

Preventing Radon Problems in the Home

Fact Sheet No. 9.953

Consumer Series | Housing

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What is Radon?

Radon is a colorless, odorless, radioactive gas emitted from uranium, a naturally occurring mineral in rocks and soil. Normally, radon rises up through the soil and dissipates in the air outside. Radon becomes a concern, however, when it seeps through openings such as cracks, loose fitting pipes, sump pits, dirt floors, slab joints or block walls and accumulates in the home. See Figure 1.

Air pressure inside the home is usually lower than pressure in the soil around the house's foundation. Because of this difference, the house acts like a vacuum, drawing radon in through foundation cracks and other openings.

Radon has been identified as a risk factor in developing lung cancer because it decays into radioactive particles that can get trapped in the lungs. These particles release bursts of energy (alpha particles) that damage lung tissue. It is estimated that radon may be associated with about 21,000 lung cancer deaths per year in the United States, with 500 in Colorado, second only to smoking.

The chances of getting lung cancer from radon depend on how much radon is in the home, the amount of time spent in the home and whether a person smokes. See Table 1. Smoking, combined with radon, adds to the health risk.

Radon in Colorado

Surveys show that homes in all of Colorado counties have the potential for radon levels above the U.S. Environmental Protection Agency's (EPA) recommended action level. The EPA has developed three radon designations, ranging from Zone 1 (the highest recommended action level) to Zone 3 (the lowest recommended action level). In Colorado, ALL counties are designated as Zone 1. See Figure 2.

Because radon levels are influenced by a variety of factors – soil type and moisture, how “tight” the home is, type of heating and ventilation system, movement of air and groundwater, air pressure, and lifestyle behavior of the occupants – the only way to know if a home has elevated levels of radon is to test it.

Radon Testing

All homes in Colorado should be tested for radon. Only individual testing can determine which houses may have a radon problem. You cannot base your radon level on a neighbor's test result. Every house is different. Measuring radon levels in the home is simple and inexpensive. Test kits include

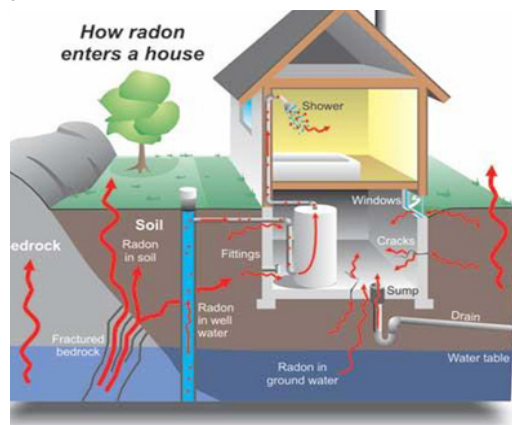
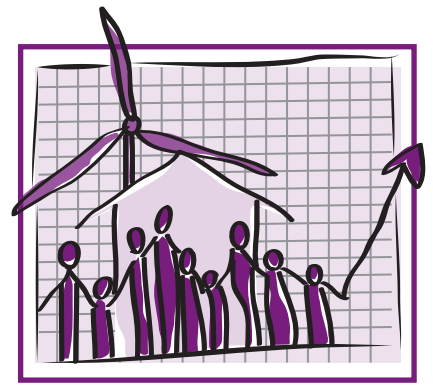


Figure 1: Radon entry locations.

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Quick Facts

- Radon is a colorless, odorless, radioactive gas that can enter the home.
- All of Colorado contains high concentrations of radon, considered the second leading cause of lung cancer behind smoking.
- All Colorado homes should be tested for radon.
- Radon mitigation methods can be planned for and installed during new home construction.
- Home buyers and renters should ask if the home has been tested for radon and ask for the results.

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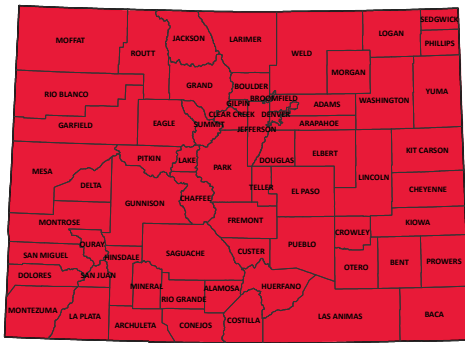


Figure 2. Source: Colorado Department of Public Health and Environment (CDPHE) Radon Outreach Program and Colorado Environmental Public Health Tracking. Notes: These radon zones were determined based on indoor radon, geology, soil, construction type and aerial radon measurements. Approximately 20,000 pre-investigation radon test results were used in development of this map. # pCi/L is the EPA action level for indoor radon.

complete instructions for mailing samples back to the lab for analysis.

Short-term detectors (such as charcoal canisters) are used for three to seven days. They provide quick screening measurements indicating potential radon problems. Short-term detectors should be placed in the lowest livable level of the house, preferably during winter. Long-term detectors (such as alpha track detectors) are left in place for three months to one year. They provide the advantage of averaging seasonal variations associated with radon levels. Long-term detectors are generally placed in main living areas.

A radon test kit costs from \$10 to \$50. Test kits are available from hardware and home improvement stores, or through mail order companies. Many communities provide free or reduced cost test kits at local health departments or Extension offices, senior citizen centers or other locations. If test kits are not available in your area, contact the Colorado Department of Public Health and Environment

(CDPHE) at 1-800-846-3986 or visit www.coloradoradon.info. You can also order a test kit from the National Radon Program Services (<http://sosradon.org>).

When buying a test kit, select one approved by the National Radon Proficiency Program (<http://aarst-nrpp.com/wp/approved-device>) (see Figure 3) and follow the instructions carefully. If you do a short-term test, close windows and outside doors and keep them closed as much as possible during the testing period. Instructions are specific as to placement and the importance of not disturbing the test kit while it is monitoring the radon level of a home.

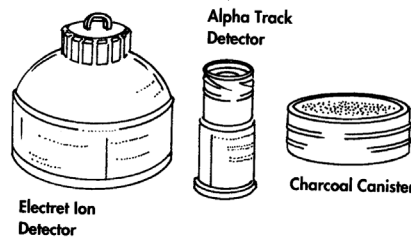


Figure 3: Examples of test kits approved by the National Radon Proficiency Program.

Homes with different foundation types (i.e. slab and crawlspace or multiple slabs) should test all of the livable areas above those areas due to potential differences in radon levels. Generally, radon levels are highest in the lower levels of the home. For this reason, some homeowners prefer to test in the basement and first floor, especially if they are used for living and sleeping spaces. Testing should not be conducted in a crawlspace; it is done in the

living area above the crawlspace. Testing should not be done in humid rooms such as kitchens, bathrooms or laundry rooms.

Once the test is finished, reseal or close the container and send it to the lab specified on the package right away. You may choose to have radon measurements performed by a professional. The CDPHE can provide a list of certified radon measurement providers, certified mitigation providers and certified radon laboratories (www.coloradoradon.info).

Understanding Test Results

Radon measurements show how much radon was present in the home during the test period. This level varies depending on detector location and the time of year it was used. As mentioned earlier, radon levels are generally highest when the house is closed and in the basement or near possible radon entry routes. Readings averaged over an entire year are usually lower than those taken in a basement during winter.

Radon gas is measured in units of picocuries per liter (pCi/L), a standard measure of radioactivity. The EPA set 4 pCi/L as a recommended action level. If a short-term measurement is over 4 pCi/L, the recommended action is to follow-up with either a long-term test or a second short-term test to better characterize the radon levels. If a long-term test or second short-term test measures over 4 pCi/L, a homeowner should consider fixing their home to reduce radon exposure. Most homes can be reduced following mitigation to 2 pCi/L or below. Definitely mitigate anything over 8 pCi/L.

Table 1. Radon risk if you have never smoked (Developed by the EPA).

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 36 people could get lung cancer	35 times the risk of drowning	Fix your home.
10 pCi/L*	about 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home.
8 pCi/L*	about 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home.
4 pCi/L*	about 7 people could get lung cancer	The risk of dying in a car crash	Fix your home.
2 pCi/L*	about 4 people could get lung cancer	The risk of dying of poison	Consider fixing between 2 and 4 pCi/L.
1.3 pCi/L*	about 2 people could get lung cancer	Average indoor radon level	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L*		Average outdoor radon level	(Reducing radon levels below 2 pCi/L is difficult.)

*pCi/L: picocuries of radon per liter of air

NOTE: If you are a former smoker, your risk may be higher.

*Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

**Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

No level of radon is safe. The average indoor radon level is estimated to be about 1.3 pCi/L in the U.S., but it is 6.3 pCi/L in Colorado. The average outside radon level is about 0.4 pCi/L. The level of radon in a home may vary considerably from neighbor to neighbor. The only way to know is to test.

Radon Mitigation

The cost of repairs to reduce radon depends on how the home was built and the extent of the radon problem. Most homes can be fixed for \$800 to \$2,500, averaging around \$1,200. A variety of methods may be used to lower radon levels in a home. These include sub-slab depressurization, drain tile suction, sump pit suction, and block wall suction. Sealing cracks and other openings in the foundation and covering sump pump holes are recommended in addition to mitigation, however, sealing alone has not proven to significantly lower radon levels.

The most commonly used radon mitigation technique, and generally the most effective method, is called sub-slab depressurization. This system uses a pipe that penetrates the basement floor, exits the home where a fan is mounted and is piped upward to terminate above the eave of the roof (Figure 4). This system collects radon gas before it enters the house and funnels it directly up through the pipe and out of the home. Similar systems also can be installed in homes with crawlspaces.

Other methods used, although they have some disadvantages and may not be appropriate for a more permanent solution, include house pressurization and ventilation such as using a heat recovery ventilator (air-to-air heat exchanger). Whatever method you use, be sure to test for radon before and after the system is installed to be sure it is reducing levels to below 4 pCi/L.

If your living patterns change and you begin occupying a lower level of your home (such as a basement), you should retest your home on that level.

Because the right system depends on the design of the home and other factors, most homeowners should not try to fix radon problems on their own. The CDPHE provides a list of certified contractors to perform radon mitigation at (www.coloradoradon.info).

For houses with several foundation types and levels, a combination of techniques may be needed.

Radon Resistant New Construction

Radon mitigation methods can be planned for and installed during new home construction. Installation costs are generally much lower during construction and careful planning allows a variety of strategies to be integrated to ensure the most effective radon mitigation system possible.

Installing passive radon-resistant features during construction of a new home will cost \$350 to \$500. New homes constructed in areas of the state known to have high levels of radon should include at least:

- ❑ A passive sub-slab depressurization system or crawlspace depressurization system.
- ❑ Foundation barrier techniques such as a layer of gas permeable material under the foundation (usually four inches of gravel), plastic sheeting over that material, and sealing and caulking of all openings in the concrete foundation floor or the floor above.
- ❑ Installation of a perforated pipe that runs under the foundation (under the sheeting covering the soil in crawlspaces) to a 3 or 4 inch PVC pipe which goes through the house to the roof.
- ❑ A roughed-in electrical junction box for future installation of a fan, if needed.

After the home is occupied, the home should be tested and if radon levels remain above 4 pCi/L, the passive sub-slab system should be converted to an active system by adding a fan.

Home Buyers, Sellers and Renters

Home buyers should have the home tested for radon during the home inspection process using a certified radon measurement contractor.

Homeowners should test their home and take precautions now to mitigate for

radon to not only protect their family's health against adverse radon effects, but to also be prepared for any future home sale. Testing your home does not mean lowered sales value or a reduced chance of selling. A home that has been mitigated is a positive selling point in Colorado.

Renters should ask about environmental issues concerning property such as whether the home has been tested for radon and what the test results showed.

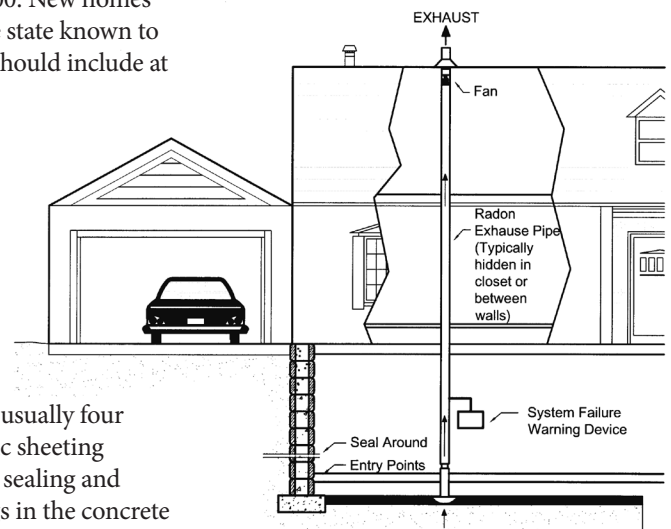


Figure 4: Typical radon mitigation system (EPA).

Resources available:

- A Citizen's Guide to Radon: The guide to protecting yourself and your family from radon. (EPA)
- Consumer's Guide to Radon Reduction: How to fix your home. (EPA)
- Radon and Real Estate Transactions in Colorado (CDPHE)

Web Sites:

- Colorado Department of Public Health and Environment:
www.coloradoradon.info
- Environmental Protection Agency:
www.epa.gov/radon