Radon: The Invisible Intruder

Radon, once a topic of frequent and often disturbing news coverage, may not vie successfully for our attention, but the problem persists. Even though radon gas is a "natural" product, it is a potential health hazard. Radon is released from soils across the length and breadth of New York State and may reach unacceptable levels in some homes while having no significant impact on other homes nearby. The only way to know if there is a problem in your home is to measure the radon levels.

The United States Environmental Protection Agency recognizes exposure to radon gas as the second leading cause of lung cancer after smoking. This health threat can be managed; we can take practical steps to reduce our exposure to radon in our homes. EPA recommends that we should test our homes for radon and, if necessary, we should take action to reduce the level of radon. This is a prudent and responsible public health policy.

This booklet was prepared to provide you with basic information on testing radon levels and to inform you about the methods available to reduce radon concentrations in your home, should that be necessary. References are included to direct you to more detailed information on both monitoring and remediation techniques.

What is radon?

Radon is a colorless, odorless, radioactive gas which is created naturally by the breakdown of uranium and radium. Radon gas is continuously released from rocks and soil containing these two elements. Uranium and radium may be found in almost all soil and rock, but are most often associated with those containing granite, shale, and phosphate.

Once formed, radon itself decays into other radioactive elements, known as "radon daughters" or "progeny". The rate at which a radioactive element decays is expressed as its half-life. (A half-life is the time it takes for half of a radioactive element in a sample to decay into another element.) Radon has a half-life of about three days; its daughter particles all have half-lives of less than half an hour.

What are the health hazards of exposure to radon?

The Surgeon General has declared radon exposure to be the second leading cause of lung cancer deaths in the United States, after smoking. Exposure to natural radon is estimated to be responsible for 7,000 to
30,000 lung cancer deaths each year in the United States. As with other forms of cancer, lung cancer resulting from exposure to radon may develop over many years before it is diagnosed.

Radon and its progeny can attach themselves to dust particles that may be inhaled and lodge in the lungs. Once there, these elements break down and emit radiation which can damage lung tissue and eventually cause lung cancer.

The best way to reduce your risk of lung cancer due to radon is to reduce your exposure to radon.

**How are people exposed to radon?**

Radon gas continuously seeps into the air from uranium- and radium-bearing soil and rock. Outdoors, due to dilution in the ambient air, concentrations are generally so low as to be insignificant. However, if the gas becomes trapped in a poorly ventilated, enclosed space, the concentrations will build up. This can be a problem in any structure built on rocks or soil naturally emitting this gas.

Any home may have elevated radon levels. Gaseous radon can enter a home through foundation cracks, openings for pipes, wall/floor joints, chimneys, sumps, unfinished crawl spaces, and hollow, concrete block foundations. Once inside, the gas may be trapped and accumulate, especially during the winter months when windows are seldom open.

If air pressure in the house is lower than that of the soil, radon gas may actually be pulled from the soil into the house. Reduced air pressure results from the use of exhaust fans (such as those in clothes dryers, kitchens, and bathrooms), and home heating devices (such as fireplaces and furnaces). Natural shifts in air pressure, such as those associated with a storm or strong winds, may also alter indoor air pressure enough to draw radon gas into the home.

Well water can be contaminated with radon and may carry radon into a house through the water pipes. Tests show that radon may be dispersed into the air when such water is either aerated, running or heated. Municipal water supplies are normally aerated, which releases radon gas from the water before it enters a house. Most public water sources therefore pose little threat. Since water from private wells is generally not aerated before entering the home, it is more likely to contain radon, if it is drawn from uranium- or radium-bearing rocks.

When radon-contaminated water is heated, agitated, or running, as in a dishwasher, washing machine, or shower, the radon will be released into the surrounding air. Studies show that the cancer risk associated with inhaling radon gas released from contaminated water is greater than that from drinking such water. The EPA estimates that 100 to 1800 annual lung cancer deaths are the result of inhaling radon from household water.
Radon has also been detected in some construction materials, although this is rare. Construction materials that are possible radon-emitters include any material made from rock or soil that contains uranium, such as brick or building block.

Usually eighty percent of any radon entering a house comes from the soil or rock on which the building is constructed. The balance is carried by water entering a house through water supply pipes, with a small percentage being emitted from materials used in construction of the house itself.

**Is there a safe level of exposure to radon?**

No federal or state standards define any indoor concentration of radon that is safe. The EPA has set a level of concern or "action level" for homes, above which remedial action should be taken. This radiation level is currently 4 picocuries per liter of air (pCi/L), which may also be referred to as 0.2 "working levels" (WL). EPA also recommends that remedial action be considered if radon levels are between 2 and 4 pCi/L.

The exposure at the action level is equivalent to having slightly more than 200 chest X-rays per year. With this exposure, approximately 2 out of every 1000 non-smokers would develop lung cancer over a 70-year period. This represents a lung cancer risk that is 9 to 12 times higher than that of people who have not been exposed to radon.

Tests show that radon exposure in conjunction with smoking greatly increases the risk of lung cancer, to a level higher than the sum of the risks of either radon exposure or smoking alone. This is called a synergistic effect, and it can have serious health consequences. For example, if exposed to a radon level of 4 pCi/L for a lifetime, approximately 30 out of 1000 smokers would develop lung cancer. The risk of lung cancer from smoking alone is approximately 10 chances out of 1000.

Children are more susceptible to the adverse effects of exposure to many toxic substances. They may be more sensitive than adults to radon exposure, since their lung cells are rapidly dividing, their lungs are smaller, and their breathing rate is faster. However, the EPA action level figure was calculated for adults.

Household radon exposure has been targeted by EPA officials because most of a person's time is spent in the home; therefore, that is where the risk of radon exposure is greatest. If you spend most of your time in another indoor location -- such as an office building or shop -- you should be equally concerned about that exposure.

If you have reason to believe that your place of work may have a radon problem, contact your employer or the building manager to ascertain if any tests have been performed or any remedial action taken. Generally speaking, the EPA believes that the greater your exposure to radon, the greater your risk of
developing lung cancer. Any exposure may carry an increased risk of cancer.

Remember that the EPA action level is not a standard of "safe" exposure to radon.

**Is there a radon problem where I live?**

Radon has been detected, at varying levels, in every county in New York. In New York, the Department of Health administers a continuous study of statewide radon levels classified by county and city. To obtain a copy, call the New York State Radon Hotline (800-458-1158) and ask for the New York State Indoor Radon by County Report. This report is updated semi-annually.

It is possible to identify those areas of New York State where there is a greater or lesser probability of having high indoor radon levels. The New York State Department of Health has measured actual indoor radon levels across the State, developing an illustrative map and other useful information. The Department of Health map displays the estimated percentage of homes with radon levels greater than 4 pCi/L for towns and cities. That map is available at [http://www.health.state.ny.us/nysdoh/radon/radonmaps.htm](http://www.health.state.ny.us/nysdoh/radon/radonmaps.htm).

The United States Environmental Protection Agency has estimated the potential for elevated radon levels based on a variety of considerations. The EPA findings are summarized in Figure 1. The EPA map depicts, by county, the average short-term radon measurement that can be expected to be measured in a building without the implementation of radon control methods. However, this map is not intended to be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all areas of the state.

It is important to remember that, regardless of where you live and how your county is ranked in these analyses, it is possible for a radon problem to exist in a home situated in any county. Two homes situated right next to each other may have substantially different indoor radon levels. The potential for a radon problem is determined by several factors including local geology, water supply, home construction, and ventilation. Although location is a very important factor, since it relates to the presence of uranium- and radium-bearing rock, your water supply, home construction, and ventilation will also help to determine if you have a radon problem.

**If I live in an area with high average radon levels, will I necessarily have a radon problem?**

No, you may or may not have a problem. Your home's construction and ventilation may affect the potential for the accumulation of radon gas. An important fact to remember is that radon levels vary from house to house, even within the same block. Only proper testing can reveal a radon problem in your home.
Figure 1. United States Environmental Protection Agency Radon Zone Map

The U.S. EPA and the U.S. Geological Survey have evaluated the radon potential in the U.S. and have developed this map to assist National, State, and local organizations to target their resources and to assist building code officials in deciding whether radon-resistant features are applicable in new construction. This map is not intended to be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones. All homes should be tested regardless of geographic location. The map assigns each of the counties New York to one of three zones based on radon potential. Each zone designation reflects the average short-term radon measurement that can be expected to be measured in a building without the implementation of radon control methods. The radon zone designation of the highest priority is Zone 1.

(Adapted from: http://www.epa.gov/radon/zonemap/newyork.htm)
How do I test for radon in my home?

There are several radon testing devices on the market. These include the activated charcoal canister, the alpha-track detector and a variety of continuous radon monitors.

The charcoal canister is the least expensive and quickest testing method currently available. It is made up of a filtered plastic container filled with charcoal. Radon present in the air is captured on the charcoal, and can later be measured in the laboratory.

The New York State Department of Health sells charcoal canisters to test for radon. The charge is $6.75, which includes the cost of the canister and of laboratory analysis.

Many hardware stores and mail-order catalogues also offer radon testing devices. If you decide to purchase one, look for the phrase, "Meets EPA Requirements" to insure a more reliable result. If laboratory analysis fees are not included in the price of the device, make sure to send the canister to a USEPA - approved lab for analysis. Call the Radon Hotline (800-458-1158) for a list of approved labs.

Although charcoal canisters are the simplest, most inexpensive method for initial testing, they are not the most accurate. Charcoal canisters may provide misleading results because radon levels may vary daily and seasonally due to changes in radon infiltration rates, home ventilation, and humidity. Therefore, the sample you take may not represent typical conditions over the course of the year.

Serious questions have also been raised about the ability of some laboratories to accurately measure the radon collected in the canisters. It is important to use only an approved lab for analysis.

Nevertheless, charcoal canisters help to quickly indicate the presence of extremely high radon levels. Using the canisters during the winter months, for example, may provide an estimate of the highest probable radon levels in the home. In any event, it is wise not to rely on a single charcoal canister test, be they high or low. EPA recommends that homeowners test for radon more than once, regardless of the initial results.

Other radon testing methods are available. They require longer testing periods and are more expensive, but they can give a more accurate estimate of long-term radon levels in your home. Alpha track detectors can measure radon on a seasonal or annual basis. An alpha track detector is comprised of a filtered container with a small piece of plastic inside. When radon decays in the air, the energy particles emitted strike the plastic and leave marks called "damage tracks". A laboratory then counts the number of tracks, which corresponds to the concentration of radioactive substances in the test area.

Like the charcoal canisters, alpha track detectors must be properly used and carefully
analyzed to obtain accurate results. The two can be used in a complementary manner.

While an alpha-track detector may be set up for several months to a year, a charcoal canister or two could provide an early warning of high radon levels.

Continuous radon monitors require the services of professionals to install and monitor, and thus are far more expensive. (See page 9 to obtain a list of EPA-certified radon testing contractors.) It may cost $200 or more to test your home with these devices.

Testing is also available for radon-bearing water supplies. The tests generally cost approximately $25 to $50. Contact the New York State Department of Health at (800)-458-1158 for a list of laboratories certified by the State of New York to perform radon-in-water tests. And, as for air monitoring, EPA recommends that homeowners repeat radon-in-water tests, regardless of the initial test results.

**Are there any testing tips I should know?**

While it is important to follow the specific instructions included with a testing device, there are some general guidelines to follow that may make your test results more accurate.

Air sampling, such as with charcoal canisters, is typically done for one or two days. Before beginning the test, it is important to reduce ventilation as much as possible. Try to keep all windows and doors closed, and all fans off, for 12 hours before opening the canisters and for the duration of the test. Try to avoid testing during storms or windy weather.

The Surgeon General suggests that radon tests be conducted on the lowest three floors of a building. EPA recommends placing any testing device on the lowest livable level of a home. "Lowest livable level" means the lowest level of the home which either is or could be made into a habitable area. This would include any existing or planned basement laundry room, play room, or basement bedroom. The "lowest livable level" designation does not mean that the area must be continuously used; even occasional use (such as with a laundry room) is enough to warrant testing.

If a test result does reveal high radon levels, homeowners might consider additional tests to confirm the initial result before undertaking remediation. EPA recommends remediation for levels above 4 pCi/L. When levels are between 2 and 4 pCi/L EPA leaves remediation to individual discretion.

**How can I reduce radon accumulation in my home?**

After testing, you may wish to take steps to reduce radon levels. This can be accomplished in a variety of ways.

Sealing the entry points for the radon gas can be a simple, low-cost, relatively quick way to reduce accumulation rates. These entry points include basement sumps, unfinished crawl spaces, cracks, and holes. A list of caulking compounds that can be used to seal a house...
(including information on lifespan, shrinkage, ease of application, flexibility, adhesion, and cost), is available through the Radon Hotline. Improving house ventilation will help move the radon gas out of your house. This may require only that you open windows or vents, or use exhaust fans. Special ventilation systems can divert radon gas before it enters the house. For example, a fan can draw radon gas out of the soil through ducts leading from the ground and/or the foundation to the outdoors. A basement sump can be enclosed and vented to the outside. These types of measures must be carefully designed and installed. Before beginning any type of radon mitigation, you should obtain additional information on radon reduction techniques and a listing of licensed contractors. Consult the sources listed on page 9. Information is also available for do-it-yourself homeowner radon reduction.

Increased ventilation may also increase energy consumption. To minimize energy costs, ventilation can be combined with air-to-air heat recovery systems, which transfer heat (with minimal use of energy) from outgoing warm air to incoming cool air and vice-versa. Local heating and cooling contractors or equipment suppliers can provide these systems.

Increasing air pressure within the house will help keep radon out. This can be done by supplying additional sources of air from the outside to furnaces and fireplaces. This type of renovation should not be attempted by the ordinary homeowner without assistance from a qualified contractor, as incorrectly-altered furnace ventilation systems may create a backdraft of combustion gases (such as carbon monoxide) into the home.

Radon mitigation methods for a typical single-family home may range in cost from $500 to $2500. The average cost is about $1200. Of the alternatives, EPA believes the most effective methods involve radon diversion and increased house ventilation in combination with air-to-air heat recovery, although these are also relatively expensive.

**What should I look for in a contractor?**

EPA has developed a checklist of important questions to ask a prospective contractor, which will provide specific information about construction contracting. (To obtain a copy of the EPA publication entitled *Consumer's Guide to Radon Reduction*, see the publications listing on page 10.) Generally speaking, it is a good idea to obtain proof of certification, liability insurance, and a contract performance guarantee. As with any home repair, we recommend obtaining several written estimates and checking the reputation of the contractor before signing any repair contract. Call your local Better Business Bureau for information about specific contractors.

**What do I do after I reduce my home's radon concentrations?**

It is important to test for radon soon after instituting radon remediation measures. This
will indicate whether the remediation measures have been successful, and if radon levels have indeed decreased. This test may also alert you to a previously-unknown radon entry pathway. EPA recommends that a 7-day test be performed within 30 days of reduction system completion.

EPA-certified reduction contractors are required to recommend that follow up testing be performed by an independent party, to prevent conflicts of interest. They are also required to install a system-failure warning device, which will monitor your home's radon reduction system’s operation after remediation and alert you to any problems.

**If I am building a new home or addition in an area with high radon levels, can I take any precautionary measures?**

Yes. Several technical manuals produced by the EPA address pre-construction concerns. You can find information on building materials and construction methods for building new homes that can minimize radon infiltration in the some of the technical manuals listed in the Publications list beginning on page 9.

**I live in an apartment building. Should I be concerned about radon?**

Most of the data available on radon is based on studies performed on single-family homes. The information that is available suggests that radon concentrations in multi-level buildings are generally a few tenths of a picocurie, which is well below the EPA level of concern.

Multi-level buildings typically show lower radon concentrations on the upper floors, and higher concentrations closer to ground level. However, if the apartment building receives drinking water from a radon-contaminated well, the radon levels are likely to be higher in the upper floors. This is because more radon gas is released from the water as elevation increases.

In closing, remember that one need not live with the risk of lung cancer that radon exposure can create. Get your home tested and, if necessary, take steps to reduce the entry and accumulation of radon gas in your home.

As the technologies of radon measurement and remediation continue to develop, improved devices and procedures may become available. Before testing for radon or attempting any remediation, consumers should obtain the latest information from the Radon Hotline (800-458-1158) or the Environmental Protection Agency (212-637-4013).
RESOURCES

Radon Testing Devices

To obtain charcoal canisters or a list of radon-in-water testing contractors from the New York State Radon Hotline, call (800) 458-1158.

Laboratories and Contractors

For a list of EPA-certified radon testing laboratories, and radon testing and reduction contractors who have completed a New York State training course, call (800) 458-1158.

If you live near New Jersey, a listing of certified contractors may be obtained by calling the New Jersey Department of Environmental Protection and Energy Hotline at (800) 648-0394.

If you live near Pennsylvania, that state's list is available by calling the Pennsylvania Bureau of Radiation Protection at (717) 783-3594. The list is currently updated each month.

PUBLICATIONS

The following publications are available free of charge. Call the New York State Radon Hotline, EPA's Public Information Center at (202) 260-7751, or EPA's Radon Division at (202) 343-9370. You can also mail your request for these documents to USEPA, National Center for Environmental Publications (NSCEP), PO Box 42419, Cincinnati, OH 42419.

A Citizen's Guide to Radon (4th edition) The guide to protecting yourself and your family from radon. EPA Doc.# 402-K02-006, May 2002. This booklet was developed by the EPA, The U.S. Department of Health and Human Services and the U.S. Public Health Service. This is the complete guide to taking action to lower the radon level in your home. It offers strategies for testing and discussions of what steps to take after you have tested, discussions of the risk of radon and radon myths. Available from the NYSDOH by calling (800)458-1158, or on the internet at www.epa.gov/iaq/radon/pubs/citguide.html.

Consumer's Guide to Radon Reduction How to Reduce Radon Levels in Your Home. EPA Doc. #402-K-03-002, February 2003. This booklet is for people who have tested their home for radon and confirmed that they have elevated radon levels. Available from the NYSDOH by calling (800) 458-1158 or at www.epa.gov/iaq/radon/pubs/consguid.html.

Home Buyer’s and Seller’s Guide to Radon
EPA Doc. #402-K-00-008, July 2000. This guide has been developed for anyone buying or selling a home who wants to learn about Radon. Available from the NYSDOH at (800) 458-1158. or on the internet at: www.epa.gov/iaq/radon/pubs/hmbyguid.html.

Model Standards and Techniques for Control of Radon in New Residential Buildings EPA Doc. # 402-R-94-009, March 1994. This document is intended to serve as a model for use by the Model Code Organizations, States and other jurisdictions as they develop and adopt building codes, appendicies to codes, or standards specifically applicable to their unique local or regional radon control requirements. Available from the NYSDOH at (800)458-1158 or at www.epa.gov/iaq/radon/pubs/newconst.html.

Radon - A Physician's Guide: The Health Threat With A Simple Solution EPA Doc. #402-K-93-008, September 1993. This booklet on radon has been developed for physicians by the EPA in consultation with the American Medical Association (AMA). Its purpose is to enlist physicians in the national effort to inform the American public about the serious health risk posed by indoor radon gas. This publication is available from NYSDOH by calling (800) 458-1158 or on the internet at www.epa.gov/iaq/radon/pubs/physic.html.

A Radon Guide for Tenants. EPA Doc. #402-K-98-004. This guide, created by the Environmental Law Institute (ELI) with EPA's review, is for people who rent their apartments or houses. The guide explains what radon is, and how to find out if there is a radon problem in your home. The guide also talks about what you can do if there are high radon levels in your home. Call the National Radon Information Hotline at 1-800-SOS-RADON to get a copy of this guide. Also available at www.epa.gov/iaq/radon/pubs/tenants.html.

Radon in Schools (Second Edition). EPA Doc. #402-F-94-009, October 1994. It is important that students, teachers and parents be aware that a potential radon problem could exist in their school. This brochure was developed in cooperation with the National Education Association, The American Lung Association, and the Parents and Teachers Association. The brochure is available at www.epa.gov/iaq/radon/pubs/schoolrm.html.

Radon Mitigation Standards EPA Doc. #402-R-93-078, October 1993 (Revised April 1994). The purpose of the Radon Mitigation Standards is to provide radon mitigation contractors with uniform standards that will ensure quality and effectiveness in the design, installation, and evaluation of radon mitigation systems in detached and attached residential buildings three stories or less in height. These standards are intended to serve as a model set of requirements that can be adopted or modified by state and local jurisdictions to fulfill objectives of their specific radon contractor certification or licensure programs. Available from the NYSDOH at (800) 458-1158. The Standards
are also available on the internet at www.epa.gov/iaq/radon/pubs/mitstds.html.

**Radon Prevention in the Design and Construction of Schools and Other Large Buildings.** EPA Doc. #625-R-92-016, June 1994. It is typically easier and much less expensive to design and construct a new building with radon-resistant and/or easy-to-mitigate features, than to add these features after the building is completed and occupied. Chapter 1 of this manual is a general introduction for those who need background information on the indoor radon problem and the techniques currently being studied and applied for radon reduction. Chapter 2 of this manual provides comprehensive information, instructions, and guidelines about the topics and construction techniques discussed in Chapter 1.

This U.S. EPA, Office of Research and Development manual is available from the NYSDOH at (800)458-1158. You can also obtain a copy by contacting the Center for Environmental Research Information at (800) 490-9198. Also available on the internet at http://www.epa.gov/ordntrnt/ORD/NRMRL/Pubs/1993/air/EPA625r-92016.htm.


**Buying a New Home: How to Protect Your Family From Radon.** EPA Doc. #402-F-98-008, April 1998. This introductory brochure provides basic information on radon-resistant construction in new homes and directs the reader to more detailed information. This brochure is also available at www.epa.gov/iaq/radon/pubs/rrnc-tri.html.

**Building a New Home: Have You Considered Radon?** EPA Doc. #402F-98-001, September 1998. This brochure is designed for consumers who are purchasing newly constructed homes and are curious about radon-resistant features, builders who construct homes with radon-resistant features, and real estate professionals who are selling homes which have radon-resistant features. It can be used as a marketing tool for the home building industry. Available on the internet at www.epa.gov/iaq/radon/pubs/builder.html.
Reducing Radon in Schools: A Team Approach. EPA Doc. #402-R-94-008, April 1994. This document will assist you in determining the best way to reduce elevated radon levels found in a school. It is designed to guide you through the process of confirming a radon problem, selecting the best mitigation strategy, and directing the efforts of a multidisciplinary team assembled to address elevated radon levels in a way that will contribute to the improvement of the overall indoor air quality of the school. Available on the internet by accessing www.epa.gov/nepis, clicking the “Publication Number/Title Search” button, and selecting “400 Series.”

Radon Reduction Techniques for Existing Detached Houses, EPA Doc. #625/R-93/011, October 1993. This manual describes radon mitigation techniques for homes that have already been built. Includes descriptions of operating principles, installation techniques, and construction details. Available on the internet by accessing www.epa.gov/nepis, clicking the “Publication Number/Title Search” button, and selecting “600 Series.”


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