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## Photoelectric vs Ionization Smoke Alarms

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### Ionization versus Photoelectric Smoke Alarms: *In Real-World Fires The Differences Are Deadly*

By Skip Walker, ACI, MCI

Imagine your car air bags deploying randomly when you hit a pothole, but failing over half the time in a collision. As unthinkable as this seems, that is the harsh reality with the smoke alarms found in most US and Canadian homes. Like most, I always assumed that a smoke alarm was a smoke alarm. What I now know is that there are two basic types of smoke alarms; Ionization and Photoelectric. In real-world fatal fires, these alarms behave very differently. In this case – different is not good. Knowing the difference could very well save your life.

***"A smoke detector that sounds approximately nineteen minutes after smoke reached its sensing chamber is like an airbag that does not deploy until nineteen minutes after a car accident."***

*-Judge David E. Schoenthaler, Mercer v. Pitway/BRK Brands (First Alert)*

Over 90% of US homes have ionization smoke alarms installed, around 5% of have photoelectric alarms installed and the rest have no alarm of any kind. In the mid-70's about 10% of US homes had at least one smoke alarm installed. Now about 96% of US homes have at least one smoke alarm. Yet after installing smoke alarms in over 100 million US homes, the risk of dying in a fire has remained roughly the same. Maybe it's just me, but that doesn't make sense.

Between 1977-2009, the number of home fire deaths decreased about 56%. During the same period, the number of home fires declined similarly for a decrease of about 50%. However, the fire death rate per thousand fluctuated considerably up and down between 6.5 and 10 deaths per 1,000 fires. The overall fire death risk remained essentially the same over the period – 7 to 8 deaths per 1000 fires. What impact did installing hundreds of millions of ionization alarms actually have?

***When the death rate per 1,000 home fire incidents is looked at, there is no steady decline, but rather the rate fluctuates considerably.... These results suggest that even though the number of home fires and home fire deaths declined similarly during the period, the death rate did not, and when there is a home fire, the fire death rate risk has not changed much for the period.***

Source: NFPA Fire Loss 2009 / Pg 7-8

The smoke alarm industry is quick to point out that all smoke alarms must meet the UL 217 and UL 268 standards developed by Underwriters Lab (UL) to be installed in US

homes. Canadian alarms have somewhat different UL-Canada (ULC) standard. The major alarm manufacturers, UL, National Fire Protection Association (NFPA), Consumer Product Safety Commission (CPSC) and National Institute for Standards and Testing (NIST) have long maintained that any UL listed alarm afford adequate protection in most fires. More recently, they have begun to recommend that we have both types of alarms. This position infers that all fires carry equal risk of death. However, the fire statistics and studies published by these same organizations do not support that position. In fact, decades of research and data shows just the opposite.

Current UL alarm standards are essentially the same as those developed in the 1970's. The UL 217 standard defines the requirements for alarm response. The UL tests use two test scenarios. One is a "fast flame" fire, the other is for smoldering fires. A "fast flame" fire is a fire that is based on accelerants, such as gasoline, cooking oils, grease, and paper fire. A smoldering fire is the early stages before open flames develop and is characterized as slow moving with significant smoke. The smoldering fire tests standards were developed when most home furnishings were natural materials, cotton, wool, etc. Today, virtually all furnishings and a large percentage of the building materials are synthetic and engineered materials. The behavior of natural and synthetic materials in a fire is radically different. Yet the UL standards have not been adjusted to account for this shift.

In tests, ionization alarms will typically respond about 30 to 90 seconds faster to "fast-flame" fires than photoelectric smoke alarms. However, in smoldering fires ionization alarms respond an average of 15 to 50 minutes slower than photoelectric alarms. Several studies indicate that they will outright fail to activate up to 20-25% of the time. The vast majority of residential fire fatalities are due to smoke inhalation, not from the actual flames and almost two-thirds of fire fatalities occur at night while we sleep.

In 1995, researchers at Texas A&M University published the results of a 2 1/2 year study on residential fire detection devices. The research showed that ionization alarms failed to provide adequate egress time in smoldering fire scenarios over 55% of the time versus a 4% failure rate with photoelectric alarms. In fast-flame fire scenarios, the study found that ionization alarms failed to provide adequate egress time about 20% of the time versus 4% with photoelectric alarms. The research demonstrates that when all factors are taken into account, i.e.; how often each alarm gets disabled due to nuisance tripping, how they respond across the full spectrum of fires, etc., photoelectric alarms have a clear advantage.

In 2007, UL published the "Smoke Characterization Study". This study tested both types of smoke alarms using current UL testing standards and materials; they also tested the alarms using UL test criteria integrating a variety of synthetic materials and current tests such as smoldering toast. The results are frightening. Ionization alarms failed the UL 217 test 20% of the time using the current standard test materials. This is the test that the alarms must pass 100% of the time to be offered for sale and installed in US homes. When tested using synthetic materials, ionization alarms DID NOT TRIGGER (DNT) in 7 out of 8 synthetic test scenarios. In the one test where the ionization alarm did trigger, it activated at a level exceeding maximum allowed under the UL standard and nearly 43 minutes after the photoelectric alarm in the same test.

In the same tests, photoelectric alarms activated 100% of the time using the UL 217 test and materials. When tested using the standard test integrated synthetic materials, photoelectric alarms responded properly in 100% of the tests. Overall, the ionization alarm outperformed the photoelectric in only one scenario, the "burnt toast" test, where it responded 22% faster. There were 3 test scenarios where neither alarm activated. The UL researchers determined that the sample size used was too small to generate sufficient smoke. Those materials were re-tested using larger samples. The results of those tests are shown in the above test scenarios.

Ionization alarms are also notorious for nuisance tripping, i.e.; going off when you cook, burn toast, shower, etc. When alarms nuisance trip, people become frustrated and intentionally disable the alarms. This leaves the family completely unprotected. According to several studies, ionization alarms are 8 times more likely to be intentionally disabled. Ionization alarms account for the vast majority of disabled

alarms. Several CPSC and NFPA studies indicate that ionization alarms account for 97% of all nuisance alarm activations. An Alaskan Public Housing Study shows that about 20% of ionization alarms will be disabled within the first year of installation; other studies indicate that this percentage may be higher.

Remember, about 96% of US homes have at least one smoke alarm. Yet 2/3's of all residential fire deaths occur in homes that are have either no alarm or no functional alarm. That implies that most people die in fires because they either do not maintain their alarms or they intentionally disable them. To complete the picture, many of the remaining 1/3 of residential fire deaths occur in homes where an alarm sounds, but it sounds too late for the occupants to escape.

***"Nationally, the percentage of people dying when the smoke detector works, but works too late, is approximately 40 percent,"***

*-Jay Fleming, Boston Deputy Fire Chief, CBS Boston Interview, 2007*

After decades, there is finally a growing awareness of this issue. On October 3, 2012, the [NBC Today Show and NBC Nightly News](#) aired a "Rossen Report" investigative segment on this issue. On [July 7, 2012](#) with a follow-up report on [August 1, 2012](#), Huntsville, AL TV station WHNT aired "A Taking Action" investigative report featuring ASHI Vice President Bill Loden. On November 16, 2012, [CBS 5 San Francisco](#) aired a [ConsumerWatch segment featuring retired Albany Fire Chief Marc McGinn and myself.](#)

The International Association of Firefighters (IAFF) is the largest firefighters union in the US and Canada with nearly 300,000 members. In 2008, the IAFF adopted an official position recommending that only photoelectric smoke alarms be installed. The IAFF position also commits the organization to working for changes in the law and model codes to require photoelectric technology alarms. Further, the IAFF position specifically states that combination type alarms are not acceptable. In July, 2010, the City of Albany, California became the first city in California to require photoelectric smoke alarms in new construction and remodels. Followed in late 2010 by Palo Alto, CA and Orange, CA that enacted ordinances requiring photoelectric technology alarms. In January 2011, the City of Sebastopol, CA enacted an ordinance requiring photoelectric technology. A number of cities in Ohio have enacted similar ordinances. The North Eastern Ohio Fire Chiefs organization has a very strong photoelectric only position.

In 2011, the California Real Estate Inspection Association (CREIA) became the first home inspection organization in the world to take a stand when CREIA adopted a position mirroring the IAFF position. At this time, Vermont, Massachusetts, Maine and Iowa have laws on the books that require photoelectric technology smoke alarms in residential construction. Similar action is under consideration in several states and in New York City. The Northern Territory in Australia recently adopted a photoelectric technology law.

### **Which type of technology do I have?**

It is not always possible to know. In general, if the label says anything about radioactive material, Americium-241 or the model number has an "I," - then it is almost certainly an ionization alarm. If you have any doubt, there is over a 90% chance that the alarm that you have is an ionization unit. To be safe, simply replace any unknown units with photoelectric-only alarms. Any smoke alarm that is 10 years or older should be replaced as well, regardless of type.

### **What about Combination Alarms?**

There are combination photoelectric/ionization smoke alarms available. In fact, many fire officials mistakenly recommend them. There is no industry or UL standard for dual/multi sensor alarms. As long as they respond to the UL 217 and 268 tests, the manufacturers are free to alter the way the sensors respond and interact with each other. These units have the same issues as ionization only detectors. In some cases - they may be worse. A CPSC study shows that they may be even more prone to nuisance tripping than ionization alarms when in close proximity to cooking sources.

In the simplest terms, if you take a device that works and pair it with a device that has serious shortcomings - how can that possibly improve performance? Both the

International Association of Fire Fighters (IAFF) and CREIA specifically recommend against installing combination alarms. NIST is on record stating, *"Since an individual sensor can be set to meet all current sensitivity standards, it is not obvious what overall benefit is achieved from a dual alarm..."*

Combination alarms use technology termed "Gated Logic". In one type, either sensor tripping will sound the alarm. In these units, the photo portion will pick up the smoldering fires so the ionization sensor does not become a factor. However, the ion portion is still susceptible to nuisance tripping. The manufacturers do not want the customer to disable the alarm. So to combat nuisance tripping, they often reduce (desensitize) the smoke sensitivity/response of ionization portion of these units. In effect, this type of combination alarm performs similarly to a photoelectric only alarm.

With the other type of unit, BOTH sensors must trigger to sound the alarm. In these units, the photoelectric portion will pick up the smoldering fires first, but will not sound until the ionization sensor triggers. Since a smoldering fire usually pose the greatest danger, this is a problem. The family is often fast asleep while the alarm waits for the ionization sensor that may never respond or responds too slow. This type alarm needs both sensors to detect the danger or it won't alert. Conversely, while this unit will be less susceptible to nuisance tripping because the photoelectric sensor must also respond to nuisance sources such as burnt toast; you risk losing your life if the ionization doesn't respond in a dangerous smoldering fire situation.

No single alarm can save everyone in every possible circumstance. There are many promising technologies being developed. With everything we know, all the facts tell us that photoelectric alarms provide superior protection in real-world fatal fires. They are affordable and available today. Do not allow your family, friends, neighbors and clients to become yet another statistic. This year, don't just replace your smoke alarm batteries – replace your alarms with photoelectric alarms and recommend that everyone you know do the same!

*About the author:*

*Skip Walker lives in the SF Bay Area and has performed over 3,500 property inspections since 2003. Skip is an ASHI Certified Inspector (ACI), a Master CREIA Inspector (MCI), an ICC Certified Residential Combination Building Inspector and an F.I.R.E. Certified Inspector. Skip is the past education chair for the Silicon Valley ASHI/CREIA Chapter, CREIA 2010-2011 State Secretary and the CREIA Region Three Director 2009-Current. Skip has spoken on smoke alarm safety issues at various ASHI and CREIA meetings. He has represented the home inspection profession at the California Association of Realtors (CAR) 2009-2012 and the National Association of Realtors (NAR), 2011. Skip's home has ONLY photoelectric alarms installed. You may reach Skip at (650) 873-4224 or by email at: HomeInspection@sanbrunocable.com.*

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