

Home Buyer's and Seller's Guide to Radon

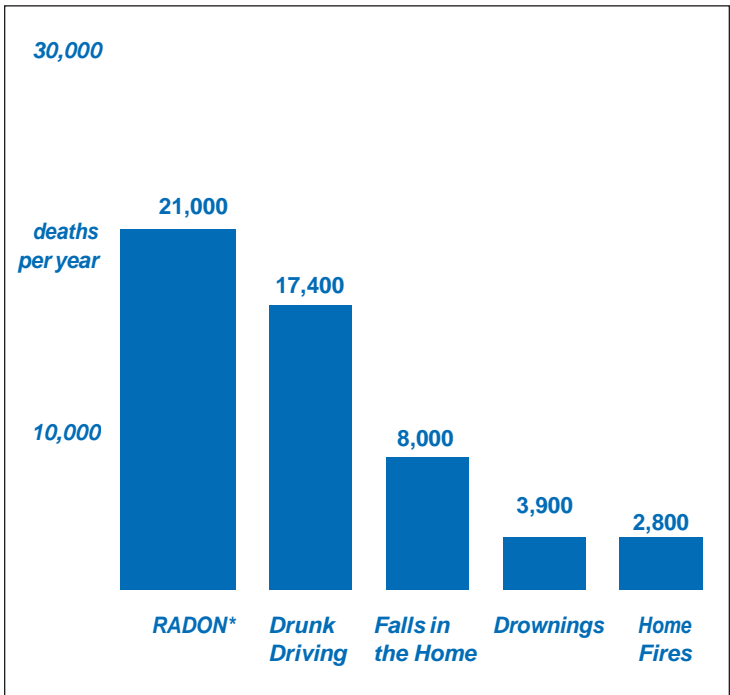


EPA RECOMMENDS:

- ❑ If you are buying or selling a home, have it tested for radon.
- ❑ For a new home, ask if radon-resistant construction features were used and if the home has been tested.
- ❑ Fix the home if the radon level is 4 picocuries per liter (pCi/L) or higher.
- ❑ Radon levels less than 4 pCi/L still pose a risk and, in many cases, may be reduced.
- ❑ Take steps to prevent device interference when conducting a radon test.



EPA estimates that radon causes thousands of cancer deaths in the U.S. each year.



**Radon is estimated to cause about 21,000 lung cancer deaths per year, according to EPA's 2003 Assessment of Risks from Radon in Homes (EPA 402-R-03-003). The numbers of deaths from other causes are taken from the Centers for Disease Control and Prevention's 2005-2006 National Center for Injury Prevention and Control Report and 2006 National Safety Council Reports.*

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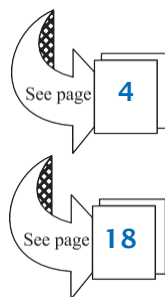
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Overview

This *Guide* answers important questions about radon and lung cancer risk. It also answers questions about testing and fixing for anyone buying or selling a home.

Radon Is a Cancer-Causing, Radioactive Gas

You cannot see, smell, or taste radon. But it still may be a problem in your home. When you breathe air containing radon, you increase your risk of getting lung cancer. In fact, the Surgeon General of the United States has warned that radon is the second leading cause of lung cancer in the United States today. *If you smoke and your home has high radon levels, your risk of lung cancer is especially high.*



EPA Risk Assessment for Radon in Indoor Air

EPA has updated its estimate of the lung cancer risks from exposure to radon in indoor air. The Agency's updated risk assessment, *EPA Assessment of Risks from Radon in Homes* (EPA 402-R-03-003, June 2003), is available at <https://www.epa.gov/radiation/epa-assessment-risks-radon-homes> as a downloadable Adobe Acrobat PDF file. EPA's reassessment was based on the National Academy of Sciences' (NAS) report on the *Health Effects of Exposure to Radon* (BEIR VI, 1999). The Agency now estimates that there are about 21,000 annual radon-related lung cancer deaths, an estimate consistent with the NAS Report's findings.

You Should Test for Radon

Testing is the only way to find out your home's radon levels. EPA and the Surgeon General recommend testing all homes below the third floor for radon.



You Can Fix a Radon Problem

If you find that you have high radon levels, there are ways to fix a radon problem. Even very high levels can be reduced to acceptable levels.

If You Are Selling a Home...

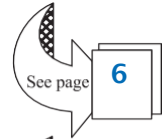
EPA recommends that you test your home before putting it on the market and, if necessary, lower your radon levels. Save the test results and all information you have about steps that were taken to fix any problems. This could be a positive selling point.

EPA 402/K-13/002 | March 2018 (revised)

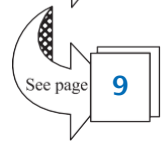
If You Are Buying a Home...

EPA recommends that you know what the indoor radon level is in any home you consider buying. Ask the seller for their radon test results. If the home has a radon-reduction system, ask the seller for any information they have about the system.

If the home has not yet been tested, you should have the house tested.



If you are having a new home built, there are features that can be incorporated into your home during construction to reduce radon levels.



The radon testing guidelines in this *Guide* have been developed specifically to deal with the time-sensitive nature of home purchases and sales, and the potential for radon device interference. These guidelines are slightly different from the guidelines in other EPA publications which provide radon testing and reduction information for *non-real estate* situations.

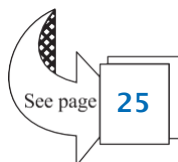
This *Guide* recommends three short-term testing options for real estate transactions. EPA also recommends testing a home in the lowest level that could be used regularly, since a buyer may choose to live in a lower area of the home than that used by the seller.



1. Why Should I Test for Radon

a. Radon Has Been Found in Homes All Over the United States

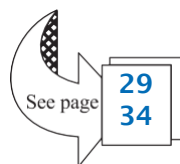
Radon is a radioactive gas that has been found in homes all over the United States. It comes from the natural breakdown of uranium in soil, rock, and water and gets into the air you breathe. Radon typically moves up through the ground to the air above and into your home through cracks and other holes in the foundation. Radon can also enter your home through well water. Your home can trap radon inside.



Any home can have a radon problem. This means new and old homes, well-sealed and drafty homes, and homes with or without basements. In fact, you and your family are most likely to get your greatest radiation exposure at home. That is where you spend most of your time.



Nearly one out of every 15 homes in the United States is estimated to have an elevated radon level (4 pCi/L or more). Elevated levels of radon gas have been found in homes in your state. Contact your state radon office for information about radon in your area.



b. EPA and the Surgeon General Recommend that You Test Your Home

Testing is the only way to know if you and your family are at risk from radon. EPA and the Surgeon General recommend testing all homes below the third floor for radon.

U.S. SURGEON GENERAL HEALTH ADVISORY

“Indoor radon is the second-leading cause of lung cancer in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country. It’s important to know that this threat is completely preventable. Radon can be detected with a simple test and fixed through well-established venting techniques.” January 2005



You cannot predict radon levels based on state, local, and neighborhood radon measurements. Do not rely on radon test results taken in other homes in the neighborhood to estimate the radon level in your home. Homes which are next to each other can have different indoor radon levels. Testing is the only way to find out what your home’s radon level is.

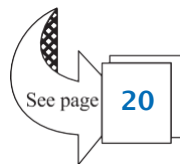
In some areas, companies may offer different types of radon service agreements. Some agreements let you pay a one-time fee that covers both testing and radon mitigation, if needed. Contact your state radon office to find out if these are available in your state.



2. I'm Selling a Home. What Should I Do?

a. If Your Home Has Already Been Tested for Radon...

If you are thinking of selling your home and you have already tested your home for radon, review the *Radon Testing Checklist* to make sure that the test was done correctly. If so, provide your test results to the buyer.



No matter what kind of test was done, a potential buyer may ask for a new test, especially if:

- G The *Radon Testing Checklist* items were not met;
- G The last test is not recent, e.g., within two years;
- G You have renovated or altered your home since you tested; or
- G The buyer plans to use a lower level of the house than was tested, such as a basement that could be used regularly by the buyer.

A buyer may also ask for a new test if your state or local government requires disclosure of radon information to buyers.

b. If Your Home Has *Not Yet* Been Tested for Radon...

Have a test taken as soon as possible. If you can, test your home before putting it on the market. You should test in the lowest level of the home that could be used regularly. This means testing in the lowest level that you currently live in or a lower level not currently used, but which a buyer might use as a family room or play area, etc.

The radon test result is important information about your home's radon level. Some states require radon measurement testers to follow a specific testing protocol. If you do the test yourself, you should carefully follow the testing protocol for your area or EPA's *Radon Testing Checklist*. If you hire a contractor to test your residence, protect yourself by hiring a **qualified*** individual or company.



You can determine a service provider's qualifications to perform radon measurements or to mitigate your home in several ways. **Check with your state radon office.** Many states require radon professionals to be licensed, certified, or registered. Most states can provide you with a list of knowledgeable radon service providers doing business in the state. In states that don't regulate radon services, **ask the contractor if they hold a professional proficiency or certification credential.** Such programs usually provide members with a photo-ID card, which indicates their qualification(s) and its expiration date. If in doubt, you should check with their credentialing organization. Alternatively, **ask the contractor if they've successfully completed formal training** appropriate for testing or mitigation, e.g., a course in radon measurement or radon mitigation.

* You should first call your state radon office for information on qualified radon service providers and state-specific radon measurement or mitigation requirements. For up-to-date information on state radon program offices, visit <http://www.epa.gov/radon/wheretheyoulive.html>. EPA's detailed and technical guidance on radon measurement and mitigation is included in Section 8 (p. 29); however, state requirements or guidance may be more stringent. Visit <http://www.epa.gov/radon/radontest.html> for links to private sector radon credentialing programs.

3. I'm Buying a Home. What Should I Do?



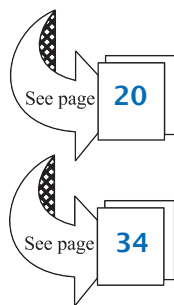
a. If the Home Has Already Been Tested for Radon...

If you are thinking of buying a home, you may decide to accept an earlier test result from the seller or ask the seller for a new test to be conducted by a qualified radon tester. Before you accept the seller's test, you should determine:

- G The results of previous testing;
- G Who conducted the previous test: the homeowner, a radon professional, or some other person;
- G Where in the home the previous test was taken, especially if you may plan to live in a lower level of the home. For example, the test may have been taken on the first floor. However, if you want to use the basement as living space, test there; and
- G What, if any, structural changes, alterations, or changes in the heating, ventilation, and air conditioning (HVAC) system have been made to the house since the test was done. Such changes might affect radon levels.

If you accept the seller's test, make sure that the test followed the *Radon Testing Checklist*.

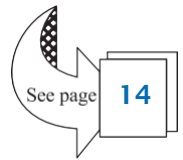
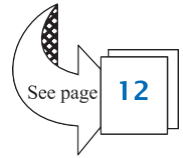
If you decide that a new test is needed, discuss it with the seller as soon as possible. If you decide to use a qualified radon tester, contact your state radon office to obtain a copy of their approved list of radon testing companies.



b. If the Home Has *Not Yet* Been Tested for Radon...

Make sure that a radon test is done as soon as possible. Consider including provisions in the contract specifying:

- Where the test will be located;
- Who should conduct the test;
- What type of test to do;
- When to do the test;
- How the seller and the buyer will share the test results and test costs (if necessary); and
- When radon mitigation measures will be taken, and who will pay for them.



Make sure that the test is done in the lowest level of the home that could be used regularly. This means the lowest level that you are going to use as living space whether it is finished or unfinished. A state or local radon official or qualified radon tester can help you make some of these decisions.

If you decide to finish or renovate an unfinished area of the home in the future, a radon test should be done before starting the project and after the project is finished. Generally, it is less expensive to install a radon-reduction system before (or during) renovations rather than afterwards.

4. I'm Buying or Building a New Home. How Can I Protect My Family?

a. Why Should I Buy a Radon-Resistant Home?

Radon-resistant techniques work. When installed properly and completely, these simple and inexpensive passive techniques can help to reduce radon levels. In addition, installing them at the time of construction makes it easier to reduce radon levels further if the passive techniques don't reduce radon levels to below 4 pCi/L. Radon-resistant techniques may also help to lower moisture levels and those of other soil gases. Radon-resistant techniques:

- ✓ **Make Upgrading Easy:** Even if built to be radon-resistant, **every new home should be tested for radon as soon as possible after occupancy.** If you have a test result of 4 pCi/L or more, a vent fan can easily be added to the passive system to make it an active system and further reduce radon levels.
- ✓ **Are Cost-Effective:** Building radon-resistant features into the house during construction is easier and cheaper than fixing a radon problem from scratch later. Let your builder know that radon-resistant features are easy to install using common building materials.
- ✓ **Save Money:** When installed properly and completely, radon-resistant techniques can also make your home more energy efficient and help you save on your energy costs.



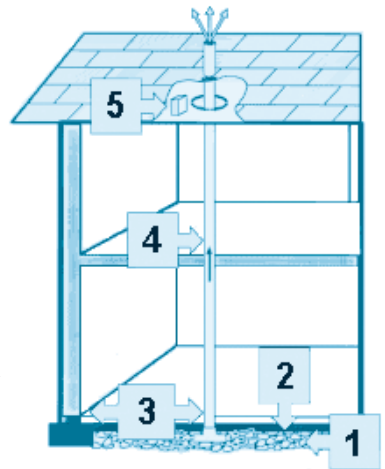
Including passive radon-resistant features in a **new home** during construction usually costs less than fixing the home later. If your radon level is 4 pCi/L or more, consult a qualified mitigator to estimate the cost of upgrading to an active system by adding a vent fan to reduce the radon level. In an **existing home**, the cost to install a radon mitigation system is about the same as for other common home repairs. Check with, and get an estimate from, one or more qualified mitigators before fixing.

b. What Are Radon-Resistant Features?

Radon-resistant techniques (features) may vary for different foundations and site requirements. If you're having a house built, ask your builder if they're using a recognized approach (International Residential Code, Appendix F, ASTM E 1465-08, and ANSI/AARST RRNC 2.0 as examples). If your new house was built (or will be built) to be radon-resistant, it will include these basic elements:



- 1. Gas-Permeable Layer:** This layer is placed beneath the slab or flooring system to allow the soil gas to move freely underneath the house. In many cases, the material used is a 4-inch layer of clean gravel. This gas-permeable layer is used only in homes with basement and slab-on-grade foundations; it is not used in homes with crawlspace foundations.
- 2. Plastic Sheeting:** Plastic sheeting is placed on top of the gas-permeable layer and under the slab to help prevent the soil gas from entering the home. In crawl spaces, the sheeting (with seams sealed) is placed directly over the crawlspace floor.
- 3. Sealing and Caulking:** All below-grade openings in the foundation and walls are sealed to reduce soil gas entry into the home.
- 4. Vent Pipe:** A 3- or 4-inch PVC pipe (or other gas-tight pipe) runs from the gas-permeable layer through the house to the roof, to safely vent radon and other soil gases to the outside.
- 5. Junction Boxes:** An electrical junction box is included in the attic to make the wiring and installation of a vent fan easier. For example, you decide to activate the passive system because your test result showed an elevated radon level (4 pCi/L or more). A separate junction box is placed in the living space to power the vent fan alarm. An alarm is installed along with the vent fan to indicate when the vent fan is not operating properly.



5. How Can I Get Reliable Radon Test Results?

Radon testing is easy and the only way to find out if you have a radon problem in your home.

a. Types of Radon Devices

Since you cannot see or smell radon, special equipment is needed to detect it. When you're ready to test your home, you can order a radon test kit by mail from a qualified radon measurement services provider or laboratory. You can also hire a qualified radon tester, very often a home inspector, who will use a radon device(s) suitable to your situation. The most common types of radon testing devices are listed below. As new testing devices are developed, you may want to check with your state radon office before you test to get the most up-to-date information.



✓ *Passive Devices*

Passive radon testing devices do not need power to function. These include **charcoal canisters**, **alpha-track detectors**, **charcoal liquid scintillation devices**, and **electret ion chamber detectors**, which are available in hardware, drug, and other stores; they can also be ordered by mail or phone. These devices are exposed to the air in the home for a specified period of time and then sent to a laboratory for analysis. Both short-term and long-term passive devices are generally inexpensive. Some of these devices may have features that offer more resistance to test interference or disturbance than other passive devices. Qualified radon testers may use any of these devices to measure the home's radon level.

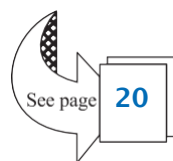
✓ *Active Devices*

Active radon testing devices require power to function. These include **continuous radon monitors** and **continuous working level monitors**. They continuously measure and record the amount of radon or its decay products in the air. Many of these devices provide a report of this information which can reveal any unusual or abnormal swings in the radon level during the test period. A qualified tester can explain this report to you. In addition, some of these devices are specifically designed to deter and detect test interference. Some technically advanced active devices offer anti-interference features. Although these tests may cost more, they may ensure a more reliable result.

b. General Information for All Devices

A state or local radon official can explain the differences between devices and recommend the ones which are most appropriate for your needs and expected testing conditions.

Make sure to use a radon measurement device from a qualified laboratory. Certain precautions should be followed to avoid interference during the test period; see the *Radon Testing Checklist* for more information on how to get a reliable test result.



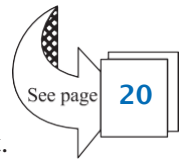
Radon Test Device Placement

EPA recommends that the test device(s) be placed in the lowest level of the home that could be used regularly, whether it is finished or unfinished. Conduct the test in any space that could be used by the buyer as a bedroom, play area, family room, den, exercise room, or workshop. Based on their client's intended use of the space, the qualified testing professional should identify the appropriate test location and inform their client (buyer). Do **not** test in a closet, stairway, hallway, crawl space or in an enclosed area of high humidity or high air velocity. An enclosed area may include a kitchen, bathroom, laundry room or furnace room.

c. Preventing or Detecting Test Interference

There is a potential for test interference in real estate transactions. There are several ways to prevent or detect test interference:

- Use a test device that frequently records radon or decay product levels to detect unusual swings;
- Employ a motion detector to determine whether the test device has been moved or if testing conditions have changed;
- Use a proximity detector to reveal the presence of people in the room which may correlate to possible changes in radon levels during the test;
- Record the barometric pressure to identify weather conditions which may have affected the test;
- Record the temperature to help assess whether doors and windows have been opened;
- Apply tamper-proof seals to windows to ensure closed-house conditions; and
- Have the seller/occupant sign a non-interference agreement.



Home buyers and sellers should consult a qualified radon test provider about the use of these precautions.

d. Length of Time to Test

Because radon levels tend to vary from day to day and season to season, a short-term test is less likely than a long-term test to tell you your year-round average radon level. However, if you need results quickly, a short-term test may be used to decide whether to fix the home.

There Are Two General Ways to Test Your Home for Radon:

✓ *Short-Term Testing*

The quickest way to test is with short-term tests. Short-term tests remain in your home from two to 90 days, depending on the device. There are two groups of devices which are more commonly used for short-term testing. The passive device group includes **alpha track detectors, charcoal canisters, charcoal liquid scintillation detectors, and electret ion chambers**. The active device group consists of different types of **continuous monitors**.

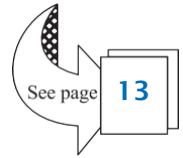
Whether you test for radon yourself or hire a qualified tester, all radon tests should be taken for a minimum of 48 hours. Some devices require a longer (minimum) length of time, e.g., a 7-day charcoal canister device.

✓ *Long-Term Testing*

Long-term tests remain in your home for more than 90 days. **Alpha track and electret ion chamber detectors** are commonly used for this type of testing. A long-term test result is more likely to tell you your home's year-round average radon level than a short-term test. If time permits (more than 90 days), long-term tests can be used to confirm initial short-term results. When long-term test results are 4 pCi/L or higher, EPA recommends fixing the home.

e. Doing a Short-Term Test...

If you are testing in a real estate transaction and you need results quickly, any of the following three options for short-term tests are acceptable in determining whether the home should be fixed. Any real estate test for radon should include steps to prevent or detect interference with the test device.



When Choosing a Short-Term Testing Option...

There are trade-offs among the short-term testing options. Two tests taken at the same time (simultaneous) would improve the precision of this radon test. One test followed by another test (sequential) would most likely give a better representation of the seasonal average. Both active and passive devices may have features which help to prevent test interference. Your state radon office can help you decide which option is best.

Short-Term Testing Options

Passive:

Take two short-term tests at the same time in the same location for at least 48 hours.

or

Take an initial short-term test for at least 48 hours. Immediately upon completing the first test, do a second test using an identical device in the same location as the first test.

Active:

Test the home with a continuous monitor for at least 48 hours.

What to Do Next

Fix the home if the average of the two tests is 4 pCi/L or more.

Fix the home if the average of the two tests is 4 pCi/L or more.

Fix the home if the average radon level is 4 pCi/L or more.

f. Using Testing Devices Properly for Reliable Results

✓ *If You Do the Test Yourself*

When you are taking a short-term test, close windows and doors to the outside and keep them closed, except for normal entry and exit. If you are taking a short-term test lasting less than four days, be sure to:

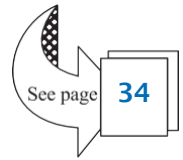


- Close your windows and outside doors at least 12 hours before beginning the test;
- Do not conduct short-term tests lasting less than four days during severe storms or periods of high winds;
- Follow the testing instructions and record the start time and date;
- Place the test device at least 20 inches above the floor in a location where it will not be disturbed and where it will be away from drafts, high heat, high humidity, and exterior walls;
- Leave the test kit in place for as long as the test instructions say; and
- Once the test is finished, record the stop time and date, reseal the package, and return it immediately to the lab specified on the package for analysis.

You should receive your test results within a few days or weeks. If you need results quickly, you should find out how long results will take and, if necessary, request expedited service.

✓ *If You Hire a Qualified Radon Tester*

In many cases, home buyers and sellers may decide to have the radon test done by a qualified radon tester who knows the proper conditions, test devices, and guidelines for obtaining a reliable radon test result. They can also:



- Evaluate the home and recommend a testing approach designed to make sure you get reliable results;
- Explain how proper conditions can be maintained during the radon test;
- Emphasize to a home's occupants that a reliable test result depends upon their cooperation. Interference with, or disturbance of, the test or closed-house conditions will invalidate the test result;
- Analyze the data and report the measurement results; and
- Provide an independent test result.

Your state radon office may also have information about qualified radon testers and certification requirements.

g. Interpreting Radon Test Results

The average indoor radon level is estimated to be about 1.3 pCi/L; roughly 0.4 pCi/L of radon is normally found in the outside air. The U.S. Congress has set a long-term goal that indoor radon levels be no more than outdoor levels. While this goal is not yet technologically achievable for all homes, radon levels in many homes *can* be reduced to 2 pCi/L or less. A radon level below 4 pCi/L still poses a risk. Consider fixing when the radon level is between 2 and 4 pCi/L.

Radon and Smoking

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 260 people could get lung cancer	↳ 250 times the risk of drowning	Fix your home
10 pCi/L	About 150 people could get lung cancer	↳ 200 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 120 people could get lung cancer	↳ 30 times the risk of dying in a fall	Fix your home
4 pCi/L	About 62 people could get lung cancer	↳ 5 times the risk of dying in a car crash	Fix your home
2 pCi/L	About 32 people could get lung cancer	↳ 6 times the risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 20 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels 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 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 from 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)	

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.

Sometimes short-term tests are less definitive about whether the radon level in the home is at or above 4 pCi/L; particularly when the results are close to 4 pCi/L. For example, if the average of two short-term tests is 4.1 pCi/L, there is about a 50 percent chance that the year-round average is somewhat below, or above, 4 pCi/L.

However, EPA believes that any radon exposure carries some risk; no level of radon is safe. Even radon levels below 4 pCi/L pose some risk. You can reduce your risk of lung cancer by lowering your radon level.

As with other environmental pollutants, there is some uncertainty about the magnitude of radon health risks. However, we know more about radon risks than risks from most other cancer-causing substances. This is because estimates of radon risks are based on data from human studies (underground miners). Additional studies on more typical populations are under way.

Your radon measurement will give you an idea of your risk of getting lung cancer. Your chances of getting lung cancer from radon depend mostly on:

- ✓ Your home's radon level;
- ✓ The amount of time you spend in your home; and
- ✓ Whether you are a smoker or have ever smoked.

Smoking combined with radon is an especially serious health risk. If you smoke or are a former smoker, the presence of radon greatly increases your risk of lung cancer. If you stop smoking now and lower the radon level in your house, you will reduce your lung cancer risk.

Radon Testing Checklist

For reliable test results, follow this *Radon Testing Checklist* carefully. Testing for radon is not complicated. Improper testing may yield inaccurate results and require another test. Disturbing or interfering with the test device, or with **closed-house conditions***, may invalidate the test results and is illegal in some states. If the seller or qualified tester cannot confirm that all items have been completed, take another test.

✓ *Before Conducting a Radon Test:*

- Notify the occupants of the importance of proper testing conditions. Give the occupants written instructions or a copy of this *Guide* and explain the directions carefully.
- Conduct the radon test for a minimum of 48 hours; some test devices have a minimum exposure time greater than 48 hours.
- When doing a short-term test ranging from 2-4 days, it is important to maintain closed-house conditions for at least 12 hours before the beginning of the test and during the entire test period.
- When doing a short-term test ranging from 4-7 days, EPA recommends that closed-house conditions be maintained.
- If you conduct the test yourself, use a qualified radon measurement device and follow the laboratory's instructions. Your state may be able to provide you with a list of do-it-yourself test devices available from qualified laboratories.
- If you hire someone to do the test, hire only a qualified individual. Some states issue photo identification (ID) cards; ask to see it. The tester's ID number, if available, should be included or noted in the test report.



*Closed-house conditions means keeping all windows closed, keeping doors closed except for normal entry and exit, and not operating fans or other machines which bring in air from outside. Fans that are part of a radon-reduction system or small exhaust fans operating for only short periods of time may run during the test.

Radon Testing Checklist

(continued)

- The test should include method(s) to prevent or detect interference with testing conditions or with the testing device itself.
- If the house has an active radon-reduction system, make sure the vent fan is operating properly. If the fan is not operating properly, have it (or ask to have it) repaired and then test.

✓ *During a Radon Test:*

- Maintain closed-house conditions during the entire duration of a short-term test, especially for tests shorter than one week in length.
- Operate the home's heating and cooling systems normally during the test. For tests lasting less than one week, operate only air-conditioning units which recirculate interior air.
- Do not disturb the test device at any time during the test.
- If a radon-reduction system is in place, make sure the system is working properly and will be in operation during the entire radon test.

✓ *After a Radon Test:*

- If you conduct the test yourself, be sure to promptly return the test device to the laboratory. Be sure to complete the required information, including start and stop times, test location, etc.
- If an elevated radon level is found, fix the home. Contact a qualified radon-reduction contractor about lowering the radon level. EPA recommends that you fix the home when the radon level is 4 pCi/L or more.
- Be sure that you or the radon tester can demonstrate or provide information to ensure that the testing conditions were not violated during the testing period.

6. What Should I Do if the Radon Level is High?

a. High Radon Levels Can Be Reduced

EPA recommends that you take action to reduce your home's indoor radon levels if your radon test result is 4 pCi/L or higher. It is better to correct a radon problem before placing your home on the market because then you have more time to address a radon problem.

If elevated levels are found during the real estate transaction, the buyer and seller should discuss the timing and costs of radon reduction. The cost of making repairs to reduce radon levels depends on how your home was built and other factors. Most homes can be fixed for about the same cost as other common home repairs. Check with and get an estimate from one or more qualified mitigators.

b. How to Lower the Radon Level in Your Home

A variety of methods can be used to reduce radon in homes. Sealing cracks and other openings in the foundation is a basic part of most approaches to radon reduction. EPA does not recommend the use of sealing alone to limit radon entry. Sealing alone has not been shown to lower radon levels significantly or consistently.

In most cases, a system with a vent pipe(s) and fan(s) is used to reduce radon. These “sub-slab depressurization” systems do not require major changes to your home. Similar systems can also be installed in homes with crawl spaces. These systems prevent radon gas from entering the home from below the concrete floor and from outside the foundation. Radon mitigation contractors may use other methods that may also work in your home. The right system depends on the design of your home and other factors.

Techniques for reducing radon are discussed in EPA's *Consumer's Guide to Radon Reduction*. As with any other household appliance, there are costs associated with the operation of a radon-reduction system.

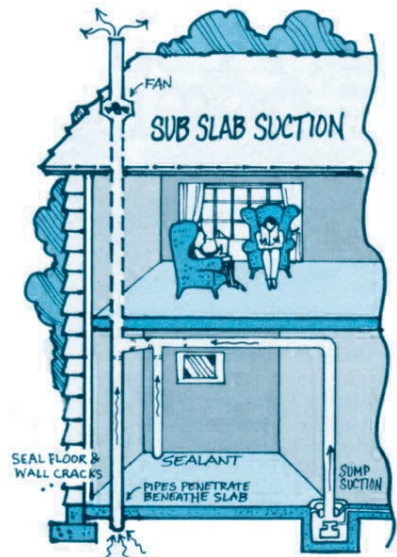


Radon and Home Renovations

If you are planning any major renovations, such as converting an unfinished basement area into living space, it is especially important to test the area before you begin.

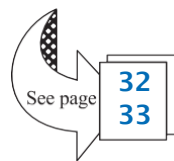
If your test results indicate an elevated radon level, radon-resistant techniques can be inexpensively included as part of the renovation. Major renovations can change the level of radon in any home. Test again after the work is completed.

You should also test your home again after it is fixed to be sure that radon levels have been reduced. 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. In addition, it is a good idea to retest your home sometime in the future to be sure radon levels remain low.



c. Selecting a Radon-Reduction (Mitigation) Contractor

Select a qualified radon-reduction contractor to reduce the radon level in your home. Any mitigation measures taken or system installed in your home must conform to your state's regulations. In states without regulations covering mitigation, EPA recommends that the system conform to ASTM E 2121.



EPA recommends that the mitigation contractor review the radon measurement results before beginning any radon-reduction work. Test again after the radon mitigation work has been completed to confirm that previous elevated levels have been reduced. EPA recommends that the test be conducted by an independent, qualified radon tester.



d. What Can a Qualified Radon-Reduction Contractor Do for You?

A qualified radon-reduction (mitigation) contractor should be able to:

- Review testing guidelines and measurement results, and determine if additional measurements are needed;
- Evaluate the radon problem and provide you with a detailed, written proposal on how radon levels will be lowered;
- Design a radon-reduction system;
- Install the system according to EPA recommended standard, or state and local codes; and
- Make sure the finished system effectively reduces radon levels to acceptable levels.

Choose a radon mitigation contractor to fix your radon problem just as you would for any other home repair. You may want to get more than one estimate, and ask for and check their references. Make sure the person you hire is qualified to install a mitigation system. Some states regulate or certify radon mitigation services providers.

Be aware that a potential conflict of interest exists if the same person or firm performs the testing and installs the mitigation system. Some states may require the homeowner to sign a waiver in such cases. If the same person or firm does the testing and mitigation, make sure the testing is done in accordance with the *Radon Testing Checklist*. Contact your state radon office for more information.

e. Radon in Water

The radon in your home's indoor air can come from two sources, the soil or your water supply. Compared to radon entering your home through the water, radon entering your home through the soil is a much larger risk. If you've tested for radon in air and have elevated radon levels **and** your water comes from a private well, have your water tested. The devices and procedures for testing your home's water supply are different from those used for measuring radon in air.

The radon in your water supply poses an inhalation risk and an ingestion risk. Research has shown that your risk of lung cancer from breathing radon in air is much larger than your risk of stomach cancer from swallowing water with radon in it. Most of your risk from radon in water comes from radon released into the air when water is used for showering and other household purposes.

Radon in your home's water is not usually a problem when its source is surface water. A radon in water problem is more likely when its source is ground water, e.g., a private well or a public water supply system that uses ground water. Some public water systems treat their water to reduce radon levels before it is delivered to your home. If you are concerned that radon may be entering your home through the water and your water comes from a public water supply, contact your water supplier.

If you've tested your private well and have a radon in water problem, it can be fixed. Your home's water supply can be treated in one of two ways. **Point-of-entry** treatment can effectively remove radon from the water before it enters your home. Point-of-entry treatment usually employs either granular activated carbon (GAC) filters or aeration devices. While GAC filters usually cost less than aeration devices, filters can collect radioactivity and may require a special method of disposal. **Point-of-use** treatment devices remove radon from your water at the tap, but only treat a small portion of the water you use, e.g., the water you drink. Point-of-use devices are not effective in reducing the risk from breathing radon released into the air from all water used in the home.

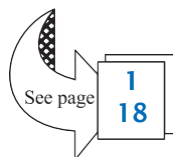
For information on radon in water, testing and treatment, and existing or planned radon in drinking water standards, visit <https://archive.epa.gov/water/archive/web/html/index-9.html>, an EPA web site. If your water comes from a private well, you can also contact your state radon office.



7. Radon Myths and Facts

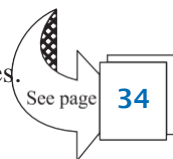
MYTH #1: Scientists are not sure that radon really is a problem.

FACT: Although some scientists dispute the precise number of deaths due to radon, all the major health organizations (like the Centers for Disease Control, the American Lung Association, and the American Medical Association) agree with estimates that radon causes thousands of preventable lung cancer deaths every year. This is especially true among smokers, since the risk to smokers is much greater than to non-smokers.



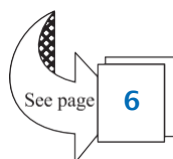
MYTH #2: Radon testing devices are not reliable and are difficult to find.

FACT: Reliable radon tests are available from qualified radon testers and companies. Active radon devices can continuously gather and periodically record radon levels to reveal any unusual swings in the radon level during the test. Reliable testing devices are also available by phone or mail-order, and can be purchased in hardware stores and other retail outlets. Contact your state radon office for a list of qualified radon test companies.



MYTH #3: Radon testing is difficult and time-consuming.

FACT: Radon testing is easy. You can test your home yourself or hire a qualified radon test company. Either approach takes only a small amount of time and effort.



MYTH #4: Homes with radon problems cannot be fixed.

FACT: There are solutions to radon problems in homes. Thousands of home owners have already lowered their radon levels. Most homes can be fixed for about the same cost as other common home repairs. Contact your state radon office for a list of qualified mitigation contractors.

MYTH #5: Radon only affects certain types of homes.

FACT: Radon can be a problem in all types of homes, including old homes, new homes, drafty homes, insulated homes, homes with basements, and homes without basements. Local geology, construction materials, and how the home was built are among the factors that can affect radon levels in homes.

MYTH #6: Radon is only a problem in certain parts of the country.

FACT: High radon levels have been found in every state. Radon problems do vary from area to area, but the only way to know a home's radon level is to test.

MYTH #7: A neighbor's test result is a good indication of whether your home has a radon problem.

FACT: It is not. Radon levels vary from home to home. The only way to know if your home has a radon problem is to test it.

MYTH #8: Everyone should test their water for radon.

FACT: While radon gets into some homes through the water, it is important to first test the air in the home for radon. If your water comes from a public water system that uses ground water, call your water supplier. If high radon levels are found and the home has a private well, call the Safe Drinking Water Hotline at (800) 426-4791 for information on testing your water. Also, call your state radon office for more information about radon in air.



MYTH #9: It is difficult to sell a home where radon problems have been discovered.

FACT: Where radon problems have been fixed, home sales have not been blocked. The added protection will be a good selling point.

MYTH #10: I have lived in my home for so long, it does not make sense to take action now.

FACT: You will reduce your risk of lung cancer when you reduce radon levels, even if you have lived with an elevated radon level for a long time.

MYTH #11: Short-term tests cannot be used for making a decision about whether to reduce the home's high radon levels.

FACT: Short-term tests can be used to decide whether to reduce the home's high radon levels. However, the closer the short-term testing result is to 4 pCi/L, the less certainty there is about whether the home's year-round average is above or below that level. Keep in mind that radon levels below 4 pCi/L still pose some risk and that radon levels can be reduced to 2 pCi/L or below in most homes.

8. Need More Information about Radon?

If you have a radon-related question, you should contact your state radon office. The following web sites, hotlines, and publications are your best sources of information. Visit our Frequent Questions web site at <https://iaq.zendesk.com/hc/en-us/sections/202370518-Indoor-Air-Quality>. You can also find indoor air quality information and publications on EPA's many web sites.

a. World Wide Web Sites (EPA)






These are EPA's most important web sites for information on radon and indoor air quality in homes. All the EPA publications listed in this section are available on EPA's web sites.

- <https://www.epa.gov/radon/>. EPA's main radon page. Includes links to the NAS radon report, radon-resistant new construction, the map of radon zones, radon publications, hotlines, and more.
- <https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>. Provides detailed information on contacting your state's radon office, including links to some state web sites. State indoor air quality contacts are also included.
- <https://www.epa.gov/radon/publications-about-radon>. Offers the full text version of EPA's most popular radon publications, including the *Home Buyer's and Seller's Guide to Radon*, the *Consumer's Guide to Radon Reduction*, and the
 - *Model Standards and Techniques for Control of Radon in New Residential Buildings*, and others.
- <https://www.epa.gov/iaq>. EPA's main page on indoor air quality. Includes information on indoor risk factors, e.g., asthma, secondhand smoke, carbon monoxide, duct cleaning, ozone generating devices, indoor air cleaners, flood
 - cleanup, etc.
- <https://archive.epa.gov/water/archive/web/html/index-9.html>. EPA's main page on radon in water. Includes information on statutory requirements and links to the drinking water standards program.

b. Radon Hotlines (Toll-Free)



EPA supports the following hotlines to best serve consumers with radon-related questions and concerns.

-  **1-800-SOS-RADON (767-7236).*** Purchase radon test kits by phone.
-  **1-800-55RADON (557-2366).*** Get live help for your radon questions.
-  **1-800-644-6999.*** Radon Fix-It Hotline. For general information on fixing or reducing the radon level in your home.
-  **1-866-528-3187.*** Línea Directa de Información sobre Radón en Español. Hay operadores disponibles desde las 9:00 AM hasta las 5:00 PM para darle información sobre radón y como ordenar un kit para hacer la prueba de radón en su hogar.
-  **1-800-426-4791.** Safe Drinking Water Hotline. For general information on drinking water, radon in water, testing and treatment, and standards for radon in drinking water. Operated under a contract with EPA.

*Operated by Kansas State University in partnership with EPA.

9.

State Radon Offices

<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>

Up-to-date information on how to contact your state radon office is available on the web (above). You will also find a list of state hotlines, state indoor air coordinators, and state web sites (if available). Some states can also provide you with a list of qualified radon services providers. Native Americans living on Tribal Lands should contact their Tribal Health Department or Housing Authority for assistance.

10.

EPA Regional Offices

<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>

E

REGION	STATES	PHONE / FAX
US EPA New England/ Region 1 One Congress Street, Suite 1100 John F. Kennedy Federal Bldg. Boston, MA 02114-2023	CT, MA, ME, NH, RI, VT	617-918-1630 617-918-4940-fax
US EPA/ Region 2 290 Broadway, 28th Floor New York, NY 10007-1866	NJ, NY, PR, VI	212-637-3745 212-637-4942-fax
US EPA/ Region 3 1650 Arch Street Philadelphia, PA 19103	DC, DE, MD, PA, VA, WV	800-438-2474 Toll-free 215-814-2086 215-814-2101-fax
US EPA/ Region 4 61 Forsyth Street, SW Atlanta, GA 30303-3104	AL, FL, GA, KY, MS, NC, SC, TN	404-562-9145 404-562-9095-fax
US EPA/ Region 5 77 West Jackson Blvd., (AE-17J) Chicago, IL 60604	IL, IN, MI, MN, OH, WI	312-353-6686 312-886-0617-fax
US EPA/ Region 6 1445 Ross Avenue (6PD-T) Dallas, TX 75202-2733	AR, LA, NM, OK, TX	800-887-6063 Toll-free 214-665-7550 214-665-6762-fax
US EPA/ Region 7 901 North 5 th Street (ARTD/ RALI) Kansas City, KS 66101	IA, KS, MO, NE	913-551-7260 913-551-7065-fax
US EPA/ Region 8 999 18th Street, Suite 500 (8P-AR) Denver, CO 80202-2466	CO, MT, ND, SD, UT, WY	800-227-8917 Toll-free 303-312-6031 303-312-6044-fax
US EPA/ Region 9 75 Hawthorne Street (Air-6) San Francisco, CA 94105	AZ, CA, HI, NV, GUAM	415-744-1046 415-744-1073-fax
US EPA/ Region 10 1200 Sixth Avenue (OAQ-107) Seattle, WA 98101	AK, ID, OR, WA	206-553-7299 206-553-0110-fax

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U.S. SURGEON GENERAL HEALTH ADVISORY

“Indoor radon is the second-leading cause of lung cancer in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country. It’s important to know that this threat is completely preventable. Radon can be detected with a simple test and fixed through well-established venting techniques.” January 2005

Consumers need to know about the health of a house they are considering purchasing, including whether there is a radon problem, and if so, how to fix it. The *Home Buyer’s and Seller’s Guide to Radon* provides practical consumer information that every home buyer needs to know.



Consumer Federation of America Foundation



American Society of Home Inspectors



National Safety Council



United States
Environmental Protection
Agency

Indoor Environments Division (6609J)
EPA 402/K-13/002 | September 2013 (revised) | www.epa.gov/radon



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with a minimum of 50% post-consumer fiber
using vegetable-based ink.

Indoor Air Quality (IAQ)

Consumer's Guide to Radon Reduction How to Fix Your Home



OVERVIEW

Reduce Radon Levels in Your Home

Radon is the leading cause of lung cancer for non-smokers and the second leading cause of lung cancer for the general population. The Surgeon General and EPA recommend testing for radon and reducing radon in homes that have high levels. Fix your home if your radon level is confirmed to be 4 picocuries per liter, pCi/L, or higher. Radon levels less than 4 pCi/L still pose a risk, and in many cases may be reduced. If you smoke and your home has high radon levels, your risk of lung cancer is especially high.

Select a State Certified and/or Qualified Radon Mitigation Contractor

Choose a qualified radon mitigation contractor to fix your home. Start by checking with your state radon office. Many states require radon professionals to be licensed, certified, or registered. You also can contact private radon proficiency programs for lists of privately certified radon professionals in your area. See pages 4 and 17 for more information.

Radon Reduction Techniques Work

Radon reduction systems work. Some radon reduction systems can reduce radon levels in your home by up to 99 percent. Most homes can be fixed for about the same cost as other common home repairs. Your costs may vary depending on the size and design of your home and which radon reduction methods are needed. Get an estimate from one or more qualified radon mitigation contractors. Hundreds of thousands of people have reduced radon levels in their homes.

Maintain Your Radon Reduction System

Maintaining your radon reduction system takes little effort and keeps the system working properly and radon levels low. See page 13 for more information.



INTRODUCTION

This booklet is for people who tested their home for radon and have elevated radon levels — 4 pCi/L or higher. This booklet can help you:

- Select a qualified radon mitigation contractor to reduce the radon levels in your home.
- Determine an appropriate radon reduction method.
- Maintain your radon reduction system.

Your state radon office can provide information on how to test your home or how to locate a qualified radon professional <https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>. EPA's A Citizen's Guide to Radon and The Home Buyer's and Seller's Guide to Radon have information on radon testing. Both documents are available at <https://www.epa.gov/radon/publications-about-radon>.

HOW RADON ENTERS YOUR HOME



Radon is a naturally occurring radioactive gas produced by the breakdown of uranium in soil, rock, and water. Air pressure inside your home is usually lower than pressure in the soil around your home's foundation. Because of this difference in pressure, your home acts like a vacuum, drawing radon in through foundation cracks and other openings.

Radon also may be present in well water and can be released into the air in your home when water is used for showering and other household uses. In most cases, radon entering the home through water is a small risk compared with radon entering your home from the soil. In a small number of homes, the building materials — such as granite and certain concrete products

— can give off radon, although building materials rarely cause radon problems by themselves. In the United States, radon gas in soils is the principal source of elevated radon levels in homes.

RADON IS A CANCER-CAUSING, RADIOACTIVE GAS

Radon is estimated to cause tens of thousands of lung cancer deaths each year. **In fact, the Surgeon General has warned that radon is the second leading cause of lung cancer in the United States.** Only smoking causes more lung cancer deaths. If you smoke and your home has high radon levels, your risk of lung cancer is especially high.

WHAT DO YOUR RADON TEST RESULTS MEAN?

Any radon exposure has some risk of causing lung cancer. **The lower the radon level in your home, the lower your family's risk of lung cancer.** The amount of radon in the air is measured in pCi/L.

The U.S. Congress has set a long-term goal that indoor radon levels be no more than outdoor levels; about 0.4 pCi/L of radon is normally found in the outside air. EPA recommends fixing your home if the results of one long-term test or the average of two short-term tests show radon levels of 4 pCi/L or higher. With today's technology, radon levels in most homes can be reduced to 2 pCi/L or below. You also may want to consider fixing if the level is between 2 and 4 pCi/L.

A short-term test remains in your home for two days to 90 days, whereas a long-term test remains in your home for more than 90 days. All radon tests should be taken for a minimum of 48 hours. A short-term test will yield faster results, but a long-term test will give you a better understanding of your home's year-round average radon level.

EPA recommends two categories of radon testing. One category is for concerned homeowners or occupants whose home is not for sale; refer to EPA's pamphlet "A Citizen's Guide to Radon" for testing guidance. The second category is for real estate transactions; refer to EPA's pamphlet "Home Buyer's and Seller's Guide to Radon," which provides guidance and answers to some common questions. Both documents are available at <https://www.epa.gov/radon/publications-about-radon>.

SELECTING A RADON TEST KIT

Since you cannot see or smell radon, special equipment is needed to detect it. When you're ready to test your home, contact your state radon office for information on locating qualified test kits or qualified radon testers. You also can order test kits and obtain information at <http://sosradon.org/> There are two types of radon testing devices. Passive radon testing devices do not need power to function. These include charcoal canisters, alpha-track detectors, charcoal liquid scintillation devices, and electret ion chamber detectors. Both short- and long-term passive devices are generally inexpensive. Active radon testing devices require power to function and usually provide hourly readings and an average result for the test period. These include continuous radon monitors and continuous working level monitors, and these tests may cost more. A state or local official can explain the differences between the devices and recommend ones that are most appropriate for your needs and expected testing conditions. Make sure to use a radon testing device from a qualified laboratory.

WHY HIRE A CONTRACTOR?

EPA recommends that you have a qualified radon mitigation contractor fix your home because lowering high radon levels requires specific technical knowledge and special skills. Without the proper equipment or technical knowledge, you could actually increase your radon level or create other potential hazards and additional costs. However, if you decide to do the work yourself, get information on appropriate training courses from your state radon office.

WILL ANY CONTRACTOR DO?

EPA recommends that you use a certified or qualified radon mitigation contractor trained to fix radon problems. You can determine a service provider's qualifications to perform radon measurements or to mitigate your home in several ways. First, check with your state radon office. Many states require radon professionals to be licensed, certified or registered, and to install radon mitigation systems that meet state requirements. Most states can provide you with a list of knowledgeable radon service providers doing business in the state (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>).

In states that don't regulate radon services, ask the contractor if they hold a professional proficiency or certification credential, and if they follow industry consensus standards, such as the American Society for Testing and Materials, ASTM, Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings, E2121. You can contact private proficiency programs for lists of privately certified professionals in your area. Such programs usually provide members with a photo ID card, which indicates their qualifications and the ID card's expiration date. For more information on private proficiency programs, visit <https://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional#what>, or contact your state radon office.

HOW TO SELECT A CONTRACTOR

Get Estimates

Choose a contractor to fix a radon problem just as you would choose someone to do other home repairs. It is wise to get more than one estimate, to ask for references, and to contact some of those references to ask if they are satisfied with the contractor's work. Also, ask your state radon office or your county or state consumer protection office for information about the contractors.

Use this checklist when evaluating and comparing contractors and ask the following questions:

YES NO

- Will the contractor provide references or photographs, as well as test results of before and after radon levels of past radon reduction work?
- Can the contractor explain what the work will involve, how long it will take to complete, and exactly how the radon reduction system will work?
- Does the contractor charge a fee for any diagnostic tests? Although many contractors give free estimates, they may charge for diagnostic tests. These tests help determine what type of radon reduction system should be used and in some cases are necessary, especially if the contractor is unfamiliar with the type of house structure or the anticipated degree of difficulty. See “Radon Reduction Techniques” on page 8 for more on diagnostic tests.
- Did the contractor inspect your home’s structure before giving you an estimate?
- Did the contractor review the quality of your radon measurement results and determine if appropriate testing procedures were followed?

Compare the contractor’s proposed costs and consider what you get for your money, taking into account: a less expensive system may cost more to operate and maintain; a less expensive system may have less aesthetic appeal; a more expensive system may be best for your home; and, the quality of the building material will affect how long the system lasts.

Do the contractors’ proposals and estimates include:

YES NO

- Proof of state certification, professional proficiency or certification credentials?
- Proof of liability insurance and being bonded, and having all necessary licenses to satisfy local requirements?
- Diagnostic testing prior to design and installation of a radon reduction system?
- Installation of a warning device to caution you if the radon reduction system is not working correctly?
- Testing after installation to make sure the radon reduction system works well?
- A guarantee to reduce radon levels to 4 pCi/L or below? And if so, for how long?

The Contract

Ask the contractor to prepare a contract before any work starts. Read the contract before you sign it. Make sure everything in the contract matches the original proposal. The contract should describe exactly what work will be done prior to



and during the installation of the system, what the system consists of, and how the system will operate. Many contractors provide a guarantee that they will adjust or modify the system to reach a negotiated radon level (e.g., 2 pCi/L or less). Carefully read the conditions of the contract describing the guarantee. Consider optional additions to your contract that

may add to the initial cost of the system, but may be worth the extra expense. Typical options might include an extended warranty, a service plan or improved aesthetics.

Important information that should appear in the contract includes:

- The total cost of the job, including all taxes and permit fees; how much, if any, is required for a deposit; and when payment is due in full.**
- The time needed to complete the work.**
- An agreement by the contractor to obtain necessary permits and follow required building codes.**
- A statement that the contractor carries liability insurance and is bonded and insured to protect you in case of injury to persons, or damage to property, while the work is being done.**
- A guarantee that the contractor will be responsible for damage during the job and cleanup after the job.**
- Details of any guarantee to reduce radon below a negotiated level.**
- Details of warranties or other optional features associated with the hardware components of the mitigation system.**
- A declaration stating whether any warranties or guarantees are transferable if you sell your home.**
- A description of what the contractor expects the homeowner to do, such as make the work area accessible, before work begins.**

WHAT TO LOOK FOR IN A RADON REDUCTION SYSTEM

In selecting a radon reduction method for your home, you and your contractor should consider several things, including: how high your initial radon level is, the costs of installation and system operation, your home size, and your foundation type.

Installation and Operating Costs

Most types of radon reduction systems cause some loss of heated or air conditioned air, which could increase your utility bills. How much your utility bills increase will depend on the climate you live in, what kind of reduction system you select, and how your home is built. Systems that use fans are more effective in reducing radon levels; however, they will slightly increase your electric bill.



RADON REDUCTION TECHNIQUES



There are several methods a contractor can use to lower radon levels in your home. Some techniques prevent radon from entering your home while others reduce radon levels after it has entered. EPA generally recommends methods that prevent the entry of radon. **Soil suction**, for example, prevents radon from entering your home by drawing the radon from below the home and venting it through a pipe, or pipes, to the air above the home where it is quickly diluted.

Any information that you may have about the construction of your home could help your contractor choose the best system. Your

contractor will perform a visual inspection of your home and design a system that considers specific features of your home. If this inspection fails to provide enough information, the contractor may need to perform **diagnostic tests** during the initial phase of the installation to help develop the best radon reduction system for your home. For instance, your contractor can use chemical smoke to find the source and direction of air movement. A contractor can learn air flow sources and directions by watching a small amount of smoke that he or she shot into holes, drains, sumps or along cracks. The sources of air flow show possible radon routes. A contractor may have concerns about backdrafting of combustion appliances when considering radon mitigation options, and may recommend that the homeowner have the appliances checked by a qualified inspector.

Another type of diagnostic test is a soil communication test. This test uses a vacuum cleaner and chemical smoke to determine how easily air can move from one point to another under the foundation. By inserting a vacuum cleaner hose in one small hole and using chemical smoke in a second small hole, a contractor can see if the smoke is pulled down into the second hole by the force of the vacuum cleaner's suction. Watching the smoke during a soil communication test helps a contractor decide if certain radon reduction systems would work well in your home.

Whether diagnostic tests are needed is decided by details specific to your home, such as the foundation design, what kind of material is under your home, and by the contractor's experience with similar homes and similar radon test results.

Home Foundation Types

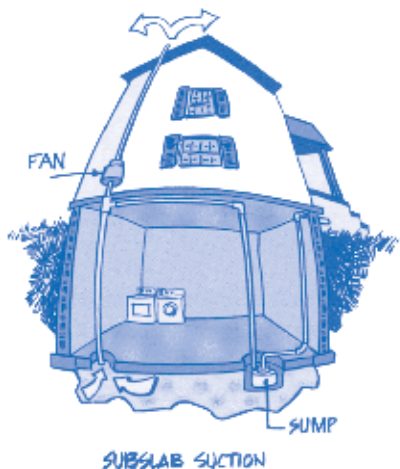
Your home type will affect the kind of radon reduction system that will work best. Homes are generally categorized according to their foundation design. For example: **basement**; **slab-on-grade**, concrete poured at ground level; or **crawlspace**, a shallow unfinished space under the first floor. Some homes have more than one foundation design feature. For instance, it is common to have a basement under part of the home and to have a slab-on-grade or crawlspace under the rest of the home. In these situations, a combination of radon reduction techniques may be needed to reduce radon levels to below 4 pCi/L.



Radon reduction systems can be grouped by home foundation design. Find your type of foundation design above and read about which radon reduction systems may be best for your home.

Basement and Slab-on-Grade Homes

In homes that have a basement or a slab-on-grade foundation, radon is usually reduced by one of four types of soil suction: **subslab suction**, **drain-tile suction**, **sump-hole suction**, or **block-wall suction**.



Active subslab suction — also called **subslab depressurization** — is the most common and usually the most reliable radon reduction method. One or more suction pipes are inserted through the floor slab into the crushed rock or soil underneath. They also may be inserted below the concrete slab from outside the home. The number and location of suction pipes that are needed depends on how easily air can move in the crushed rock or soil under the slab and on the strength of the radon source. Often, only a single suction point is needed.

A contractor usually gets this information from visual inspection, from diagnostic tests or from experience. A radon vent fan connected to the suction pipes draws the radon gas from below the home and releases it into the outdoor air while simultaneously creating a negative pressure or vacuum beneath the slab. Common fan locations include unconditioned home and garage spaces, including attics and the exterior of the home.

Passive subslab suction is the same as active subslab suction except it relies on natural pressure differentials and air currents instead of a fan to draw radon up from below the home. Passive subslab suction is usually associated with radon-resistant features installed in newly constructed homes. **Passive subslab suction** is generally not as effective in reducing high radon levels as active subslab suction.

Some homes have **drain tiles or perforated pipe** to direct water away from the foundation of the home. Suction on these tiles or pipes is often effective in reducing radon levels.

One variation of subslab and drain tile suction is **sump-hole suction**. Often, when a home with a basement has a sump pump to remove unwanted water, the sump can be capped so that it can continue to drain water and serve as the location for a radon suction pipe.

Block-wall suction can be used in basement homes with hollow block foundation walls. This method removes radon and depressurizes the block wall, similar to subslab suction. This method is often used in combination with subslab suction.

Crawlspace Homes

An effective method to reduce radon levels in crawlspace homes involves covering the earth floor with a high-density plastic sheet. A vent pipe and fan are used to draw the radon from under the sheet and vent it to the outdoors. This form of soil suction is called **submembrane suction, and when properly applied is the most effective way to reduce radon levels in crawlspace homes**. Another less-favorable option is active crawlspace depressurization, which involves drawing air directly from the crawlspace using a fan. This technique generally does not work as well as submembrane suction and requires special attention to combustion appliance backdrafting and sealing the crawlspace from other portions of the home. It also may result in increased energy costs due to loss of conditioned air from the home.

In some cases, radon levels can be lowered by ventilating the crawlspace passively, or actively, with the use of a fan. Crawlspace ventilation may lower indoor radon levels both by reducing the home's suction on the soil and by diluting the radon beneath the home. Passive ventilation in a crawlspace is

achieved by opening vents or installing additional vents. Active ventilation uses a fan to blow air through the crawlspace instead of relying on natural air circulation. In colder climates, for either passive or active crawlspace ventilation, water pipes, sewer lines and appliances in the crawlspace may need to be insulated against the cold. These ventilation options could result in increased energy costs for the home.

Other Types of Radon Reduction Methods

Other radon reduction techniques that can be used in any type of home include: sealing, house or room pressurization, heat recovery ventilation and natural ventilation.

Sealing cracks and other openings in the foundation is a basic part of most approaches to radon reduction. Sealing the cracks limits the flow of radon into your home, thereby making other radon reduction techniques more effective and cost-efficient. It also reduces the loss of conditioned air. EPA does not recommend the use of sealing alone to reduce radon because, by itself, sealing has not been shown to lower radon levels significantly or consistently. It is difficult to identify and permanently seal the places where radon is entering. Normal settling of your home opens new entry routes and reopens old ones.

House or room pressurization uses a fan to blow air into the basement, or living area from either upstairs or outdoors. It attempts to create enough pressure at the lowest level indoors — in a basement, for example — to prevent radon from entering into the home. The effectiveness of this technique is limited by home construction, climate, other appliances in the home and occupant lifestyle. In order to maintain enough pressure to keep radon out, the doors and windows at the lowest level must not be left opened, except for normal entry and exit. This approach generally results in more outdoor air being introduced into the home, which can cause moisture intrusion and energy penalties. Consequently, this technique should only be considered after the other, more-common techniques have not sufficiently reduced radon.

A **heat recovery ventilator**, or **HRV**, also called an **air-to-air heat exchanger**, can be installed to increase ventilation, which will help reduce the radon levels in your home. An HRV will increase ventilation by introducing outdoor air while using the heated or cooled air being exhausted to warm or cool the incoming air. HRVs can be designed to ventilate all or part of your home, although they are more effective in reducing radon levels when used to ventilate only the basement. If properly balanced and maintained, they ensure a constant degree of ventilation throughout the year. HRVs also can improve air quality in homes that have other indoor pollutants. There could be significant increase in the heating and cooling costs with an HRV, but not as great as ventilation without heat recovery.

Some **natural ventilation** occurs in all homes. By opening windows, doors and vents on the lower floors, you increase the ventilation in your home. This increase in ventilation mixes outdoor air with the indoor air containing radon, and can result in reduced radon levels. However, once windows, doors and vents are closed, radon concentrations most often return to previous values within about 12 hours. Natural ventilation in any type of home should normally be regarded as only a temporary radon reduction approach because of the following disadvantages: loss of conditioned air and related discomfort; greatly increased costs of conditioning additional outside air; and security concerns.

CHECKING YOUR CONTRACTOR'S WORK

Below is a list of basic installation requirements that your contractor should meet when installing a radon reduction system in your home. It is important to verify with your contractor that the radon mitigation standards (ASTM E2121 in particular) are properly met to ensure that your radon reduction system will be effective. You also can check with your state radon office to see if there are state requirements that your contractor must meet.

- Radon reduction systems must be clearly labeled. This will avoid accidental changes to the system that could disrupt its function.**
- The exhaust pipes of soil suction systems must vent above the surface of the roof and 10 feet or more above the ground, and must be at least 10 feet away from windows, doors or other openings that could allow radon to reenter the home, if the exhaust pipes do not vent at least 2 feet above these openings.**
- The exhaust fan must not be located in or below a livable area. For instance, it should be installed in unconditioned space.**
- If installing an exhaust fan outside, the contractor must install a fan that meets local building codes for exterior use.**
- Electrical connections of all active radon reduction systems must be installed according to local electrical codes.**
- A warning device must be installed to alert you if an active system stops working properly. Examples of system failure warning devices are: a liquid gauge, a sound alarm, a light indicator, and a dial, or needle display, gauge. The warning device must be placed where it can be seen or heard easily. Your contractor should check that the warning device works. Later on, if your monitor shows that the system is not working properly, call a contractor to have it checked.**

- A post-mitigation radon test should be done within 30 days of system installation, but no sooner than 24 hours after your system is in operation with the fan on, if it has one. The contractor may perform a post-mitigation test to check his work and the initial effectiveness of the system; however, it is recommend that you also get an independent follow-up radon measurement. Having an independent tester perform the test, or conducting the measurement yourself, will eliminate any potential conflict of interest. To test the system's effectiveness, a two- to seven-day measurement is recommended. Test conditions: windows and doors must be closed 12 hours before and during the test, except for normal entry and exit.
- Make sure your contractor completely explains your radon reduction system, demonstrates how it operates and explains how to maintain it. Ask for written operating and maintenance instructions and copies of any warranties.

LIVING IN A HOME WITH A RADON REDUCTION SYSTEM

Maintaining Your Radon Reduction System

Similar to a furnace or chimney, radon reduction systems need occasional maintenance. If you have a fan powered (or active) system, you should look at your warning device, usually a manometer, on a regular basis to make sure the system is working correctly. Fans may last for five years or more — manufacturer warranties tend not to exceed five years — and may then need to be repaired or replaced. The cost to replace a fan varies as it is based on labor and materials. Ask qualified mitigators for estimates before work begins. It is a good idea to retest your home at least every two years to be sure radon levels remain low.

Remember, the fan should NEVER be turned off; it must run continuously for the system to work correctly.

The filter in an HRV requires periodic cleaning and should be changed twice a year. Replacement filters for an HRV are easily changed and are priced between \$10 and \$25. Ask your contractor where filters can be purchased. Also, the vent that brings fresh air in from the outside needs to be inspected for leaves and debris. The ventilator should be checked annually by a heating, ventilating and air conditioning professional to make sure the air flow remains properly balanced. HRVs used for radon control should run all the time.

Remodeling Your Home after Radon Levels Have Been Lowered

If you decide to make major structural changes to your home after you have had a radon reduction system installed, such as converting an unfinished basement area into living space, ask your radon contractor whether these changes could void any warranties. If you are planning to add a new foundation for an addition to your home, ask your radon contractor what measures should be taken to ensure reduced radon levels throughout the home. After you remodel, retest in the lowest lived-in area to make sure the construction did not reduce the effectiveness of the radon reduction system.

BUYING OR SELLING A HOME?

If you are buying or selling a home and need to make decisions about radon, consult EPA's "Home Buyer's and Seller's Guide to Radon." If you are selling a home that has a radon reduction system, inform potential buyers and supply them with information about your system's operation and maintenance. If you are building a new home, consider that it is almost always less expensive to build radon-resistant features into new construction than it is to fix an existing home that has high radon levels. Ask your builder if he or she uses radon-resistant construction features. Your builder can refer to EPA's document "Building Radon Out: A Step-by-Step Guide On How To Build Radon-Resistant Homes," (<https://www.epa.gov/radon/publications-about-radon>) or your builder can work with a qualified contractor to design and install the proper radon reduction system. To find a qualified contractor contact your state radon office.



All homes should be tested for radon and elevated radon levels should be reduced. **Even new homes built with radon-resistant features should be tested after occupancy to ensure that radon levels are below 4 pCi/L.** If you have a test result of 4 pCi/L or more, you can have a qualified mitigator add a vent fan to an existing passive system to further reduce the radon level in your home.

RADON IN WATER

Most often, the radon in your home's indoor air can come from two sources, the soil or your water supply. Compared to radon entering your home through water, radon entering your home through soil is usually a much larger risk. If you are concerned about radon and you have a private well, consider testing for radon in both air and water. By testing for radon in both air and water, the results could enable you to more completely assess the radon mitigation options best suited to your situation. The devices and procedures for testing your home's water supply are different from those used for measuring radon in air.

The radon in your water supply poses an inhalation risk and a small ingestion risk. Most of your risk from radon in water comes from radon released into the air when water is used for showering and other household purposes. Research has shown that your risk of lung cancer from breathing radon in air is much larger than your risk of stomach cancer from swallowing water with radon in it.

Radon in your home's water is not usually a problem when its source is surface water. A radon in water problem is more likely when its source is ground water, such as a private well or a public water supply system that uses ground water. Some public water systems treat their water to reduce radon levels before it is delivered to your home. If you are concerned that radon may be entering your home through the water and your water comes from a public water supply, contact your water supplier.

If you've tested your private well and have a radon in water problem, it can be easily fixed. Your home's water supply can be treated in one of two ways; point-of-use or point-of-entry. Point-of-entry treatment for the whole home can effectively remove radon from the water before it enters your home's water distribution system. Point-of-entry treatment usually employs either granular activated carbon, or GAC, filters or aeration systems. While GAC filters usually cost less than aeration systems, filters can collect radioactivity and may require a special method of disposal. Both GAC filters and aeration systems have advantages and disadvantages that should be discussed with your state radon office or a water treatment professional. Point-of-use treatment devices remove radon from your water at the tap, but only treat a small portion of the water you use, such as the water you drink. Point-of-use devices are not effective in reducing the risk from breathing radon released into the air from all water used in the home.

For information on radon in water, testing and treatment, and radon in drinking water standards, or for general help, contact your state radon office <https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>.

RADON REDUCTION OF VARIOUS MITIGATION TECHNIQUES

Technique	Typical Radon Reduction	Comments
Subslab Suction (Subslab depressurization)	50 to 99 percent	Works best if air can move easily in material under slab.
Passive Subslab Suction	30 to 70 percent	May be more effective in cold climates; not as effective as active subslab suction.
drain tile Suction	50 to 99 percent	Can work with either partial or complete drain tile loops.
Block-wall Suction	50 to 99 percent	Only in homes with hollow block-walls; requires sealing of major openings.
Sump-Hole Suction	50 to 99 percent	Works best if air moves easily to sump from under the slab.
Submembrane depressurization in a Crawlspace	50 to 99 percent	Less heat loss than natural ventilation in cold winter climates.
natural ventilation in a Crawlspace	0 to 50 percent	Costs variable.
Sealing of Radon Entry Routes	See Comments	Normally only used with other techniques; proper materials and installation required.
House (Basement) Pressurization	50 to 99 percent	Works best with tight basement isolated from outdoors and upper floors.
natural ventilation	Variable/Temporary	Significant heated or cooled air loss; operating costs depend on utility rates and amount of ventilation.
Heat Recovery ventilation (HRV)	Variable/ See comments	Limited use; effectiveness limited by radon concentration or the amount of ventilation air available for dilution by the HRV. Best Applied in limited-space areas like basements.
Private well water Systems: Aeration	95 to 99 percent	Generally more efficient than GAC; requires annual cleaning to maintain effectiveness and to prevent contamination; requires venting radon to outdoors.
Private well water Systems: Granular Activated Carbon, or GAC	85 to 95 percent	Less efficient for higher levels than aeration; use for moderate levels, around 5,000 pCi/L or less in water; radioactive radon by-products can build on carbon; may need radiation shield around tank and care in disposal.

Note: Mitigation costs vary due to technique, materials, and the extent of the problem. Typically the cost of radon mitigations are comparable to other common home repairs.

FOR FURTHER INFORMATION

EPA Radon Web site

<https://www.epa.gov/radon>

EPA's main radon home page. Includes links to publications, hotlines, private proficiency programs and more.

EPA Regional Offices

<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>. Check this Web site for a listing of your EPA regional office.

EPA Publications

Most EPA radon publications are available online at

<https://www.epa.gov/radon/publications-about-radon>.

Hotlines

1-800-SOS-RADON (767-7236)

Operated by Kansas State University in partnership with EPA. Order radon test kits by phone.

1-800-426-4791

Safe Drinking Water Hotline, privately operated under contract to EPA. For general information on drinking water, radon in water, testing and treatment and radon drinking water standards.

Proficiency Programs

National Radon Proficiency Program (NRPP)

1-800-269-4174

www.aarst-nrpp.com/wp/

National Radon Safety Board (NRSB)

1-866-329-3474

www.nrsb.org

U.S. SURGEON GENERAL HEALTH ADVISORY

“Indoor radon is the second leading cause of lung cancer in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country. It’s important to know that this threat is completely preventable. Radon can be detected with a simple test and fixed through well-established venting techniques.” January 2005