

Smoke Detectors

Smoke detectors have saved thousands of lives since they came into use in the 1960s. “Ionization chamber smoke detectors,” the most common type, use radiation to detect smoke. The NRC allows this “beneficial use” of radioactive material because a smoke detector’s ability to save lives far outweighs any health risk from the radiation. These products use very small amounts of radioactive materials. They are so safe homeowners can use them without an NRC license. Manufacturers and distributors must obtain an NRC license by showing their products meet the NRC’s health and safety requirements and are properly labeled.



Ionization chamber smoke detector

From accidental discovery to commercial use

In the late 1930s, a Swiss physicist was working on a sensor for detecting poison gas. Walter Jaeger’s device failed to register small amounts of gas. Frustrated, he lit a cigarette—and the smoke moved the meter on his gadget. Jaeger’s experiment helped pave the way for today’s smoke detector.

The Atomic Energy Commission granted the first license to distribute smoke detectors using radioactive material in 1963. These early models were used mainly in factories, public buildings and warehouses. In 1969, the AEC allowed homeowners to use smoke detectors without the need for a license. Their use in homes expanded in the early 1970s. The NRC took over from the AEC in 1975.

Smoke detectors are very safe

Most units sold today use 1 microcurie or less of Am-241. A 2001 [study](#) found people living in a home with two of these units receive less than 0.002 millirems of radiation dose each year. That is the dose from space and the earth, known as “background radiation,” that an East Coast resident receives in about 12 hours or a Denver resident receives in about three hours.

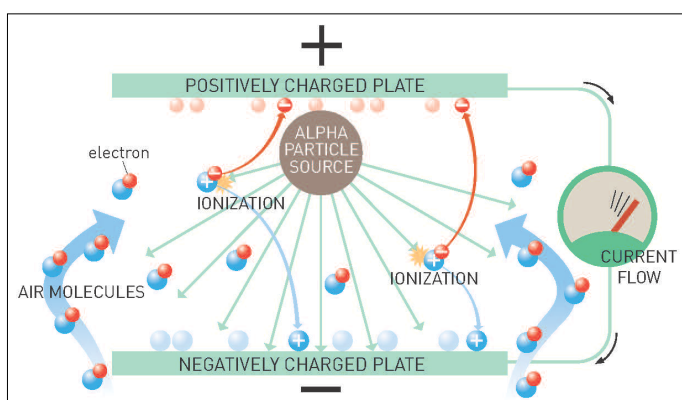
The study also looked at doses from misuse. It found that a teacher who removed an americium source from a smoke detector could receive a dose of 0.009 millirems per year from storing it in the classroom, 0.001 mrem from handling it for 10 hours each year for classroom demonstrations, and 600 mrem from swallowing the source as it passes through the body.

A 1979 [analysis](#) looked at the annual dose from normal use and disposal of Am-241 smoke detectors. The study used actual data and conservative assumptions that would overstate the risk. It allowed the NRC to conclude that 10 million unwanted smoke detectors each year can be safely put in the trash.

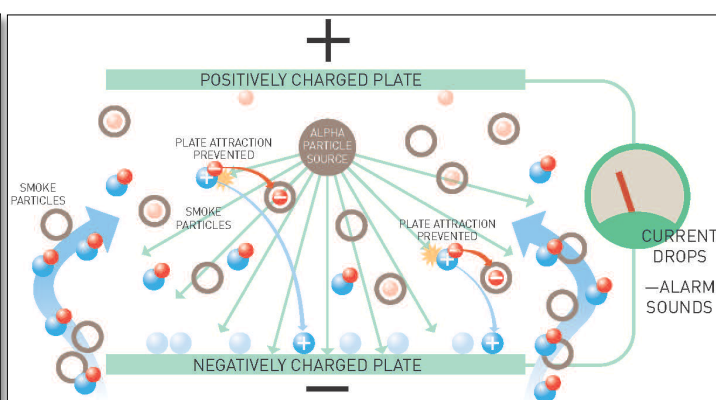
How they work

Ionization chamber smoke detectors rely on radiation to “ionize” the air inside the chamber.

- A radioactive source “decays,” or sheds particles and photons from unstable atoms.
- The particles interact with neutral air molecules flowing through the chamber.
- The particles remove electrons from air molecules, creating positive ions.
- The free electrons attach to other neutral molecules, becoming negative ions.
- Two electrodes, or charged plates, attract the positive and negative ions, creating a small but steady current.
- Any smoke entering the chamber would interrupt the current and trigger the alarm.



Schematic of smoke detector when no smoke is present



Schematic of smoke triggering the alarm

Most smoke detectors use americium-241 as their source. Some early models used radium-226, and commercial smoke detectors and some residential units used nickel-63. These types of radiation cannot make anything else radioactive.

- Ni-63 emits beta particles, which can travel a few feet but cannot penetrate a smoke detector’s plastic housing.
- Am-241 and Ra-226 primarily emit alpha particles. These particles only travel a few inches, are easily stopped and only present a health hazard if taken into the body.
- Am-241 and Ra-226 also emit gamma radiation in an amount so low it cannot be distinguished from natural radiation from space and the earth.

The radioactive sources are in a form that does not break down or corrode over time. The source is sandwiched between two layers of metal and rolled thin. This “foil” is sealed inside the ionization chamber. The seal can only be broken by the deliberate use of force, such as taking a hammer to the smoke detector. The NRC discourages this kind of intentional destruction. In a fire, the sources would release less than 0.1 percent of their radioactivity.