



Radon: The Gas, Threat, Detection, and Control¹

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THE GAS

Radon is a potentially dangerous radioactive gas occurring naturally in the environment. It is one of a long chain of decay products of uranium, which ultimately turns to radium and then to non-radioactive lead. Radon has a half-life of 3.8 days. This means that for every given quantity of radon, half of it will change into an isotope in 3.8 days. Being a noble gas, radon does not chemically react with other elements to form compounds.

Relatively high radon concentrations are produced by soils having significant quantities of uranium and radium. In Florida, eighteen counties with definite evidence of elevated radon potential have been identified (Figure 1). Counties particularly susceptible to high radon potential are Hillsborough, Polk, Marion, Alachua, and counties to the norther and northwest of Alachua.

Even within counties of high radon potential, there is a wide variance in predicting levels within houses. Soils having significant quantities of uranium and radium produce relatively high radon concentrations, but there are other geological factors that may confine or direct the gas into certain areas. Clay, for example, is relative impermeable to radon gas, but if the clay has been eroded by streams or other natural forces, radon may have an opportunity to leak into homes located in these particular areas. A home with insignificant radon levels can be located right in the midst of other homes having high radon levels.

THE THREAT

There has been documentation of a longstanding correlation between smoking and lung cancer. In the past, researchers have been puzzled by the number of non-smokers who developed lung cancer. It took a number of years, but a connection was established between lung cancer in non-smokers and exposure to high radon levels.

Radon produces radiation when it decays into its progeny, also called "daughters" of radon. In doing so, alpha, beta and gamma radiation is produced.

Radon levels are measured in picocuries per liter, picocurie being a quantity of radiation, and a liter being a volume of air. Experts vary widely in what they consider a relatively save level. The Environmental Protection Agency (EPA) has conservatively established radon levels of 4 picocuries per liter (pCi/l) or lower as reasonably tolerable. The average outdoor level of radon is about 0.2 pCi/l; the average indoor level of radon is about one pCi/l. A person living in a home with an average radon concentration of 30 pCi/l has about the same risk of developing lung cancer as a person who smokes two packs of cigarettes a day. This risk is maintained as long as the person is exposed to that level (refer to Radon Risk Evaluation Chart, Figure 2). The risk to a person decreases if the indoor level decreases, or if the person spends a greater amount of time away from the house.

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pci/l	Estimated lung cancer deaths due to radon* (exposure) (per 1000)	Comparable exposure levels	Comparable risk*
200	440-770	1000 times average outdoor level	More than 60 times non-smoker risk 4 pack-a-day smoker
100	270-630	100 times average indoor level	20,000 chest x-rays per year
40	120-380		2 pack-a-day smoker
20	60-210	100 times average outdoor level	1 pack-a-day smoker
10	30-120	10 times indoor level	5 times non-smoker risk
4	13-50		200 chest x-rays per year
2	7-30	10 times average outdoor level	Non-smoker risk of dying from lung cancer
1	3-13	Average indoor level	
0.2	1-3	Average outdoor level	20 chest x-rays per year

DETECTION

One's normal senses cannot determine the presence of radon because the gas cannot be smelled, seen, felt, or tasted. There are two methods used commonly to detect radon: charcoal canisters and alpha track detectors. Both of these commercially available detectors are exposed to air in a home for a specified period of time, and a laboratory determines the level of radon.

With the more common charcoal canister, the test period is generally from two to seven days. A test kit can normally be purchased in various retail outlets such as pharmacies, hardware, health, or grocery stores for between \$5 and \$25. After being exposed to the home's atmosphere, the test kit must be promptly sent to a laboratory for analysis. An additional laboratory fee of \$10 to \$20 may be required at this time.

Another method is the alpha track detector which has a minimum test period of two to four weeks. The approximate cost is between \$20 and \$50 for one detector, including laboratory analysis. The alpha track detector is not as common as the charcoal canister, but it usually produces a better average reading because of the longer test period. Both the alpha track and the charcoal canister come with complete instructions which should be followed.

For a family concerned about the risk of radon in their home, it is suggested that they first purchase a charcoal test canister. Because higher levels are expected when the house is closed, the best time to test is in the winter or in the summer when the windows are closed for heating or cooling. The canisters are generally located about three feet off the floor in an area suspected to have cracks or pipes running through the foundation, thus permitting radon to get into the home. Other locations having high potential for gas intrusion include basements, or areas of the home partially underground. Most tests suggest that the home be closed as much as possible; windows closed and door openings minimized during the entire period of the test. After the test period is completed, the canister should immediately be sent to the laboratory.

If the reading is significantly above 4 pCi/l, then the occupants may wish to conduct a follow-up test using an alpha track detector. This test provides a better average reading under normal living conditions. Other techniques for radon detection exist, but they require operation by trained personnel and are much more

expensive than either the charcoal canister or alpha track detection.

CONTROL

If the detector shows that you have levels of radon higher than 4 pCi/l, there are steps an individual can take immediately to reduce the risk of developing lung cancer:

1. The most important is not to smoke and not to permit smoking in your home. This will reduce the family's overall risk of developing lung cancer. When radon decays, highly radioactive particles (radon's progeny) tend to attach to smoke and dust particles where they may be easily breathed into the lungs.
2. Spend less time in areas having higher concentrations of radon.
3. Whenever practical, open windows or use fans to increase air flow into the home.
4. Do not open windows or use fans in such a way that they create a negative pressure within the house. It is important that air blow into a home, rather than be sucked out of the home. If a home has a crawl space, make sure that all the vents are open and vegetation and weeds are cleared away from them so that a maximum amount of ventilation is permitted through the vents.

These suggestions will reduce risk but they do not offer a long-term solution. To reduce radon levels on a permanent basis, physical modifications must be made. Some are very expensive and may increase utility bills. Two simple low energy modifications a homeowner can make are suggested here: 1) ventilating the crawlspace is generally a low energy radon mitigation technique for homes built off grade; 2) sealing radon entry points, such as known cracks in the foundation or slab, or sealing around pipes that go through the slab or foundation into the ground, particularly bathtubs and toilet fixtures. After doing this with a high grade of sealant, the home should be retested. If the radon level is still significantly above 4 pCi/l after retesting, the county environmental officer or county health department should be contacted. They might be able to refer you to professionals qualified to mitigate (reduce) the radon levels. Buyer beware--ask questions. Contracts should be in writing, guaranteeing results.

Some more expensive mitigation techniques require drilling through the home's ceiling and roof.

There are also other sub-slab ventilation techniques. (See Table 1).

For further information, please contact the Office of Radiation Control, P.O. Box 15590, Orlando, FL 32858 ((407) 297-2095), or your county public health unit.

Comparison of Mitigation Techniques				
Method	Installation Cost	Operating Cost	Maximum Possible Reductions*	Comment
Natural ventilation:				Useful immediate step to reduce high radon levels
Basement or lowest floor	Minimal	Very high	Up to 90%	
Crawl space	Minimal	Moderate	Up to 90%	
Forced ventilation				More controlled than natural ventilation
Basement or lowest floor	Low	Very high	Up to 90%	
Crawl space	Low	Moderate	Up to 90%	
Air supply	Low to moderate	Low	Site specific	May be required to make other methods work
Heat recovery ventilation	Moderate to high	Moderate	Up to 90+%	Air intake and exhaust must be equal
Covering exposed earth	Moderate	Low	Site specific	Required to make most other methods work
Sealing cracks and spaces	Minimal to moderate	None	Site specific	Required to make most other methods work
Drain-tile suction	Moderate to high	Low	Up to 97+%	Best when drain tiles are continuous, unblocked loop
Block-wall ventilation	High to very high	Low	Up to 97+%	Applies to block-wall basements. Sub-slab suction may be needed to supplement
Sub-slab suction	High to very high	Low	Up to 97+%	Important to have good aggregate or highly permeable soil under slab
<p>*These represent the best reductions that a single method can accomplish. You may get higher or lower reductions depending on the unique characteristics of your house. It is likely that reductions in your house will not be as great as those shown. Especially with high initial radon levels, several methods may have to be combined to achieve acceptable results.</p>				
<p>Source: U.S. Environmental Protection Agency. Radon Reduction Methods: A Homeowner's Guide, Washington, D.C., Research and Development, August 1986.</p>				

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ADDITIONAL REFERENCE

1. Roessler, Genevieve S., "*Indoor Radon Progeny Exposure in the Florida Phosphate Mining Region: A Review*." Health Physics, 45, 1983, p. 389.