# 1. PUBLIC HEALTH STATEMENT

This public health statement tells you about radon and the effects of exposure to it.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Radon has been found in at least 34 of the 1,699 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which radon is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance may harm you.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact. External exposure to radiation may occur from natural or man-made sources. Naturally occurring sources of radiation are cosmic radiation from space or radioactive materials in soil or building materials. Man-made sources of radioactive materials are found in consumer products, industrial equipment, atom bomb fallout, and to a smaller extent from hospital waste and nuclear reactors.

If you are exposed to radon many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

## 1.1 WHAT IS RADON?

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| **Radioactive gas** | Radon (Rn) is a naturally occurring colorless, odorless, tasteless radioactive gas that occurs in different forms with the same atomic number but different atomic mass, called isotopes.<br><br>As radon undergoes radioactive decay, radiation is released predominantly by high-energy alpha particle emissions, which are the source of health concerns.<br><br>Radon is measured in terms of its activity (curies or becquerels). Both the curie (Ci) and the becquerel (Bq) tell us how much a radioactive material decays every second (1 Ci = 37 billion Bq = 37 billion decays per second). |
| **Natural product of the environment** | Radon isotopes are formed naturally through the radioactive decay of uranium or thorium.<br><br>Uranium and thorium (solids) are found in rocks, soil, air, and water. Uranium and thorium decay to other elements such as radium (a solid), which in turn decays into radon gas.<br><br>Uranium and thorium have been present since the earth was formed and have very long half-lives (4.5 billion years for uranium and 14 billion years for thorium). The half-life is the time it takes for half of the atoms of a radionuclide to undergo radioactive decay and change it into a different isotope. Uranium, thorium, radium, and thus radon, will continue to exist indefinitely at about the same levels as they do now.<br><br>Radon has no commercial uses. |
| **Exists in various forms called isotopes and decays to other radioactive isotopes** | The most common radon isotope is radon-222 ($^{222}$Rn), which is part of the uranium decay chain.<br><br>An atom of $^{222}$Rn gives off an alpha particle (which is the size of a helium atom without electrons), transforming into an atom of polonium-218 ($^{218}$Po), which later gives off an alpha particle of its own, transforming into an atom of radioactive lead ($^{214}$Pb). This process is called radioactive decay and radon decay products are called radon progeny or radon daughters. The final step in the radioactive decay of radon progeny results in the formation of an atom of stable lead which is not radioactive.<br><br>The half-life of $^{222}$Rn is 3.82 days. Some of the radon decay products have the following half-lives: $^{218}$Po is 3.05 minutes; $^{214}$Pb is 26.8 minutes; and $^{210}$Pb is 22.3 years. |

More information about the properties of radon can be found in Chapters 4, 5, and 6.

## 1.2 WHAT HAPPENS TO RADON WHEN IT ENTERS THE ENVIRONMENT?

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| **Moves to air, groundwater, and surface water** | Radon gas in the rocks and soil can move to air, groundwater, and surface water.<br><br>Decay products of $^{222}Rn$, such as $^{218}Po$ and $^{214}Pb$, are solids that can attach to particles in the air and be transported this way in the atmosphere. They can be deposited on land or water by settling or by rain.<br><br>Radon will undergo radioactive decay in the environment. |

For more information on radon in the environment, see Chapter 6.

## 1.3 HOW MIGHT I BE EXPOSED TO RADON AND RADON PROGENY?

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| **Air** | Since radon progeny are often attached to dust, you are exposed to them primarily by breathing them in. They are present in nearly all air. Depending on the size of the particles, the radioactive particulates can deposit in your lungs and impart a radiation dose to the lung tissue.<br><br>Background levels of radon in outdoor air are generally quite low, but can vary based on location and the underlying soil geology.<br><br>In indoor locations, such as homes, schools, or office buildings, levels of radon and radon progeny are generally higher than outdoor levels and may be particularly high in some buildings, especially in newer construction that is more energy-efficient.<br><br>Cracks in the foundation or basement of your home may allow increased amounts of radon to move into your home. Also, radon is heavier than ambient air, and therefore, the concentrations of radon are generally higher in the lower levels or basement of the homes. |
| **Water** | You may be exposed to radon and radon progeny by coming into contact with radon-contaminated surface or groundwater or by drinking water from wells that contain radon.<br><br>Radon in water can become airborne; it is estimated that 1/1,000$^{th}$ of the radon in water may become airborne during indoor activities that use water. |

Further information on how you might be exposed to radon and radon progeny is given in Chapter 6.

## 1.4 HOW CAN RADON AND RADON PROGENY ENTER AND LEAVE MY BODY?

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| **When they are inhaled or swallowed** | Radon and its radioactive progeny can enter your body when you breathe them in or swallow them.<br><br>Most of the inhaled radon gas is breathed out again.<br><br>Some of the radon progeny, both unattached and, attached to particles, may remain in your lungs and undergo radioactive decay. The radiation released during this process passes into lung tissue and can cause lung damage.<br><br>Some of the radon that you swallow with drinking water passes through the walls of your stomach and intestine.<br><br>After radon enters your blood stream most of the radon quickly moves to the lungs where you breathe most of it out.<br><br>Radon that is not breathed out goes to other organs and fat tissue where it may remain and undergo decay. |

Further information on how radon and radon progeny enter and leave the body is given in Chapter 3.

## 1.5 HOW CAN RADON AND RADON PROGENY AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

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| **Lung cancer** | Many scientists believe that long-term exposure to elevated levels of radon and radon progeny in air increases your chance of getting lung cancer.<br><br>The greater your exposure to radon, the greater your chance of developing lung cancer.<br><br>Smoking cigarettes greatly increases your chance of developing lung cancer if you are exposed to radon and radon progeny at the same levels as people who do not smoke. Because tobacco is naturally sticky, many of the radon decay products actually stick to tobacco products. Therefore, when tobacco is smoked or otherwise used, these radon products may also enter your system. Breathing in other substances that cause lung cancer may also increase your chance of developing lung cancer from exposure to radon progeny. |

More information on the health effects of radon and radon progeny is presented in Chapters 2 and 3.

## 1.6 HOW CAN RADON AND RADON PROGENY AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

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| **Differences between children and adults** | Smaller lungs and faster breathing rates in children may result in higher estimated radiation doses to the lungs of children relative to adults. However, limited information from children employed as miners in China do not provide evidence of increased susceptibility to the effects of exposure to radon. |

## 1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO RADON AND RADON PROGENY?

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| **Reduce indoor exposure levels** | Indoor radon levels can be reduced by methods that include the sealing of surfaces between the ground and the building and installation of ventilation systems that route air from materials under the building to outdoor air. Certified radon mitigation experts can be located by contacting your state health or environmental program. |

## 1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO RADON AND RADON PROGENY?

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| **Radon decay products in urine and in lung and bone tissues** | Radon in human tissues is not detectable by routine medical testing.<br><br>Some radon decay products can be detected in urine and in lung and bone tissue. Tests for these products are not generally available to the public and are of limited value since they cannot be used to accurately determine how much radon you were exposed to, nor can they be used to predict whether you will develop harmful health effects. |

Further information on how radon and radon progeny can be measured in exposed humans is presented in Chapters 3 and 7.

## 1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and

Health Administration (OSHA), the Food and Drug Administration (FDA), and the U.S. Nuclear Regulatory Commission (USNRC).

Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR), the National Institute for Occupational Safety and Health (NIOSH), and the FDA.

Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday, a 24-hour day, or a work-year), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it.

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| **Air** | EPA recommends fixing your home if measured indoor levels of radon are 4 or more pCi per liter (pCi/L) of air EPA also notes that radon levels less than 4 pCi/L still pose a health risk and can be reduced in many cases. The EPA recommends using a certified radon mitigation specialist if indoor radon levels need to be reduced to ensure that appropriate methods are used to reduce radon levels.<br><br>The Mine Safety and Health Administration (MSHA) has adopted an exposure limit of 4 Working Level Months (WLM) per year for people who work in mines (WLMs basically combine the concentration of radon in mine air with length of exposure inside the mine).<br><br>The Nuclear Regulatory Commission published a table of allowable exposure to radon by workers and allowable releases of radon to the environment by its licensees. |
| **Water** | In the 1990s, EPA introduced a proposal to limit levels of radon in drinking water. As of August 2008 the proposal had not been adopted as a regulation. |

Additional information on governmental regulations regarding radon and radon progeny can be found in Chapter 8.

## 1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below.

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

Toxicological profiles are also available on-line at www.atsdr.cdc.gov and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at cdcinfo@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE
Mailstop F-32
Atlanta, GA 30333
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000
Web site: http://www.ntis.gov/