

# COMMUNICATING THE HEALTH RISK OF RADON



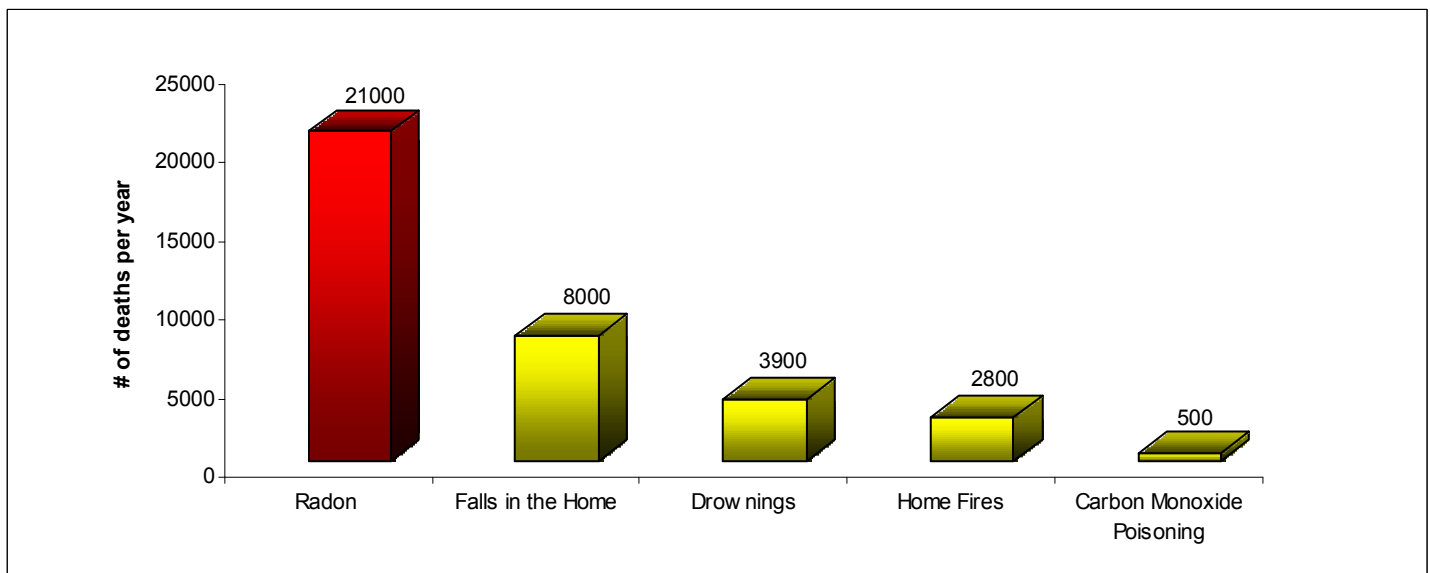
**AMERICAN LUNG ASSOCIATION®**  
*of the Upper Midwest*

## INTRODUCTION

Radon is a Class-A human carcinogen recognized as the leading cause of lung cancer in the United States among nonsmokers. The National Academy of Sciences (NAS) and the Surgeon General estimate that as many as 21,000 lung cancer deaths that occur in the U.S. annually may be a result of radon exposure. It is therefore essential that as part of its mission to promote lung health, the American Lung Association of the Upper Midwest disseminates information pertaining to radon risks.

This document is definitive in detailing the physical and biochemical processes associated with radon. Also included are procedures and methods for correcting elevated indoor radon levels. Ultimately, these efforts are crucial in reducing the number of lung cancer deaths.

## RADON HEALTH RISK



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## WHAT IS RADON?

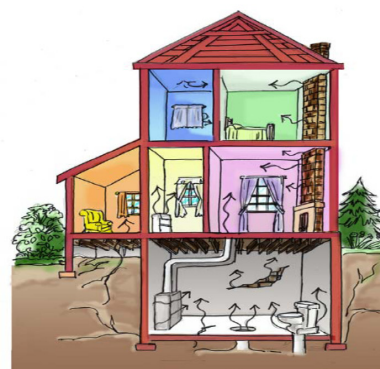
Radon is a naturally occurring radioactive gas released during the decay of thorium and uranium, which are common elements found in varying amounts in rock, soil and water. Radon is also colorless, odorless and tasteless, making it undetectable to human senses.

When radioactive elements such as radon decay, radiation is released. Products of radon decay like polonium-218 and polonium-214 emit alpha particles that are effective in damaging lung tissues. Research has established a causal relationship with alpha-emitters and lung cancer in humans.

## CHARACTERISTICS AND SOURCES OF RADON

It is estimated that fifty-five percent of the radiation that people are exposed to comes from radon and radon decay products. The location of greatest exposure to radon is in the home. While uranium is the source of radon, factors that influence its concentration in indoor air will include radon in soil, building materials, and groundwater. Air pressure differences between soil and house as well as foundation openings cause radon gas to flow towards the foundation of a home. Indoor radon concentrations also depend on soil permeability and porosity (the type of material in which the gas passes), uranium and moisture content and home foundation type.

Radon can also enter a home from the soil via cracks in floors and walls, floor drains, sump pumps and construction joints. Radon is usually more concentrated in basements and ground floor rooms that have contact with the soil. The design, construction details and building materials used can affect the pathways and sources that can draw radon into a home. Domestic water contaminated with radon can also contribute to indoor radon levels. Fortunately, water radon levels will contribute significantly less than soil radon levels to the indoor radon concentration.



## WHAT IS THE EVIDENCE?

Research on the risk of radon exposure and human health is more extensive than many studies on other human carcinogens. Most radon research was derived from epidemiological studies on underground miners. As early as the Middle Ages, miners in parts of Germany and Czechoslovakia were diagnosed with lung-related illnesses. The initial identification of this lung illness as cancer was in 1879. It was not hypothesized that radon was a cause of the lung cancers in the miners until 1924. Radon as a cause of the lung cancers in miners was not universally recognized until further epidemiological reports were issued in the 1950's and 1960's. During that time, it was also identified that it was alpha particles emitted from radon and its decay products that caused the lung cancer.

Human health risk models for predicting the risk of radon exposure by the public have been developed by the Committee on the Biological Effects of Ionizing Radiation (BEIR) under directive from the United States National Academy of Sciences. The preferred models derived by BEIR produced estimates of 15,400 or 21,800 radon-related lung cancer deaths in the United States per year. Additional data pooled from North American and European residential radon studies have also provided direct evidence of a statistically significant association between residential radon exposure and lung cancer.



## THE HEALTH RISK: HOW DOES RADON INDUCE LUNG CANCER?

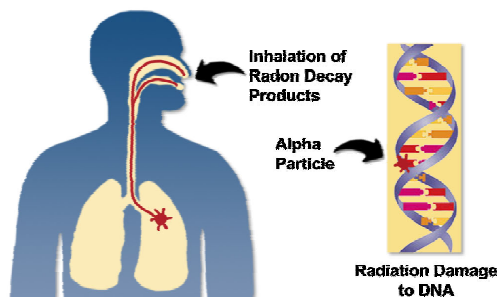
The primary route of exposure to radon is by inhalation. Exposure to alpha radiation from radon and its decay products produces significant adverse health effects. Radiation in the form of alpha particles can damage cells and intercellular DNA and may reduce the cells capacity to repair itself.

When cells are damaged, they are repaired or destroyed. Damage of genetic material can result in varying forms of mutation due to the changes in information carried by DNA. Cell mutations have varying capabilities. They may not necessarily affect the cellular functions, may kill the cell or can allow the cell to reproduce without constraint and subsequently invade and damage areas reserved for other cells. It is the uncontrolled replication of mutated cells that increases the likelihood for further mutations.

Radon decay products (RDPs) are charged heavy metals and can be inhaled as attachments to atmospheric particles. Such atmospheric particles include dust, smoke or biological entities. The smaller the particles, the deeper into the respiratory tract the RDPs may travel. Within the respiratory system, particles may chemically or physically adhere to the mucus lining of the alveoli or bronchial regions. Adherence can increase the retention period for RDPs and also increase the probability of decay occurring while still inside the lungs because of their short half-lives. Decay and resulting emission of alpha particles may damage cells and initiate cellular mutations. Lung cancer due to inhalation of radon decay products constitutes the only known risk associated with radon.

According to some underground miner studies, variables such as age, duration of exposure, time since initiation of exposure and the use of tobacco have been found to influence individual risk. In fact, the use of tobacco has a synergistic effect on radon-induced lung cancer.

### How Radon Causes Lung Cancer



## RADON IN MINNESOTA

Much of the soil in the Upper Midwest contains widespread uranium and radium. These minerals continuously break down to release radon gas. Therefore, Minnesota's geology provides an ongoing supply of radon.

In addition, a large percentage of Minnesota homes have elevated levels of radon in the indoor air because of how they are built and how they operate in our climate. One important factor is that many Minnesota homes have basements that are used as living spaces.

The Minnesota Department of Health (MDH) estimates that about one in three (1/3) Minnesota homes have enough radon to pose a significant risk to the occupants' health over many years of exposure.

For more information regarding radon in Minnesota contact:



MDH Indoor Air Unit  
 625 Robert St N  
 P.O. Box 64975  
 St. Paul, MN 55164-0975  
 651-201-4601  
[www.health.state.mn.us](http://www.health.state.mn.us)

**RADON & TOBACCO SMOKE**

Radon is able to attach to the surface of aerosols, dusts, and smoke particles. Studies have shown that indoor tobacco smoke is the highest generator of attached radon decay product concentrations in the air. Smoking indoors can increase the amount of aerosols, dusts, and smoke particles within the air as much as 600 times the original amount within a room. Normally radon alpha particles that impose cellular lung damage will attach to walls and other surfaces within a room. When tobacco smoke is present it attaches to the tobacco smoke particles, resulting in high concentrations being inhaled into the lungs.

**RADON-SMOKER RISK COMPARISON**

**LIFETIME RISK OF LUNG CANCER DEATH (PER PERSON)  
FROM RADON EXPOSURE IN HOMES**

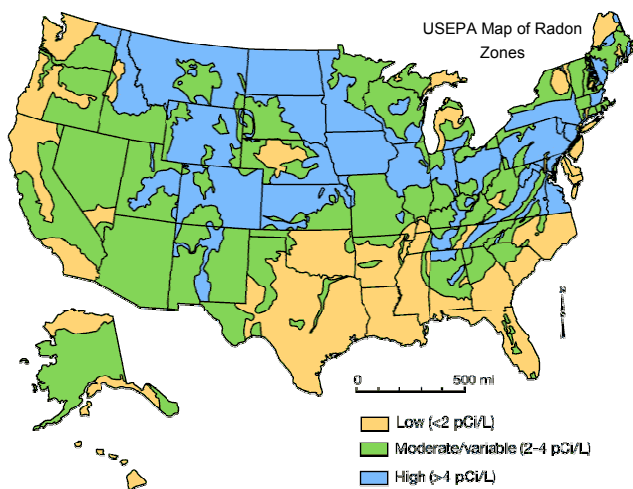
<u>Radon Level</u>	<u>Never Smoker</u>	<u>Current Smokers</u>	<u>General Population</u>
20 pCi/L	36 out of 1000	26 out of 100	11 out of 100
10 pCi/L	18 out of 1000	15 out of 100	56 out of 1000
8 pCi/L	15 out of 1000	12 out of 100	45 out of 1000
4 pCi/L	73 out of 10000	62 out of 1000	23 out of 1000
2 pCi/L	37 out of 10000	32 out of 1000	12 out of 1000
1.3 pCi/L	23 out of 10000	20 out of 1000	73 out of 10000
0.4 pCi/L	73 out of 100000	64 out of 10000	23 out of 10000

Table has been adapted from:

\*Equivalent Tobacco Risk/Use from Weinstein N.D., Sandman & Roberts 1989.

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

MOST COMMONLY ASKED QUESTIONS ABOUT RADON



The USEPA estimates that about 1/4 of all radon-related lung cancers could be averted by mitigating homes with radon levels above 4.0 pCi/L. In every state there are homes with dangerously high radon levels.

Q. Where does radon come from?

A. Radon is a naturally occurring gas that results from the breakdown of uranium commonly found in soil.

Q. How does radon enter my home?

A. Radon comes up through the rocks and soil surrounding your home and seeps through cracks in concrete walls and floors, floor drains, sump pumps, joints, and hollow-brick walls.

Q. Why haven't I heard of the radon danger until recently?

A. Radon has always existed. However, it was not until the 1980s that dangerous radon levels were found inside homes across the United States.

Q. What are the health risks?

A. Radon is the leading cause of lung cancer among nonsmokers.

Q. How do I know if I have radon in my home?

A. By testing with an EPA-listed or State-certified easy-to-use, inexpensive test kit as soon as possible, or by hiring an EPA-listed or State-certified contractor to test your home for you.

Q. If I have a radon problem, can it be corrected?

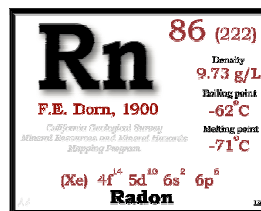
A. Yes. The use of trained personnel is recommended. State radon offices can recommend qualified contractors. In some cases, the problem can be treated by the homeowners if they have experience with other kinds of home repair.

Q. Will my neighbor's radon measurement indicate whether or not I have a radon problem?

A. No. Radon levels vary from house to house. The only way to know if you have a radon problem is to conduct a test.

Q. How can I get a reliable radon test kit?

A. Some state radon programs or American Lung Association offices offer free test kits. They can also be purchased from a local hardware store or other retail outlet.



**RADON MEASUREMENTS IN THE HOME***Radon Measurement Devices*

Short-term and long-term test kits can be purchased at most hardware and department stores, as well as some other specialty locations. State radon programs or local chapters of the American Lung Association can provide a list of radon measurement professionals, and a list of businesses which offer testing kits through the mail. Over limited periods, free test kits may also be offered by the above organizations.

*Testing Duration*

Short-term tests may last between two and 90 days. Most last between two and seven days. Examples of short-term detectors include: activated charcoal devices, charcoal liquid scintillation vials, electret chambers and continuous radon monitors.

Long-term tests last between 91 and 365 days, and are mostly recommended after an initial short-term test result of between 4.0 to 8.0 pCi/L. Long-term tests provide an estimate of the year-round radon concentration in the home. The closer the test duration is to a full year, the closer the test result will be to the actual average since radon concentrations in a home can vary from season to season. An example of a long-term test is an alpha track detector.

*When Testing*

Be aware that any tests lasting less than a week (that is, most short-term tests) require closed-house conditions. Closed-house conditions mean keeping all windows closed, keeping doors closed except for normal entry and exit, and not operating fans or other appliances which bring air in from outside (except for fans that are part of a radon reduction system, or small exhaust fans that operate for only short periods of time).

- Before Testing: Begin closed-house conditions at least 12 hours before starting the short-term test.
- During Testing: Maintain closed-house conditions during the entire duration of the short-term test, especially for tests less than one week in duration. Operate home heating or cooling systems normally during the test. For tests lasting less than one week, only operate air conditioning units that recirculate interior air.

**RADON MEASUREMENTS IN THE HOME***Where the Test Should Be Conducted*

Place the detector or detectors in each lowest area suitable for occupancy, such as:

- a family room, living room, den, playroom, bedroom, workshop, or exercise room; and/or
- in the lowest level suitable for occupancy, even if it isn't currently used but could be, without renovating.

For instance, if the house has one or more of the following foundation types, e.g., basement, crawlspace, or slab-on-grade, a test should be performed in the basement and in at least one room over the crawlspace and slab-on-grade area. If an elevated radon concentration is found and confirmed in one or more of these areas, the radon levels should be reduced.

*Do Not Measure:*

- in kitchen, laundry room and bathroom (because fan systems and humidity may affect some detectors); or
- in crawl spaces, on floor or wall cracks, or right next to a sump pump, as this may cause a false high reading.

*The Detector Should Be Placed:*

- in an area where it will not be disturbed;
- at least three feet from doors and windows to the outside;
- at least one foot from exterior walls;
- 20 inches to 6 feet from the floor;
- at least four inches away from other objects horizontally and directly above the detector;
- away from drafts; and
- away from heat, fireplaces, furnaces, direct sunlight and areas of high humidity.

*After the Test*

Ensure that all instructions that come with the test kit are followed. This also includes verification of the conditions in which the test was conducted. Should short term detectors such as activated charcoal devices be utilized, ensure the package is properly sealed and promptly returned to the respective laboratory for analysis.

Should you choose a qualified professional, your state radon program can provide general advice about radon testing and mitigation, as well as specific information about qualified radon professionals in your area.

## RADON ACTION LEVEL

### *Interpreting Test Results*

- For results less than 4.0 pCi/L, no immediate action is required. However, retesting again in two years is recommended.
- When results are over 4.0 pCi/L, the recommendation is to perform a second test. If the results are less than 10.0 pCi/L perform either a short-term or long-term test. If 10.0 pCi/L or more, perform another short term test.
- If the second or average results are above 4.0 pCi/L, contact a licensed mitigation contractor to reduce radon levels in your home to below 4.0 pCi/L.

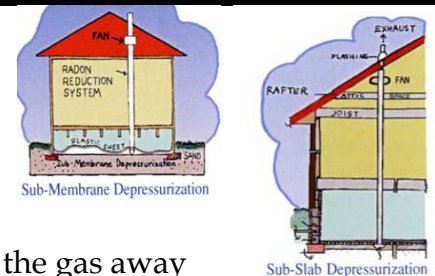
The average indoor radon level is estimated to be about 1.3 pCi/L, and about 0.4 pCi/L of radon is normally found in the outside air. The U.S. Congress has set a long-term goal that indoor radon levels be no more than outdoor levels. While this goal is not yet technologically achievable in all cases, 4.0 pCi/L has been established as the USEPA's Radon Action Level and is the average indoor radon level to which homes can be consistently mitigated.

## REDUCING RADON LEVELS

Mitigation involves repairing or altering a building or building design for the purpose of reducing the concentration of radon in the indoor atmosphere.

### *Existing Homes*

The primary radon mitigation technique is sub-slab depressurization. This technique removes radon from beneath the foundation and vents the gas away from the house. In this system, one or more suction pipes are placed through the ground or soil under a home. A fan is attached to the pipes to facilitate the ventilation process. A similar process is called sub-membrane depressurization and is most effective in buildings with earth-floored crawlspaces or basements. This is identifiable since it uses a plastic barrier over the soil as a collection cover. Another depressurization method is block wall depressurization and uses a fan and duct work to draw suction on the hollow interior cavities of a concrete block wall. By keeping the air pressure within the block wall lower than the air pressure in the basement, the soil gas is removed before it can enter the basement.



### *Installation of a Mitigation System Must Include:*

- Effective radon reduction
- Unobtrusive and permanent installation
- Quiet operation
- A primary suction point independent of the sump pit
- A system function indicator
- Sump covers with observation ports
- Exhaust above the highest eave
- Energy efficient operation and maintenance

## REDUCING RADON LEVELS

### *Discharging Above the Highest Eave:*

The point of discharge for a mitigation system should be above the highest eave and this ensures dilution of exhausted radon gas to the outdoor environment and minimizes re-entry into the home and persons in the surrounding areas. In Illinois, it is required that the point of discharge be located:

- 10 feet from any window, door or other opening (into the building) that is less than 2 feet below the exhaust point
- As close to the roof ridge line as possible
- 10 feet or more from any opening to an adjacent building
- Above the highest eave of the roof



### *Costs and Benefits of a Radon Mitigation System:*

A radon mitigation system will typically reduce home radon levels by up to 99 percent. It is always recommended that a qualified radon mitigation professional be contracted to provide corrective action. As such it is also advisable to compare prices and services.

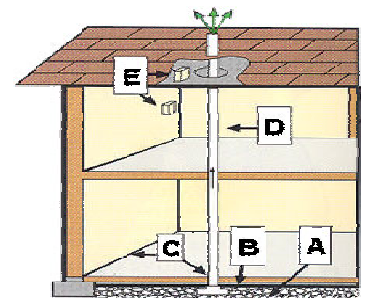
Mitigation systems will require occasional maintenance. All properly installed systems will have a warning device such as a manometer (right) to indicate if the system is working properly. Most warranties on vent fans last for five years while some older fans may require replacement or repair.



### *Radon Resistant New Construction*

This involves techniques that reduce radon entry as well as make radon removal easier and less costly. These methods vary with different foundations and site requirements, but basic elements are:

- A. **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.
- B. **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 crawlspaces, the sheeting is placed over the crawlspace floor.
- C. **Sealing and Caulking** All openings in the concrete foundation floor are sealed to reduce soil gas entry into the home.
- D. **Vent Pipe** A 3- or 4-inch gas-tight or PVC pipe (commonly used for plumbing) runs from the gas permeable layer through the house to the roof to safely vent radon and other soil gases above the house.
- E. **Junction Box** An electrical junction box is installed in case an electric venting fan is needed later.



## PUBLIC HEALTH AWARENESS CAMPAIGNS

- The USEPA has selected the month of January to be National Radon Action Month and the third week in October to be Radon Action Week .
- Various local, state and federal agencies have developed public health outreach projects to promote state and national awareness.
- The American Lung Association the Upper Midwest and United States Environmental Protection Agency are among the organizations actively participating in educating health professionals and the general public on communicating the risks of indoor radon.

## RADON INFORMATION AND RESOURCES

For more information regarding radon, contact your state radon program or USEPA regional office. Radon information is updated regularly and is usually available online. Most state contacts should also be able to provide a list of qualified radon measurement and mitigation professionals.

The following websites, hotlines and contacts provide additional radon information:

### Websites:

- ♦ American Lung Association of the Upper Midwest (www.lungum.org)
- ♦ Minnesota Department of Health Indoor Air Unit (www.health.state.mn.us/radon)
- ♦ United States Environmental Protection Agency (www.epa.gov/iaq/radon)
- ♦ World Health Organization (www.who.int/ionizing\_radiation/env/radon/en)

### Hotlines:

- ♦ American Lung Association Helpline 1-800-548-8252
- ♦ National Hispanic Indoor Air Quality Hotline 1-866-528-3187
- ♦ National Safety Council in partnership with USEPA 1-800-SOS-RADON (767-7236)

### Resources:

- ♦ Agency for Toxic Substances and Disease Registry (www.atsdr.cdc.gov)
- ♦ American Association of Radon Scientists and Technologists (www.aarst.org)
- ♦ Conference of Radiation Control Program Directors (www.crcpd.org)
- ♦ National Center for Healthy Housing (www.centerforhealthyhousing.org)
- ♦ National Radon Proficiency Program (www.radongas.org)

*According to the Office of the Surgeon General: Indoor radon gas is a serious health problem in our nation that can be addressed by individual action. Unless people become aware of the danger radon poses, they will not act. Millions of homes are estimated to have elevated radon levels. Fortunately, the solution to this problem is straight-forward. Like the hazards from smoking, the health risks of radon can be reduced.*