

June 2005

Radionuclides in Public Drinking Water

What are radionuclides?

Radionuclides are chemical elements with unstable atomic structures called radioactive isotopes. There are more than 1,500 different radioactive isotopes which are identified by a number after the element name. The unstable structures break down to release or emit radiation energy from the nucleus or other parts of the atom. Three types of radiation can be released: alpha particles, beta particles and gamma rays (photons). Radionuclides emitting more than one type of radiation are classified by the predominant type released.

Most naturally occurring radionuclides are alpha particle emitters (uranium and radium-226), but some beta particle emitters also occur naturally (radium-228 and potassium-40). Manmade radionuclides are mainly beta and photon (gamma) emitters. Tritium is a beta particle emitter that may be formed naturally in the atmosphere or by human activities.

What are the sources of radionuclides?

Most of the radionuclides found in drinking water sources are naturally occurring. Radionuclides usually enter drinking water through natural erosion and chemical weathering of mineral deposits. Naturally occurring tritium in the atmosphere can enter surface waters from rain or snow and can accumulate in ground water from seepage.

Radioactive materials are used in electricity production, nuclear weapons, medicines, commercial products and research. Human activities (mining, industrial, and military) may increase the levels of radioactive materials found in water. Contamination of drinking water sources can occur from the release of manmade radioactive materials primarily due to improper waste storage, leaks or transportation accidents.

What are the limits for radionuclides in drinking water?

The maximum contaminant level (MCL) is the maximum allowable level of a contaminant that may be present in drinking water without a high risk of causing health problems. The MCLs for radionuclides are: 15 picocuries per liter (pCi/L) for alpha particle emitters, excluding radon and uranium; 5 pCi/L for combined radium-226/radium-228 isotopes; 4 millirem per year (mrem/yr) for beta particle and photon emitters and 30 micrograms per liter ($\mu\text{g/L}$) for uranium.

Radionuclides are measured as pCi/L related to the amount of radiation emitted per minute in a liter of water, mrem/yr for the amount of ionizing radiation delivered to the body in a year and $\mu\text{g/L}$ for the amount of contaminant in a liter of water, equal to parts per billion (ppb).

What are the health effects of radionuclides?

Exposure to radionuclides in drinking water at levels above the MCLs may significantly increase the risk of cancer. Radiation pulls electrons off atoms in a process called ionization. In living tissue, ionization can damage chromosomes or other cell parts and affect cell operations. The damage can cause cell death, prevent the cell from repairing itself or trigger uncontrolled cell growth. If uncontrolled cell growth continues, cancer develops.

In addition to posing cancer risks from its radiation, uranium may damage the kidneys as well. Exposure to elevated uranium levels in drinking water can cause changes in kidney function, indicating the potential for kidney failure.

How often is monitoring required?

The frequency at which community public water systems monitor for radionuclides is based on their most recent drinking water results (yearly average). Monitoring is required more often when systems have results indicating higher levels of radionuclides as shown in the table on the next page:



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| Monitoring Frequency: | Radionuclide Results for System: |
|-----------------------------|---|
| Every 3 months (Quarterly) | Results are above the MCL or have few results for the system. |
| At least once every 3 years | Results are above half the MCL, but below the MCL. |
| At least once every 6 years | Results are at or below half of the MCL. |
| At least once every 9 years | Results do not show any radionuclides are present. |

What happens if the MCL is exceeded?

Most drinking water sources in Ohio have very low levels of radionuclides, but the levels are not considered to be a public health concern. However, if the MCL is exceeded, the community system is required to monitor quarterly and issue a public notice about the level of radionuclide contamination in the drinking water and potential health effects. The system must also take action to decrease the level of contamination such as using treatment or another drinking water source.

What treatments can be used to remove radionuclides?

The treatment depends on the type of radionuclide found in the drinking water. Reverse osmosis can remove all types of radionuclides. Ion exchange is effective in removing combined

radium-226/radium-228, beta particle and photon emitters and uranium. Lime softening can be used only for the removal of combined radium-226/radium-228 and uranium. If a system has coagulation and filtration, the processes can be enhanced to remove uranium.

Reverse osmosis and ion exchange treatment units for faucets may remove radionuclides from tap water, but proper maintenance is necessary to be effective and avoid possible bacterial contamination. For information about these treatment units, call the National Sanitation Foundation (NSF) or access the NSF's Web site <http://www.nsf.org/consumer/>

For More Information:

- U.S. EPA's Web site at: <http://www.epa.gov/safewater/radionuc.html>
- The Safe Drinking Water Hotline: (800) 426-4791
- Ohio EPA Division of Drinking and Ground Waters (DDAGW): (614) 644-2752
- Ohio EPA DDAGW Web site at: <http://www.epa.state.oh.us/ddagw/>

