IMPORTANT INFORMATION ON SMOKE ALARMS

(Why Photoelectric Technology is Superior to Ionization Technology)

By

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INTRODUCTION

I believe that all smoke alarms, even ionization, alarms save lives. However, I feel that photoelectric alarms have the potential to save many more lives. . This paper expresses my position on a number of issues related to residential smoke alarms. In particular it will explain the reasons for my belief that all smoke alarms used in residential occupancies should utilize photoelectric technology. This position is based on almost 20 years of research and a review of all of the pertinent literature on the topic.

There are two principle types of smoke alarms, ionization and photoelectric smoke alarms. Ionization smoke alarms predominantly detect the presence of extremely small particles of smoke while the photo-electric smoke alarms predominantly detect visible smoke.

Some organizations indicate that both ionization and photoelectric smoke alarms provide occupants adequate time to escape**. The position of F&LSC however, based on current knowledge about smoke alarm performance is; that photo-electric alarms are generally more effective than ionization alarms across the broader range of fire experienced in homes, and should be promoted as the technology of choice.**

Current, and historical, research (see the end of this article) indicates that:

- Ionization smoke alarms detect flaming fires marginally earlier than photoelectric smoke alarms.
- Photoelectric smoke alarms detect smoldering fires and fires starting in areas remote from smoke alarms significantly earlier than ionization smoke alarms.
- Ionization smoke alarms may not operate in time to alert occupants early enough to escape from smoldering fires.
- For both flaming fires and smoldering fires, photoelectric smoke alarms are likely to alert occupants in time to escape safely.

A smoke alarm provides the greatest benefit to occupants while they are sleeping. Since many residential fires, particularly those that occur while occupants are sleeping, begin as smoldering fires, photoelectric smoke alarms provide more effective all-round detection and alarm than ionization alarms. Homeowner, who currently have ionization smoke alarms may choose to maintain them until the end of their service life. However, homeowners should also install photoelectric smoke alarms in accordance with the locations described below.

Smoke alarms fitted with dual photoelectric/ionization alarms are available. Home owners may choose to install such alarms in lieu of photoelectric alarms. However, research indicates that they are more costly and prone to more false alarms than photoelectric alarms, and the benefits are marginal.

To check to see which kind is currently installed in your home or apartment, take the alarm down from the ceiling. If, on the back of the alarm, the term “Americium 241” or a radioactive symbol appears then it is an ionization alarm. According to a study conducted by the Consumer Product Safety Commission the vast majority currently installed are ionization, since they are cheaper.

WHERE WOULD I GET SMOKE ALARMS?

Many hardware, home supply, or general merchandise stores carry smoke alarms. Some smaller stores only carry ionization due to a shortage of shelf space, as well as lack of demand, due to the lack of knowledge on the part of consumers regarding the relative benefits of the different technologies. Larger stores and electrical supply stores carry many different types of alarms. Some fire departments offer smoke alarms for little or no cost. (Typically because they are a little cheaper these free smoke alarms use ionization technology.)

WHERE SHOULD SMOKE ALARMS BE INSTALLED?

At a minimum, install smoke alarms on every level of your home, including the basement. They should be located on the ceiling, near stairwells, so that any smoke passing by up the stairs will have to pass the alarm. There should be enough alarms on each level so that no room is more than 20 feet from an alarm. If a room is very large and/or has a very high ceiling, it may be prudent to place an alarm in that room.

A smoke alarm's primary function is to awaken sleeping persons and warn them of a dangerous fire. As such, the most important rule for locating a smoke alarm is that the alarm be between the bedrooms and the rest of the house, but closer to the bedrooms. For extra safety, install smoke alarms both inside and outside bedrooms. This is important if occupants sleep with the bedroom doors closed since the smoke from a fire that starts in a bedroom may not reach the smoke alarm in time.

Note: Historically it has been recommended to sleep with bedroom doors closed to keep toxic gases given off by a fire from entering the bedroom. Unfortunately a closed bedroom door may make it much harder to awaken to a smoke alarm that is located on another floor, particularly if a window air conditioner is being used.

Also, smoke alarms should be installed on the ceiling or on the wall 6-12 inches from the ceiling. Never install within six inches of where the wall and the ceiling meet. This is usually dead air space and smoke tends to miss it. Since smoke and many deadly gases rise, installing your smoke alarms at the proper level will provide you with the earliest warning possible. Always follow the manufacturer s installation instructions.

WHERE SHOULD SMOKE ALARMS NOT BE INSTALLED?

Do not place smoke alarms in or adjacent to the kitchen or bathrooms where cooking, steam, etc. might unnecessarily set off the alarm. Do not place smoke alarms near vents, heating ducts, and other sources of air current, which may keep smoke from reaching the alarm. Avoid placing alarms on a ceiling, which is significantly warmer, or colder than the rest of the room because a thermal barrier might exist which prevents smoke from entering the smoke alarm. This is of primary concern with mobile homes, poorly insulated houses, outside ceilings, and outside walls.

WHAT IF THE ALARM GOES OFF WHILE I AM COOKING?

Then it is doing its job. Do not disable your smoke alarm if it alarms due to cooking or other non-fire causes. You may not remember to put the batteries back in the alarm after cooking. Instead, clear the air by waving a towel near the alarm, leaving the batteries in place. The alarm may have to be moved to a new location. In cases of small apartments it may not be possible to relocate the alarm away from the nuisance source and still meet the recommended installation guidelines. Some smoke alarms come equipped with a "silence" button, which can be used to reduce the sensitivity for a period of time. This may not be a good option for the elderly or handicapped, who may not be able to reach the button. Many studies show that photoelectric alarms are less prone to nuisance alarms so switching from ionization to photoelectric should help.

Note: I would like to point out that the use of photoelectric smoke alarms in areas prone to nuisance alarms has even been recommended by the manufacturers of ionization smoke alarms.

HOW DO I KEEP MY SMOKE ALARM WORKING?

Smoke alarms are very easy to take care of. There are two steps to remember:

1. Simply replace the batteries at least once a year. Tip: Pick a holiday or your birthday and replace the batteries each year on that day. Some smoke alarms now on the market come with a 10-year battery. These alarms are designed to be replaced as a whole unit, thus avoiding the need for battery replacement. If your smoke alarm starts making a chirping noise, it means that the battery is low on power. Replace the batteries and retest it.
2. Keep them clean. Dust and debris can interfere with their operation, so vacuum over and around your smoke alarm regularly.
3. Do not ever paint over a smoke alarm.

HOW LONG WILL MY SMOKE ALARM LAST?

Smoke alarm should last about 8 to 10 years, after which time they should be replaced. Like most electrical devices, smoke alarms wear out. You may want to write the purchase date with a marker on the inside of your unit. That way, you will know when to replace it. (Some newer

alarms have the date of manufacture on the alarm.) Always follow the manufacturer's instructions for replacement. Although it is likely that your smoke alarm will still be operational after ten years, it is a reasonable time to consider replacing it.

IN APARTMENTS, WHO IS RESPONSIBLE FOR MAINTAINING THE ALARM?

The responsibility varies from jurisdiction to jurisdiction. Many require the landlord to insure that at the start of a lease the tenant has a working smoke alarm with a new battery. After that it is the tenant's responsibility. In some cases the landlord is required to re-check the alarm and install a new battery yearly. Most require the tenant to notify the landlord of any problems with the alarm. The important thing to remember is that the responsibility is clarified at the beginning of a lease. In cases of excessive nuisance alarms tenants should inform landlords of the options/solutions mentioned earlier. It is unlikely that the landlord is aware of them.

ALARM AUDIBILITY ISSUES

Testing by the Consumer Product Safety Commission has demonstrated that a closed bedroom door could prevent a sleeping occupant from hearing an alarm remote from the bedroom, such as one on another level. If the occupants of the bedroom have a room air conditioner on or are watching television, they may not hear an alarm right outside the room. As a consequence, some experts are re-thinking the traditional advice to always sleep with bedroom doors closed. This advice was given based on studies which showed that a closed bedroom door would delay the time for the occupant to be overcome by products of combustion form a fire that started outside the bedroom. However, if the right kind of alarm is properly installed this should not happen. As a consequence, unless the alarms are interconnected and installed in bedrooms and common areas, occupants should sleep with bedroom doors open, or at least slightly ajar, to insure that they hear the smoke alarms.

COMBINATION CARBON MONOXIDE/SMOKE ALARMS

Unfortunately, at this time (April 2009) many combination Smoke/CO Alarms utilize ionization technology. This may be an attempt to keep the cost as low as possible. Consequently, in order to be adequately protected form fire, which poses a greater risk than CO, if consumers cannot find a Smoke/Co Alarm with photoelectric technology, we recommend that occupants use separate devices.

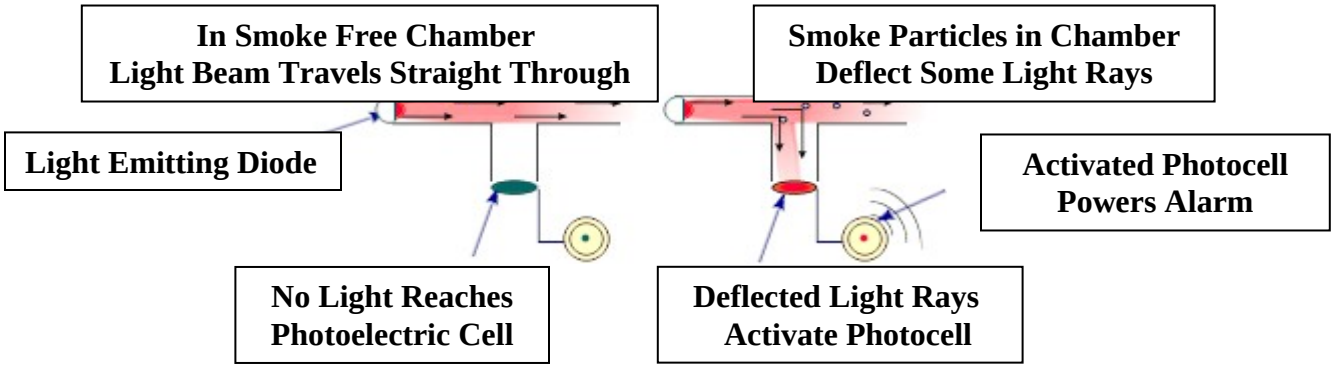
WIRELESS SMOKE ALARMS

Some manufacturers now sell a wireless smoke alarm that allows al of the smoke alarm to communicate to each other without the need to run wires throughout the house. This is a great solution to the "closed bedroom door" problem since if one alarm goes off all of the alarms go off. Once again, it is critical to purchase an alarm that uses photoelectric technology.

SMOKE ALARM TECHNOLOGY

Photoelectric Smoke Alarm Technology

Photoelectric technology smoke alarms use a T-shaped chamber fitted with a light-emitting diode (LED) and a photocell. The LED sends a beam of light across the horizontal bar of the chamber. The photocell sits at the bottom of the vertical portion of the chamber. The photocell will generate a current, when exposed to light.
The diagram below illustrates how the technology works. Under normal, smoke-free conditions, the LED beam moves in a straight line, through the chamber without striking the photocell. When smoke enters the chamber, smoke particles deflect some of the light rays, scattering them in all directions. Some of it reaches the photocell. When enough light rays hit the photocell, they activate it. The activated photocell generates a current. The current powers the alarm, and the smoke alarm has done its job.

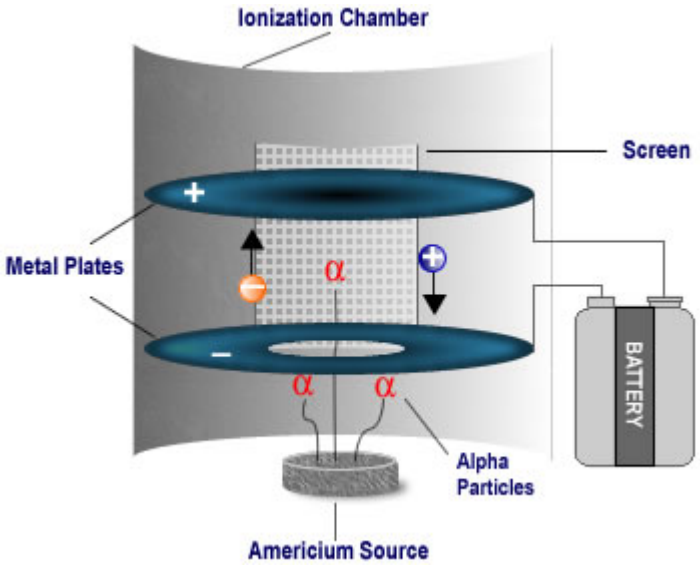


Ionization Smoke Alarm Technology

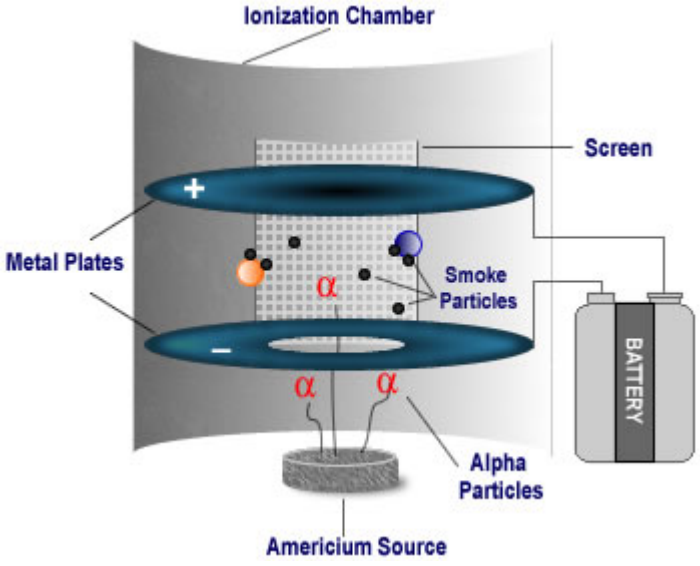
The ionization chamber is basically two metal plates a small distance apart. One of the plates carries a positive charge, the other a negative charge. Between the two plates, air molecules-made up mostly of oxygen and nitrogen atoms-are ionized when electrons are kicked out of the molecules by alpha particles from the radioactive material (alpha particles are big and heavy compared to electrons). The result is oxygen and nitrogen atoms that are positively charged because they are short one electron; the free electrons are negatively charged.

The diagrams below illustrate how ionization technology works. The positive atoms flow toward the negative plate, as the negative electrons flow toward the positive plate. The movement of the electrons registers as a small but steady flow of current. When smoke enters the ionization chamber, the current is disrupted as the smoke particles attach to the charged ions and restore them to a neutral electrical state. This reduces the flow of electricity between the two plates in the ionization chamber. When the electric current drops below a certain threshold, the alarm is triggered.

Alpha particles from the americium source ionize air molecules. In the smoke-free chamber, positive and negative ions create a small current as they migrate to charged plates



Smoke particles and combustion gases interact with the ions generated by the alpha particles, restoring them to their neutral electronic state and decreasing the electrical current passing through the cell.



As fewer ions are available to migrate to the plates, the disrupted current triggers the alarm

Consequences of Different Alarm Technologies

The difference in operational technology between the two alarms is the reason for the ionization alarms higher sensitivity to fast-flaming fires, which produce small particle smoke. It is this same technological difference that causes ionization alarms to be most sensitive to "invisible smoke," i.e. nuisance alarms," while at the same time photoelectric alarms are virtually insensitive to invisible smoke. The operational differences also explain why the photoelectric alarm is far more sensitive to smoldering smoke, which generally contain larger and fewer particles than smoke from flaming fires.

CONCLUSIONS FROM RESEARCH STUDIES

In 1980 a special committee of the International Association of Fire Chiefs reached the following conclusions regarding testing conducted by the Los Angeles Fire Dept.

> *"**Therefore, because of the present state of the art in detecting smoke, the Subcommittee on Smoke Alarms can take no other course but to recommend the installation of photoelectric alarms."***

Researchers in Australia reached similar conclusions in 1986. They investigated smoke alarms ability to detect smoldering fire in a typical residential dwelling. Their conclusions were the following:

> *"Photoelectric alarms sighted in the hallway are more effective for detecting smoldering smoke than ionization alarms, providing adequate escape time for most conditions of size and location of the smoke sources.* ***Ionization alarms sited in the hallway generally provide inadequate escape times …****"*

In 1991 Norwegian researcher placed smoke alarms inside and outside the room of origin. They reached the following conclusions.

> *The ionization alarms detected smoke from a smoldering fire much later than optical (photoelectric) alarms. When the particular conditions during the fire development are taken into consideration there are reasons to indicate* ***that this detection principle (i.e. ionization) would not provide adequate safety during this type of fire.***

In testimony provided to the Boston City Council (1997), the National Institute of Standards and Technology stated the following.

> ***However, ionization detectors have been shown to sometimes fail to alarm in a smoldering fire even when visibility in the room is significantly degraded by smoke.*** *Most photoelectric detectors alarm substantially sooner in these situations. In the NIST experiments the photoelectric detectors sensed smoldering fires on average 30 minutes earlier than the ionization detectors.*

More important information, on this topic, can be obtained at the following web-sites.

These 2 addresses link to the Boston City Council TV Library. They involve 2 hearings on Smoke Alarms.

http://www.cityofboston.gov/citycouncil/cc_video_library.asp?id=385

Title: ***Discussion of Smoke Alarm Technology***

Committee: Public Safety

Description: Discussion of smoke alarm technology and the differences between photoelectric and ionization smoke alarms

http://www.cityofboston.gov/citycouncil/cc_video_library.asp?id=401

Title: ***Smoke Alarm Technology, Part I of II***

Committee: Public Safety

Description: Discussion of smoke alarm technology, comparing photoelectric and ionization smoke alarms (follow-up from 7/9/07 hearing), Part I of II

http://www.fc-tv.com/webcast/sunmountain/iaff-10-07/portal.asp
(Once on this link, go to Monday afternoon speakers and link on. "***The Truth about Smoke Alarms***"

- This is a presentation by Joseph Fleming to the International Association of Firefighters (IAFF) Redmond Symposium, October 22, 2007 Chicago, IL

http://www.interfire.org/features/smokealarm.asp

- This web address will bring one to a paper that I wrote titled "*Smoke Alarm Technology and the Investigation of Fatal Fires*". It was intended to help fire investigators. It has an in-depth technical explanation of the problem.

http://wbztv.com/local/Safe.smoke.alarms.2.588321.html

- This links will go to a series of news stories on this issue. It includes video of an actual fire tests involving both smoke alarm types. It culminates in a story describing how Massachusetts changed the Building and Fire Codes to restrict the use of ionization smoke alarms.

http://www.scribd.com/doc/4445715/ALARMING-Most-Smoke-Detectors-Dont-Detect-Deadly-Smoke

- This links will go to a series of news stories on this issue. It covers actual fires were an ionization alarm operated too late.