ENVIRONMENTAL
Fact Sheet
NEW HAMPSHIRE DEPARTMENT OF Environmental Services
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WD-DWGB-3-12 2009

Radon in Air and Water
An Overview For The Homeowner

Does your household water come from a well? If so, your water probably has radon gas. Radon gas is normally found in all well water. Bedrock wells typically have much higher radon concentrations than dug or point wells.

What is Radon?
Radon is a colorless, odorless, tasteless, naturally occurring radioactive gas produced from the Decay of the element radium, which occurs naturally in rocks and soil worldwide. Radon gas can dissolve in groundwater and later be released into the air during such normal household activities as showering, dishwashing and doing laundry. When radon accumulates in indoor air it can pose an increased health risk, primarily, lung cancer.

Radon Pathways into Your Home
Radon can enter a home via at least three common pathways:
• Migration (up from the soil) into the basement through cracks and/or other openings in the foundation.
• Release of dissolved radon gas from the household on-site water supply.
• Release from building materials such as a granite block foundation, some fireplace materials, and floor or wall tiles.

Although there are some exceptions, in general, **the migration of radon up from the soil contributes** the largest percent of radon found in the average home. Radon from a groundwater type water supply source, particularly a bedrock well (also known as an artesian or drilled well), contributes the next largest percentage of radon in the home. The radon contributed from building materials is typically very small. DES recommends that the two predominant pathways should be evaluated and that initial action to reduce radon exposure should target the pathway that contributes the largest percentage of risk to occupants.

Health Effects
The primary risk pathway from exposure to radon gas is through inhalation of radon-laden air in a home. Studies indicate that high levels of radon gas in the air increase the risk of lung cancer. An additional health risk is associated with the ingestion of the radon that remains dissolved in the water and is consumed. On average, this latter risk is substantially lower than that associated with inhalation. The risk from radon in water is relatively high when compared to other drinking water contaminants. For more health risk information concerning radon in air and water call the

DES Health Risk Assessment Program at (603) 271-4664 or go to their website to see the health related fact sheet on radon at www.des.nh.gov/EOH/Radon/RadonQ&A.doc.

How Much Radon is too Much?
Radon in Indoor Air
The U.S. Environmental Protection Agency has set an advisory "action level" of 4 pCi/L for radon gas in indoor air. While not a mandated health standard, this level is a guideline for people to use in assessing the seriousness of their exposure to airborne radon. Concentrations noticeably lower than 4 pCi/L are desireable.

Development of the Radon in Drinking Water Standard
There are no water quality standards for private home wells in New Hampshire. Consequently, private wells owners often turn to the water quality standards for public water systems (PWSs) to evaluate the safety of their private wells. At present there is no federal or state standard for radon in drinking water. Such a standard is known as a **maximum contaminant level** (MCL). EPA current schedule is to complete a standard for radon in water by the end of 2005. Since many New Hampshire residents have questions concerning what level of radon in drinking water is safe, and given the lack of a state or federal standard, we summarize below the history of recent radon proposals.

History – In 1991 EPA proposed to limit radon gas in residential PWSs to 300 pCi/L. Over 95 percent of New Hampshire wells would exceed this concentration. During the public comment period, DES and the Department of Health and Human Services (DHHS) commented on the proposal and suggested that in view of both societal cost and health benefit, that EPA set the radon standard for PWSs at 2,000 pCi/L instead of 300 pCi/L.

1996 SDWA Reauthorization – In 1996, Congress reached a compromise on reauthorization of the federal Safe Drinking Water Act (SDWA). Relative to radon gas in water, this legislation specified that EPA would re-propose the standard for the radon MCL and complete the entire regulatory task by August 2000. This statute specified that if EPA selected a stringent MCL for radon gas in water, an alternative MCL (AMCL) would also be proposed. The AMCL is explained below. The goal of Congress in establishing the AMCL was to provide regulatory flexibility characterized by both the regulated drinking water arena and the unregulated indoor air quality arena. The alternative MCL would have a risk similar to that from the equivalent concentration of radon normally found in outside air.

On November 2, 1999, EPA began the formal process of establishing a radon gas standard for community PWSs. The proposal consists of two standards that would regulate the concentration of radon gas in community PWSs. A health based standard with two different concentrations is unique in the drinking water field.

a. a. One standard would be the conventional MCL. If a PWS meets this MCL, the utility will be in full compliance with the requirement and will have totally satisfied its responsibilities under the Safe Drinking Water Act (SDWA). The proposed MCL is 300 pCi/L.

b. b. The second standard would be called the **alternative** maximum contaminant level (AMCL). If proposing to be evaluated by this AMCL, a water utility will need to apply to DES or EPA for approval to use the higher standard. The approval process will require the establishment of a supplemental program that addresses radon from the foundation of typical homes referred to as multi-media mitigation (MMM), as explained below. The proposed AMCL is 4,000 pCi/L. The

AMCL was set at an equivalent to the concentration of radon occurrence in outside air approximately five feet above the ground surface (0.4 pCi/L).

Multi-Media Mitigation (MMM)
The multi-media mitigation (MMM) approach to radon reduction described above is based on an understanding of the two principal radon exposure pathways as explained further below. In order to use the less restrictive AMCL as identified above, a second health outreach program must be provided. The goal of this program is to reduce radon exposure from the foundation pathway. The MMM program will involve a variety of outreach programs. The basic goal of the MMM program will be to reduce the risk from the radon contribution associated with the foundation pathway by an amount equal or greater than the increased risk associated with using the AMCL of 4,000 pCi/L rather than MCL of 300 pCi/L. Each public water system MMM program will require initial approval by DES/DHHS/EPA and subsequent periodic review of the program's accomplishments. The EPA has not interpreted how the MMM program would apply to a single family home with a private on-site well.

Other State Radon in Water Guidance
In the absence of a final EPA standard, states surrounding New Hampshire (Maine 4,000 pCi/L; Massachusetts 10,000 pCi/L; Vermont 5,000 pCi/L) are offering significantly different recommendations for a safe level for radon gas in drinking water. DES believes it is very unlikely that the future EPA Radon standard would exceed 4,000 pCi/L.

Transfer Ratio
As radon escapes from water it raises the radon level of the air within a building. The "radon transfer ratio" predicts the increased radon level of indoor air in a home due to the off-gassing of radon from the water. The transfer ratio can very widely from one home to another. On average this transfer ratio predicts that 10,000 pCi/L of radon in water can be expected to increase the overall annual average radon concentration of the air in a conventional single family home by approximately 1 pCi/L. To illustrate this conversion assume the following example: if the radon in water concentration was 5,000 pCi/L, and the radon in the air measure was 3 pCi/L, then 0.5 pCi/L of the airborne radon would likely be attributed to the water and the remaining 2.5 pCi/L would be attributed to radon gas migration up from the soil through the home's foundation. It is important to note that this ratio is an approximation and may vary widely from home to home.

Testing for Radon
DES recommends that both the interior air of a home and that private well water supplies should be tested for radon.

Testing Water for Radon – A test for radon gas in drinking water requires approximately two weeks for processing, requires a special sample bottle, and costs $20 (2005) A sample container for the radon water test may be obtained from the DES Laboratory by calling 603-271-3445/ 3446. Many independent laboratories also provide testing for radon in water. Water testing can be done at any time of the year. If the well/water system has not been in regular use, the entire system should be flushed for at least 20 minutes to ensure that fresh water is captured in the sample container. "Old" water will have a lower radon concentration due to radon's half-life of approximately 3.6 days.

A review of PWS data shows that radon concentrations in water may vary substantially from one test to another due to many reasons including the level of saturated soil above the rock, atmospheric pressure, prior well pumping and other factors. DES recommends at least two radon tests (at least one month apart when possible) be processed before determining the average radon concentration in water.

Testing for Radon in Air - See Appendix I at the end of this document.

Frequency of Occurrence of Radon in Water
Radon is a common New Hampshire groundwater quality problem. An analysis of the data from approximately 3,400 PWSs samples submitted over a six-year period and analyzed for radon shows the following occurrence distribution. DES believes that this distribution is equally representative for private wells.

Radon Concentration	% Occurrence
Less than 300 pCi/L	6%
300 to 1,000 "	19%
1,001 to 2,000 "	20%
2,001 to 4,000 "	17%
4,001 to 6,000 "	11%
6,001 to 10,000 "	8%
Greater than 10,000 "	19%

It is possible that this data is slightly skewed to a higher average radon concentration due to more repeat samples from wells with high concentrations.

Testing for Other Radionucleotides in Water
In addition to radon gas, other radioactive minerals such as radium and uranium may be dissolved in drinking water. A test of drinking water for radon gas does not provide meaningful knowledge concerning the presence or absence of any other mineral radionuclides, nor does an elevated level for these dissolved minerals imply the presence of an excessive amount of radon gas. In other words, a minimum of three different laboratory tests will be required to make an initial assessment of the radioactivity level of a particular well. These tests are:
• Radon gas.
• Dissolved analytical gross alpha radioactivity.
• Radium 228 testing.*
• Radium 226 testing - the need for radium 226 testing can be partially evaluated by a review of the analytical gross alpha data.
Radon gas and dissolved analytical gross alpha are the testing priorities.

*The DES laboratory does not process radium 226/228 radioactivity samples. This service, however, is available from some independent laboratories in New Hampshire and through the Maine's Public Health Laboratory. The Maine laboratory can be reached at (207) 287- 2727. Other specialty radionuclide laboratories are given in www.des.nh.gov.

Treatment of Water to Reduce Radon
Introduction – In some cases, elevated radon gas concentrations exist in both air and water. Normally there is much more health protection to be realized by reducing radon originating from the foundation pathway than reducing radon in water. You are welcomed to contact DES radon health coordinator at 603-271-4764, to discuss radon reduction priorities. See Appendix II, Treatment to Reduce Radon in Air.

Aeration Treatment – Radon gas can be easily removed from drinking water by the process known as aeration. Aeration can achieve over 99 percent removal of radon gas from water. The process consists of mixing large volumes of clean air with the well water. The moist radon laden air is discharged outside the home. The treated water is re-pressurized so as to flow through your plumbing. A list of radon aerator distributors is given in Appendix III of this document.

Water Quality – Aeration will intensify the staining affect of untreated iron and manganese. If iron/manganese are meaningfully present, pretreatment for their removal is recommended. If iron and manganese remain untreated, iron bacteria or a film of inorganic precipitates would be expected to form on the inside of the aerator. This condition can loosen in large clumps and may clog pumps or reduce the pump service life. Where high carbon dioxide (CO2) is present in the well water, release of the CO2, may raise the pH of the water. This is beneficial as higher pH water is generally less corrosive.

Aeration Design Considerations – The design concept of a radon aeration devices can be of either of a pressurized or vacuum type. A vacuum type design prevents the possible escape of radon if there were a leak in the outer jacket of the device. Most radon aerators have components made from plastic or stainless steel. This is important since ordinary steel will rust in the high moisture environment of an aerator. Aerators can be relatively noisy. Listen to the aerator while running in the showroom and consider noise when locating the device in the basement. Ease of disassembly of the device is important relative to periodic cleaning. The installation location should be well lit, warm and have good access space on all sides. The device should have redundant solenoid valves or adequate sized floor drain to prevent basement flooding if equipment malfunction occurs. See fact sheet WD-DWGB-2-23 for suggested installation considerations for aeration devices.

Purchase Costs – Aeration treatment devices, installed and warranted by others, typically cost from $3,500 to $4,500. As with all mechanical/electrical devices, aerators will eventually need repair (more likely after approximately five years). Removal of iron or manganese, where necessary, will result in higher cost.

Maintenance Costs – In addition, an aeration device may need cleaning every six to 12 months depending on water quality. Approximate cleaning cost (consisting of flushing, disinfecting and air filter replacement by a water treatment professional) may have a cost of $150-$200 per visit. Cleaning by the homeowner is also possible.

Activated Carbon Treatment – Activated carbon (AC), similar to charcoal, is effective in removing radon gas from drinking water. The water is passed through the AC, which is placed in a water treatment tank, and the entire system works under pressure. There are minimal moving parts in AC type treatment system.

Purchase Cost – The cost of an AC treatment system, installed and guaranteed by water treatment professionals, is approximately $2,000.

Maintenance Cost – AC replacement can be costly. When considering AC treatment determine the expected cost of periodic replacement of the media. ***CAUTION:*** DES does not generally recommend AC for radon removal, since radioactivity will build up on the carbon. In some cases this could make the carbon in the treatment container too radioactive to be near (in the basement or floor above) and would result in very expensive disposal.

Some technical authors have suggested that AC is a reasonable treatment method for radon in water for concentrations below 5,000 pCi/L. DES is considering this recommendation further. In addition to radon, mineral radioactivity may in some cases also be removed by AC. This removal process may be enhanced in the presence of iron (and possibly manganese). Thus the concentration of mineral radionuclides and iron /manganese should be evaluated and be very low before considering the use AC.

AC Disposal – The AC should be replaced on a periodic basis to prevent excessive radionuclide buildup. DES suggests that the AC canister, when first installed, should be labeled "REPLACE CARBON ANNUALLY" in large letters oriented on the canister so as to be easily seen. (DES is reviewing more specific guidance concerning the frequency of carbon replacement and will provide this information at a future date.)

Suppliers and Manufacturers

Manufacturers and suppliers of radon water treatment devices can be found in the Yellow Pages. Look under the listings for "Water Treatment," "Water Conditioning," or "Radon Testing & Services." Well drillers, pump installers, building and code enforcement officials, and realtors often know of local radon treatment equipment suppliers.

For More Information

For more information about radon reduction methods for the air in your home, contact the DES radon health coordinator at 603-271-4764. For more information on radon in water, contact the DES Drinking Water and Groundwater Bureau, at (603) 271-2513. For a detailed discussion of radon from a geological perspective, please see fact sheet CO-GEO-2. Drinking water fact sheets are available through the DES web site at www.des.nh.gov.

Appendix I Testing Indoor Air for Radon

Radon in air test devices are typically placed in the lowest frequently occupied level of the home. The testing period that typically yields the highest results is during the winter months. The year round average measurement maybe appreciably lower than the winter reading. There are three air testing methods:

Type – Duration – Cost

Activated Carbon Method – 4 days – $25
Alpha Trac Device – 30 days – $30-$60
Continuous On-line Monitor – As desired – $100s

For further information concerning radon air testing, please contact the DES radon coordinator at (603) 271-4764 or go to www.des.nh.gov/ .

Appendix II Treatment to Reduce Radon in Air

In many cases, the removal of radon that originates from infiltration through a home's foundation is the most effective means of reducing one's risk from exposure to radon. The most common method used for radon removal from indoor air is soil-gas ventilation, which works by drawing away radon gas from under and around the house foundation. Typical cost for simple air mitigation ranges from approximately $800 to $1,500. Contractors offering this service may be found in the Yellow Pages under "Radon Testing & Services." For further information concerning radon air mitigation please call DES radon coordinator at (603) 271-4764 or go to www.des.nh.gov and search “Radon” in the A to Z List.