every consumer, young and old.

The U.S. Consumer Product Safety Commission

To report a product hazard or a product-related injury, write to the U.S. Consumer Product Safety Commission, Washington, D.C. 20207. In the continental United States, call the toll-free CPSC hotline 800-638-8326. Maryland only 800-492-8363. Alaska, Hawaii, Puerto Rico, Virgin Islands 800-638-8333. A teletype for the deaf is available, from 8:30 a.m. to 5:00 p.m. EST for people who call the hotline.

Based on the Fire Education Booklets developed by the National Fire Prevention and Control Administration, with technical assistance from the Center for Fire Research, National Bureau of Standards.
We don’t want to scare you, but...

Home fires are a serious threat to your family’s safety. More than 6,000 people die and over 300,000 are injured each year by fire in residences.* Many home fire injuries and deaths are caused by smoke, not flames.

But a closer look gives an important clue to a way that those frightening numbers can be reduced. Many deaths and injuries occur in fires that happen at night, while the victims are asleep. A reliable way to awaken these sleepers before the smoke becomes unbearably dense would help more people escape uninjured.

Now there is a way — the home smoke detector, available at your local store for between $10 and $50. This booklet is designed to answer your questions about smoke detectors and to help you select, install, and maintain a smoke detector so that it will contribute significantly to the safety of your family.

Should We Have a Smoke Detector?

If you’re not certain, maybe you share some of the misconceptions that make many Americans underestimate the danger of death from night-time fires.

For example:

"The smell of smoke would wake me." It might, if acrid-smelling smoke were the only thing produced by a household fire. Unfortunately, many home fires smolder slowly for hours before they burst into open flames. And while this incomplete combustion is taking place, large quantities of toxic gases, including carbon monoxide, are produced. Carbon monoxide is the same odorless, tasteless and colorless gas that causes death when people breathe automobile exhausts in a closed garage or because of a leak in a car’s muffler. If you’re awake, you may feel a headache and dizziness — possibly some nausea. If you’re asleep when the gas enters your room, you probably will never wake up.

"There’s usually plenty of time to get out." Possibly, if you’re awake and if you have time to round up the family and if none of them inhaled too much smoke or carbon monoxide before you woke up. The spread of toxic gases long before flames become visible and noisy may not give you enough time.

"Fires only happen to other people." This is perhaps the most dangerous idea of all. And it’s probably just what all those “other people” thought before their fire occurred.

One more thing: the law is getting into the act, in favor of smoke detectors. Detectors are already required in mobile homes, and many states and municipalities have enacted statutes that require them in new and existing homes and apartments.

"Well, just how effective are they?" They won’t prevent fires, they won’t protect your property (especially if you’re not home), and they won’t put the fire out for you. But they will increase your chances of getting up, getting out, and calling the Fire Department.
How Do They Work?

There are two basic kinds of smoke detectors — ionization and photoelectric. Each senses smoke by a different principle of operation. You'll hear arguments in favor of and against each type, but the best information currently available is that either type can provide adequate home fire protection. In fact, there often appears to be more difference in performance between two models of the same type than there is between the two types.

Ionization Smoke Detectors

The ionization principle depends on the fact that even a very weak source of radiation will increase the ability of air to conduct electricity. In these detectors, a small and carefully shielded bit of radioactive material "ionizes" the air in the detector's smoke chamber. As a result, a very weak electrical current flows through that chamber and is sensed by the detector's circuit.

But when tiny particles of smoke drift into the chamber, they reduce that electrical current flow. When enough particles have entered the chamber, the electrical current drops below the acceptable threshold, and the detector circuit turns on the alarm horn or buzzer.

Smoke particles don't have to be very large to reduce the current flow in the ionization detector's smoke chamber. In fact, they can be invisibly small! Since hot blazing fires tend to produce more smaller smoke particles, and since these float further in the rising hot air from the fire, ionization detectors usually have a slight edge in giving early warning of open, flaming fires.

What about that radiation in ionization smoke detectors?

According to the U. S. Nuclear Regulatory Commission, if you held an ionization smoke detector close to you for eight hours a day through a whole year, you would receive only a tenth as much radiation as you'd get on one round trip airline flight across the USA.
Photoelectric Smoke Detectors

The other most frequently purchased type of home smoke detector uses the photoelectric principle. It detects smoke by “seeing it” in much the same way your eyes do — by means of light reflected by the particles of smoke.

When particles of smoke are carried into the detector by room air circulating through it, they each reflect or “scatter” light from a small lamp in the device. Some of that reflected light falls on a photocell, causing it to produce a slight electrical current. As more particles enter and scatter more light onto the photocell, more electricity is generated. Finally, when the smoke particles are dense enough to reflect a pre-set amount of light, the detector circuit actuates the alarm.

Because they sense the light reflected by smoke particles, photoelectric smoke detectors detect larger particles more readily than they sense the invisible particles to which ionization detectors respond. It happens that cooler, smoldering fires produce more of these large particles than do hot, blazing fires, so photoelectric detectors are somewhat more likely to give the alarm while a fire is still smoldering.

But remember that many household fires produce detectable amounts of both visible and invisible smoke. Either kind of detector has a high probability of giving you enough warning for a safe escape.

Of course, to really cover all the possibilities, you might want to install one of each type of smoke detector.

Do I need a heat detector too?

Some manufacturers offer a heat sensing device as either a standard or optional part of their smoke detectors, or as a separate product. Most of them use a piece of specially-formulated metal which either melts or distorts because of heat in the air around it. Heat detectors built into smoke detectors usually set off the main detector’s alarm when a certain temperature is exceeded, while separate detector devices sound their own alarm or send an electrical signal to a central alarm.

Heat detectors do add protection, but they must be close to a fire to set off the alarm. They are especially useful in environments that could fool or disable a smoke detector, such as a kitchen, where grease particles in the air might cause a smoke sensor to give false alarms. Properly selected heat detectors can also be used in areas that are too hot or too cold for smoke detectors to function properly, such as furnace rooms, attics, and attached garages.

But a heat sensor is no substitute for a smoke detector. Remember, it is more often the smoke that causes injury and death than the heat of a home fire. A heat detector is capable of totally ignoring a smoldering fire that is putting out lethal amounts of smoke, carbon monoxide, and other toxic gases.
House Current or Battery-Powered ...Which Kind Is Better?

That depends — on where you plan to put your detector, how likely you are to test it regularly, and even the likelihood of power failures where you live.

Smoke detectors which operate on batteries tend to take less time and fewer tools to install, though there are exceptions. Usually most of the effort is devoted to physically attaching the detector itself to the ceiling or wall. This may be done with adhesives, screws, or expansion fasteners, depending on the manufacturer. Once the battery-powered unit is mounted, the owner simply slips in the battery, tests the unit, and the job is done. In about a year the detector will begin to emit “beeps” every minute or so, and will keep this up for a week or longer, to tell the owner that the battery has begun to fall below a safe minimum of power and should be replaced.

In these instances, it will be necessary to have an electrical outlet installed (by an electrician) in the proper location, at the cost of some delay and expense. In fact, if such electrical work is necessary to install a plug-in detector, it may be simpler to have the electrician install a detector which he can wire directly to household wiring, without an external plug.

Smoke detectors which operate on household electric current have the power they need to operate as long as there is current in the circuit to which they are connected. However, installation is somewhat more complicated with these units. In the simplest versions, the detector has an ordinary line cord which is plugged into a wall socket just like other appliances. A problem can arise, however, when the best location for the detector (in terms of air flow or nearness to the bedrooms) may not have a convenient outlet.

Plug-in units should not get their power from a distant plug by means of an extension cord. This puts an extra plug connection into the circuit which could become disconnected without being noticed, rendering the detector useless. The line cord of most plug-in detectors, in fact, has a device for securing the plug to the wall outlet in a way that makes it difficult for children or pets to remove.

In the event of a power failure, detectors which operate on household electric current will become inoperable (except for some brands, which contain stand-by batteries). In most regions this is a rare event, but if power outages are frequent where you live, you might think twice about depending only on this type of smoke warning device.

It is also possible that a fire could actually start in the circuit which supplies power to the detector, and power to the unit might fail before it gave the alarm. However, this does not appear to be a significant danger.
What Kind of Smoke Detector Do We Need?

Because most home fires produce a rich mixture of smoke types, with detectable amounts of both large-particle and small-particle smoke early in the fire's growth, either an ionization or a photoelectric detector will meet most needs. Rather than delay purchases while you decide between them, why not buy one and get it installed at once? Whichever type you get, it will provide more protection than no detector.

...and How Many?

This may be a more important question than “what kind?” Tests conducted for the U.S. National Bureau of Standards have shown that two detectors, on different levels of a two-story home are twice as likely to provide an adequate amount of time for escape as one detector. The upstairs detector senses smoke wherever it originates, while the downstairs unit will react sooner to fire which could block escape routes through the first floor.

One detector gives more protection than no detector; two detectors, if properly installed, provide more reliable early warning than one. Having two detectors also lets you select both an ionization type and a photoelectric model, giving you the best capabilities of both. It also lets you have one battery-powered and one plug-in or wire-in model, so that neither a battery failure nor a power outage leaves your family defenseless. Finally, two smoke detectors are far less likely, statistically, to both be “on the blink” when needed than a lone detector.

Shopping for Your Smoke Detector

Once you’ve decided on which type and how many, you’ll discover a wide selection at your hardware, department, building supply, or discount store. In choosing, it’s a good idea to look for a mark or statement on the package or the unit itself that the detector has been tested and certified by a recognized testing organization. If you don’t see such a mark, or if you don’t recognize the name of the testing laboratory, you can’t be sure that this detector model meets minimum performance standards.

Next, look at the instructions, and ask yourself these questions:

1. Are the instructions clear and complete? They should tell you how to install it, suggest where to put it, and provide guidance for testing and maintenance.

2. Can you do the installation yourself — safely? Is there a step-by-step explanation, with enough diagrams to tell you exactly what you’ll need to do? This is a good time to decide if you should do the installation yourself. If you don’t feel confident on a stepladder, for example, you may want to ask a friend, relative, or carpenter to do it for you.

3. What maintenance is required? Do the instructions tell you how to test and clean the unit, and how often? If the unit uses batteries or replaceable lamps, is there a readily visible or audible signal to tell you when replacement is necessary? Ask the clerk if the store carries whatever parts may be needed.

Then, bring home some protection for your family.
Where Do We Put It?

Where you should put one or more detectors depends on the size and layout of your home, and on where the members of your family sleep.

Since the primary job of a smoke detector is to awaken sleeping persons and warn them of urgent danger, the most critical requirement is to put your detector as close as possible to the bedrooms in which your family sleeps. If two sleeping areas are separated by any significant distance, each should have its own detector.

Next consider the probable path along which smoke would flow from the rest of your home. In single floor homes, this usually means placing the detector in the hallway off which the bedrooms open. In a house where the bedrooms are upstairs, the detector should be near the top of the stairs to the bedroom area.

The simplest rule for locating the basic (or the only) smoke detector in your home should be, "Between the bedrooms and the rest of the house, but closer to the bedrooms."

sleep with bedroom doors shut. Closed bedroom doors actually offer some protection against both fire and smoke from outside the room, but they will also make it more difficult to hear a detector alarm outside the bedroom. Furthermore, they can keep smoke produced by a fire in the bedroom from reaching a detector in the hall. A detector in the bedroom will serve to awaken the sleeping occupant before the smoke concentration in the closed room reaches a dangerous level.

Once We've Picked the Proper Location, What's the Right Position for the Detector?

Check the instructions that come with your detector. Most will recommend installing smoke detectors on the ceiling or on the walls between 6 and 12 inches below the ceiling. This not only takes advantage of the fact that most smoke rises, but puts the detector safely above accidental bumps and the inquiring hands of children. There is one place not to put a detector. Don't put it within six inches of where the wall and the ceiling meet, on either surface. This has proven to be a "dead air" space that gets little air circulation.

Some peculiarities of air flow and ceiling temperature need to be considered in certain installations. Excessive "clean" air flow across a detector can keep smoke-filled air from reaching the smoke chamber. This can happen if the detector is mounted in front of an air supply duct outlet, or between the bedroom and the furnace cold air return. In either of these instances, relatively clean air may still be "washing" the detector even when most of the air in the house is unbreathable.

Also avoid putting detectors on a ceiling which is substantially warmer or colder than the rest of the room. In either of these cases, an invisible "thermal barrier" near the surface can prevent smoke from reaching the detector. This can be a problem in mobile homes or in older, poorly insulated houses. In such cases, mounting the unit on an inside wall, between 6 and 12 inches from the ceiling, will provide more reliable operation.
How Do We Take Care of It?

Smoke detectors are tough — they don't need much attention, except for regular testing and the prompt replacement of batteries, bulbs, or other owner-replaceable components. But neglect these few requirements, and your detector won't be able to do its job if the critical moment of a fire ever comes.

Monthly Testing

Once every month, test your detector by holding a candle six inches under it. If you're testing an ionization detector, let the flame burn. To test a photoelectric unit, extinguish the candle and let visible smoke drift into the detector. Heavy tobacco smoke will also work. Within twenty seconds the unit's alarm should begin to sound. As soon as the alarm sounds, fan the smoke away from the detector. Soon the detector will become silent, and you can walk away knowing it's still on guard.

Using real smoke is more dependable than pressing the “test” button found on many older smoke detectors. In some older units, the button only activates the warning horn or buzzer, and does not tell you whether the detector circuit itself is working. Some newer detectors have more refined functional test systems which simulate the presence of smoke in the chamber. These don't need to be tested with real smoke. Check the package or instructions of your detector to see if it has this feature.

Some authorities suggest testing every two weeks. This should not reduce battery life significantly. Testing more often than this may diminish your battery's endurance.

Replace Batteries and/or Lamps At Once

If your battery-powered detector begins to emit its low-power warning, remove the weak battery and replace it immediately with a fresh one. It is important to always have a fresh battery on hand.

Replacement lamps for photoelectric detectors should also be kept on hand so that there is no delay in restoring them to full function. Owner negligence of testing and part replacement has been a cause of smoke detector failure, often with tragic results.

Don't Play “False Alarm”

The detector is not a toy. Remind everyone in your family that it should not be operated, or even touched, except for testing, maintenance, and cleaning. Some authorities suggest using the detector test feature to operate the alarm as part of a family “fire drill” on occasion, but operating the alarm excessively draws heavily on battery power, and may leave you flat when it's needed most.

If It “Acts Up”

Most manufacturers back up their detectors with a service or replacement warranty. If your detector begins to malfunction during the period, send it to them at once.
How Can We Help Our Smoke Detector Protect Us?

There's more to surviving a home fire than waking up before it's too late. Just-awakened people, including children, are often confused, and may panic in the excitement. The safety of all may depend on knowing instinctively what to do.

Plan and Practice for a Safe Escape

Home fire drills may sound silly, and a serious fire is no fun to talk about, but a little time spent selecting escape routes and practicing what to do if the detector goes off may save lives if fire ever comes to your home.

1. Walk through the main escape route several times. Try it in the dark or with eyes closed. Memorize the number of steps between obstacles or turns. If a piece of furniture keeps getting in the way, move it to clear the path.

2. Plan alternate ways of escape from each room. If the main route were blocked by fire or impenetrable smoke, how would each family member get out? If bedroom windows are too high for safe jumping, perhaps you should buy rope or chain escape ladders to keep at a window in each bedroom.

3. If you must go through a smoke-filled area, crawl on hands and knees, with your head low to avoid breathing smoke.

4. Before opening an inside door, touch the knob and the top of the door. If either feels hot, don't open the door. Fire on the other side might flash into your room. Use your secondary escape route.

5. Agree on a place to meet outside the home, so you can count noses and be sure everyone is safe.

6. Don't call the Fire Department from the burning home. Get out safely, then telephone from a neighbor's home or use an alarm box.

7. Go back into the house or apartment only after the firefighters have assured you that the fire is fully extinguished and the structure is sound.

Your smoke detector is one of the most significant improvements in home fire safety ever to occur. But its effectiveness depends on your own efforts to prevent and to escape fires.

Any more questions?