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Radon: An Indoor Health Hazard?

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Indoor air can be polluted in a number of ways. Indoor pollutants include formaldehyde, carbon monoxide, respirable dust, nitrogen dioxide, radon and other gases. This publication focuses on just one of these pollutants — radon.

What is the risk level?

People exposed to radon or other pollutants face some uncertainty about the amount of health risk the radon poses. Radon risk estimates are based on scientific studies of miners exposed to varying levels of radon in their work underground. Consequently, scientists are considerably more certain of the radon risk estimates than they are the risk levels based totally on animal studies.

The Environmental Protection Agency's Science Advisory Board estimates that radon exposure causes somewhere between 5,000 and 20,000 lung cancer deaths each year in the United States. The U.S. Surgeon General has estimated that about 85 percent of these lung cancer deaths were caused by smoking. Despite some uncertainty in the risk estimates of radon, it is widely believed that **the greater your exposure to radon, the greater your risk of developing lung cancer.**

What is radon?

Radon is an odorless, colorless, radioactive gas that is caused by the natural breakdown (radioactive decay) of materials that contain uranium. Radon can be found in high concentrations in soils and rocks containing uranium, granite, shale, phosphate and pitchblende. You can also find radon in soils contaminated with certain types of industrial waste, such as the byproducts from uranium or phosphate mining.

In the outdoors, radon is diluted to such low levels that there is usually nothing to worry about. Once inside an enclosed space such as a home, however, radon can accumulate, depending upon the building's construction and the concentration of radon in underlying soil.

Sources

Radon in homes may come from many sources. The main route of entry is from the soil and rock underneath the home. Radon migrates from the soil and rock through the cracks and openings in walls and floors or through floor drains, sumps, joints and tiny cracks or pores in hollow-block walls. Earth-contact and solar-heated homes using rock-heat storage may have higher levels of radon because of the additional soil and rock used in such construction.

Radon can also enter water in private wells and be released into a home when the water is used. Usually, radon is not a problem with large community water supplies where it would probably be released into the outside air before the water reaches a home.

In some unusual situations, radon may be released from materials used in the construction of a home. For example, a problem might arise if a house has a large stone fireplace or has a solar heating system where heat is stored in large beds of stone. In general, however, building materials are not a major source of indoor radon.

Risk areas in Missouri

According to the State Geological Service, "There are more questions than answers as to where we expect high risks in Missouri." We have little scientific data on where we might find high levels caused by specific geological formations. Areas of the state that might be suspect are:

- Lamont sandstone areas.
- Mountain areas in southeast Missouri.
- Southwest Missouri — black shale (especially old mine areas).
- Oil formation areas.
- Northern Missouri — black or dark shale.

Detection techniques

The two most popular commercially available detectors for homeowners are charcoal canisters and alpha track detectors. Both are exposed to air in the home for a specific period of time and then sent to a laboratory for analysis.

Alpha track detectors (AT). Alpha track detectors use a small sheet of special plastic material. The material is permanently marked by alpha particles. The units are installed in the home for up to three months for screening and for 12 months as a follow-up measure.

Advantages:

- Relatively low cost per detector; cost of one unit may range from $20 to $60.
- Convenient to handle and install.
- Unobtrusive when installed.
- No special skills required for deployment.
- Can be distributed by mail.
- Completely passive; need no external power.
- Can measure the integrated average concentration over a 12-month period, which is the optimal measure of long-term concentration.

Disadvantages:

- Relatively long measurement period necessary; three months are the recommended minimum for currently available detectors.
- Large inherent variability (precision errors), particularly at low concentrations if the area counted is small.

Charcoal canisters (CC). Charcoal canisters are containers filled with a pre-measured amount of activated charcoal. The homeowner unseals the airtight canisters and places them in the home according to manufacturer's guidelines for up to seven days. At the end of the test period, the canisters are re-sealed and returned to the laboratory or distribution point for analysis.

Advantages:

- Low cost per canister; one canister may range from $10 to $25.
- Convenient to handle and install.
- Unobtrusive when installed.
- No special skills needed for deployment.
- Can be distributed by mail.
- Completely passive; need no external power.
- With proper analysis, can yield precise results.

Disadvantages:

- Some canister types are more sensitive to temperature and humidity than others.
- The charcoal absorption technique is inherently limited to a few days of sampling, which makes a longer term measurement impossible with a single detector.

Other techniques to measure radon are available, but they require trained personnel and special instrumentation. The techniques are also extremely expensive ($2,500 to $10,000). They include:

- Continuous radon monitor or continuous working level monitor.
- Grab sample.
- Radon progeny integrating sampling unit.

The EPA conducts a Radon Measurement Proficiency Program. This voluntary program allows laboratories and businesses to demonstrate their capabilities in measuring indoor radon. For names of firms participating in the program, contact the Bureau of Radiological Health, 1730 East Elm Plaza, P.O. Box 570, Jefferson City, MO, 65102 or call 314/751-6083.

Measurement results

In most cases, the screening measurement is not a reliable measure of the average radon level. Because radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate potential for a radon problem. Depending upon the results of the screening measurement, a homeowner may need to have follow-up measurements to determine the average radon level in a home. The EPA strongly recommends that follow-up measurements be made before undertaking major efforts to permanently correct the problem.

Measurement results will be reported in one of two forms — working level (WL) or picocuries per liter (pCi/l).

For a radon risk evaluation chart, see Table 1.

How to reduce risk

Lung cancer resulting from radon exposure depends upon the level and length of exposure.

The following measures can be taken to reduce exposure level. They are easy and inexpensive.

- Stop smoking and discourage smoking in the leveling area. Scientific evidence indicates smoking may increase the risk of radon exposure.
- Spend less time in areas with higher concentrations of radon, such as basements. Radon concentrations tend to be greater in lower levels of a home. Persons who spend a great deal of time in these areas, whether sleeping or working, will probably experience higher risk levels than persons with reduced exposure.

Table 1. Radon risk evaluation chart.*

pCi/l	WL	Estimated number of lung cancer deaths due to radon exposure (out of 1,000)	Comparable exposure levels	Risk
200	1	440 - 770	1,000 times average outdoor level	More than 60 non-smoker risk 4 pack-a-day smoker
100	0.5	270 - 630	100 times average outdoor level	20,000 chest x-rays per year
40	0.2	120 - 380	100 times average outdoor level	2 pack-a-day smoker
20	0.1	60 - 210		1 pack-a-day smoker
10	0.05	30 - 120	10 times average indoor level	5 times non-smoker risk
4	0.02	13 - 50	10 times average outdoor level	200 chest x-rays per year
2	0.01	7 - 30		Non-smoker risk of dying from lung cancer
1	0.005	3 - 13	Average indoor level	20 chest x-rays per year
0.2	0.001	1 - 3	Average outdoor level	

*Source EPA Publication OPA-86-004.
*Risk levels are based upon a person spending 75 percent of his or her time at home. Persons who spend more or less time than this will probably have a higher or lower risk level.

- When practical, open all windows and turn on fans to increase the air flow into and through the house. This is especially important in basements.
- If a home has a crawl space beneath it, keep the crawl space vents on all sides of the house fully open all year.

While these actions will help to reduce risks occurring from radon, they generally do not offer a long-term solution. There are a number of permanent solutions that a homeowner may want to consider to alleviate a radon problem. The first is to seal all entry points, such as cracks, pipe openings and capped sumps. Another solution might be to use natural, fan-forced or heat-recovery ventilation to get rid of as much as 90 percent of the radon in the home. Table 2 is a comparison chart of various permanent, cost-effective solutions recommended by the EPA.

For more detailed explanations of techniques, see the EPA publication, *Radon Reduction Methods — A Homeowner's Guide*. You can obtain a copy of this booklet from the Kansas City EPA Regional Office, Office of Public Affairs, 726 Minnesota Avenue, Kansas City, KS 66101, or call 913/236-2803.

Table 2. Comparison of features.

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+%	Works 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 high permeable soil under slab.

*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. Source: EPA Booklet - OPA-86-005 -"Radon Reduction Methods - A Homeowners Guide."

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