



Arkansas Department of Health

4815 West Markham Street • Little Rock, Arkansas 72205-3867 • Telephone (501) 661-2000

Governor Asa Hutchinson

Nathaniel Smith, MD, MPH, Director and State Health Officer

September 4, 2019

Mayor Trae Reed
City of Lonoke
216 W. Academy
Lonoke, AR 72086

RE: Lonoke Community Radon Exposure Investigation

Dear Mayor Reed,

The Arkansas Department of Health (ADH) Environmental Epidemiology Section has evaluated radon sampling data collected at Lonoke Schools, the Lonoke Community Center, and residences in Lonoke, AR. ADH prepared this health consultation to address potential public health issues resulting from exposure to radon gas. ADH has completed this document under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services*.

Background and History

On April 11, 2019, an isolated portion of Lonoke High School was partially evacuated after a student reported feeling ill. The Arkansas Department of Environmental Quality (ADEQ) requested the assistance of the Environmental Protection Agency's (EPA) Superfund Technical Assessment and Response Team (START) team to provide air monitoring support to local and state authorities. EPA START mobilized in Lonoke on April 22, 2019 and provided air monitoring support to state and local officials on April 22, 23 and 25, 2019.

On April 25, 2019, representatives from EPA START, Lonoke Fire Department, and the 61st Civil Support Team (CST) conducted air monitoring activities at the Lonoke High School southeast annex building and two vacant residences (both located on Ponderosa Drive) monitoring conducted in eight (8) locations in Lonoke High School confirmed low oxygen levels ranging from 4% at floor level to 19.9% at breathing zone height (approximately three to five feet from floor level). [1] Normal oxygen levels are 20.9%. Carbon dioxide (CO₂) readings were high, ranging from 10,200 ppm (parts per million) (1.02%) to greater than 50,000 ppm (5%). Normal CO₂ levels in occupied spaces with adequate air exchange range from 350 ppm (0.035%) to 1,000 ppm (0.1%). [2]

Air monitoring conducted inside the first vacant Ponderosa residence (approximately 1,000 feet from Lonoke High School) identified oxygen levels ranging from 1.1% (bathtub drain) to 13.5% (sunroom breathing level). Air monitoring conducted at seven (7) locations within the same residence confirmed CO₂ readings ranging from 40,790 ppm (4.079%) to greater than 50,000 ppm (5%). Air monitoring conducted within the second vacant Ponderosa residence identified oxygen levels ranging from 20% to 20.1%. Air monitoring conducted at four (4) locations within the second Ponderosa residence confirmed CO₂ readings ranging from 4,600 ppm (0.46%) to 6,100 ppm (0.61%). [1] Currently, the source of CO₂ is unknown.

Upon completion of air monitoring activities, ADEQ recommended to the City of Lonoke that a private consultant be hired to further investigate the cause of elevated levels of CO₂. The 61st CST conducted additional analysis of the air monitoring readings and identified carbon disulfide (CS₂) as a factor that may have contributed to the elevated levels of CO₂. ADH offered support in evaluating any environmental sampling results that may be collected in the future.

At the recommendation of Atoka, Inc., an environmental consulting firm hired by a private citizen associated with one of the Ponderosa Drive residences, a short term radon test kit was placed in the vacant home on May 9, 2019, where the test kit remained for 112.25 hours (kit manufacturer's recommended duration is 48 to 96 hours). The radon test report indicated a level of 535.1 picocuries per liter of air (pCi/L). [2] This test result was shared with the ADH Agency for Toxic Substances and Disease Registry (ATSDR) cooperative agreement program and the ADH Radiation Control Section. Based on the unusually elevated radon reading, the ADH Radiation Control Section recommended that the citizen retest. The second test was placed in the vacant home on June 4, 2019, and remained for 50.72 hours. The second test result indicated a radon level of 169.4 pCi/L. [3] An average indoor radon level is 1.3 pCi/L. The EPA recommends mitigation in structures with readings at or above 4 pCi/L. [4]

Radon Sampling Plan Implementation

In order to determine potential risk to public health from radon exposure in the Lonoke community, the ADH developed a radon sampling plan to target classrooms within the four Lonoke schools, the Lonoke Community Center, and private residences within a half-mile radius of Lonoke High School. [5] On July 12, 2019, with the permission of the Lonoke School District Superintendent, the ADH placed short-term radon test kits in selected rooms within each of Lonoke School Districts' four school campuses, including High School classrooms (Lonoke High School southeast annex building) where high levels of CO₂ were detected in April. Radon test kits were also placed in the Lonoke Community Center.

In addition, on July 12, 2019, ADH placed radon test kits in private residences whose owners volunteered to have their houses tested. Homeowners were instructed to leave the radon kits in place for at least forty-eight (48) hours. Staff from ADH retrieved the radon kits on July 15, 2019. The kits were shipped to Alpha Energy Laboratories in Carrollton, TX. Validated lab results for the four school campuses and community center were received on July 17, 2019. Validated residential results were received on July 19, 2019.

Discussion

Exposure to a contaminant of concern (COC) is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., radon gas),
2. An environmental medium, such as air that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium (e.g., radon gas in classrooms or residential living areas),
4. An exposure route, such as inhalation, and
5. A population who could come in contact with the contaminants (i.e., students, teachers, staff, and residents).

An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur. For this evaluation, a potential inhalation pathway exists at Lonoke Schools, the community center, and at residences in the city of Lonoke.

Results

Data included fifty-four (54) radon results from Lonoke Schools [eleven (11) middle school, eleven (11) elementary school, fourteen (14) primary school, eighteen (18) high school], and four (4) radon results from the Lonoke Community Center. Data also included forty-nine (49) residential radon results. [6,7,8] See Figure 1 in Attachment A for general sample locations.

Radon levels in Lonoke Middle School, Lonoke Elementary School, and the Lonoke Community Center were all below the lower limit of detection. Lonoke Primary School had two (2) results that had detectable levels of radon, including 0.4 and 0.8 pCi/L. The remaining fourteen (14) results were below the Lower Limit of Detection. Lonoke High School had two (2) results that exceeded the EPA's radon action level of 4 pCi/L. Both of these radon results were collected in the same location (southeast annex building), and in the same room where the high levels of CO₂ were detected in April. The remaining sixteen (16) results were below the Lower Limit of Detection. Only one residence had radon levels that exceeded the EPA action level of 4 pCi/L, and was the same vacant residence where high levels of CO₂ (ranging from 40,790 ppm to greater than 50,000 ppm) were detected in April. The second vacant residence that had elevated levels of CO₂ (ranging from 4,600 ppm to 6,100 ppm) in April was not tested for radon. Results are listed in Table 1. All other radon levels were below 4 pCi/L, or below the Lower Limit of Detection.

Table 1: Lonoke Community Radon Sampling Results and EPA Radon Action Level of 4 pCi/L*

Location	Radon Samples Collected	Lowest Radon Test Result, pCi/L	Highest Radon Test Result, pCi/L	Results Above 4 pCi/L
Lonoke Primary School	14	0.4	0.8	0
Lonoke Elementary School	11	<0.4**	<1.2**	0
Lonoke Middle School	11	<0.7**	<1.2**	0
Lonoke High School	18 [†]	<0.3**	20.5 and 31.0***	2
Lonoke Community Center	4	<0.6**	<1.6**	0
Residences	49 [†]	<0.3**	6.9	1

EPA: Environmental Protection Agency

pCi/L: picocuries per liter of air

*Source: Environmental Protection Agency. May 2012. A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon. Available at: https://www.epa.gov/sites/production/files/2016-12/documents/2016_a_citizens_guide_to_radon.pdf

**The measured radon level was below Lower Limit of Detection

[†] One high school sample and one residential sample returned error due to excessive moisture content and short run time, respectively.

***Two radon kits placed in same classroom to serve as validation.

Average outdoor levels for radon gas are estimated to be 0.4 pCi/L. In the United States, the average indoor radon level is 1.3 pCi/L. [4]

Data Limitations

Radon samples were not collected from all classrooms within each of Lonoke's four school campuses, nor from all residences within the Lonoke community. Since radon is a naturally occurring gas found in varying levels in Arkansas, a completed pathway for inhalation exposure could exist in many indoor environments in Lonoke. Variable building conditions, such as ventilation and structural factors (i.e. foundation cracks) may affect indoor radon levels. As a result, the EPA recommends all homes and schools be tested for radon. [4]

Conclusions

The ADH understands that the Lonoke High School southeast annex building, where radon levels were detected at 20.5 and 31.0 pCi/L, will be left vacant until it can be demolished. In addition, the residence where radon levels were detected at 6.9 pCi/L is also vacant. Based on this information, and the radon sample data collected in July 2019, Lonoke School staff and students, as well as the general public, do not appear to be at risk of exposure to elevated levels of radon gas. Since the elevated CO₂ readings and findings of CS₂ appear to be an isolated event, the ADH is unable to develop conclusions as to the environmental factors that may have contributed to their cause.

Recommendations

The ADH has provided technical assistance and guidance to individual homeowners as needed. The ADH recommends testing a home or building using commercially available radon test kits per manufacturer's instructions if concerned about possible indoor radon gas levels. The ADH also recommends the Lonoke School District and community members contact an environmental consultant if concerns about indoor air quality arise in the future. The ADH offers support in evaluating any environmental sampling data that may be collected in the future.

Please feel free to contact me at 501-280-4186 or kerry.krell@arkansas.gov, if you have any questions.

Sincerely,



Kerry Krell, MPH, CHES
ADH Environmental Epidemiologist
ATSDR Cooperative Agreement Health Outreach Coordinator

cc: Shirley Louie, M.S. CIH, Center Director, ADH
Dr. Dirk Haselow, State Epidemiologist, ADH
Bernard Beville, Radiation Control Section Chief, ADH
Lori Simmons, M.S., Branch Chief, Epidemiology, ADH
Ashley Whitlow, M.S., ATSDR Principal Investigator, ADH
Chris C. Hemann, M.S., ATSDR Health Assessor, ADH
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Carey Woods, R.S., Lonoke County Health Unit Administrator, ADH
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*This publication was made possible by Grant Number CDC-RFA-TS17-170102CONT19 from the Agency for Toxic Substances and Disease Registry. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Agency for Toxic Substances and Disease Registry, or the Department of Health and Human Services.

References

1. Environmental Protection Agency Pollutions/Situation Report. April 26, 2019. *Lonoke School Monitoring*.
2. Wisconsin Department of Health Services. Nov. 20, 2018. *Carbon Dioxide*. Retrieved from: <https://www.dhs.wisconsin.gov/chemical/carbondioxide.htm>
3. Alpha Energy Laboratories. May 24, 2019. Radon Test Report. Prepared for private citizen.
4. Alpha Energy Laboratories. June 18, 2019. Radon Test Report. Prepared for private citizen.
5. Environmental Protection Agency. May 2012. *A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon*. Retrieved from: https://www.epa.gov/sites/production/files/2016-12/documents/2016_a_citizens_guide_to_radon.pdf
6. Arkansas Department of Health. July 2019. *Community Sampling Plan: Evaluation of Community Air Exposures to Potential Underground Compounds*. July 2019.
7. Alpha Energy Laboratories. July 17, 2019. *Lonoke School District Radon Results Summary*. Prepared for Arkansas Department of Health.
8. Alpha Energy Laboratories. July 17, 2019. *Lonoke Community Center Radon Results Summary*. Prepared for Arkansas Department of Health.
9. Alpha Energy Laboratories. July 19, 2019. *Lonoke Residential Radon Sampling Results Summary*. Prepared for Arkansas Department of Health.

Attachment A

Sampling Locations

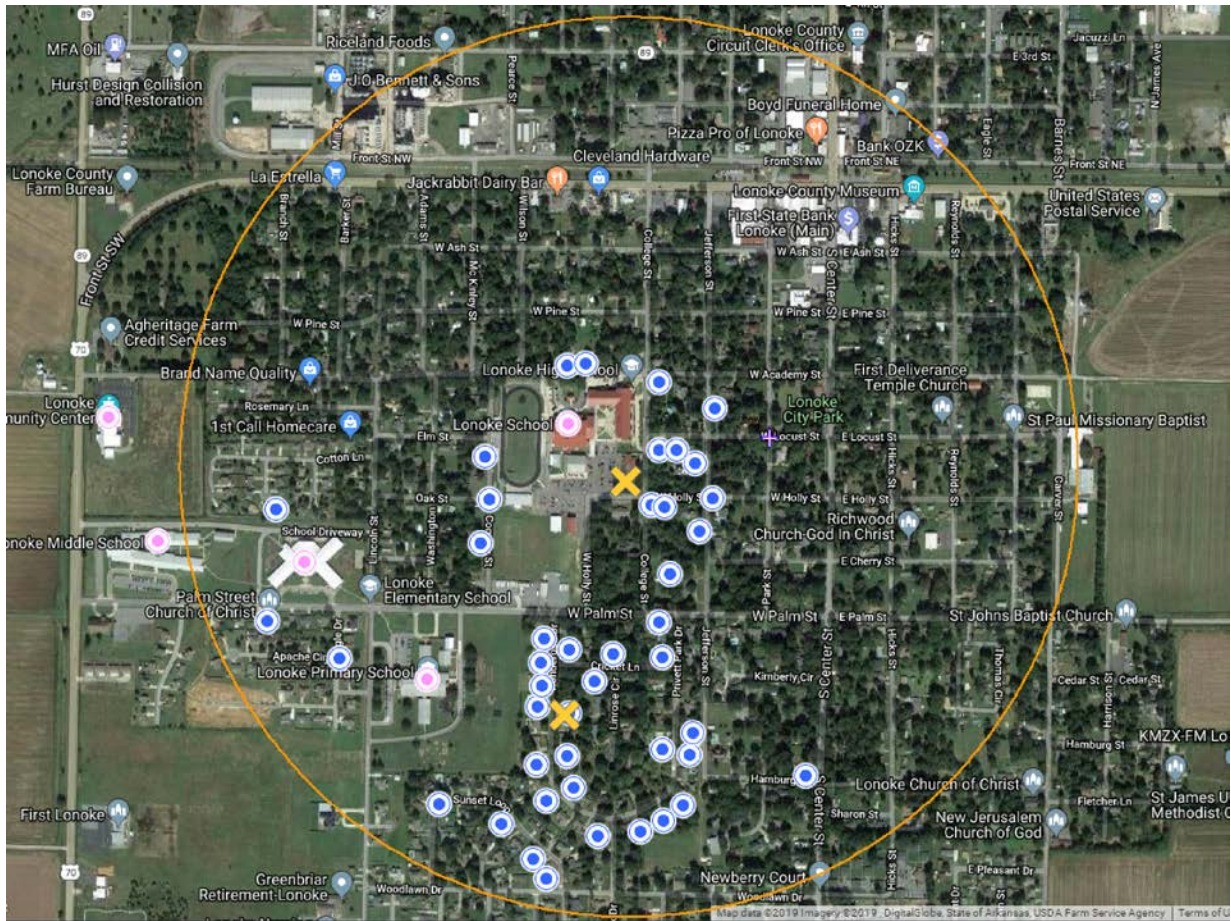


Figure 1: Arkansas Department of Health (ADH) radon sample location map featuring school campuses, community center, and residences during July 12, 2019 sampling event. Blue dots indicate residential samples, pink dots indicate school campus or community center. Yellow X indicates locations where radon levels exceeded Environmental Protection Agency's (EPA) action level from data collected on July 12-15, 2019.



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Governor Asa Hutchinson

José R. Romero, MD, Secretary of Health

Lonoke Community Carbon Dioxide (CO₂) Information Sheet

This information sheet provides general information on carbon dioxide (CO₂) and guidance for Lonoke community residents. Please contact your health care provider if you have questions or concerns about your health.

What is Carbon Dioxide (CO₂)?

CO₂ is a colorless, odorless, non-flammable gas that is a normal part of our atmosphere and the air we breathe. CO₂ is also a normal component of exhaled breath, and is found throughout the environment as part of natural and manmade processes.

How can CO₂ harm my health?

Certain environmental conditions may increase the amount of CO₂ in the air, which can reduce or displace the portion of oxygen necessary for people to breathe. This can lead to CO₂ poisoning, which can cause mild symptoms such as headache, dizziness, nausea, or drowsiness, or more severe symptoms such as rapid breathing, confusion, increased or irregular heart rate, and increases in blood pressure. ***If you or someone you know may be experiencing CO₂ poisoning seek immediate medical attention.***

How do I know if I have elevated CO₂ levels in my home?

A heating, ventilation, and air conditioning (HVAC) technician or weatherization contractor may be able to measure CO₂ levels in your home. In addition, CO₂ monitors are available for purchase at major retailers. Indoor spaces with good air exchange will generally have CO₂ levels below 1,000 parts per million (ppm). Elevated levels of CO₂ (1,000 ppm or higher) in your home may require temporary relocation until CO₂ levels can be lowered.

How can I prevent elevated CO₂ levels in my home or other indoor spaces?

Improving ventilation is the easiest and most effective way to lower elevated CO₂ levels in homes or other indoor spaces. This may include opening windows, turning on fans, or adjusting HVAC systems so that outside air is circulating through the home or building. HVAC systems may require adjustments or modifications to ensure enough fresh outside air is moving through the indoor space.



A Citizen's Guide to Radon

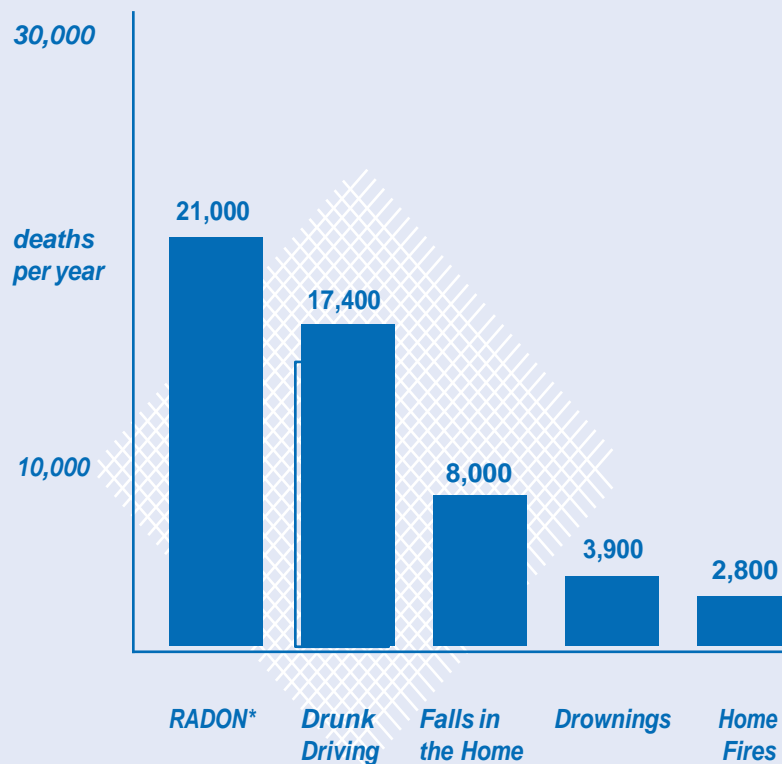
The Guide to Protecting
Yourself and Your Family from
Radon



EPA Recommends:

- ▼ **Test your home for radon—it's easy and inexpensive.**
- ▼ **Fix your home if your 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.**

Radon is estimated to cause thousands of lung 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 1999-2001 National Center for Injury Prevention and Control Report and 2002 National Safety Council Reports.

OVERVIEW

Radon is a cancer-causing, radioactive gas.

You can't see radon. And you can't smell it or taste it. But it may be a problem in your home.

Radon is estimated to cause many thousands of deaths each year. That's because when you breathe air containing radon, you can get lung cancer. In fact, the Surgeon General has warned that radon is the second leading cause of lung cancer in the United States today. 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.**

Radon can be found all over the U.S.

Radon comes from the natural (radioactive) breakdown of uranium in soil, rock and water and gets into the air you breathe. Radon can be found all over the U.S. It can get into any type of building—homes, offices, and schools—and result in a high indoor radon level. But you and your family are most likely to get your greatest exposure at home, where you spend most of your time.

You should test for radon.

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. EPA also recommends testing in schools.

Testing is inexpensive and easy—it should only take a few minutes of your time. Millions of Americans have already tested their homes for radon (see page 5).

You can fix a radon problem.

Radon reduction systems work and they are not too costly. Some radon reduction systems can reduce radon levels in your home by up to 99%. Even very high levels can be reduced to acceptable levels.

New homes can be built with radon-resistant features.

Radon-resistant construction techniques can be effective in preventing radon entry. When installed properly and completely, these simple and inexpensive techniques can help reduce indoor radon levels in homes. In addition, installing them at the time of construction makes it easier and less expensive to reduce radon levels further if these passive techniques don't reduce radon levels to below 4 pCi/L.

Every new home should be tested after occupancy, even if it was built radon-resistant. If radon levels are still in excess of 4 pCi/L, the passive system should be activated by having a qualified mitigator install a vent fan. For more explanation of radon resistant construction techniques, refer to EPA publication, *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (see page 15).

HOW DOES RADON GET INTO YOUR HOME?

Any home may have a radon problem.

Radon is a radioactive gas. It comes from the natural decay of uranium that is found in nearly all soils. It typically moves up through the ground to the air above and into your home through cracks and other holes in the foundation. Your home traps radon inside, where it can build up. Any home may have a radon problem. This means new and old homes, well-sealed and drafty homes, and homes with or without basements.

Radon from soil gas is the main cause of radon problems. Sometimes radon enters the home through well water (see page 8). In a small number of homes, the building materials can give off radon, too. However, building

RADON GETS IN THROUGH:

1. Cracks in solid floors.
2. Construction joints.
3. Cracks in walls.
4. Gaps in suspended floors.
5. Gaps around service pipes.
6. Cavities inside walls.
7. The water supply.



materials rarely cause radon problems by themselves.

Nearly 1 out of every 15 homes in the U.S. is estimated to have elevated radon levels. Elevated levels of radon gas have been found in homes in your state. Contact your state radon office (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>) for general information about radon in your area. While radon problems may be more common in some areas, any home may have a problem. The only way to know about your home is to test.

Radon can also be a problem in schools and workplaces. Ask your state radon office (www.epa.gov/radon/wherelive.html) about radon problems in schools, daycare and childcare facilities, and workplaces in your area (also visit <https://www.epa.gov/radon>).

HOW TO TEST YOUR HOME

You can't see radon, but it's not hard to find out if you have a radon problem in your home. All you need to do is test for radon. Testing is easy and should only take a few minutes of your time.

The amount of radon in the air is measured in "picocuries per liter of air," or "pCi/L." There are many kinds of low-cost "do it yourself" radon test kits you can get through the mail and in some hardware stores and other retail outlets. If you prefer, or if you are buying or selling a home, you can hire a qualified tester to do the testing for you. You should first contact your state radon office about obtaining a list of qualified testers. You can also contact a private radon proficiency program for lists of privately certified radon professionals serving your area. For links and more information, visit <https://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional>.

There are Two General Ways to Test for Radon:

SHORT-TERM TESTING:

The quickest way to test is with short-term tests. Short-term tests remain in your home for two days to 90 days, depending on the device. "Charcoal canisters," "alpha track," "electret ion chamber," "continuous monitors," and "charcoal liquid scintillation" detectors are most commonly used for short-term testing. 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. If you need results quickly, however, a short-term test followed by a second short-term test may be used to decide whether to fix your home (see also page 7 under Home Sales).

LONG-TERM TESTING:

Long-term tests remain in your home for more than 90 days. "Alpha track" and "electret" detectors are commonly used for this type of testing. A long-term test will give you a reading that is more likely to tell you your home's year-round average radon level than a short-term test.

How To Use a Test Kit:

Follow the instructions that come with your test kit. If you are doing a short-term test, close your windows and outside doors and keep them closed as much as possible during the test. Heating and air conditioning system fans that re-circulate air may be operated. Do not operate fans or other machines which bring in air from outside. Fans that are part of a radon-reduction system or small exhaust fans operating only for short periods of time may run during the test. If you are doing a short-term test lasting just 2 or 3 days, be sure to close your windows and outside doors at least 12 hours **before** beginning the test, too. You should not conduct

**Testing is easy
and should only
take a few
minutes of
your time.**

HOW TO TEST YOUR HOME *continued*

short-term tests lasting just 2 or 3 days during unusually severe storms or periods of unusually high winds. The test kit should be placed in the lowest lived-in level of the home (for example, the basement if it is frequently used, otherwise the first floor). It should be put in a room that is used regularly (like a living room, playroom, den, or bedroom) but **not** your kitchen or bathroom. Place the kit at least 20 inches above the floor in a location where it won't be disturbed—away from drafts, high heat, high humidity, and exterior walls. Leave the kit in place for as long as the package says. Once you've finished the test, reseal the package and send it to the lab specified on the package right away for analysis. You should receive your test results within a few weeks.

EPA Recommends the Following Testing Steps:

Step 1. *Take a short-term test. If your result is 4 pCi/L or higher, take a follow-up test (Step 2) to be sure.*

Step 2. *Follow up with either a long-term test or a second short-term test:*

- *For a better understanding of your year-round average radon level, take a long-term test.*
- *If you need results quickly, take a second short-term test.*

The higher your initial short-term test result, the more certain you can be that you should take a short-term rather than a long-term follow up test. If your first short-term test result is more than twice EPA's 4 pCi/L action level, you should take a second short-term test immediately.

Step 3. • *If you followed up with a long-term test: Fix your home if your long-term test result is 4 pCi/L or more.*

- *If you followed up with a second short-term test: The higher your short-term results, the more certain you can be that you should fix your home. Consider fixing your home if the average of your first and second test is 4 pCi/L or higher (see also page 7 under Home Sales).*



WHAT YOUR TEST RESULTS MEAN

The average indoor radon level is estimated to be about 1.3 pCi/L, and about 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 in all cases, most homes today *can* be reduced to 2 pCi/L or below.

Sometimes short-term tests are less definitive about whether or not your home is above 4 pCi/L. This can happen when your results are close to 4 pCi/L. For example, if the average of your two short-term test results is 4.1 pCi/L, there is about a 50% chance that your year-round average is somewhat below 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, and you can reduce your risk of lung cancer by lowering your radon level.

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.

Even if your test result is below 4 pCi/L, you may want to test again sometime in the future.

Test your home now and save your results. If you find high radon levels, fix your home before you decide to sell it.

RADON AND HOME SALES

More and more, home buyers and renters are asking about radon levels before they buy or rent a home. Because real estate sales happen quickly, there is often little time to deal with radon and other issues. The best thing to do is to test for radon NOW and save the results in case the buyer is interested in them. Fix a problem if it exists so it won't complicate your home sale. If you are planning to move, review EPA's pamphlet "Home Buyer's and Seller's Guide to Radon," which addresses some common questions (<https://www.epa.gov/radon/home-buyers-and-sellers-guide-radon>). You can also use the results of two short-term tests done side-by-side (four inches apart) to decide whether to fix your home.

During home sales:

- *Buyers often ask if a home has been tested, and if elevated levels were reduced.*
- *Buyers frequently want tests made by someone who is not involved in the home sale. Your state radon office (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>) can assist you in identifying a qualified tester.*
- *Buyers might want to know the radon levels in areas of the home (like a basement they plan to finish that the seller might not otherwise test.*

Today many homes are built to help prevent radon from coming in. Building codes in your state or local area may require these radon-resistant construction features. If you are buying or renting a new home, ask the owner or builder if it has radon-resistant features. The EPA recommends building new homes with radon-resistant features in high radon potential (Zone 1) areas. Even if built radon-resistant, every new home should be tested for radon after occupancy. If you have a test result of 4 pCi/L or more, consult a qualified mitigator (<http://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional#who>) 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.

RADON IN WATER

There are two main sources for the radon in your home's indoor air, the soil and the water supply. Compared to radon entering the home through water, radon entering your home through the soil is usually a much larger risk.

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.

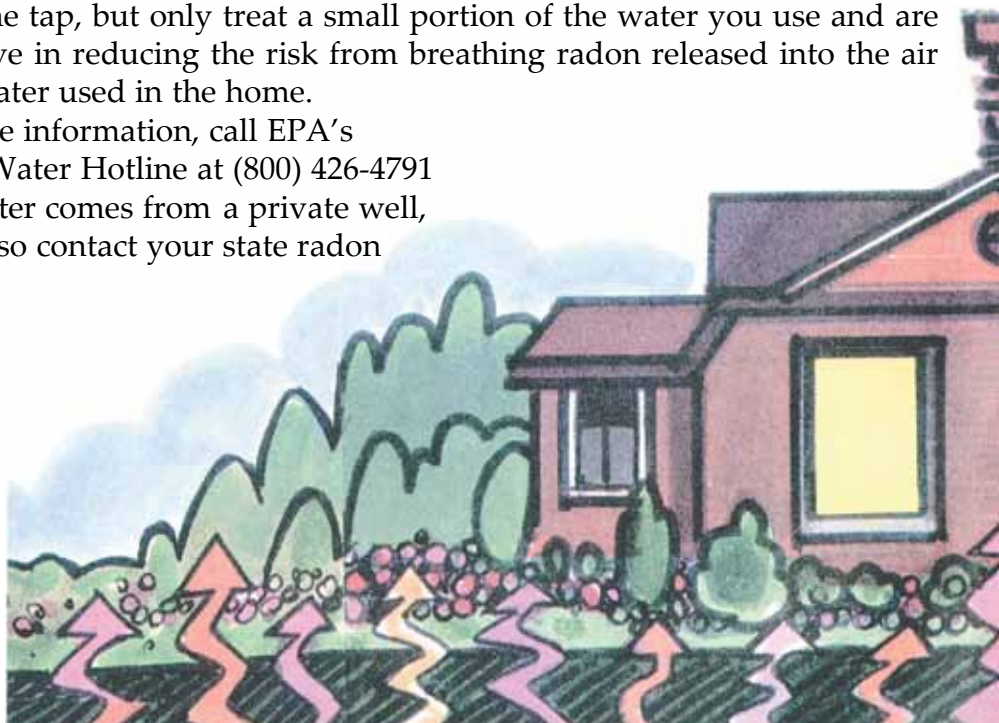
Radon in your home's water is not usually a problem when its source is surface water. A radon in water problem is more likely when its source is ground water, e.g., a private well or a public water supply system that uses ground water. If you are concerned that radon may be entering your home through 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 two ways. Point-of-entry treatment can effectively remove radon from the water before it enters your home. Point-of-use treatment devices remove radon from your water at the tap, but only treat a small portion of the water you use and are not effective in reducing the risk from breathing radon released into the air from all water used in the home.

For more information, call EPA's Drinking Water Hotline at (800) 426-4791. If your water comes from a private well, you can also contact your state radon office.



If you've tested the air in your home and found a radon problem, and your water comes from a well, have your water tested.



HOW TO LOWER THE RADON LEVEL IN YOUR HOME

Since there is no known safe level of radon, there can always be some risk. But the risk can be reduced by lowering the radon level in your home.

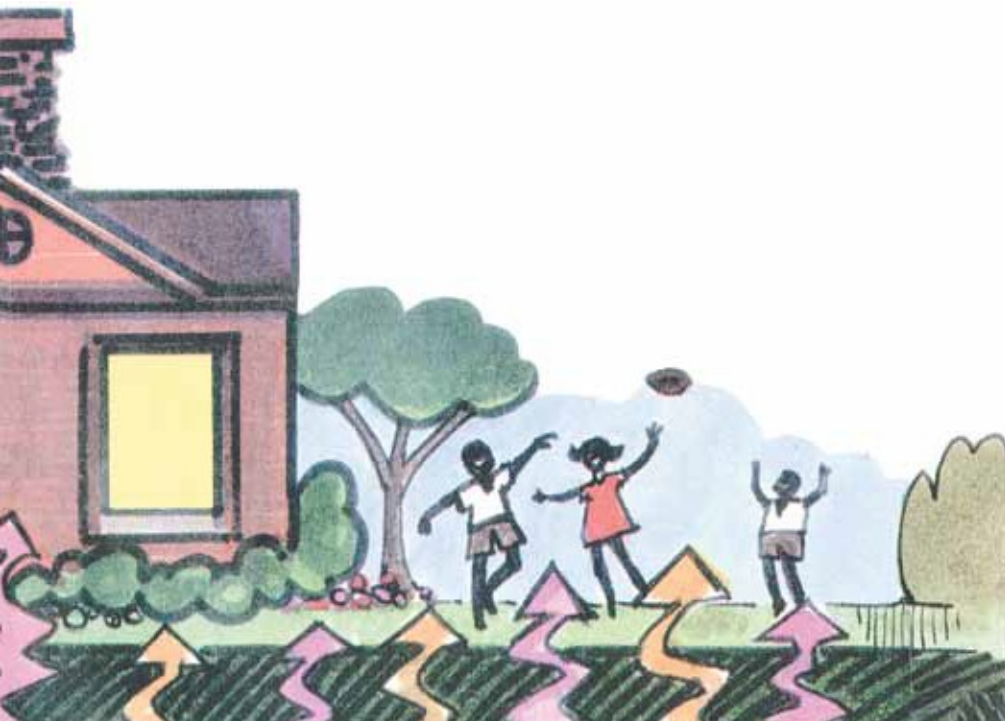
There are several proven methods to reduce radon in your home, but the one primarily used is a vent pipe system and fan, which pulls radon from beneath the house and vents it to the outside. This system, known as a soil suction radon reduction system, does not require major changes to your home. Sealing foundation cracks and other openings makes this kind of system more effective and cost-efficient. Similar systems can also be installed in houses with crawl spaces. Radon contractors can use other methods that may also work in your home. The right system depends on the design of your home and other factors.

Ways to reduce radon in your home are discussed in EPA's *Consumer's Guide to Radon Reduction*. You can get a copy at [-about-radon https://www.epa.gov/radon/publications-about-radon](https://www.epa.gov/radon/publications-about-radon).

The cost of reducing radon in your home depends on how your home was built and the extent of the radon problem. Most homes can be fixed for about the same cost as other common home repairs. The cost to fix can vary widely; consult with your state radon office or get one or more estimates from qualified mitigators. The cost is much less if a passive system was installed during construction.

RADON AND HOME RENOVATIONS

If you are planning any major structural renovation, such as converting an unfinished basement area into living space, it is especially important to test the area for radon before you begin the renovation. If your test results indicate a radon problem, radon-resistant techniques can be inexpensively included as part of the renovation. Because major renovations can change the level of radon in any home, always test again after work is completed.



HOW TO LOWER THE RADON LEVEL IN YOUR HOME *continued*

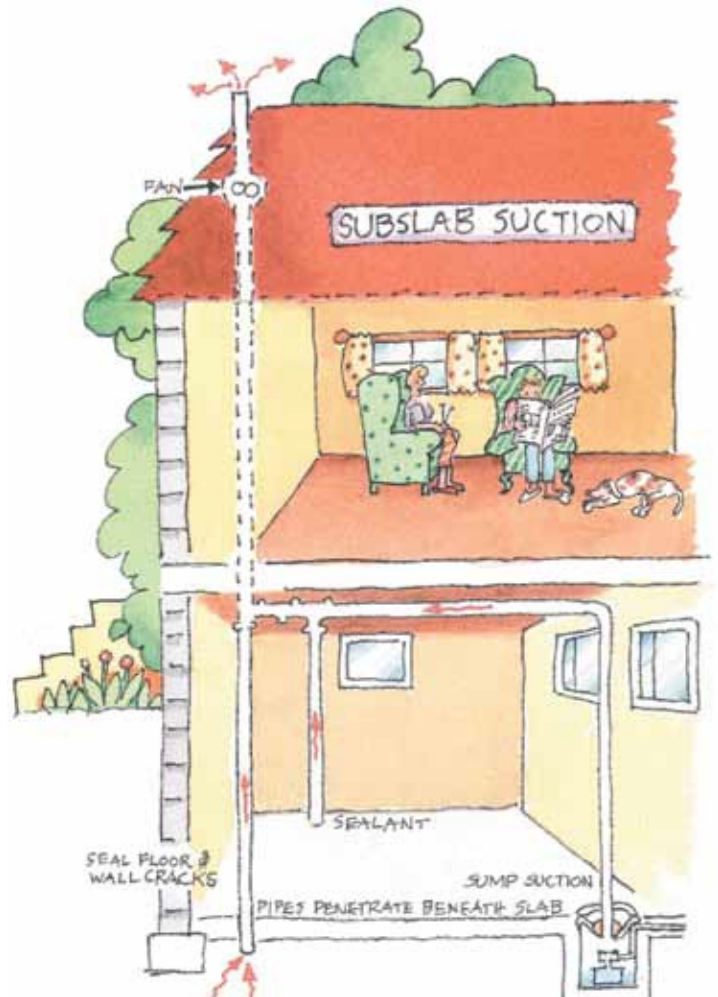
Most homes can be fixed for about the same cost as other common home repairs.

Lowering high radon levels requires technical knowledge and special skills. You should use a contractor who is trained to fix radon problems. A qualified contractor can study the radon problem in your home and help you pick the right treatment method.

Check with your state radon office for names of qualified or state certified radon contractors in your area. You can also contact private radon proficiency programs for lists of privately certified radon professionals in your area. For more information on private radon proficiency programs, visit <https://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional>. Picking someone to fix your radon problem is much like choosing a contractor for other home repairs—you may want to get references and more than one estimate.

If you are considering fixing your home's radon problem yourself, you should first contact your state radon office for guidance and assistance (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>).

You should also test your home again after it is fixed to be sure that radon levels have been reduced. Most soil suction radon reduction systems include a monitor that will indicate whether the system is operating properly. In addition, it's a good idea to retest your home every two years to be sure radon levels remain low.



Note: This diagram is a composite view of several mitigation options. The typical mitigation system usually has only one pipe penetration through the basement floor; the pipe may also be installed on the outside of the house.

THE RISK OF LIVING WITH RADON

Radon gas decays into radioactive particles that can get trapped in your lungs when you breathe. As they break down further, these particles release small bursts of energy. This can damage lung tissue and lead to lung cancer over the course of your lifetime. Not everyone exposed to elevated levels of radon will develop lung cancer. And the amount of time between exposure and the onset of the disease may be many years.

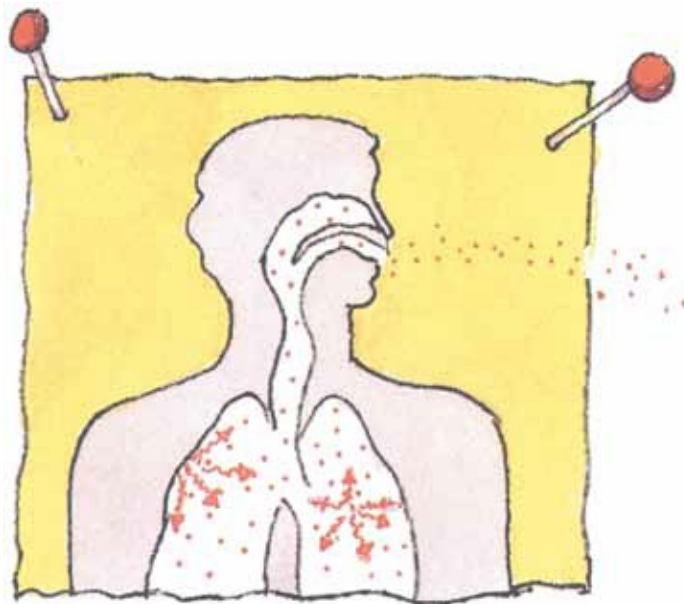
Like other environmental pollutants, there is some uncertainty about the magnitude of radon health risks. However, we know more about radon risks than risks from most other cancer-causing substances. This is because estimates of radon risks are based on studies of cancer in humans (underground miners).

Smoking combined with radon is an especially serious health risk. Stop smoking and lower your radon level to reduce your lung cancer risk.

Children have been reported to have greater risk than adults of certain types of cancer from radiation, but there are currently no conclusive data on whether children are at greater risk than adults from radon.

Your chances of getting lung cancer from radon depend mostly on:

- *How much radon is in your home*
- *The amount of time you spend in your home*
- *Whether you are a smoker or have ever smoked*



Scientists are more certain about radon risks than risks from most other cancer-causing substances.

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		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be lower.

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

RADON RISK IF YOU'VE 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.

RADON MYTHS AND FACTS

MYTH: Scientists aren't sure radon really is a problem.

FACT: Although some scientists dispute the precise number of deaths due to radon, all 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: Radon testing is difficult, time consuming and expensive.

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: Homes with radon problems can't be fixed.

FACT: There are simple solutions to radon problems in homes. Hundreds of thousands of homeowners have already fixed radon problems in their homes. Most homes can be fixed for about the same cost as other common home repairs; check with one or more qualified mitigators. Call your state radon office (www.epa.gov/radon/wherelive.html) for help in identifying qualified mitigation contractors.

MYTH: Radon only affects certain kinds of homes.

FACT: House construction can affect radon levels. However, radon can be a problem in homes of all types: old homes, new homes, drafty homes, insulated homes, homes with basements, 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: 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 your radon level is to test.

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

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

RADON MYTHS AND FACTS *continued*

MYTH: Everyone should test their water for radon.

FACT: Although radon gets into some homes through 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.

MYTH: It's difficult to sell homes where radon problems have been discovered.

FACT: Where radon problems have been fixed, home sales have not been blocked or frustrated. The added protection is sometimes a good selling point.

MYTH: I've lived in my home for so long, it doesn't make sense to take action now.

FACT: You will reduce your risk of lung cancer when you reduce radon levels, even if you've lived with a radon problem for a long time.

MYTH: Short-term tests can't be used for making a decision about whether to fix your home.

FACT: A short-term test followed by a second short-term test* can be used to decide whether to fix your home. However, the closer the average of your two short-term tests is to 4 pCi/L, the less certain you can be about whether your year-round average is above or below that level. Keep in mind that radon levels below 4 pCi/L still pose some risk. Radon levels can be reduced in most homes to 2 pCi/L or below.

**If the radon test is part of a real estate transaction, the result of two short-term tests can be used in deciding whether to mitigate. For more information, see EPA's "Home Buyer's and Seller's Guide to Radon."*

FOR FURTHER INFORMATION

EPA Radon Website

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

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

Frequent Questions:

<https://iaq.zendesk.com/hc/en-us/sections/202349927>

Radon Hotlines

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 finding 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.

EPA Regional Offices

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

Ordering Radon Publications

Many EPA radon publications are available from <https://www.epa.gov/radon/publications-about-radon>

Radon publications may be ordered through the National Service Center for Environmental Publications (NSCEP) by calling 1-800-490-9198, by visiting the NSCEP website at <https://www.epa.gov/nscep> or by email at nscep@lmsolas.com.



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

U.S. EPA Assessment of Risks from Radon in Homes

In June 2003, the EPA revised its risk estimates for radon exposure in homes. EPA estimates that about 21,000 annual lung cancer deaths are radon related. EPA also concluded that the effects of radon and cigarette smoking are synergistic, so that smokers are at higher risk from radon. EPA’s revised estimates are based on the National Academy of Sciences 1998 BEIR VI (Biological Effects of Ionizing Radiation) Report which concluded that radon is the second leading cause of lung cancer after smoking.



Indoor Environments Division (6609J)
EP 402/K-12/002 | May 2012 | www.epa.gov/radon