Radon in Water, Air, and Soil

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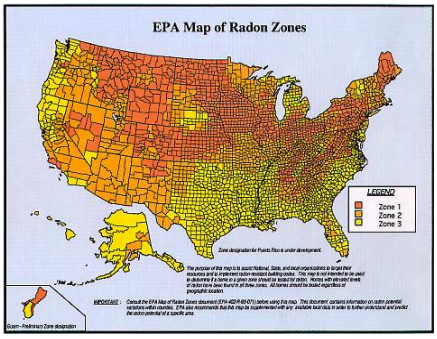

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Radon causes an estimated 14,000 lung cancer deaths each year. It is the earth's only naturally produced radioactive gas and comes from the breakdown of uranium in soil, rock, and water. You cannot see or smell radon, but it can become a health hazard when it accumulates indoors. It can enter your home through cracks and openings in the foundation floor and walls. When radon decays and is inhaled into the lungs, it releases energy that can damage the DNA in sensitive lung tissue and cause cancer.

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Radon is a gas produced by the radioactive decay of the element radium. Radioactive decay is a natural, spontaneous process in which an atom of one element decays or breaks down to form another element by losing atomic particles (protons, neutrons, or electrons). When solid radium decays to form radon gas, it loses two protons and two neutrons. These two protons and two neutrons are called an alpha particle, which is a type of radiation. The elements that produce radiation are called radioactive. Radon itself is radioactive because it also decays, losing an alpha particle and forming the element polonium.

Elements that are naturally radioactive include uranium, thorium, carbon, and potassium, as well as radon and radium. Uranium is the first element in a long series of decay that produces radium and radon. Uranium is referred to as the parent element, and radium and radon are called daughters. Radium and radon also form daughter elements as they decay.

The decay of each radioactive element occurs at a very specific rate. How fast an element decays is measured in terms of the element "half-life", or the amount of time for one half of a given amount of the element to decay. Uranium has a half-life of 4.4 billion years, so a 4.4-billion-year-old rock has only half of the uranium with which it started. The half-life of radon is only 3.8 days. If a jar was filled with radon, in 3.8 days only half of the radon would be left. But the newly made daughter products of radon would also be in the jar, including polonium, bismuth, and lead . Polunium is also radioactive - it is this element, which is produced by radon in the air and in people's lungs, that can hurt lung tissue and cause lung cancer.

Radioactivity is commonly measured in picocuries (pCi). This unit of measure is named for the French physicist Marie Curie, who was a pioneer in the research on radioactive elements and their decay. One pCi is equal to the decay of about two radioactive atoms per minute.

Radon is measured in picocuries per liter and written as (pCi/L). One picocurie is one-trillionth of 37 billion disintegrations per second. One curie, named for Marie Curie, the discoverer of metallic radium, is the amount of radiation given off by one gram of radium.

Radon decay products (RDPs) such as polonium(218), lead(214), bismuth(214), and polonium(214), lead(210), bismuth(210), polonium(210) are measured in working levels (WL). A working level is the amount of RDP which normally results when the decay products are in equilibrium (maximum concentration) with 100 picocuries of radon in the air.

RDPs are difficult to measure in a house though, because among other problems, RDPs have a static charge and tend to plate out (stick) to walls, furniture, clothing, dust, smoke, and other objects and substances.

One of the problems with understanding the amount of risk due to a specific radon level measurement is that the risk statistics are based on an average lifetime (70 years) spent in an exposed area, even though the average American moves every 7 years, and is thus exposed to many different radon levels.

The American Society of Heating, Refrigeration, and Air Conditioning Engineers has set the lowest level, which suggests a radon action level of 2 picocuries per liter or less for commercial buildings and residences. The EPA has adopted a 4 picocuries per liter of air action level. The U.S. Mine Safety and Health Administration, on the other hand, suggests an action level of 16 picocuries per liter (while miners are in underground mines).

Because the level of radioactivity is directly related to the number and type of radioactive atoms present, radon and all other radioactive atoms are measured in picocuries. For instance, a house having 4 picocuries of radon per liter of air (4 pCi/L) has about 8 or 9 atoms of radon decaying every minute in every liter of air inside the house. A 1,000-square-foot house with 4 pCi/L of radon has nearly 2 million radon atoms decaying in it every minute.

Radon levels in outdoor air, indoor air, soil air, and ground water can be very different. Outdoor air ranges from less than 0.1 pCi/L to about 30 pCi/L, but it probably averages about 0.2 pCi/L. Radon in indoor air ranges from less that 1 pCi/l to about 3,000 pCi/L, but it probably averages between 1 and 2 pCi/L. Radon in soil air (the air that occupies the pores in soil) ranges from 20 or 30 pCi/L to more than 100,000 pCi/L; most soils in the United States contain between 200 and 2,000 pCi of radon per liter of soil air. The amount of radon dissolved in ground water ranges from about 100 to nearly 3 million pCi/L.

Why do radon levels vary so much between indoor air, outdoor air, soil air, and ground water? Why do some houses have high levels of indoor radon while nearby houses do not? The reasons lie primarily in the geology of radon - the factors that govern the occurrence of uranium, the formation of radon, and the movement of radon, soil gas, and ground water.

Radon is a naturally-occurring radioactive gas that may cause cancer, and may be found in drinking water and indoor air. Some people who are exposed to radon in drinking water may have increased risk of getting cancer over the course of their lifetime, especially lung cancer. Radon in soil under homes is the biggest source of radon in indoor air, and presents a greater risk of lung cancer than radon in drinking water. The map shown above represents the potential for a radon problem based on geologic boundaries, so that rock and soil units with similar radon generation and transport characteristics.

Radon will dissolve into groundwater and can be transported some way from the source. When the water is exposed to air the radon is released. If a well or bore hole is supplied from such water, the use in an enclosure such as a dwelling or greenhouse will release radon into that environment. Showers and sprays are a prime release method and the greater the water usage, the greater the potential radon problem.

The United States Environmental Protection Agency is reportedly prepared to set an maximum contaminant Level of 300 to 4,000 pico curies per liter for radon in drinking water. At high levels (i.e. among mine workers) radon is a known human carcinogen. There is, however, epidemiological evidence that low levels present no increase cancer risk (Journal of the National Cancer Institute, Dec. 1994). Additional research is needed before the true level of risk associated with low level radon is known.

RADON RISK IF YOU SMOKE

Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime...	The risk of cancer from radon exposure compares to...	WHAT TO DO: Stop smoking and...
20 pCi/L	About 135 people could get lung cancer	100 times the risk of drowning	Fix your home
10 pCi/L	About 71 people could get lung cancer	100 times the risk of dying in a home fire	Fix your home

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Radon

Sulfur

Taste & Odor

Autoimmune Diseases

8 pCi/L	About 57 people could get lung cancer		Fix your home
4 pCi/L	About 29 people could get lung cancer	100 times the risk of dying in an airplane crash	Fix your home
2 pCi/L	About 15 people could get lung cancer	2 times the risk of dying in a car crash	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 9 people could get lung cancer	(Average indoor radon level)	(Reducing radon evels below 2 pCi/L is difficult.)
0.4 pCi/L	About 3 people could get lung cancer	(Average outdoor radon level)	
Note: If you are a former smoker, your risk may be lower.			

RADON RISK IF YOU HAVE NEVER SMOKED

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime...	The risk of cancer from radon exposure compares to...	WHAT TO DO:
20 pCi/L	About 8 people could get lung cancer	The risk of being killed in a violent crime	Fix your home
10 pCi/L	About 4 people could get lung cancer		Fix your home
8 pCi/L	About 3 people could get lung cancer	10 times the risk of dying in an airplane crash	Fix your home
4 pCi/L	About 2 people could get lung cancer	The risk of drowning	Fix your home
2 pCi/L	About 1 person could get lung cancer	The risk of dying in a home fire	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	Less than 1 person could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L	Less than 1 person could get lung cancer	(Average outdoor radon level)	
Note: If you are a former smoker, your risk may be higher.			

It's never too late to reduce your risk of lung cancer. Don't wait to test and fix a radon problem. If you are a smoker, stop smoking.

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