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## Radon

### What is radon?

Radon is a radioactive gas. It is colorless, odorless, tasteless, and chemically inert. Unless you test for it, there is no way of telling how much is present.

Radon is formed by the natural radioactive decay of uranium in rock, soil, and water. Naturally existing, low levels of uranium occur widely in Earth's crust. It can be found in all 50 states. Once produced, radon moves through the ground to the air above. Some remains below the surface and dissolves in water that collects and flows under the ground's surface.

Radon has a half-life of about four days—half of a given quantity of it breaks down every four days. When radon undergoes radioactive decay, it emits ionizing radiation in the form of alpha particles. It also produces short-lived decay products, often called progeny or daughters, some of which are also radioactive.

Unlike radon, the progeny are not gases and can easily attach to dust and other particles. Those particles can be transported by air and can also be breathed.

The decay of progeny continues until stable, non-radioactive progeny are formed. At each step in the decay process, radiation is released.

Sometimes, the term radon is used in a broad sense, referring to radon and its radioactive progeny all at once. When testing measures radiation from the progeny, rather than radon itself, the measurements are usually expressed in working level (WL) units. When radiation from radon is measured directly, the amount is usually expressed in picocuries per liter of air (pCi/L).

### What health effects are associated with radon exposure?

The Surgeon General has warned that radon is the second leading cause of lung cancer in the United States. There are currently no conclusive data on whether children are at greater risk than adults from radon. No specific subtype of lung cancer is associated with radon exposure.

Only smoking causes more cases of lung cancer. If you smoke and you are exposed to elevated radon levels, your risk of lung cancer is especially high. The U.S. Environmental Protection Agency (EPA) provides radon risk comparison charts for people who smoke and those who have never smoked. Stop smoking and lower your radon level to reduce your lung cancer risk.

Radon gas decays into radioactive particles that can get trapped in your lungs when you breathe. As they break down further, these particles release small bursts of energy. This can damage lung tissue and lead to lung cancer over the course of your lifetime. Not everyone exposed to elevated levels of radon will develop lung cancer, and the amount of time between exposure and the onset of the disease may be many years.

Breathing radon does not cause any short-term health effects such as shortness of breath, coughing, headaches, or fever.

Research suggests that swallowing water with high radon levels may pose risks, too, although risks from drinking water containing radon are much lower than those from breathing air containing radon. A NAS report on radon in drinking water, "Risk Assessment of Radon in Drinking Water," was released in 1999. It concluded drinking radon in water causes about 19 stomach cancer deaths per year.

### **What is the "acceptable" level of radon in air?**

The EPA states that any radon exposure carries some risk; no level of radon exposure is always safe. However, EPA recommends homes be fixed if an occupant's long-term exposure will average 4 picocuries per liter (pCi/L) or higher.

### **What is a "picocurie" (pCi)?**

A pCi is a measure of the rate of radioactive decay of radon. One pCi is one trillionth of a Curie, 0.037 disintegrations per second, or 2.22 disintegrations per minute. Therefore, at 4 pCi/L (picocuries per liter, EPA's recommended action level), there will be approximately 12,672 radioactive disintegrations in one liter of air during a 24-hour period.

### **What is a "working level" (WL)?**

Some devices measure radiation from radon decay products, rather than radiation coming directly from radon. Measurements from these devices are often expressed as WL. As noted above, conversions from WL to pCi/L are usually approximate. A level of 0.02 WL is usually equal to about 4 pCi/L in a typical home.

If a working level (WL) value is converted to a radon level (pCi/L), the conversion is usually approximate and is based on a 50 percent equilibrium ratio. If the actual equilibrium ratio is determined (which is rare), it should be stated. The 50 percent ratio is typical of the home environment, but any indoor environment may have a different and varying relationship between radon and its decay products.

Technically speaking, 1 WL represents any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of  $1.3 \times 10^5$  MeV of potential alpha energy.

### **How often is indoor radon a problem?**

Nearly one out of every 15 homes has a radon level EPA considers to be elevated—4 pCi/L or greater. The U.S. average radon-in-air level in single family homes is 1.3 pCi/L.

Because most people spend as much as 90 percent of their time indoors, indoor exposure to radon is an important concern.

### **How does radon get into a building?**

Most indoor radon comes into the building from the soil or rock beneath it. Radon and other gases rise through the soil and get trapped under the building. The trapped gases build up pressure. Air pressure inside homes is usually lower than the pressure in the soil. Therefore, the higher pressure under the building forces gases through floors and walls and into the building. Most of the gas moves through cracks and other openings. Once inside, the radon can become trapped and concentrated.

Openings which commonly allow easy flow of the gases in include the following:

- Cracks in floors and walls
- Gaps in suspended floors
- Openings around sump pumps and drains
- Cavities in walls
- Joints in construction materials
- Gaps around utility penetrations (pipes and wires)
- Crawl spaces that open directly into the building

Radon may also be dissolved in water, particularly well water. After coming from a faucet, about one ten thousandth of the radon in water is typically released into the air. The more radon there is in the water, the more it can contribute to the indoor radon level.

Trace amounts of uranium are sometimes incorporated into materials used in construction. These include, but are not limited to concrete, brick, granite, and drywall. Though these materials have the potential to produce radon, they are rarely the main cause of an elevated radon level in a building.

Outdoor air that is drawn into a building can also contribute to the indoor radon level. The average outdoor air level is about 0.4 pCi/L, but it can be higher in some areas.

While radon problems may be more common in some geographic areas, any home may have an elevated radon level. New and old homes, well-sealed and drafty homes, and homes with or without basements can have a problem. Homes below the third floor of a multi-family building are particularly at risk.

### **Can the radon level in a building's air be predicted?**

No, it is not possible to make a reliable prediction.

The only way to determine the level is to test. EPA and the Surgeon General recommend testing all homes below the third floor for radon.

A map of radon zones has been created to help national, state, and local organizations to target their resources and to implement radon-resistant building codes. However, the map is not intended to be used for determining if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones.

In addition, indoor radon levels vary from building to building. Do not rely on radon test results taken in other buildings in the neighborhood—even ones next door—to estimate the radon level in your building.